WOOLPERT

Mississippi Coastal QL2 Lidar with 3DEP Extension Lidar

USGS/ Rolla, MO

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Section 1: Overview

Project Name: Mississippi Coastal QL2 Lidar with 3DEP Extension

Project: # 75157

This report contains a comprehensive outline of the Mississippi Coastal QL2 Lidar with 3DEP Extension Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G15PD00091. This task order requires lidar data to be acquired over approximately 5981 square miles. 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 and a Chiroptera II 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	
Post Spacing	2.3ft / 0.7 m
AGL (Above Ground Level) average flying height	6,500 ft / 1,981 m
MSL (Mean Sea Level) average flying height	varies
Average Ground Speed:	150 knots / 173 mph
Field of View (full)	40 degrees
Pulse Rate	272 kHz
Scan Rate	41.0 Hz
Side Lap	20%

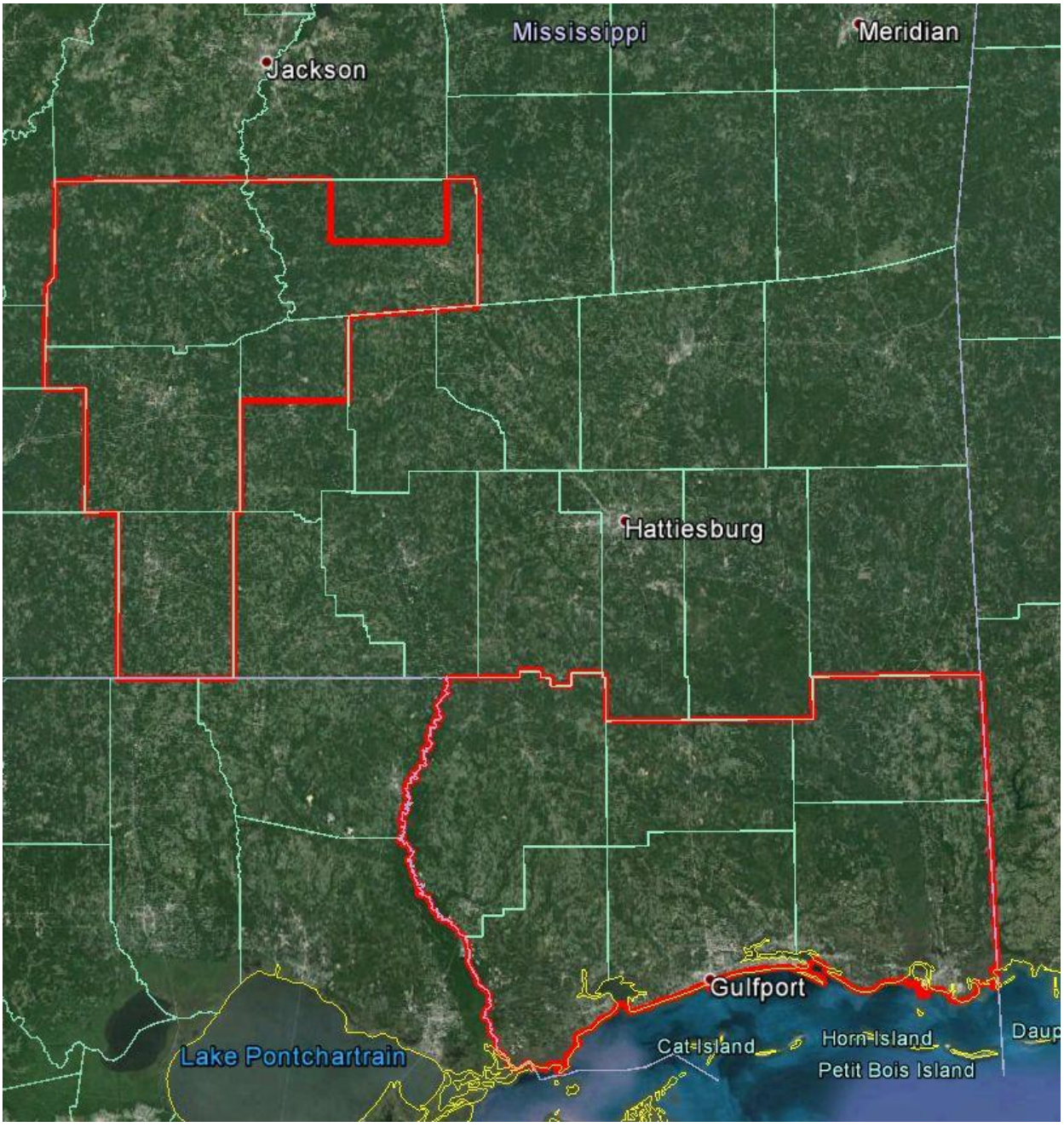
The Chiroptera II sensor provides 35 kHz bathymetric data and up to 500 kHz topographic data. The system acquires bathymetric lidar, topographic lidar and 4-band 80 MP digital camera imagery simultaneously. For this project, the flight parameters were used to provide 100% coverage. Two multiple pulse in air zones were used.

Table 1.2: Chiroptera II Specifications	All Areas
Topo Points per m2	4
Swath Width (m)	700
Flight Line Sidelap (%)	15
Altitude (m)	1000
Survey Speed (knots)	125
Topo PRF (kHz)	250
Mirror Speed (RPM)	3805
Peak Threshold (Samples)	300
Pulse Energy (µJ)	36

The 3DEP Extension data was processed and projected in UTM, Zone 15, North American Datum of 1983 (2011) and UTM, Zone 16, North American Datum of 1983 (2011) in units of meters. The vertical datum used for the task order was referenced to NAVD 1988, GEOID12A, in units of meters.

The Coastal delivery was processed and projected in Mississippi State Plane East Zone, NAD83(2011). The vertical datum used for the task order was referenced to NAVD88, GEOID12A/12B in units of US Survey Feet.

Figure 1.1: Lidar Task Order AOI



Section 2: Acquisition

The existing lidar data was acquired on board Woolpert Cessna aircraft with a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar Sensor System and a Chiroptera II (CHII) sensor

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

The Chiroptera II sensor was mounted in a Leica PAV100 gyro-stabilized mount integrated with a NovAtel SPAN GNSS and LCI-100C IMU. Real time navigation and GNSS/IMU data logging was provided by Leica FlightPro software. Lidar data were logged on the Airborne Hydrography, AB (AHAB) operator console.

Table 2.2: Chiroptera II Laser Specifications

	Topographic Laser	Shallow Bathy Laser
Wavelength	1064nm	515nm
Pulse Length	4 +/- 1ns	2.5 +/- 1ns
Beam Divergence	0.5mRad	4.5mRad
Pulse Duration	5ns	0.5ns

Prior to mobilizing to the project site, 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 Thirty-one (31) 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, Mississippi Coastal QL2 Lidar with 3DEP Extension Lidar

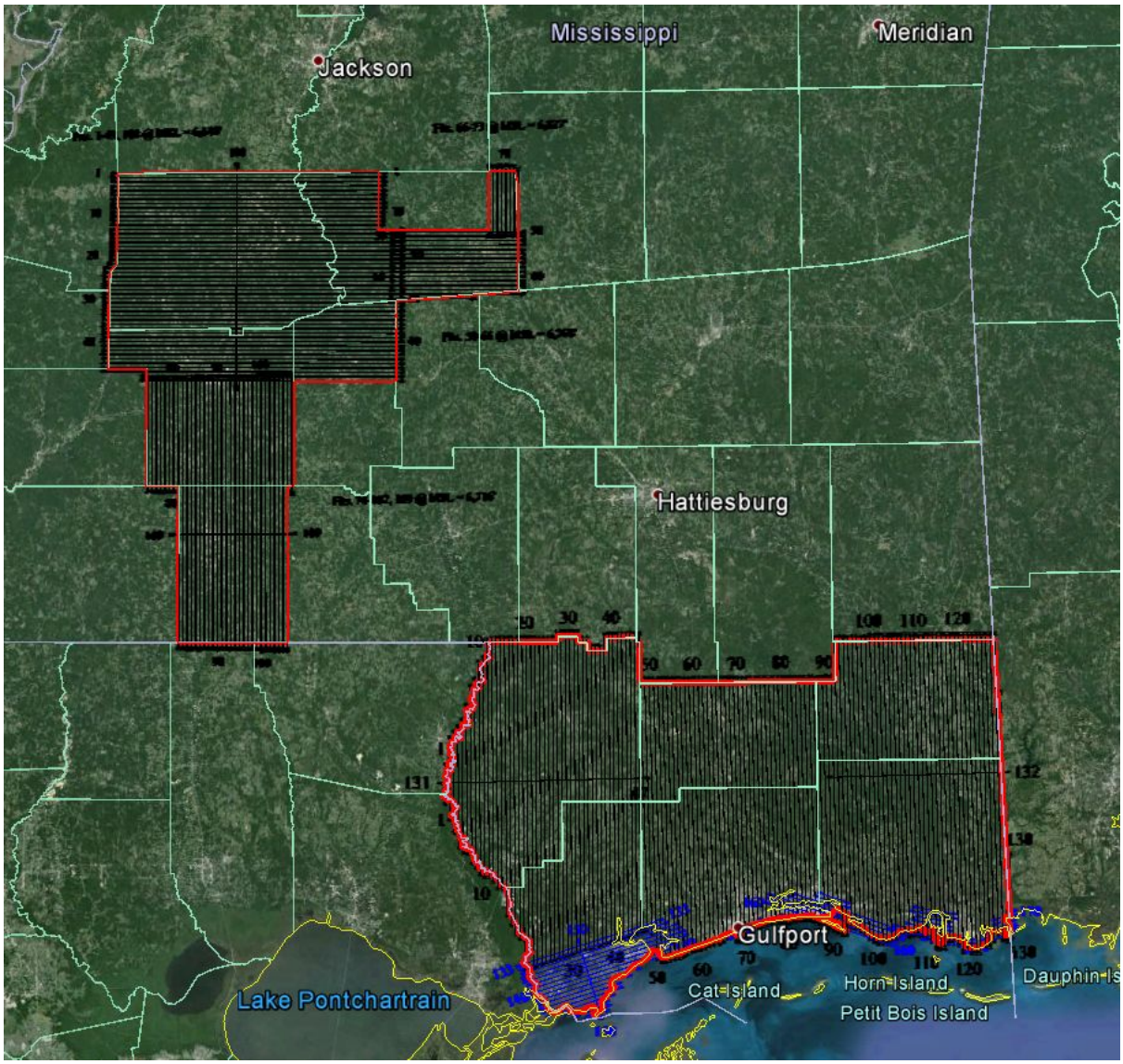


Table 2.3: Airborne Lidar Acquisition Flight Summary
Woolpert

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down	Mission Time (Local = EDT) Wheels Up/ Wheels Down
January 28, 2015 – Sensor ALS-7177	1-18	17:00 – 22:45	11:00 AM – 4:45PM
January 29, 2015 – Sensor ALS-7177	19-23	14:30 – 17:45	8:30 AM – 11:45 AM
January 30, 2015 – Sensor ALS-7177	21-40	14:30 – 22:00	8:30 AM – 16:00 PM
January 31, 2015 – Sensor ALS-7177	14, 21, 41-60	13:30 – 21:45	7:30 AM – 15:45 PM
February 7, 2015 – Sensor ALS-7177	39, 57-58	19:00 – 21:00	1:00 PM – 3:00 PM
February 27, 2015 – Sensor ALS-7108_A	59-73	17:45 – 22:35	11:45 AM – 4:35 PM
February 27, 2015 – Sensor ALS-7108_B	74-83	23:00– 2:25	5:00 PM – 8:25 PM
February 28, 2015 – Sensor ALS-7108	84-97	14:50 – 19:45	8:50 AM – 1:45 PM
March 6, 2015 – Sensor ALS-7108_A	95-108	16:05 – 21:10	10:05 AM – 2:10 PM
March 6, 2015 – Sensor ALS-7108_B	109-120	22:18 – 3:13	3:18 PM – 8:13 PM
March 6, 2015 – Sensor ALS-7108_C	121 - 131	3:49 – 7:37	09:49 PM – 1:37 AM
March 7, 2015 – Sensor ALS-7108_A	94-108	15:50 – 20:30	9:50 AM – 2:30 PM
March 7, 2015 – Sensor ALS-7108_B	81-93	21:35 – 2:15	3:35 PM – 8:15 PM
March 7, 2015 – Sensor ALS-7108_C	40-49, 74-80	3:20 – 7:34	09:20 AM – 1:34 PM
March 8, 2015 – Sensor ALS-7108	1-6	15:00 – 17:30	10:00 AM – 12:30 PM
March 17, 2015 – Sensor ALS-7108	7-11, 50-56	12:20 – 16:00	7:20 AM – 11:00 AM
March 27, 2015 – Sensor ALS-7108_A	12-24	13:15 – 18:20	8:15 AM – 1:20 PM
March 27, 2015 – Sensor ALS-7108_B	37-39, 72-73, 108	19:00 – 21:40	2:00 PM – 4:40 PM
March 28, 2015 – Sensor ALS-7108_A	25-36	13:05 – 18:05	8:05 AM – 1:05 PM

March 28, 2015 – Sensor ALS-7108_B	56, 57-73	18:45 – 22:05	1:45 PM – 5:05 PM
March 29, 2015 – Sensor ALS-7108	37-39, 61	17:30 – 19:10	1:30 PM –2:10 PM
April 2 , 2015 – Sensor ALS-7108	37	20:25 – 1:00	4:25 PM –20:00 PM

Table 2.4: Airborne Lidar Acquisition Flight Summary Geomatics Data Solution

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down
March 16, 2015 – Chiroptera II	1-16	9:05 – 13:57
March 17, 2015 – Chiroptera II	1, 17-35	10:06 – 14:46
March 18, 2015 – Chiroptera II	36-45, 53-60	9:10 – 13:50
March 22, 2015 – Chiroptera II	45-52	0:16 – 2:33
March 24, 2015 – Chiroptera II	66-79	4:21 – 7:30
March 26, 2015 – Chiroptera II	61-71	5:17 – 7:26
March 26, 2015 – Chiroptera II	11, 33-35	20:51 – 21:53

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., Leica Lidar Survey Studio (LSS)
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 Chiroptera II system includes a NovAtel SPAN GNSS system with an LCI-100C IMU for aircraft position and orientation. Flight lines are shown on a pilots display, and the aircraft is controlled by the pilots at all times. Information from the IMU are also used in real-time by the PAV100 gyro-stabilized mount to compensate for deviations in pitch and roll.

