LiDAR Project Report

G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR

QL2 LiDAR

Prepared For:

United States Geological Survey

Prepared By:

Digital Aerial Solutions, LLC

CONTRACT: #G10PC00093
CONTRACTOR: DIGITAL AERIAL SOLUTIONS
TASK ORDER: # G16PD00019

Project Report

LiDAR Collection, Processing, and QA/QC

G16PD00019, Middle Brazos Lake
Whitney, TX QL2 LiDAR

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