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

Table 3.1: GNSS Base Station Woolpert

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
KGPT Airport Base	30°24'08.32425"	89°04'22.55622"	-20.664
KHKS Airport Base	32°20'24.71962"	90°13'42.06555"	72.558
KHSA Airport Base	30°22'27.49298"	89°27'06.82562"	-21.188
KMCB Airport Base	31°10'56.01838"	90°28'17.11884"	97.075
KPQL Airport Base	30°27'47.69164"	88°31'35.95157"	-24.146
MSEV CORS	31°35'42.08167"	89°12'13.27473"	53.831

Table 3.2: GNSS Base Station Geomatics Data Solution

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
BH2999	30° 22’ 23.16238”	89° 27’ 10.92677”	-22.638
N/A	30° 24’ 07.74732”	89° 4’ 22.48901”	-20.773
BH3112	30° 27’ 49.67304”	89° 31’ 38.97875”	-23.786

Data Processing

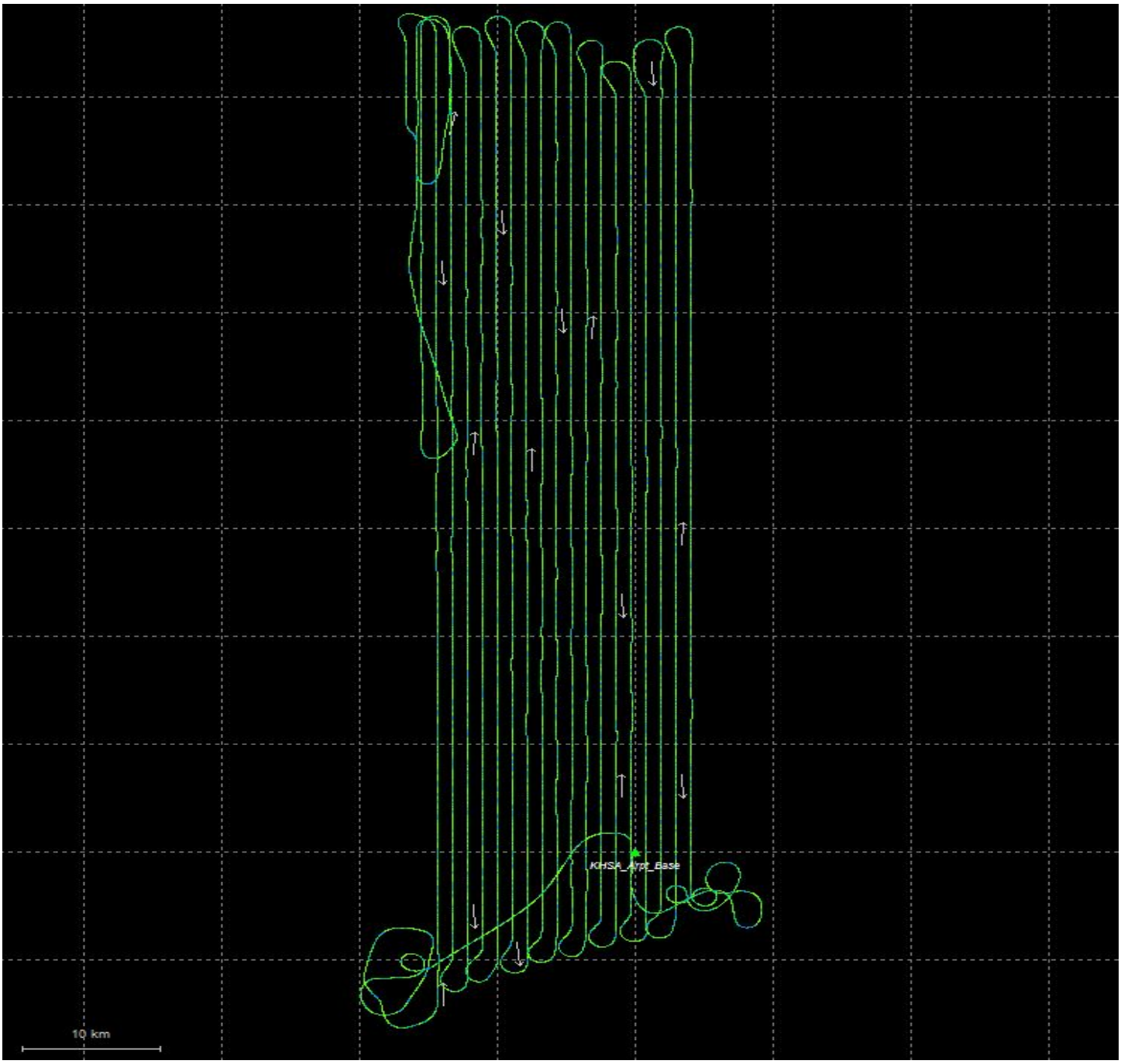
All airborne GNSS and IMU data was post-processed and quality controlled using Applanix MMS software. GNSS data was processed at a 1 and 2 Hz data capture rate and the IMU data was processed at 200 Hz.

Position and orientation data were acquired in the aircraft using a NovAtel SPAN with LCI-100C IMU. All data were post-processed using NovAtel Inertial Explorer software to provide a tightly-coupled kinematic position and orientation solution.

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, Day03015_SH7177

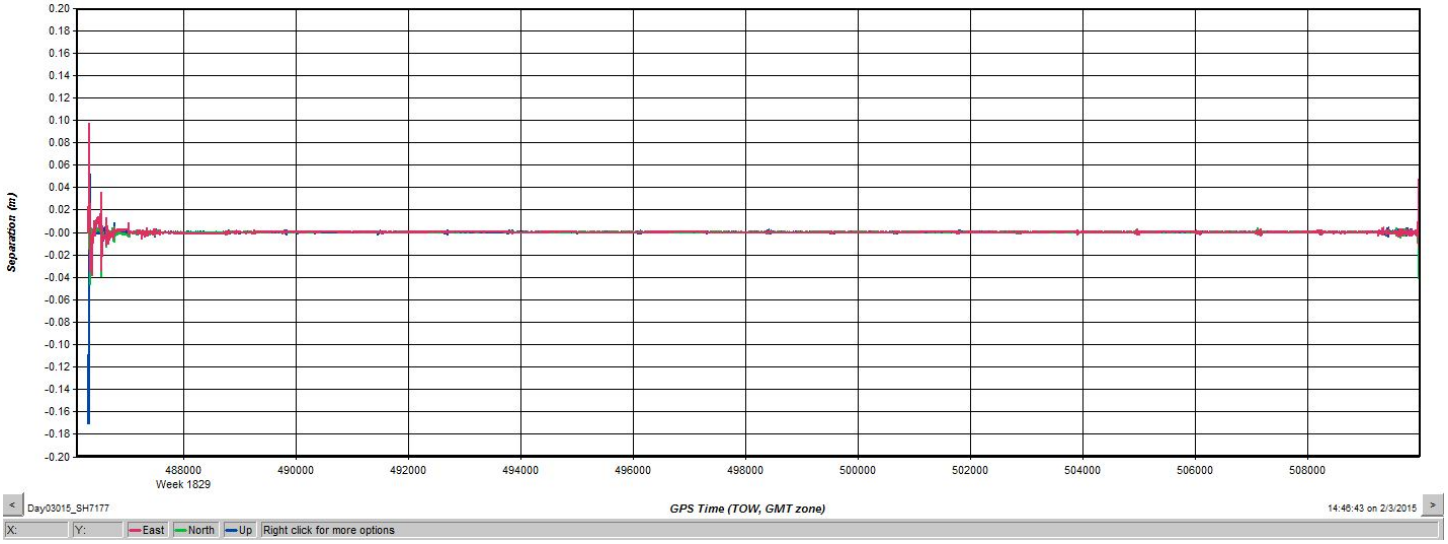


Combination Separation

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, Day03015_SH7177

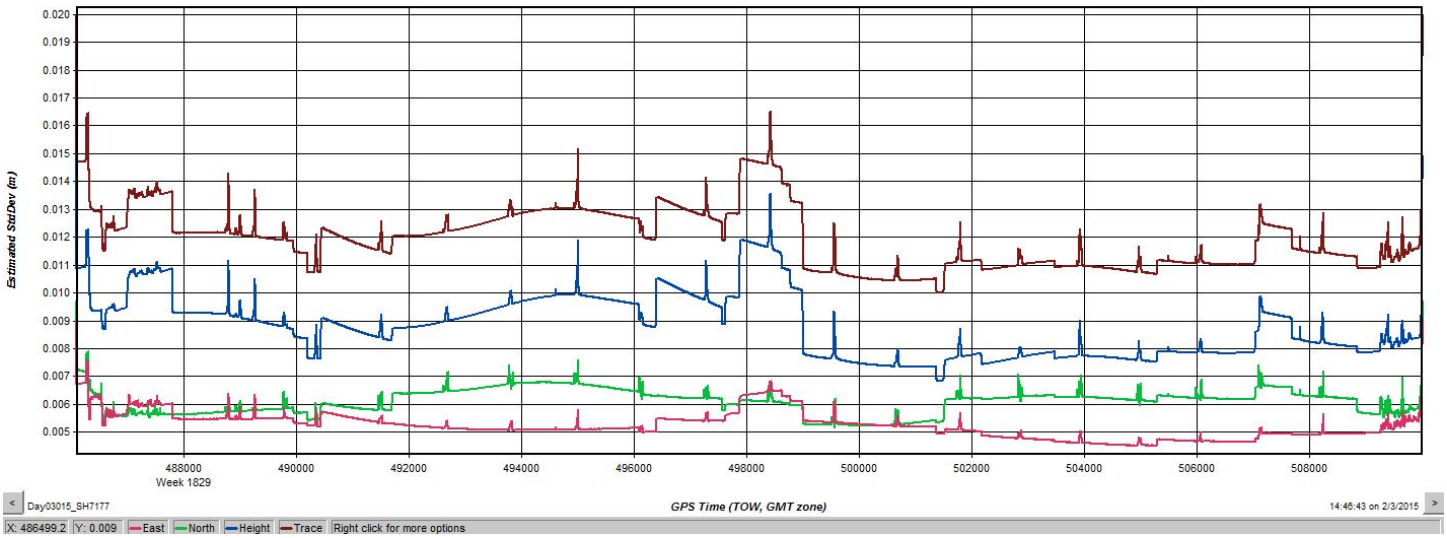


Estimated Positional Accuracy

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, Day03015_SH7177

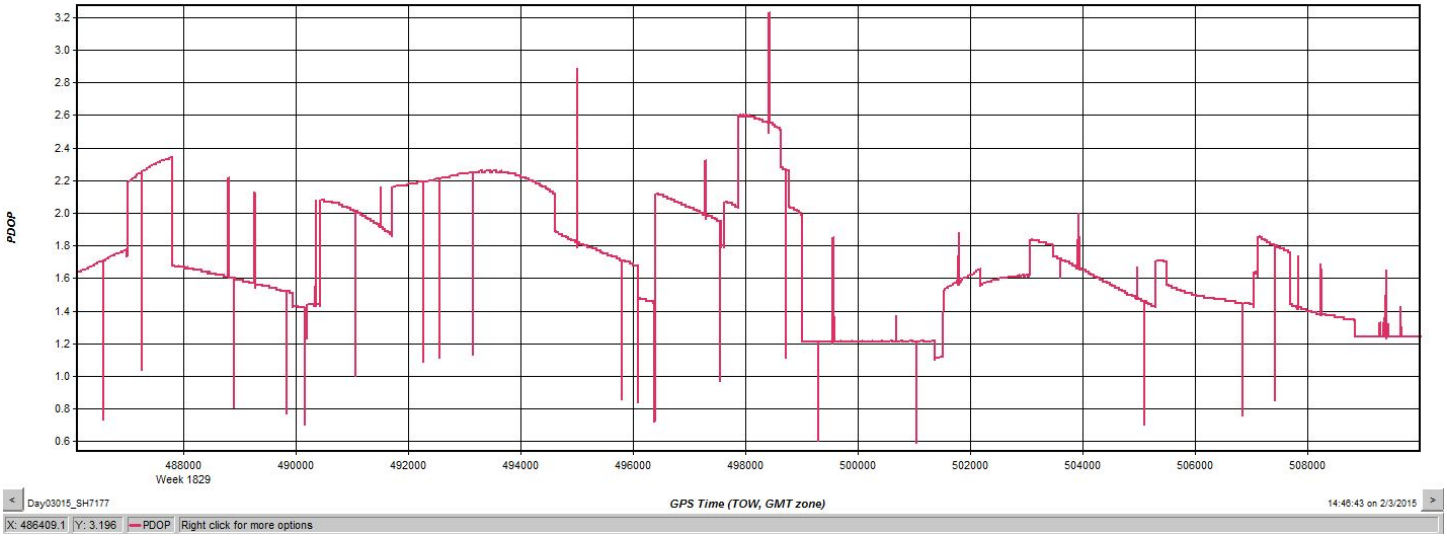


PDOP

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, Day03015_SH7177



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), Bridge Decks (Class 17) and High Noise (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 3DEP Extension data was referenced to UTM15N North American Datum of 1983 (2011) and UTM16N North American Datum of 1983 (2011). The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12A. Coordinate positions were specified in units of meters.

- The horizontal datum used for Coastal delivery was referenced to Mississippi State Plane East Zone, NAD83(2011). The vertical datum used for the task order was referenced to NAVD88, GEOID12A/12B in units of US Survey Feet.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

Mississippi Coastal QL2 Lidar with 3DEP Extension 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. One coastal elevation was applied to entire project area. Due to differing acquisition dates and thus differing tide levels there will be areas in the DEM exhibiting what appears to be "digging" water features.

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 30 meters (100 feet) nominal width, were compiled to meet task order requirements. **Figure 4.1** illustrates an example of 30 meters (100 feet) nominal streams identified and defined with hydrologic breaklines. The breaklines defining rivers and streams, at a nominal minimum width of 30 meters (100 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

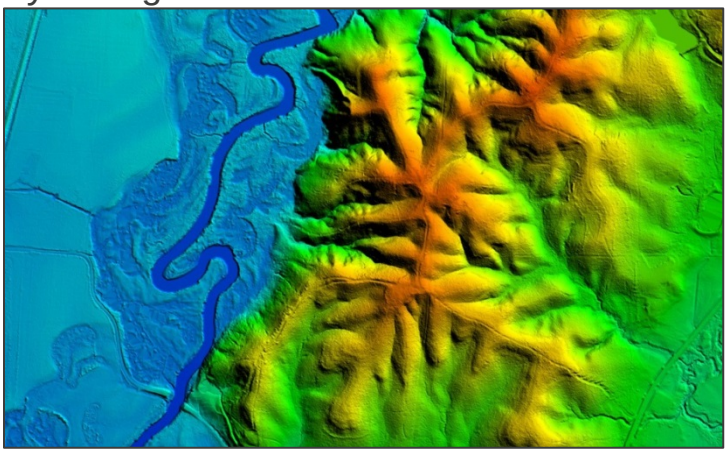


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

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

This section contains accuracy assessments for both the 3DEP Extension AOI and the MS Coastal QL2 AOI. The vertical accuracy statistics were calculated by comparison of the lidar bare earth points to the ground surveyed QA/QC points. 3DEP Extension Lidar was processed and delivered in NAD1983(2011) UTM16, NAVD88 Geoid12A meters. A portion of the AOI falls into the UTM 15 zone. Data deliverables were reprojected and also delivered in NAD1983(2011) UTM16, NAVD88 Geoid12A meters. It should be noted that accuracy analysis was reported for the UTM15 data delivery. The Coastal delivery was processed and projected in Mississippi State Plane East Zone, NAD83(2011). The vertical datum used for the task order was referenced to NAVD88, GEOID12A/12B in units of US Survey Feet.

Table 5.1: Overall Vertical Accuracy Statistics 3DEP Extension

Average error	0.061	meter
Minimum error	-0.119	meter
Maximum error	0.202	meter
Average magnitude	0.071	meter
Root mean square	0.085	meter
Standard deviation	0.060	meter

Table 5.2: Raw Swath Quality Check Point Analysis NVA 3DEP Extension

Point ID	Easting (meter)	Northing (meter)	TIN Elevation (meter)	Dz (meter)
2001	723990.132	3548212.705	61.64	0.201
2002	743747.499	3542909.535	133.3	0.165
2003	761677.292	3537871.323	101.93	0.08
2004	774786.021	3542326.766	96.03	-0.043
2005	718174.719	3530259.914	129.65	0.202
2006	787067.723	3534490.696	83.67	0.121
2007	746354.689	3529346.026	128.23	0.104
2008	731604.252	3523342.218	142.14	0.081
2009	723273.302	3539865.952	69.59	0.104
2010	717424.257	3519709.083	96.37	0.019
2011	786068.962	3518097.587	119.89	0.03
2012	774885.92	3525228.483	94.67	0.092
2013	793412.795	3525887.175	165.59	-0.025
2014	806879.07	3523877.938	162.19	0.054
2015	802205.688	3529936.019	169.84	0.005
2016	816948.996	3521201.685	120.08	0.044
2017	814774.372	3535737.106	133.88	0.077

2018	810050.279	3544553.19	117.36	0.019
2019	810169.23	3549130.278	126.62	0.039
2020	815941.345	3545951.941	164.22	0.022
2021	750384.906	3497656.289	154.05	0.073
2022	731546.981	3512844.417	152.86	0.068
2023	720068.234	3506151.784	148.52	0.064
2024	730171.534	3494188.65	120.27	0.05
2025	747022.475	3511243.768	140.12	0.072
2026	757746.672	3521018.386	136.29	0.078
2027	765431.832	3509660.132	93.29	0.086
2028	784686.436	3499543.671	84.54	0.064
2029	741553.47	3481053.159	134.12	0.052
2030	762126.504	3472215.003	139.26	-0.048
2031	725504.296	3472131.87	138.81	0.128
2032	746671.308	3459218.077	125.86	0.119
2033	758036.912	3452485.33	94.1	0.061
2034	740633.609	3448478.866	117.79	0.012
2035	761103.968	3434342.592	103.15	-0.011
2036	734113.728	3432515.021	85.26	0.124
2038	734552.29	3529197.487	83.47	0.095
2039	767658.987	3521615.787	72.28	0.033
2040	768442.081	3500243.318	77.84	0.118
2041	780370.779	3545856.224	117.83	0.161
2042	754735.014	3437715.464	113.19	0.054
2043	780763.664	3508574.176	110.1	0.02
2045	751323.828	3445733.05	115.34	0.073
2046	742045.369	3439620.465	98.98	-0.119
2047	745405.429	3470486.827	116.64	0.123
2048	757139.714	3486630.69	147.78	0.037
2049	732764.052	3484501.119	128.06	0.045
2050	744958.288	3493139.666	145.52	0.037
2051	730722.901	3505612.144	152.89	0.039
2052	746973.697	3519703.766	134.86	0.036
2053	734109.374	3537637.429	70.57	0.082
2054	755142.387	3537806.075	140.89	0.055
2055	732010.616	3545644.573	75.61	0.158
2056	768175.595	3529993.323	71.78	0.067
2057	757826.776	3531289.578	96.12	0.053
2058	797837.288	3520813.502	140.74	-0.004
2059	815046.137	3530557.56	149.91	-0.049
2060	755154.205	3479821.12	128.34	0.049

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.166 meters Non-Vegetated Vertical Accuracy (NVA)at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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 Non-Vegetated Vertical Accuracy (NVA) Tested 0.158 meters Non-Vegetated Vertical Accuracy (NVA) at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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 ground points.

SUPPLEMENTAL VERTICAL ACCURACY ASSESSMENTS

Table 5.3: Non-Vegetated Vertical Accuracy Quality Check Point Analysis NVA 3DEP Extension

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
2001	723990.132	3548212.705	61.61	0.171
2002	743747.499	3542909.535	133.28	0.145
2003	761677.292	3537871.323	101.9	0.05
2004	774786.021	3542326.766	96.03	-0.043
2005	718174.719	3530259.914	129.66	0.212
2006	787067.723	3534490.696	83.63	0.081
2007	746354.689	3529346.026	128.22	0.094
2008	731604.252	3523342.218	142.13	0.071
2009	723273.302	3539865.952	69.58	0.094
2010	717424.257	3519709.083	96.37	0.019
2011	786068.962	3518097.587	119.87	0.01
2012	774885.92	3525228.483	94.67	0.092
2013	793412.795	3525887.175	165.58	-0.035
2014	806879.07	3523877.938	162.21	0.074
2015	802205.688	3529936.019	169.78	-0.055
2016	816948.996	3521201.685	120.07	0.034
2017	814774.372	3535737.106	133.86	0.057
2018	810050.279	3544553.19	117.31	-0.031
2019	810169.23	3549130.278	126.64	0.059
2020	815941.345	3545951.941	164.25	0.052
2021	750384.906	3497656.289	154.13	0.153
2022	731546.981	3512844.417	152.85	0.058
2023	720068.234	3506151.784	148.52	0.064
2024	730171.534	3494188.65	120.27	0.05
2025	747022.475	3511243.768	140.1	0.052
2026	757746.672	3521018.386	136.26	0.048
2027	765431.832	3509660.132	93.27	0.066
2028	784686.436	3499543.671	84.54	0.064
2029	741553.47	3481053.159	134.1	0.032

2030	762126.504	3472215.003	139.3	-0.008
2031	725504.296	3472131.87	138.81	0.128
2032	746671.308	3459218.077	125.86	0.119
2033	758036.912	3452485.33	94.02	-0.019
2034	740633.609	3448478.866	117.78	0.002
2035	761103.968	3434342.592	103.1	-0.061
2036	734113.728	3432515.021	85.26	0.124
2037	721332.412	3543354.487	81.12	0.137
2038	734552.29	3529197.487	83.47	0.095
2039	767658.987	3521615.787	72.24	-0.007
2040	768442.081	3500243.318	77.76	0.038
2041	780370.779	3545856.224	117.81	0.141
2042	754735.014	3437715.464	113.2	0.064
2043	780763.664	3508574.176	110.09	0.01
2044	757045.815	3548716.597	81.05	-0.001
2045	751323.828	3445733.05	115.3	0.033
2046	742045.369	3439620.465	98.96	-0.139
2047	745405.429	3470486.827	116.62	0.103
2048	757139.714	3486630.69	147.79	0.047
2049	732764.052	3484501.119	128.03	0.015
2050	744958.288	3493139.666	145.5	0.017
2051	730722.901	3505612.144	152.88	0.029
2052	746973.697	3519703.766	134.83	0.006
2053	734109.374	3537637.429	70.54	0.052
2054	755142.387	3537806.075	140.9	0.065
2055	732010.616	3545644.573	75.63	0.178
2056	768175.595	3529993.323	71.75	0.037
2057	757826.776	3531289.578	96.16	0.093
2058	797837.288	3520813.502	140.72	-0.024
2059	815046.137	3530557.56	149.99	0.031
2060	755154.205	3479821.12	128.33	0.039

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.158 meters Non-Vegetated Vertical Accuracy (NVA) at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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.

Table 5.4: Vegetated Vertical Accuracy Quality Check Point Analysis VVA 3DEP Extension

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
3001	724004.3	3548233	61.64	0.225
3002	743730.7	3542898	132.66	0.168
3003	761740.4	3537844	99.22	0.128
3004	774759.2	3542300	95.03	0.144
3005	718169.7	3530305	130.32	0.074
3006	787079.3	3534453	83.26	0.219
3007	746133.9	3529460	128.4	0.128
3008	731607.6	3523321	142.7	0.218
3009	723274.4	3539880	69.98	0.104
3010	717436.2	3519705	95.7	-0.001
3011	786098.9	3518065	119.47	0.158
3012	774876.3	3525215	94.12	0.126
3013	793357.1	3525882	163.62	0.064
3014	806880	3523848	163.45	0.152
3015	802183.5	3529940	169.58	0.023
3016	816970.1	3521180	120.52	0.114
3017	814793	3535748	132.5	0.148
3018	810080.6	3544519	114.63	0.083
3019	810162.7	3549137	126.73	-0.011
3020	815952.8	3545965	164.52	0.311
3021	750347.5	3497661	153.39	0.14
3022	731549.9	3512857	152.89	0.089
3023	720104.4	3506166	147.86	0.106
3024	730189.3	3494151	119.38	0.118
3025	747034.9	3511288	142.23	0.151
3026	757776.2	3521058	136.22	0.174
3027	765431.7	3509696	94.06	0.083
3028	784696	3499575	84.1	0.151
3029	741501.7	3481029	132.41	0.172
3030	762139.9	3472224	138.76	0.083
3031	725518.9	3472152	138.23	0.216
3032	746673.9	3459245	124.09	0.207
3033	757987.9	3452490	95.73	-0.007
3034	740672.7	3448458	116.86	0.033
3035	761124.9	3434361	102.14	0.17
3036	734151.3	3432472	84.89	0.101
3037	721337.1	3543363	81.5	0.218
3038	734564.2	3529225	84.97	0.296
3039	767675.8	3521630	72.26	0.02
3040	768434	3500227	76.8	0.198
3041	780358	3545845	116.97	0.261
3042	754736.4	3437701	112.61	0.017
3043	780733.3	3508583	109.88	0.15
3044	757027.8	3548734	80.94	0.073
3045	723301.8	3539862	69.91	0.018
3046	734128	3432540	84.89	0.097

3047	761093.2	3434343	103.07	0.149
3048	746966.8	3510889	133.68	0.156
3049	746290.4	3529305	127.62	0.185
3050	746635.3	3459228	124.53	0.063

VERTICAL ACCURACY CONCLUSIONS

Non-Vegetated Vertical Accuracy (VVA) Tested 0.168 meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. VVA Errors larger than 95th percentile include:
Point 3001, Easting 724004.291, Northing 3548233.071, Z-Error 0.225 meters
Point 3006, Easting 787079.316, Northing 3534453.052, Z-Error 0.219 meters
Point 3008, Easting 731607.602, Northing 3523320.522, Z-Error 0.218 meters
Point 3020, Easting 815952.763, Northing 3545965.053, Z-Error 0.311 meters
Point 3026, Easting 757776.203, Northing 3521057.809, Z-Error 0.174 meters
Point 3029, Easting 741501.653, Northing 3481028.863, Z-Error 0.172 meters
Point 3031, Easting 725518.905, Northing 3472151.735, Z-Error 0.216 meters
Point 3032, Easting 746673.921, Northing 3459245.033, Z-Error 0.207 meters
Point 3035, Easting 761124.855, Northing 3434361.214, Z-Error 0.170 meters
Point 3037, Easting 721337.070, Northing 3543363.166, Z-Error 0.218 meters
Point 3038, Easting 734564.219, Northing 3529225.023, Z-Error 0.296 meters
Point 3040, Easting 768433.956, Northing 3500227.496, Z-Error 0.198 meters
Point 3041, Easting 780357.999, Northing 3545844.660, Z-Error 0.261 meters
Point 3049, Easting 746635.337, Northing 3529305.001, Z-Error 0.185 meters

Table 5.5: Overall Vertical Accuracy Statistics Coastal		
Average error	0.064	US feet
Minimum error	- 0.42	US feet
Maximum error	0.51	US feet
Average magnitude	0.141	US feet
Root mean square	0.141	US feet
Standard deviation	0.169	US feet

Table 5.6: Raw Swath Quality Check Point Analysis NVA Coastal

Point ID	Easting (US feet)	Northing (US feet)	TIN Elevation (US feet)	Dz (US feet)
2001A	691509.91	481230.22	88.85	0.05
2001	691476.77	481129.81	89.38	0.1
2002	724287.6	527940.17	198.7	-0.02
2002A	724455.89	527951.41	202.61	0.06
2003	760795.16	491887.09	335.56	-0.13
2003A	761147.76	491823.01	340.42	-0.06
2004	786107.28	518632.33	369.94	0.05
2004A	786104.45	518719.17	368.52	-0.03
2005	836663.5	479583.31	354.43	-0.17
2005A	836683.1	479691.99	354.35	-0.33
2006	878428.51	512055.43	304.39	0.2
2006A	878513.68	512123.95	303.03	0.31
2007	911028.38	437649.96	209.33	0.05
2007A	911113.37	437719.55	209.1	0.08
2008	960181.39	503324.01	127.59	0.07
2008A	960205.36	503180.75	128.23	-0.15
2009	1013534.95	436454.54	126.26	0.03
2009A	1013704.06	436414.11	125.69	0.41
2010	1058439.18	528269.29	228.76	0.12
2010A	1058439.31	528137.16	220.65	0.14
2011	1112157.37	441752.88	132.31	-0.01
2011A	1112156.8	441766.36	132.18	-0.11
2012	1082298.16	306286.12	4.48	0.04
2012A	1082223.51	306298.07	4.3	-0.02
2013	1033061.58	391889.32	71.94	-0.04
2013A	1032971.58	391827.49	77.22	0.01
2014	986555.22	375494.87	48.58	-0.03

2014A	986427.87	375485.11	48.57	0.18
2015	939579.79	411652.26	125.05	-0.36
2015A	939639.73	411752.2	123.34	-0.15
2016	864486.94	363899.63	70.07	0.05
2016A	864271.31	363900.75	69.97	0.08
2017	820192.21	438349.4	195.22	-0.06
2017A	820287.75	438262.71	195.85	0
2018	784879.09	343979.81	62.75	0.07
2018A	784889.19	344075.96	62.95	0.09
2019	742644.64	296696.96	19.42	0.29
2019A	742609.6	296549.76	21.7	0.17
2020	711974.56	373250.96	57.66	0.21
2020A	711973.78	373153.87	57.58	0.15
2021	748458.45	445858.67	187	0.18
2021A	748510.59	445841.15	187.03	0.22
2022	1094939.51	351086.68	11.77	-0.1
2022A	1094947.91	350783.08	11.52	0.17
2023	771118.65	257993.54	3.15	-0.01
2023A	771076.12	258060.81	3.02	-0.03
2024	665535.34	439624.11	66.67	0.23
2024A	665550.75	439513.5	66.09	0.2
2025	798221.58	537650.17	286.42	-0.01
2025A	798243.56	537702.9	286.49	-0.11
2026	734111.12	507511.04	186.39	-0.24
2026A	733448.03	507656.97	185.96	0
2027	705185.27	431455.16	192.46	0.05
2027A	705147.41	431333.01	194.67	-0.08
2028	748007.5	405382.06	159.54	0.01
2028A	747969.61	405441.06	158.09	0.1
2029	749599.42	335992.44	36.58	-0.1
2029A	749744.31	336279.41	35.03	-0.04
2030	755281.48	280222.1	16.27	0.1
2030A	755355.98	280103.5	16.22	0.05
2031	794926.56	289176.66	15.91	0.25
2031A	794829.32	289192.53	15.9	0.32
2032	763877.63	326446.4	27.54	-0.08
2032A	763738.28	326343.29	22.79	-0.04
2033	761153.97	370380.82	96.69	0.12
2033A	761077.08	370453.93	96.26	0.08
2034	810838.88	404585.8	220.01	0
2034A	810781.72	404684.8	218.66	0.32
2035	725649.21	473704.5	131.45	-0.02
2035A	725550.87	473771.72	131	0.11
2036	787154.78	466183.81	319.2	0.16

2036A	787189.98	466287.09	318.51	0.04
2037	817148.19	507893.2	356.8	0.16
2037A	817091.65	507858.05	358.56	0.02
2038	756884.27	544386.6	354.32	-0.05
2038A	756853.23	544446.67	353.04	-0.14
2039	758916.55	524746.77	365.96	-0.15
2039A	758874.32	524858.44	362.75	-0.04
2040	783226.94	435089.18	258.43	0.2
2040A	783164.97	435124.6	260.68	0.09
2041	791311.13	406254.72	176.12	0.21
2041A	791160.89	406306.46	173.18	0.16
2042	805412.35	366491.39	106.4	0.18
2042A	805479.3	366330.35	106.4	0.14
2043	826569.86	341301.98	79.97	0.28
2043A	826630.67	341212	80.87	0.25
2044	855995.64	322123.11	20.3	0.09
2044A	855920.28	322221.96	17.86	-0.16
2045	849681.52	299556.9	11.71	0.05
2045A	849810.82	299597.7	11.12	0.06
2046	901749.87	315453.49	22.62	0.11
2046A	901801.66	315533.72	22.22	0.14
2047	781596.36	306896.08	13.14	0.11
2047A	781830.67	306991.79	14.28	0.03
2048	914034.54	358337.62	71.59	0.15
2048A	914116.72	358365.02	70.9	0.14
2049	889944.65	408169.78	142.06	0.36
2049A	889945.57	408102.4	142.86	0.38
2050	861393.22	403860.83	171.37	0
2050A	861590.13	403946.08	179.45	0
2051	863274.67	451358.1	227.37	-0.09
2051A	863377.04	451352.42	226.92	-0.09
2052	915031.28	477111.86	184.6	-0.14
2052A	915169.05	477025.42	183.77	0.25
2053	958884.06	462253.68	83.72	0.03
2053A	958826	462367.07	74.85	0.14
2054	997602.17	490605.25	162.09	0.42
2054A	997536.2	490707.36	162.17	0.23
2055	1001397.44	538551.06	57.25	0.11
2055A	1001588.22	538579.4	57.18	0.21
2056	1026547.66	513150.68	177.61	-0.27
2056A	1026569.93	513223	176.14	-0.02
2057	1109569.53	541980.14	193.88	0
2057A	1109385.01	541967.46	192.69	0.05
2058	1092319.34	513832.19	239.56	-0.01

2058A	1092428.52	513843.55	241.04	-0.04
2059	1058252.2	497110.25	253.18	0.11
2059A	1058255.38	497221.52	253.77	0.13
2060	1036950.56	476614.29	53.59	0.01
2060A	1036993.53	476607.3	53.85	0.09
2061	999098.29	462534	80.09	-0.08
2061A	999152.65	462572.81	78.84	-0.09
2062	984850.92	417073.88	115.7	-0.04
2062A	984862.63	416993.41	116.52	-0.06
2063	918396.91	388331.75	142.7	0.22
2063A	918530.44	388479.83	137.09	0.15
2064	961885.3	347048.95	17.7	0.22
2064A	961946.2	347049.96	17.93	0.34
2065	894125.27	347874.05	39.33	0.16
2065A	894193.26	347875.15	41.69	0.08
2066	976445.2	323681.73	4.36	-0.03
2066A	976368.61	323667.65	3.51	0.01
2067	935722.29	340323.66	14.69	-0.17
2067A	935763.45	340287.48	14.45	-0.04
2068	1006095.42	313040.84	3.08	-0.05
2068A	1006105.08	313151.09	3.01	-0.07
2069	1026762.35	355524.93	31.71	-0.04
2069A	1026627.61	355513.17	30.68	-0.06
2071	996959.74	346550.1	48.04	0.02
2071A	996947.26	346509.15	48.1	0.13
2072	1102417.39	335039.86	9.02	0.22
2072A	1102346.63	334917.32	8.21	0.3
2073	1076312.85	373088.23	19.62	0.14
2073A	1076284.4	373200.11	19.84	0.25
2074	1116733.71	413114.13	102.89	0.14
2074A	1116734.24	413219.95	103.41	0.24
2075	1075567.79	419412.38	54.61	-0.29
2075A	1075664.86	419308.56	51.52	-0.03
2076	1055348.98	448519.76	62.61	0.07
2076A	1055445.79	448496.32	60.29	0.15
2077	1111135.4	495173.5	84.55	-0.42
2077A	1111238.25	495158.82	83.9	-0.16
2078	1091430.24	458759.7	97.06	-0.06
2078A	1091494.43	458776.66	97.36	0.48
2079	1036325.46	416186.08	142.65	0.31
2079A	1036373.43	416168.06	143.55	0.5
2080	1102096.38	392987.6	32.59	0.25
2080A	1102111.92	392871.89	33.32	0.31
2081	961575.66	384607.59	74.74	0.51

2081A	961611.85	384683.53	74.66	0.19
2082	945358.74	441459.08	162.57	-0.41
2082A	945421.76	441609.34	158.22	-0.39
2083	1073684.6	476237.92	132.9	0.02
2083A	1073782.04	476232.51	136.86	0.1
2084	1090242.18	443341.44	111.87	0.21
2084A	1090200.88	443340.23	112.32	0.09
2085	1018309.51	405818.35	147.67	0.17
2085A	1018396.38	405837.61	146.32	0.14
2086	1069545.03	395310.5	32.28	0.32
2086A	1069616.63	395351.58	31.78	0.11
2087	1092727.53	423012.71	94.52	0.31
2087A	1092717.37	423073.15	94.53	0.23
2088	1103613.21	369784.62	21.92	0.25
2088A	1103540.59	369822.15	21.5	0.27
2089	925534.44	505290.52	198.01	0.2
2089A	925495.8	505361.58	198.26	-0.37
2090	816407.81	473519.73	175.53	0.04
2090A	816316.11	473416.13	175.09	0.06
2091	790732.86	491395.63	268.94	0.14
2091A	790793.57	491316.6	259.15	-0.02
2092	849277.77	510804.24	223.75	0.02
2092A	849305.15	510669.88	222	0.05
2093	944319.03	482307.88	193.88	-0.15
2093A	944209.73	482378.98	196.76	-0.28
2094	973374.24	439258.67	169.03	0.36
2094A	973257.61	439279.3	168.47	0.25
2095	869990.42	491811.45	156.46	-0.15
2095A	869921.05	491766.02	155.28	-0.04
2096	699210.93	406004.43	114.15	-0.01
2096A	699168.43	406043.52	110.94	0.01
2097	685946.2	386646.86	43.53	-0.1
2097A	685937.46	386534.31	43.41	-0.1
2098	731033.83	426017.87	242.13	-0.09
2098A	730955.85	426054.56	242.74	-0.07
2099	839812.16	385281.03	126.44	-0.07
2099A	839820.22	385171.87	123.31	-0.08
2100	887451.59	466313.1	138.56	0.22
2100A	887502.52	466252.82	136.95	0.29
2101	813551.18	319080.18	42.04	0.27
2101A	813917.87	318812.27	42.62	0.26
2102	893013.89	481642.56	241.2	0.12
2102A	892859.78	481818.57	243.09	-0.01
2040A	783164.97	435124.6	260.68	0.09

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.355 US feet Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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 Non-Vegetated Vertical Accuracy (NVA) Tested 0.347 US feet Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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 ground points.

SUPPLEMENTAL VERTICAL ACCURACY ASSESSMENTS

Table 5.7: Non-Vegetated Vertical Accuracy Quality Check Point Analysis NVA Coastal

Point ID	Easting (US feet)	Northing (US feet)	DEM Elevation (US feet)	Dz (US feet)
2001A	691509.91	481230.22	88.85	0.05
2001	691476.77	481129.81	89.44	0.16
2002	724287.6	527940.17	198.921	0.201
2002A	724455.89	527951.41	202.531	-0.019
2003	760795.16	491887.09	335.511	-0.179
2003A	761147.76	491823.01	340.371	-0.109
2004	786107.28	518632.33	369.921	0.031
2004A	786104.45	518719.17	368.481	-0.069
2005	836663.5	479583.31	354.501	-0.099
2005A	836683.1	479691.99	354.361	-0.319
2006	878428.51	512055.43	304.371	0.181
2006A	878513.68	512123.95	302.921	0.201
2007	911028.38	437649.96	209.121	-0.159
2007A	911113.37	437719.55	208.901	-0.119
2008	960181.39	503324.01	127.591	0.071
2008A	960205.36	503180.75	128.251	-0.129
2009	1013534.95	436454.54	126.241	0.011
2009A	1013704.06	436414.11	125.691	0.411
2010	1058439.18	528269.29	228.711	0.071
2010A	1058439.31	528137.16	220.761	0.251
2011	1112157.37	441752.88	132.271	-0.049
2011A	1112156.8	441766.36	132.311	0.021
2012	1082298.16	306286.12	4.43	-0.01
2012A	1082223.51	306298.07	4.27	-0.05
2013	1033061.58	391889.32	71.91	-0.07
2013A	1032971.58	391827.49	77.18	-0.03
2014	986555.22	375494.87	48.5	-0.11

2014A	986427.87	375485.11	48.44	0.05
2015	939579.79	411652.26	124.961	-0.449
2015A	939639.73	411752.2	123.1	-0.39
2016	864486.94	363899.63	70.03	0.01
2016A	864271.31	363900.75	69.81	-0.08
2017	820192.21	438349.4	195.241	-0.039
2017A	820287.75	438262.71	195.861	0.011
2018	784879.09	343979.81	62.88	0.2
2018A	784889.19	344075.96	62.94	0.08
2019	742644.64	296696.96	19.02	-0.11
2019A	742609.6	296549.76	21.72	0.19
2020	711974.56	373250.96	57.67	0.22
2020A	711973.78	373153.87	57.45	0.02
2021	748458.45	445858.67	186.981	0.161
2021A	748510.59	445841.15	186.681	-0.129
2022	1094939.51	351086.68	11.73	-0.14
2022A	1094947.91	350783.08	11.54	0.19
2023	771118.65	257993.54	3.15	-0.01
2023A	771076.12	258060.81	2.96	-0.09
2024	665535.34	439624.11	66.6	0.16
2024A	665550.75	439513.5	66.11	0.22
2025	798221.58	537650.17	286.271	-0.159
2025A	798243.56	537702.9	286.401	-0.199
2026	734111.12	507511.04	186.631	0.001
2026A	733448.03	507656.97	185.821	-0.139
2027	705185.27	431455.16	192.431	0.021
2027A	705147.41	431333.01	194.741	-0.009
2028	748007.5	405382.06	159.491	-0.039
2028A	747969.61	405441.06	157.951	-0.039
2029	749599.42	335992.44	36.61	-0.07
2029A	749744.31	336279.41	34.95	-0.12
2030	755281.48	280222.1	16.25	0.08
2030A	755355.98	280103.5	16.25	0.08
2031	794926.56	289176.66	15.9	0.24
2031A	794829.32	289192.53	15.87	0.29
2032	763877.63	326446.4	27.52	-0.1
2032A	763738.28	326343.29	22.81	-0.02
2033	761153.97	370380.82	96.51	-0.06
2033A	761077.08	370453.93	96.23	0.05
2034	810838.88	404585.8	220.051	0.041
2034A	810781.72	404684.8	218.491	0.151
2035	725649.21	473704.5	131.271	-0.199
2035A	725550.87	473771.72	130.851	-0.039
2036	787154.78	466183.81	319.131	0.091
2036A	787189.98	466287.09	318.551	0.081
2037	817148.19	507893.2	356.581	-0.059
2037A	817091.65	507858.05	358.501	-0.039
2038	756884.27	544386.6	354.091	-0.279
2038A	756853.23	544446.67	352.961	-0.219
2039	758916.55	524746.77	365.881	-0.229
2039A	758874.32	524858.44	362.581	-0.209

2040	783226.94	435089.18	258.341	0.111
2040A	783164.97	435124.6	260.471	-0.119
2041	791311.13	406254.72	176.131	0.221
2041A	791160.89	406306.46	173.251	0.231
2042	805412.35	366491.39	106.34	0.12
2042A	805479.3	366330.35	106.44	0.18
2043	826569.86	341301.98	79.97	0.28
2043A	826630.67	341212	80.76	0.14
2044	855995.64	322123.11	20.21	0
2044A	855920.28	322221.96	17.86	-0.16
2045	849681.52	299556.9	11.71	0.05
2045A	849810.82	299597.7	11.06	0
2046	901749.87	315453.49	22.63	0.12
2046A	901801.66	315533.72	22.28	0.2
2047	781596.36	306896.08	12.98	-0.05
2047A	781830.67	306991.79	14.23	-0.02
2048	914034.54	358337.62	71.58	0.14
2048A	914116.72	358365.02	70.76	0
2049	889944.65	408169.78	142.021	0.321
2049A	889945.57	408102.4	143.001	0.521
2050	861393.22	403860.83	171.161	-0.209
2050A	861590.13	403946.08	179.441	-0.009
2051	863274.67	451358.1	227.371	-0.089
2051A	863377.04	451352.42	226.811	-0.199
2052	915031.28	477111.86	184.351	-0.389
2052A	915169.05	477025.42	183.431	-0.089
2053	958884.06	462253.68	83.66	-0.03
2053A	958826	462367.07	74.84	0.13
2054	997602.17	490605.25	161.871	0.201
2054A	997536.2	490707.36	162.041	0.101
2055	1001397.44	538551.06	57.23	0.09
2055A	1001588.22	538579.4	57.13	0.16
2056	1026547.66	513150.68	177.531	-0.349
2056A	1026569.93	513223	175.821	-0.339
2057	1109569.53	541980.14	193.781	-0.099
2057A	1109385.01	541967.46	192.691	0.051
2058	1092319.34	513832.19	239.571	0.001
2058A	1092428.52	513843.55	241.031	-0.049
2059	1058252.2	497110.25	253.071	0.001
2059A	1058255.38	497221.52	253.521	-0.119
2060	1036950.56	476614.29	53.53	-0.05
2060A	1036993.53	476607.3	53.83	0.07
2061	999098.29	462534	80.08	-0.09
2061A	999152.65	462572.81	78.83	-0.1
2062	984850.92	417073.88	115.74	0
2062A	984862.63	416993.41	116.34	-0.24
2063	918396.91	388331.75	142.701	0.221
2063A	918530.44	388479.83	137.201	0.261
2064	961885.3	347048.95	17.71	0.23
2064A	961946.2	347049.96	17.69	0.1
2065	894125.27	347874.05	39.35	0.18

2065A	894193.26	347875.15	41.61	0
2066	976445.2	323681.73	4.33	-0.06
2066A	976368.61	323667.65	3.43	-0.07
2067	935722.29	340323.66	14.66	-0.2
2067A	935763.45	340287.48	14.36	-0.13
2068	1006095.42	313040.84	3.06	-0.07
2068A	1006105.08	313151.09	2.97	-0.11
2069	1026762.35	355524.93	31.57	-0.18
2069A	1026627.61	355513.17	30.6	-0.14
2071	996959.74	346550.1	47.99	-0.03
2071A	996947.26	346509.15	48.01	0.04
2072	1102417.39	335039.86	8.9	0.1
2072A	1102346.63	334917.32	8.13	0.22
2073	1076312.85	373088.23	19.61	0.13
2073A	1076284.4	373200.11	19.79	0.2
2074	1116733.71	413114.13	102.85	0.1
2074A	1116734.24	413219.95	103.19	0.02
2075	1075567.79	419412.38	54.74	-0.16
2075A	1075664.86	419308.56	51.47	-0.08
2076	1055348.98	448519.76	62.63	0.09
2076A	1055445.79	448496.32	60.1	-0.04
2077	1111135.4	495173.5	84.56	-0.41
2077A	1111238.25	495158.82	83.79	-0.27
2078	1091430.24	458759.7	97.08	-0.04
2078A	1091494.43	458776.66	97.26	0.38
2079	1036325.46	416186.08	142.621	0.281
2079A	1036373.43	416168.06	143.451	0.401
2080	1102096.38	392987.6	32.57	0.23
2080A	1102111.92	392871.89	33.45	0.44
2081	961575.66	384607.59	74.68	0.45
2081A	961611.85	384683.53	74.58	0.11
2082	945358.74	441459.08	162.541	-0.439
2082A	945421.76	441609.34	158.161	-0.449
2083	1073684.6	476237.92	132.991	0.111
2083A	1073782.04	476232.51	136.951	0.191
2084	1090242.18	443341.44	111.87	0.21
2084A	1090200.88	443340.23	112.22	-0.01
2085	1018309.51	405818.35	147.611	0.111
2085A	1018396.38	405837.61	146.231	0.051
2086	1069545.03	395310.5	31.98	0.02
2086A	1069616.63	395351.58	31.67	0
2087	1092727.53	423012.71	94.48	0.27
2087A	1092717.37	423073.15	94.37	0.07
2088	1103613.21	369784.62	21.84	0.17
2088A	1103540.59	369822.15	21.5	0.27
2089	925534.44	505290.52	197.671	-0.139
2089A	925495.8	505361.58	198.331	-0.299
2090	816407.81	473519.73	175.541	0.051
2090A	816316.11	473416.13	175.021	-0.009
2091	790732.86	491395.63	268.811	0.011
2091A	790793.57	491316.6	259.371	0.201

2092	849277.77	510804.24	223.501	-0.229
2092A	849305.15	510669.88	221.721	-0.229
2093	944319.03	482307.88	193.551	-0.479
2093A	944209.73	482378.98	196.571	-0.469
2094	973374.24	439258.67	169.011	0.341
2094A	973257.61	439279.3	168.401	0.181
2095	869990.42	491811.45	156.391	-0.219
2095A	869921.05	491766.02	155.091	-0.229
2096	699210.93	406004.43	114.09	-0.07
2096A	699168.43	406043.52	110.81	-0.12
2097	685946.2	386646.86	43.51	-0.12
2097A	685937.46	386534.31	43.37	-0.14
2098	731033.83	426017.87	242.191	-0.029
2098A	730955.85	426054.56	242.741	-0.069
2099	839812.16	385281.03	126.311	-0.199
2099A	839820.22	385171.87	123.31	-0.08
2100	887451.59	466313.1	138.591	0.251
2100A	887502.52	466252.82	136.731	0.071
2101	813551.18	319080.18	41.81	0.04
2101A	813917.87	318812.27	42.48	0.12
2102	893013.89	481642.56	241.251	0.171
2102A	892859.78	481818.57	243.061	-0.039

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.361 US feet Non-Vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (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.

Table 5.8: Vegetated Vertical Accuracy Quality Check Point Analysis VVA Coastal

Point ID	Easting (US feet)	Northing (US feet)	DEM Elevation (US feet)	Dz (US feet)
3001A	691250.71	481429.97	85.26	0.02
3001	691037.81	481275.29	85.23	0.28
3002	716906.62	526861.1	164.291	0.231
3002A	716897.63	526784.85	163.831	-0.079
3003	771250.24	489371.5	256.051	-0.019
3003A	771263.89	489468.82	257.501	0.111
3004	786766.08	518988.66	356.071	0.141
3004A	786705.18	518999.9	358.011	0.021
3005	836690.99	479804.37	352.991	-0.039
3005A	836604.6	479774.54	354.391	-0.059
3006	877698.93	511196.73	261.341	0.901
3006A	877608.61	511219.63	258.731	0.621
3007	910984.94	437778.24	213.151	0.331
3007A	911166.88	437743.7	210.511	-0.059
3008	997546.9	490646.45	160.521	0.531
3008A	997493.95	490774.65	162.201	0.341
3009	1017309.63	434565.88	119.5	0.62
3009A	1017262.88	434524.88	119.6	0.23
3010	1058755.62	527154.5	162.081	0.231
3010A	1058675.44	527259.87	168.081	-0.459
3011	1105803.28	445904.14	59.71	0.57
3011A	1105740.83	445880.31	59.41	0.51
3012	1028375.82	308438.87	8.05	-0.1
3012A	1028403.51	308308.72	10.09	-0.07
3013	1033037.89	391897.3	72.89	0.35
3013A	1033010.71	391816.95	79.03	0.37
3014	987941.97	375531.25	59.77	0.28
3014A	987931.76	375437.49	57.98	0.25
3015	939673.52	411690.64	127.771	0.251
3015A	939504.77	411646.86	128.961	0.081
3016	864506.86	363878.21	69.6	-0.2
3016A	864519.4	363931.74	68.17	0.35
3017	820249.28	438346.14	195.081	-0.209
3017A	820160.06	438278.96	194.341	0.151
3018	784910.14	344925.99	60.31	0.35
3018A	784977.42	344877.49	59.68	0.32
3019	747475.63	292116.9	23.03	0.35
3019A	747468.77	292000.24	24.91	0.29
3020	716009.72	370725.91	58.42	0.42
3020A	715925.89	370597.13	57.86	0.43
3021	748957.84	445770.06	177.601	0.011
3021A	749016.77	445747.34	175.751	-0.109
3022	1094953.61	350956.66	10.91	0.53
3022A	1094910.58	351102.19	11.86	0.42
3023	771168.99	258078.54	3.11	0.66
3023A	771238.92	258074.7	3.09	0.78

3024	756943.84	544407.69	352.801	0.061
3024A	756834.03	544410.66	352.861	-0.169
3025	798178.08	537570.81	283.371	0.031
3025A	798143.59	537601.59	281.771	0.141
3026	725102.71	473656.41	129.161	0.041
3026A	725042.65	473575.25	129.261	0.001
3027	705188.91	431308.28	193.041	0.321
3027A	705209.24	431425.46	191.401	0.291
3028	747937.1	405476.06	155.631	-0.129
3028A	748004.93	405541.56	148.871	0.091
3029	749696.94	336197.47	33.75	0.62
3029A	749849.02	336241.04	33.43	0.07
3030	794705.09	289235.58	15.33	0.37
3030A	794659.29	289207.55	15.46	0.54
3031	856033.17	322016.2	20.63	0.01
3031A	855903.56	322251.89	18.04	0.03
3032	839788.21	385155.81	124.31	0.34
3032A	839842.41	385240.99	125.851	0.201
3033	918460.31	388271.03	137.451	0.671
3033A	918512.44	388181.22	140.621	0.811
3034	863377.61	451410.98	229.211	0.151
3034A	863237.4	451419.81	231.351	0.071
3035	791290.04	406289.52	175.661	0.171
3035A	791145.34	406352.32	172.561	0.161
3036	787206.77	466156.75	317.191	0.151
3036A	787205.37	466331.54	316.681	0.211
3037	817131.32	507933.96	356.111	-0.039
3037A	817137.08	507803.09	357.711	0.041
3038	892594.83	481600.81	240.501	-0.179
3038A	892599.4	481719.22	244.181	0.531
3039	925564.68	505323.46	195.161	0.321
3039A	925510.84	505389.21	197.301	0.441
3040	958801.68	462454.86	66.7	0.34
3040A	958769.93	462558.12	63.65	0.18
3041	944218.47	482410.35	195.861	-0.219
3041A	944300.36	482295.06	192.211	-0.139
3042	1001391.09	538598.85	53.28	0.42
3042A	1001544.88	538465.78	54.97	0.45
3043	1026570.5	513106.36	177.221	0.171
3043A	1026599.14	513190.88	176.451	0.231
3044	1109565.37	542000.9	193.221	0.121
3044A	1109412.82	542015.86	192.951	0.011
3045	1092164.34	513929.33	230.621	0.331
3045A	1092140.3	513839.57	223.791	0.261
3046	1058374.17	497213.79	249.661	0.261
3046A	1058371.21	497097.4	249.261	0.291
3047	1036916.47	476672.13	54.1	-0.03
3047A	1036983.86	476686.49	54.35	0.53
3048	1073687.86	476206.07	130.501	0.161
3048A	1073779.49	476278.46	138.881	0.081
3049	999146.83	462535.93	77.93	0.44

3049A	999096.1	462616.62	79.35	0.92
3050	1055413.51	448542.28	61.68	0.15
3050A	1055285.44	448597.15	64.25	0.07
3051	1092836.92	423102.51	94.07	0.54
3051A	1092718.66	423108.76	94.03	0.44
3052	1116794.63	413227.49	103.87	0.54
3052A	1116706.52	413220.12	103.78	0.05
3053	1102131.61	393032.44	30.71	0.23
3053A	1102141.38	392876.35	33.66	0.61
3054	1069467.47	395245.6	28.64	0.03
3054A	1069533.49	395213.26	31.51	0.32
3055	1076208.03	373193.26	20.39	0.9
3055A	1076234.34	373087.77	19.95	0.85
3056	1103520.04	369767.15	19.96	0.51
3056A	1103596.95	369542.06	21.25	0.28
3057	1082038.51	306271.63	5.24	-0.01
3057A	1081947.04	306359.27	6.45	0.23
3058	1102292.26	334928.67	7.87	0.75
3058A	1102285.68	334800.97	8.68	0.61
3059	1026687.39	355516	31.26	0.34
3059A	1026799.14	355499.39	31.78	0.32
3060	996974.79	346462.98	46.56	-0.01
3060A	996995.25	346375.12	47.61	0.94
3061	984819.85	416978.24	112.55	-0.27
3061A	984786.79	417071.31	113.1	-0.29
3062	961640	384641.66	74.5	1.08
3062A	961537.68	384546.79	74.49	0.47
3063	961797.45	346999.71	23.55	0.71
3063A	961780.24	346928.3	23.41	0.41
3064	914135.51	358412.21	71.66	0.58
3064A	914008.28	358447.02	73.08	0.55
3065	899421.07	337496.89	20.61	0.37
3065A	899255.44	337506.22	20.3	0.36
3066	889927.83	408037.45	141.881	0.531
3066A	889758.56	407986.76	139.661	0.861
3067	945313.77	441468.19	165.411	-0.159
3067A	945369.5	441648.31	161.951	0.171
3068	826561.51	341274.27	80.04	0.37
3068A	826585.17	341163.43	80	0.2
3069	761016.12	370424.51	96.71	0.05
3069A	760987.61	370329.98	96.04	0.08
3070	699128.82	406042	106.54	0.04
3070A	699159.68	405969.12	112.98	-0.12
3071	685975.79	386501.38	42.62	-0.1
3071A	685891.18	386513.93	44	0.83
3072	783305.08	435063.6	261.581	0.061
3072A	783114.31	435115.85	258.721	0.271
3073	734051.15	507475.22	182.101	0.181
3073A	733389.39	507646.86	182.621	-0.049
3074	758849.77	524907.48	362.221	-0.139
3074A	758855.25	525010.19	357.131	-0.339

3075	805384.67	366501.19	103.9	0.5
3075A	805521.08	366280.04	104.88	0.48
3076	973378.43	439320.76	168.861	0.111
3076A	973258.84	439255.79	165.341	-0.029
3077	814128.21	318945.49	45.02	0.64
3077A	814142.27	319104.92	54.6	0.45
3078	861539.88	403943.08	177.521	-0.139
3078A	861542.7	403851.25	174.801	0.201
3079	1111186.9	495217.1	86.2	-0.01
3079A	1111137.2	495107.41	78.61	-0.42

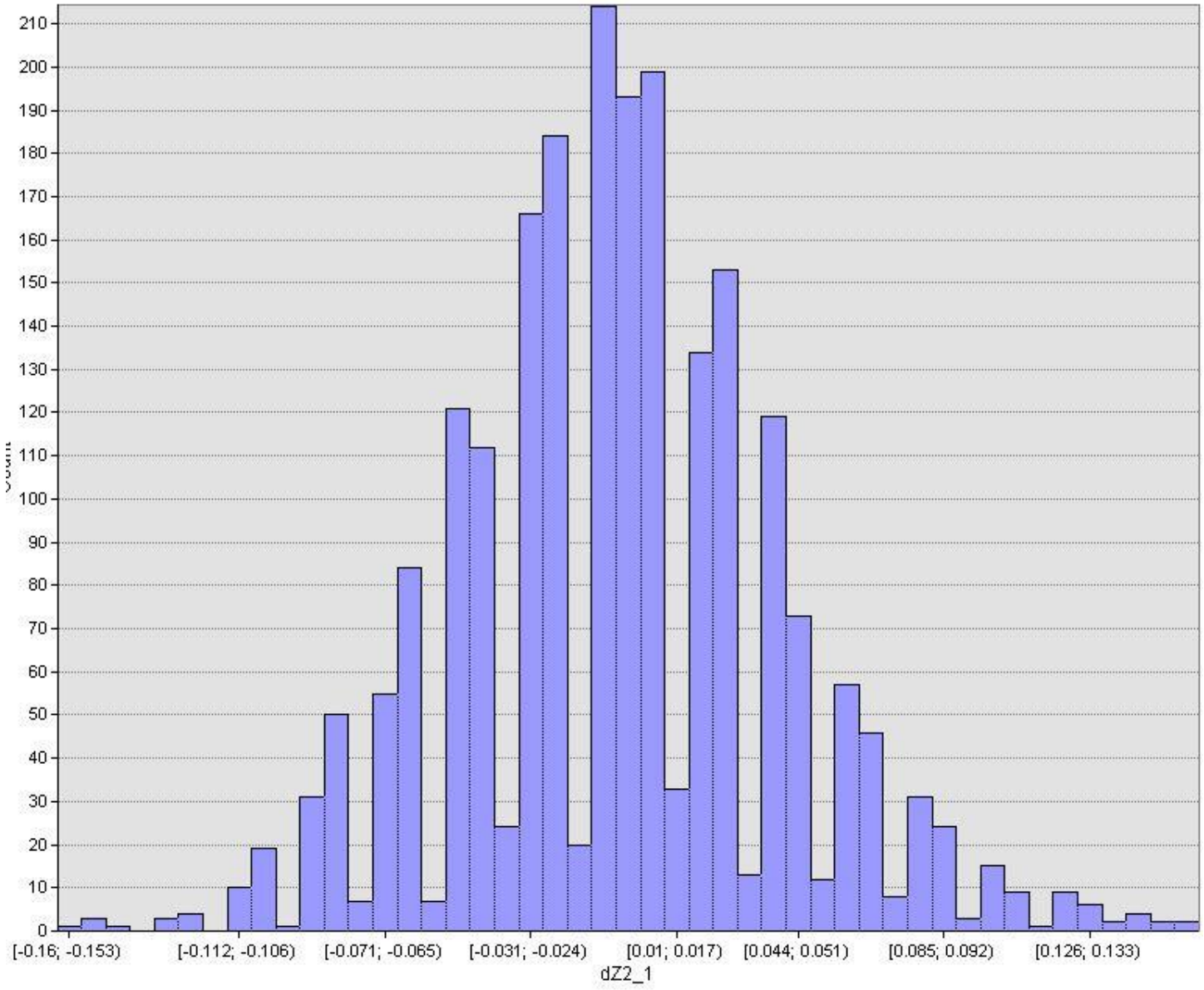
VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.813 US feet at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. VVA Errors larger than 95th percentile include:
Point 3006, Easting 877698.930, Northing 511196.730, Z-Error 0.901 US feet
Point 3049A, Easting 999096.100, Northing 462616.620, Z-Error 0.920 US feet
Point 3055, Easting 1076208.030, Northing 373193.260, Z-Error 0.900 US feet
Point 3055A, Easting 1076234.340, Northing 373087.770, Z-Error 0.850 US feet
Point 3060A, Easting 996995.250, Northing 346375.120, Z-Error 0.940 US feet
Point 3062, Easting 961640.000, Northing 384641.660, Z-Error 1.080 US feet
Point 3066A, Easting 889758.560, Northing 407986.760, Z-Error 0.861US feet
Point 3071A, Easting 685891.180, Northing 386513.930, Z-Error 0.830 US feet

RELATIVE ACCURACY ASSESSMENT AND CONCLUSION

Relative accuracy also known as "between swath" accuracy was tested through a series of well distributed flight line overlap locations. The relative accuracy for the Mississippi Coastal QL2 Lidar with 3DEP Extension tested at 0.055 meters RMSDz.

Figure 5.1: Relative Accuracy Histogram, Mississippi Coastal QL2 Lidar with 3DEP Extension Lidar



Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		January 2016

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
	1/28/2015	28	75157	2	USGS Mississippi Coast

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3579.3	11:00:00	17:00:00	WOOLPERT PIN
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PIB**
RADER	ALS-7177	3583.7	4:45:00	22:45:00	PIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
090 6	10+	Clear		15	-1	30.31		Departing	KHSA
								Arriving	KHSA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41	272	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	6500 Ft	6500 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: 11:44:10
		↓ Times entered are Zulu / GMT ↓						Verify S-Turns Before Mission Yes X No
1	N	18:09:14	18:11:20	12:34:32	18	0.6	1.2	Takeoff: 1752z
2	S	18:15:06	18:19:26	0:00:00	18	0.6	1.1	
3	N	18:22:26	18:27:53	0:00:00	18	0.6	1.1	
4	S	18:30:24	18:36:51	0:00:00	18	0.6	1.1	
5	N	18:39:27	18:46:29	0:00:00	19	0.6	1	
6	S	18:49:33	18:57:14	0:00:00	18	0.6	1.1	
7	N	19:00:03	19:09:20	0:00:00	16	0.6	1.1	
8	S	19:11:57	19:20:52	0:00:00	15	0.6	1	
9	N	19:24:06	19:35:11	0:00:00	14	0.6	1.1	
10	S	19:37:42	19:49:10	0:00:00	15	0.6	1	
11	N	19:50:57	20:03:30	0:00:00	17	0.7	1	
12	S	20:05:50	20:18:39	0:00:00	16	0.8	1.3	
13	N	20:20:31	20:33:41	0:00:00	15	0.7	1.3	
14	S	20:35:45	20:48:54	0:00:00	16	0.7	1.4	
15	N	20:51:48	21:06:21	0:00:00	17	0.7	1.4	
16	S	21:08:28	21:23:29	0:00:00	17	0.6	1.2	
17	N	21:25:22	21:40:57	0:00:00	17	0.6	1.2	
18	S	21:43:11	21:58:57	0:00:00	15	0.6	1.2	70.4 GB
				0:00:00				Landing: 2214z
				0:00:00				Static: 22:18:02 - 22:20:02
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				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 #
	112

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/29/2015	29	75157	2	USGS Mississippi Coast

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3583.7	8:30:00	14:30:00	WOOLPERT PIN
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3585.6	11:45:00	17:45:00	PIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
Calm	10+	Clear		13	9	30.26		Departing	KHSA
								Arriving	KHSA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41	272	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	6500 Ft	6500 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: 15:24:47
		↓ Times entered are Zulu / GMT ↓						Verify S-Turns Before Mission Yes X No
19	N	15:47:57	16:05:33	8:33:32	15	0.7	1.3	Takeoff: 1534z
20	S	16:08:00	16:25:32	0:00:00	16	0.7	1.2	
21	N	16:27;29	16:44:50	0:00:00	17	0.7	1.1	Wpts 3-1 clouds
22	S	16:47:02	17:04:25	0:00:00	18	0.7	1.1	wpts 1-4, 27, 33 clouds
23	N	17:06:34	17:13;00	0:00:00	19	0.7	1	wpts 58-53 clouds Manual Stop
				0:00:00				28 GB
				0:00:00				Landing 1726z
				0:00:00				Static: 17:29:15 - 17:31:15
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				70.4 GB
				0:00:00				
				0:00:00				
				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				
↑ Times entered are Zulu / GMT ↑			Page		1			Verify S-Turns After Mission Yes X No

Additional Comments:

Drive #: 112

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/30/2015	30	75157	2	USGS Mississippi Coast

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3585.6	8:30:00	14:30:00	WOOLPERT PIN
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3592.0	16:00:00	22:00:00	PIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
020 12 g18	10+	Clear		9	1	30.39		Departing	KHSA
								Arriving	KHSA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41	272	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	6500	Ft	6500	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:	15:02:02
↓ Times entered are Zulu / GMT ↓								Verify S-Turns Before Mission	Yes X No
23	N	15:27:04	15:44:28	7:35:54	15	0.7	1.2	REFLIGHT/Takeoff: 1510z	
21	S	15:47:34	15:48:20	0:00:00	15	0.6	1.2		
22	S	15:55:17	16:02:28	0:00:00	16	0.6	1.2		
24	N	16:13:37	16:30:41	0:00:00	16	0.6	1.1		
25	S	16:32:40	16:49:45	0:00:00	16	0.7	1.3		
26	N	16:52:10	17:09:11	0:00:00	16	0.7	1.2		
27	S	17:11:05	17:28:27	0:00:00	16	0.7	1.4		
28	N	17:30:40	17:47:49	0:00:00	17	0.7	1.3		
29	S	17:49:39	18:06:56	0:00:00	17	0.6	1.2		
30	N	18:09:01	18:26:04	0:00:00	19	0.6	1.1		
31	S	18:27:41	18:44:43	0:00:00	19	0.6	1.1		
32	N	18:46:39	19:03:33	0:00:00	19	0.6	1.1		
33	S	19:05:18	19:21:48	0:00:00	19	0.6	1.1		
34	N	19:23:40	19:40:02	0:00:00	18	0.6	1.1		
35	S	19:41:42	19:57:28	0:00:00	17	0.8	1.3		
36	N	19:59:30	20:15:15	0:00:00	17	0.8	1.4		
37	S	20:16:00	20:32:37	0:00:00	16	0.7	1.2	Smoke so thick you can't see	
38	N	20:34:48	20:51:00	0:00:00	15	0.7	1.3	through, but 90% success	
39	S	20:52:54	21:09:10	0:00:00	15	0.7	1.3		
40	N	21:11:10	21:27:14	0:00:00	16	0.6	1.2		
41	S			0:00:00				Landing: 2137z	
42	N			0:00:00				Static: 21:40:10 - 21:42:10	
43	S			0:00:00					
44	N			0:00:00					
45	S			0:00:00					
46	N			0:00:00					
47	S			0:00:00					
				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 #
	112

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/31/2015	31	75157	2	USGS Mississippi Coast

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3592.0	7:30:00	13:30:00	WOOLPERT PIN
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3598.3	15:45:00	21:45:00	PIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
050 5	10+	Clear		4	-3	30.34		Departing	KHSA
								Arriving	KHSA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41	272	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	6500	Ft	6500	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:	14:55:04
		↓ Times entered are Zulu / GMT ↓						Verify S-Turns Before Mission	Yes X No
41	N	15:18:21	15:34:23	7:29:50	16	0.7	1.2	Takeoff: 1505z	
42	S	15:36:50	15:53:00	0:00:00	16	0.7	1.2		
43	N	15:54:37	16:10:34	0:00:00	17	0.6	1.2		
14	S	16:18:24	16:19:52	0:00:00	17	0.6	1.1	Patch 1-6 Manual Stop	
21	N	16:22:31	16:24:29	0:00:00	17	0.7	1.3	Patch 6-1 Manual Start/Stop	
44	S	16:30:50	16:47:00	0:00:00	16	0.7	1.2		
45	N	16:48:29	17:04:15	0:00:00	16	0.7	1.3		
46	S	17:06:10	17:21:05	0:00:00	16	0.7	1.4	Numerous Fires in the project	
47	N	17:24;10	17:30:52	0:00:00	16	0.7	1.4	area	
48	S	17:38:55	17:52:17	0:00:00	16	0.7	1.4		
49	N	17:54:05	18:07:32	0:00:00	18	0.6	1.1		
50	S	18:09:43	18:24:38	0:00:00	18	0.6	1.1		
51	N	18:26:36	18:41:31	0:00:00	18	0.6	1.1		
52	S	18:43;22	18:58:26	0:00:00	19	0.6	1.1		
53	N	19:00:07	19:14:00	0:00:00	20	0.5	1		
54	S	19:16:52	19:31:51	0:00:00	18	0.6	1.2		
55	N	19:33:32	19:48:14	0:00:00	19	0.7	1.2		
56	S	19:50:12	20:05:04	0:00:00	17	0.7	1.3		
57	N	20:06:37	20:21:03	0:00:00	16	0.8	1.3		
58	S	20:23:00	20:37:41	0:00:00	16	0.7	1.2		
59	N	20:39:25	20:53:33	0:00:00	16	0.7	1.2		
60	S	20:55:34	21:10:05	0:00:00	16	0.7	1.2	Smoke (66%) wpts 9-27	
				0:00:00					
				0:00:00				110 GB Used	
				0:00:00				Landing: 2121z	
				0:00:00				Static: 21:25:02-21:27:02	
				0:00:00					
				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 #
	112

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	2/7/2015	38	75157	2	USGS Mississippi Coast

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
GALAMBOS	N7079F	3614.0	13:00:00	19:00:00	WOOLPERT PIN
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3615.4	15:00:00	21:00:00	PIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
220 6	10+	Clear		19	3	30.22		Departing	KHSA
								Arriving	KHSA

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41	272	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	6500	Ft	6500	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:	19:17:16
		↓ Times entered are Zulu / GMT ↓						Verify S-Turns Before Mission	Yes X No
39	N	19:36:27	19:42:20	15:37:26	17	0.8	1.3	1924z depart/ UL001/wpt55-32	
57	N	19:47:13	19:50:13	0:00:00	16	0.7	1.1	UL002/wp 12-1 Man Srt/Stop	
58	S	19:52:39	19:55:01	0:00:00	16	0.7	1.3	WP 1-10 Man Stop	
				0:00:00	17	0.6	1.1	Smoke in the area	
59	N	19:57:11		0:00:00	15	0.7	1.3	wp 10-1/ Sensor Issue No GNSS	
				0:00:00	16	0.7	1.2	Data for 22 seconds/Shut Down	
				0:00:00	16	0.7	1.3	Overfly Base 20:22:35 - 20:26:55	
61	N			0:00:00	16	0.7	1.4	System Malfunction Data Logger	
				0:00:00					
				0:00:00				Landing: 2:47 pm	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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				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 ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	2/27/2015	58	75157

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 ^	2518.2	11:45	17:45
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2522.8	16:35	22:35

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KGPT
340/4	10	10	60	11	-1	30.37		Arriving ICAO	KGPT

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 ☐
60	N	18:14:00	18:24:00		12	0.7	1.6	20 mi FNE re-glight
59	S	18:26:00	18:30:00					8 nm FNE re-flight
71	S	18:38:00	18:52:00					Moved for clouds
70	N	18:55:00	19:09:00					
69	S	19:11:00	19:26:00					
68	N	19:28:00	19:42:00					
67	S	19:46:00	20:00:00					
66	N	20:02:00	20:16:00					
65	S	20:19:00	20:33:00					
64	N	20:36:00	20:50:00					
63	S	20:53:00	21:07:00					
62	N	21:10:00	21:24:00					
61	S	21:36:00	21:41:00					
72	N	21:45:00	21:59:00					Moved to avoid clouds
73	S	22:01:00	20:14:00					
↑ 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, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70

MM/DD/YYYY	Day of Year	Mission Name / Job #
2/27/2015	58	75157

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2522.5	17:00	23:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2525.7	20:25	2:25

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KGPT
030/7	10	Clear	0	13	-2	30.31		Arriving ICAO	KGPT

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 ☒ No ☐
74	N	23:29:00	23:43:00		18	0.6	1.2	
75	S	23:45:00	23:59:00					
76	N	0:02:00	0:15:00					
77	S	0:17:00	0:31:00					
78	N	0:34:00	0:47:00					
79	S	0:50:00	1:03:00					
80	N	1:06:00	1:19:00					
81	S	1:23:00	1:36:00					
82	N	1:39:00	1:52:00					
83	S	1:55:00	2:09:00					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ No ☐

Additional Comments: System worked well, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	2/28/2015	59	75157

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2525.7	8:50	14:50
Pilot			Hobbs End	Local End Time	Zulu End Time
Daniels			2530.1	13:45	19:45

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
040/8	10	Clear	0	7	-2	30.43		KGPT	KGPT

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 ☒ No ☐
84	N	15:17:00	15:30:00		19	0.6	1.1	
85	S	15:34:00	15:47:00					
86	N	15:50:00	16:03:00					
87	S	16:06:00	16:20:00					
88	N	16:23:00	16:36:00					
89	S	16:39:00	16:53:00					
90	N	16:56:00	17:09:00					
91	S	17:11:00	17:25:00					
92	N	17:28:00	17:44:00					
93	S	17:46:00	18:03:00					
94	N	18:06:00	18:20:00					
95	S	18:23:00	18:39:00					Fire/smoke 11.5 FSE
96	N	18:42:00	18:59:00					Clouds popping, 2mi FSE
97	S	19:00:00	19:18:00					Cloud undercast 7 mi FSE
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ 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 #
	3/6/2015	65	75157 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 ☐	2530.1	10:05	16:05
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2534.8	14:10	21:10

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KPQL
240/15	10	clear	10	34	10	30.47		Arriving ICAO	KPQL

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 ☐
95	S	16:37:00	16:39:00		17	0.6	1.1	Reflight for smoke
96	S	16:40:00	16:43:00					Refllight for clouds 3 FSE
97	N	16:46:00	16:49:00					Reflight for couds 7 FSE
98	N	16:56:00	17:13:00					
99	S	17:16:00	17:33:00					
100	N	17:36:00	17:52:00					
101	S	17:55:00	18:11:00					Nav glitches, line jumps
101	N	18:17:00	18:34:00					Reflew this line
102	S	18:36:00	18:53:00					
103	N	18:56:00	19:12:00					
104	S	19:15:00	19:32:00					
105	N	19:34:00	19:51:00					
106	S	19:53:00	20:10:00					
107	N	20:12:00	20:29:00					
108	S	20:31:00	20:47:00					
		↑ Times entered are Zulu / GMT ↑		0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:
While working line 101 the system would automatically change lines, I'd return it and it would change again. Reflew line, then worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #2

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/6/2015	65	75157 Flt 2

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Carlton/Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2534.8	15:18	22:18
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2539.2	20:13	2:13

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KPQL
240/15	10	clear	8	30	10	20.38		Arriving ICAO	KPQL

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 ☐
109	N	22:18:00	22:35:00		17	0.6	1.1	
110	S	22:37:00	22:53:00		17	0.6	1.1	
111	N	22:56:00	23:13:00		17	0.6	1.1	
112	S	23:15:00	23:31:00		17	0.6	1.1	
113	N	23:35:00	23:52:00		17	0.6	1.1	
114	S	23:55:00	0:12:00		17	0.6	1.1	
115	N	0:14:00	0:31:00		17	0.6	1.1	
116	S	0:34:00	0:51:00		17	0.6	1.1	
117	N	0:53:00	1:11:00		17	0.6	1.1	
118	S	1:13:00	1:31:00		17	0.6	1.1	
119	N	1:33:00	1:51:00		17	0.6	1.1	
120	S	1:55:00	3:13:00		17	0.6	1.1	
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:
While working line 101 the system would automatically change lines, I'd return it and it would change again. Reflew line, then worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #3

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/6/2015	65	75157 Flt 3

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Carlton	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2539.2	21:49	3:49
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Shelton			2543.7	1:37	7:37

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KPQL
240/15	10	clear	8	30	10	20.38		Arriving ICAO	KPQL

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 ☐
121	N	3:49:00	4:06:00		16	0.6	1.1	
122	S	4:09:00	4:26:00		15	0.6	1.1	
123	N	4:29:00	4:47:00		17	0.6	1.1	
124	S	4:51:00	5:08:00		18	0.6	1.1	
125	N	5:10:00	5:27:00		18	0.6	1.1	
126	S	5:31:00	5:47:00		17	0.6	1.1	
127	N	5:50:00	6:07:00		17	0.6	1.1	
128	S	6:09:00	6:26:00		17	0.6	1.1	
129	N	6:28:00	6:43:00		16	0.6	1.1	
130	S	6:52:00	6:56:00		17	0.6	1.1	
132	W	7:07:00	7:17:00		18	0.6	1.1	Line 132 was closer than 131
131	W	7:26:00	7:37:00		19	0.6	1.1	
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:
While working line 101 the system would automatically change lines, I'd return it and it would change again. Reflew line, then worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/7/2015	66	75157 Flt1

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 X SH-7108 ☐	2544.4	9:50	15:50
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2548.8	14:30	20:30

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KMCB
L/V	10	N/A	0	8	-6	30.49		Arriving ICAO	KMCB

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 ☐
109	E	16:20:00	16:27:00					
107	N	16:30:00	16:36:00					
106	S	16:39:00	16:54:00					
105	N	16:56:00	17:11:00					
104	S	17:14:00	17:28:00					
103	N	17:31:00	17:46:00					
102	S	17:49:00	18:04:00					
101	N	18:07:00	18:22:00					
100	S	18:24:00	18:39:00					Light smoke 0.5 FSE
99	N	18:42:00	18:56:00					
98	S	18:58:00	19:14:00					Light smoke 0.7 FSE
97	N	19:16:00	19:30:00					
96	S	19:33:00	19:48:00					
95	N	19:50:00	20:06:00					
94	S	20:08:00	20:23:00					
↑ 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, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/7/2015	66	75157 Flt2

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2548.8	15:35	21:35
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2553	20:15	2:15

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

Wind Dir/Speed	Viability	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KMCB
L/V	10	25000	40	18	-10	30.35		Arriving ICAO	KMCB

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 ☒ No ☐
93	N	21:58:00	22:13:00		19	0.6	1.1	
92	S	22:15:00	22:59:00					
91	N	22:33:00	22:47:00					
90	S	22:50:00	23:05:00					
89	N	23:08:00	23:23:00					
88	S	23:26:00	23:40:00					
87	N	23:46:00	23:58:00					
86	S	0:00:00	0:15:00					
85	N	0:18:00	0:33:00					
84	S	0:36:00	0:51:00					
83	N	0:53:00	1:09:00					
82	S	1:11:00	1:26:00					
81	N	1:29:00	1:44:00					
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ No ☐

Additional Comments: System worked well, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #3

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/7/2015	66	75157 Flt 3

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Carlton	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q X	SH-7177 ☐ SH_6157 ☐ SH-7108 X	2553	9:20	3:20
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Shelton			2557.7	1:34	7:34

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	20.18	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
050/02	10	clear	8	30	10	20.18		KPQL	KPQL

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Gain	Mode	
0	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 ☐
80	N	3:19:00	3:26:00		16	0.6	1.3	
79	S	3:29:00	3:35:00		17	0.6	1.2	
78	N	3:37:00	3:43:00		17	0.6	1.1	
77	S	3:46:00	3:53:00		16	0.6	1.1	
76	N	3:56:00	4:02:00		16	0.6	1.1	
75	S	4:05:00	4:11:00		17	0.6	1.1	
74	N	4:14:00	4:20:00		17	0.6	1.1	
49	E	4:24:00	4:38:00		17	0.6	1.1	
48	W	4:41:00	4:56:00		17	0.6	1.1	
47	E	5:01:00	5:17:00		18	0.6	1.1	
46	W	5:21:00	5:38:00		18	0.6	1.1	
45	E	5:42:00	5:58:00		16	0.6	1.1	
44	W	6:01:00	6:18:00		18	0.6	1.1	
43	E	6:20:00	6:36:00		17	0.6	1.1	
42	W	6:39:00	6:56:00		18	0.6	1.1	
41	E	6:59:00	7:15:00		19	0.6	1.1	
40	W	7:17:00	7:34:00		20	0.6	1.1	
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes X No ☐

Additional Comments:
While working line 101 the system would automatically change lines, I'd return it and it would change again. Reflew line, then worked well.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/8/2015	67	75157

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	2557.7	10:00	15:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2560	12:30	17:30

Passengers	Using or Relying on CORS	GPS Base #1	Operator	PID
	Yes ☐ No X	GPS Base #1	Annen	KHKS
		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	8K	90	8	3	30.3		KHKS	KHKS

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 ☐
1	E	15:30:00	15:45:00		19	0.6	1.2	
2	W	15:48:00	16:03:00					
3	E	16:05:00	16:21:00					
4	W	16:23:00	16:38:00					
5	E	16:41:00	16:57:00					
6	W	16:59:00	17:14:00					
↑ 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, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70	MM/DD/YYYY	Day of Year	Mission Name / Job #
	3/17/2015	76	75157

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2573.5	7:20	12:20
Pilot			Hobbs End	Local End Time	Zulu End Time
Daniels			2578.8	11:00	16:00
Passengers	Using or Relying on CORS: Yes ☐ No ☒		GPS Base #1 Operator: Annen		PID: KHKS
			GPS Base #2 Operator:		PID:

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
270/4	10	Clear	0	17	13	30.12		KHKS	KHKS

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 ☒ No ☐
7	E	12:55:00	13:10:00		19	0.6	1.1	
8	W	13:12:00	13:28:00					
9	E	13:31:00	13:46:00					
10	W	13:49:00	14:05:00					
11	E	14:07:00	14:22:00					Clouds 14 FWE to 17 FEW
50	E	14:26:00	14:33:00					Clouds building, moved east
51	W	14:36:00	14:43:00					
52	E	14:46:00	14:53:00					
53	W	14:57:00	15:04:00					
54	E	15:07:00	15:14:00					
55	W	15:16:00	15:24:00					
56	E	15:26:00	15:33:00					Clouds again, looking for a spot.
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ 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 #
	3/27/2015	86	75157 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 X	2596.4	8:15	13:15
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2601.2	13:20	18:20

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
340/6	7	10K	80	6	3	30.07		KHKS	KHKS

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 ☐
12	W	13:51:00	14:06:00		19	0.6	1.1	
13	E	14:09:00	14:24:00					
14	W	14:27:00	14:43:00					
15	E	14:47:00	15:03:00					
16	W	15:06:00	15:22:00					
17	E	15:25:00	15:41:00					
18	W	15:44:00	16:00:00					
19	E	16:03:00	16:18:00					
20	W	16:22:00	16:38:00					
21	E	16:41:00	16:56:00					
22	W	17:00:00	17:17:00					
23	E	17:20:00	17:35:00					
24	W	17:38:00	17:57:00					
↑ 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, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70

MM/DD/YYYY	Day of Year	Mission Name / Job #
3/27/2015	86	75157

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	2601.2	14:00	19:00
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2603.4	16:40	21:40

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KHKS
310/16	10	7k	40	16	1	30.06		Arriving ICAO	KHKS

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 ☐
108	S	19:26:00	19:38:00		19	0.6	1	Cross line southbound
39	E	19:50:00	20:07:00					
38	W	20:11:00	20:38:00					Turbulance
37	E	20:31:00	20:47:00					Clouds coming down
73	N	20:56:00	20:59:00					Moved for weather
72	S	21:00:00	21:06:00					
								Done due to clouds & Turb.
↑ 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 #
3/28/2015	87	75157

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	2603.4	8:05	13:05
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2607.8	13:05	18:05

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KHKS
070/4	10	Clear	0	6	3	30.24		Arriving ICAO	KHKS

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 ☐
25	E	13:42:00	13:58:00		17	0.6	1.4	
26	W	14:01:00	14:18:00					
27	E	14:20:00	14:37:00					
28	W	14:40:00	14:57:00					
29	E	15:00:00	15:16:00					
30	W	15:19:00	15:36:00					
31	E	15:39:00	15:55:00					
32	W	15:58:00	16:15:00					
33	E	16:17:00	16:33:00					
34	W	16:36:00	16:53:00					
35	E	16:55:00	17:11:00					
36	W	17:14:00	17:31:00					
↑ 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, no issues.

Drive #

WOOLPERT FLIGHT LOG SHEET #1

Leica ALS-70

MM/DD/YYYY	Day of Year	Mission Name / Job #
3/28/2015	87	75157 Flt 2

Operator	Aircraft	Sensor	Hobbs Start	Local Start Time	Zulu Start Time
Annen	N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒	SH-7177 ☐ SH_6157 ☐ SH-7108 ☒	2607.8	13:45	18:45
Pilot			**Hobbs End**	**Local End Time**	**Zulu End Time**
Daniels			2611	17:05	22:05

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

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	Arriving ICAO
050/5	10	9K	100	11	1	30.26		KHKS	KHKS

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 ☒ No ☐
R56	E	19:10:00	19:17:00		15	0.6	1.2	Reflight
57	W	19:19:00	19:27:00					
58	E	19:30:00	19:37:00					
59	W	19:41:00	19:48:00					
60	E	19:51:00	19:58:00					
61	W	20:02:00	20:10:00					Light smoke 5NM FEE
62	E	20:12:00	20:19:00					
63	W	20:22:00	20:30:00					
64	E	20:32:00	20:29:00					
65	W	20:43:00	20:48:00					
66	N	20:55:00	20:58:00					
67	S	21:00:00	21:04:00					
68	N	21:07:00	21:10:00					
69	S	21:13:00	21:17:00					
70	N	21:19:00	21:23:00					
71	S	21:26:00	21:30:00					
72R	N	21:32:00	21:36:00					Reflight
73R	S	21:39:00	21:42:00					Reflight
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ 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 #
3/29/2015	88	75157

Operator	Pilot	Passengers
Annen	Daniels	

Aircraft: N475RC ☐ N404CP ☐ N7079F ☐ N475CP ☐ N1107Q ☒

Sensor: SH-7177 ☐ SH_6157 ☐ SH-7108 ☒

Using or Relying on CORS: Yes ☐ No ☒

Hobbs Start	Local Start Time	Zulu Start Time
2611	13:30	17:30
Hobbs End	**Local End Time**	**Zulu End Time**
2612.4	14:10	19:10

GPS Base #1	Operator	Annen	PID	KHKS
GPS Base #2	Operator		PID	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing ICAO	KHKS
170/8	10	Clear	0	18	6	30.27		Arriving ICAO	KHKS

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 ☒ No ☐
61	E	18:02:00	18:04:00		14	0.6	1.4	Re-flight for smoke
37	W	18:12:00	18:22:00					We could only fly the 20 NM
38	E	18:26:00	18:35:00					On the east side due to clouds
39	W	18:38:00	18:46:00					and a controlled forrestry burn
								on the west side of the AOR
↑ Times entered are Zulu / GMT ↑				0:00:00 Total Time On Line				Verify S-Turns After Mission Yes ☒ No ☐

Additional Comments: System worked well, no issues.

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	4/2/2015	92			Mississippi-South-Grant / Reflight

Operator	Aircraft	Hobbs Start	Local Start Time	Zulu Start Time	Base
SIMMONS	N1107Q	2614.2	16:25:00	20:25:00	CORS
Pilot	**Sensor Type**	**Hobbs End**	**Local End Time**	**Zulu End Time**	**PID**
Other	ALS-7108	2617.5	20:00:00	1:00:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
	10	CLR				3036		Departing	KFFC
								Arriving	KJAN

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	X	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
37	W	23:56:00	0:14:00	0:46:00				ENTIRE LINE AT ORIGINAL ALTITUDE - 6
37	E	0:22:00	0:24:00	0:00:00				PATCH FLIGHT AT LOWER ALTITUDE - 4
37	W	0:27:00	0:28:00	0:00:00				PATCH FLIGHT AT LOWER ALTITUDE - 4
				0:00:00				
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑			Page		1			Verify S-Turns After Mission Yes X No

Additional Comments:	Drive #

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/15/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Calibration		
Area	Falcon Field Calibration	Mission ID	FFC
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2	Dushan Arumugam	Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	FFC 3001 Rebar	System	Chiroptera II
Airport Start	Falcon Field, GA	Airport End	Falcon Field, GA

Times (UTC):

Engine Start	14:05	Survey Stop	15:58
GNSS Start	14:10	Touchdown	16:00
Static Start	14:15	Static Start	16:01
Static Stop	14:20	Static Stop	16:06
Takeoff	14:26	GNSS Off	16:10
Survey Start	14:49	Engines Off	16:10

Weather:

Sea State	N/A	Wind Speed (kts)	5
Cloud Cover	Clear	Wind Direction	Variable

Topo Settings:		**Shallow Settings:**	
Scanner Speed	4200	Scanner Speed	1457@1000m, 2013@500m
Laser PRF	360@1000m, 420@500m	RTC	200
Peak Threshold	300	Delta Voltage	300@1000m, 163@500m
Energy	23@1000m, 18@500m		

Notes:

Calibration flight at several altitudes with topo and bathy sensor active. Also ran lower altitudes for RCD30 resolution evaluation. No LiDAR recorded on those flight lines.

Time (UTC)	FL #	Heading	Remarks
			Begin 1000m calibration lines
14:49	11	NW	Along runway alignment
14:52	38	SE	Along runway alignment
14:56	34	NE	Across runway to NW
15:00	33	SW	Across runway midway
15:04	33	NE	Across runway midway
15:08	35	SE	Across runway to SE
15:12	35	NW	Across runway to SE
			Begin 500m calibration lines
15:17	1	SE	Along runway alignment- RERUN back reflection alarm
15:22	1	NW	Turned down PRF from 440 to 420
15:25	28	NE	Across runway to NW
15:30	24	SW	Across runway midway
15:35	24	NE	Across runway midway
15:37	26	SW	Across runway to SE
15:42	26	NE	Across runway to SE
			Turned off AHAB OC and powered down lasers
			Ran RCD30 test lines

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/15/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Calibration		

Time (UTC)	FL #	Heading	Remarks
			GSD evaluation lines using same flight plan
15:52	1	NW	Along runway 400m (2000' Alt when using 689' ground)
15:56	1	SE	Along runway 300m (1670' Alt when using 689' ground)
			Flight complete

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/16/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		
Area	Area 1 - West	Mission ID	2015-005_1000m
Operator 1	Dushan Arumugam	Aircraft	Cessna 401 N6255Q
Operator 2	Ben Hocker	Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	STENNIS 1986	System	Chiroptera II
Airport Start	Stennis, MS	Airport End	Stennis, MS

Times (UTC):

Engine Start	9:05	Survey Stop	13:40
GNSS Start	9:10	Touchdown	13:48
Static Start	9:15	Static Start	13:50
Static Stop	9:20	Static Stop	13:55
Takeoff	9:27	GNSS Off	13:57
Survey Start	9:45	Engines Off	13:57

Weather:

Sea State	N/A	Wind Speed (kts)	5kts
Cloud Cover	Clear	Wind Direction	Variable

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	300
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Waveland for this area - predicted low was a -0.12 meters at 11:53 UTC. Note that first line was a few minutes before the 2 hour window.

Time (UTC)	FL #	Heading	Remarks
9:45	1	E (74)	Begin Area 1 @ 3030' (1000m AGL) ~120kts
9:59	2	W (253)	
10:13	3	E	
10:28	4	W	
10:42	5	E	
10:58	6	W	
11:13	7	E	
11:28	8	W	
11:43	9	E	
11:59	10	W	
12:15	11	E	
12:30	12	W	
12:46	13	E	
13:03	14	W	
13:18	15	E	
13:30	16	W	Last line of the day

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/17/2015
Project Name	Mississippi LiDAR
Project Number	2015-005
Operations	Tide coordinated topographic mapping

Area	Area 1 - West	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	STENNIS 1986	System	Chiroptera II
Airport Start	Stennis, MS	Airport End	Stennis, MS

Times (UTC):

Engine Start	10:16	Survey Stop	14:28
GNSS Start	10:22	Touchdown	14:35
Static Start	10:24	Static Start	14:39
Static Stop	10:29	Static Stop	14:44
Takeoff	10:34	GNSS Off	14:46
Survey Start	10:45	Engines Off	14:46

Weather:

Sea State	N/A	Wind Speed (kts)	15
Cloud Cover	Clear but misty- heavy dew	Wind Direction	NW

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	300
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Waveland for this area - predicted low was at 12:26 UTC. Tide window from 10:26 to 14:26 UTC. Possibility that hight power was causing back reflection in misty conditions.

Time (UTC)	FL #	Heading	Remarks
10:45	17	W (253)	REJECT: laser 1 error. Restart AHAB computer
10:58	17	E (73)	Begin Area 1 @ 3030' (1000m AGL) ~120kts
11:12	18	W	
11:24	19	E	
11:36	20	W	Back reflection alarm near SOL - may need to rerun part
11:47	21	E	
11:59	22	W	
12:09	23	E	
12:20	24	W	
12:29	25	E	
12:39	26	W	
12:49	27	E	
12:58	28	W	
13:15	29	W	
13:23	30	E	
13:30	31	W	
13:37	32	E	
13:45	33	W	

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/17/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		

Time (UTC)	FL #	Heading	Remarks
13:52	34	E	Continue area 1
13:59	35	W	
14:07	20	E	Rerun of line with back reflection alarm
14:20	1	W	Rerunning portion of line that may have been before
			Tide window on previous day
14:28			End survey

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/18/2015

Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		

Time (UTC)	FL #	Heading	Remarks
13:04	44	E	Continue Area 3
13:17	45	W	Final line. Note that frames 27 onwards to west were
			past tide window (EOL 4 mins outside of window)
			We had to transit this way to GPT - may need to rerun
13:28			Survey complete

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/18/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		
Area	Area 2 and 3 - Central	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	GULFPORT TCP	System	Chiroptera II
Airport Start	Gulfport, MS (GPT)	Airport End	Gulfport, MS (GPT)

Times (UTC):

Engine Start	9:10	Survey Stop	13:28
GNSS Start	9:13	Touchdown	13:38
Static Start	9:15	Static Start	14:40
Static Stop	9:20	Static Stop	13:45
Takeoff	9:28	GNSS Off	13:49
Survey Start	9:38	Engines Off	13:50

Weather:

Sea State	N/A	Wind Speed (kts)	12
Cloud Cover	Clear but hazy	Wind Direction	NW

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	230
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Gulfport for this area - predicted low was at 11:24 UTC. Tide window from 09:24 to 13:24 UTC.

Time (UTC)	FL #	Heading	Remarks
9:38	53	W (255)	Start Area 2, Central West, 1000m (3063' AGL)
9:52	54	E (75)	
10:07	55	W	
10:21	56	E	
10:36	57	W	
10:58	58	E	
11:07	59	W	
11:22	60	E	Last line of Area 2
11:33			Completed Area 2 moving to Area 3
11:38	36	E (118)	Begin Area 3, Central East, 1000m (3046' AGL)
11:45	37	W(292)	
11:52	38	E	
12:02	39	W	
12:16	40	E	
12:26	41	W	
12:39	42	E	
12:50	43	W	
13:04	44	E	

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/22/2015

Project Name	Mississippi LiDAR
Project Number	2015-005
Operations	Tide coordinated topographic mapping

Area	Area 3 - Central	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	GULFPORT TCP	System	Chiroptera II
Airport Start	Gulfport, MS (GPT)	Airport End	Gulfport, MS (GPT)

Times (UTC):

Engine Start	0:16	Survey Stop	2:17
GNSS Start	0:19	Touchdown	2:24
Static Start	0:20	Static Start	2:26
Static Stop	0:25	Static Stop	2:31
Takeoff	0:33	GNSS Off	2:33
Survey Start	0:41	Engines Off	2:33

Weather:

Sea State	N/A	Wind Speed (kts)	22
Cloud Cover	Scattered 4200	Wind Direction	W (260)

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	230
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Gulfport for this area - predicted low was at 21:14L (02:14 UTC). Tide window from 00:14 to 04:14 UTC. Note local date is 03/22/2015, UTC is 03/23/2015.

Time (UTC)	FL #	Heading	Remarks
0:41	45	E (112)	Rerun of last line from 3/18/2015
0:55	46	W (292)	
1:08	47	E	
1:21	48	W	
1:34	49	E	
1:47	50	W	
1:59	51	E	
2:10	52	W	
2:17			Area 3 complete, returning to GPT

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/23/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		
Area	Area 4 - East	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	FAA M 50 A	System	Chiroptera II
Airport Start	Trent Lott, Pascagoula, MS	Airport End	Trent Lott, Pascagoula, MS

Times (UTC):

Engine Start	0:15	Survey Stop	N/A
GNSS Start	0:20	Touchdown	0:44
Static Start	0:22	Static Start	N/A
Static Stop	0:27	Static Stop	N/A
Takeoff	0:32	GNSS Off	0:45
Survey Start	N/A	Engines Off	0:46

Weather:

Sea State	N/A	Wind Speed (kts)	15
Cloud Cover	Broken cloud <3000'	Wind Direction	NE

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	230
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Pascagoula for this area - predicted low was at 02:45 UTC. Tide window from 00:45 to 04:45 UTC. Note local date started on 03/23 then rolled over midnight to 3/24. Was all UTC 3/24.

Time (UTC)	FL #	Heading	Remarks
0:40			Unable to survey- broken clouds over area.

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/24/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		
Area	Area 4 - East	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	FAA M 50 A	System	Chiroptera II
Airport Start	Trent Lott, Pascagoula, MS	Airport End	Trent Lott, Pascagoula, MS

Times (UTC):

Engine Start	4:21	Survey Stop	7:15
GNSS Start	4:25	Touchdown	7:22
Static Start	4:26	Static Start	7:23
Static Stop	4:31	Static Stop	7:28
Takeoff	4:36	GNSS Off	7:30
Survey Start	4:43	Engines Off	7:30

Weather:

Sea State	N/A	Wind Speed (kts)	10-15
Cloud Cover	3100	Wind Direction	ESE

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	200
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Pascagoula for this area - predicted low was at 6:41 UTC. Tide window from 04:41 to 08:41 UTC. Note local date at start was 3/24 then rolled over to 3/25. UTC was all 3/25.

Time (UTC)	FL #	Heading	Remarks
4:43	79	E (95)	Begin Area 4
4:50	78	W (275)	
4:58	77	E	
5:07	76	W	
5:15	75	E	
5:25	74	W	
5:36	73	E	
5:48	72	W	
6:01	71	E	Back reflection alarm prior to SOL- rerun just in case
6:13	70	W	
6:26	69	E	
6:38	68	W	Small cloud below aircraft in area data not required
6:50	67	E	Ceiling dropping- reduce altitude 50 feet
7:02	66	W	Ended early before EOL -in clouds
			Looked over rest of area. Clouds too low.
			Return to Trent Lott.

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/26/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Tide coordinated topographic mapping		
Area	Area 4 - East	Mission ID	2015-005_1000m
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	FAA M 50 A	System	Chiroptera II
Airport Start	Trent Lott, Pascagoula, MS	Airport End	Trent Lott, Pascagoula, MS

Times (UTC):

Engine Start	5:17	Survey Stop	7:08
GNSS Start	5:25	Touchdown	7:16
Static Start	5:26	Static Start	7:19
Static Stop	5:31	Static Stop	7:24
Takeoff	5:36	GNSS Off	7:26
Survey Start	5:46	Engines Off	7:26

Weather:

Sea State	N/A	Wind Speed (kts)	20
Cloud Cover	Clear, heavy dew	Wind Direction	SSW

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	173
Energy	36		

Notes:

Tide coordinated mapping: 2 hours +/- of predicted low. Working from NOAA predicted tides at Pascagoula for this area - predicted low was at 07:41 UTC. Tide window from 05:41 to 09:41 UTC.

Time (UTC)	FL #	Heading	Remarks
5:46	61	E (95)	Continue Area 4
5:56	62	W (275)	Back reflection alarm at SOL. Abort.
6:03	62	W	Rerun
6:14	63	E	
6:26	64	W	
6:36	65	E	
6:47	66	W	
6:59	71	E	Rerun
7:08			Area 4 complete.

GEOMATICS DATA SOLUTIONS

Flight Log

Date	3/26/2015		
Project Name	Mississippi LiDAR	Project Number	2015-005
Operations	Calibration at end of project		
Area	1000m calibration	Mission ID	FFC
Operator 1	Ben Hocker	Aircraft	Cessna 401 N6255Q
Operator 2		Pilot 1	Ray Laroque
Other Crew		Pilot 2	
GNSS Base	FFC 3001 Rebar	System	Chiroptera II
Airport Start	Falcon Field, GA	Airport End	Falcon Field, GA

Times (UTC):

Engine Start	20:51	Survey Stop	21:38
GNSS Start	20:55	Touchdown	21:44
Static Start	20:58	Static Start	21:47
Static Stop	21:03	Static Stop	21:52
Takeoff	21:07	GNSS Off	21:53
Survey Start	21:15	Engines Off	21:53

Weather:

Sea State	N/A	Wind Speed (kts)	12
Cloud Cover	Clear	Wind Direction	SW

Topo Settings:		**Shallow Settings:**	
Scanner Speed	3805	Scanner Speed	1423
Laser PRF	250	RTC	200
Peak Threshold	300	Delta Voltage	230
Energy	36		

Notes:

Time (UTC)	FL #	Heading	Remarks
21:15	35	NE (42)	Begin calibration at 1000 m AGL
21:19	33	SW (222)	
21:24	34	NE	
21:28	11	NE (311)	
21:33	33	NE	
21:37	11	SE (131)	Calibration lines complete.

Section 7: Final Deliverables

The final lidar deliverables are listed below.

- LAS v1.4 classified point cloud
- LAS v1.4 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 layout and data extent provided as ESRI shapefile
- Control Points provided as ESRI shapefile
- Flight line vectors provided as ESRI shapefile
- FGDC compliant metadata per product in XML format
- Lidar processing report in pdf format
- Survey report in pdf format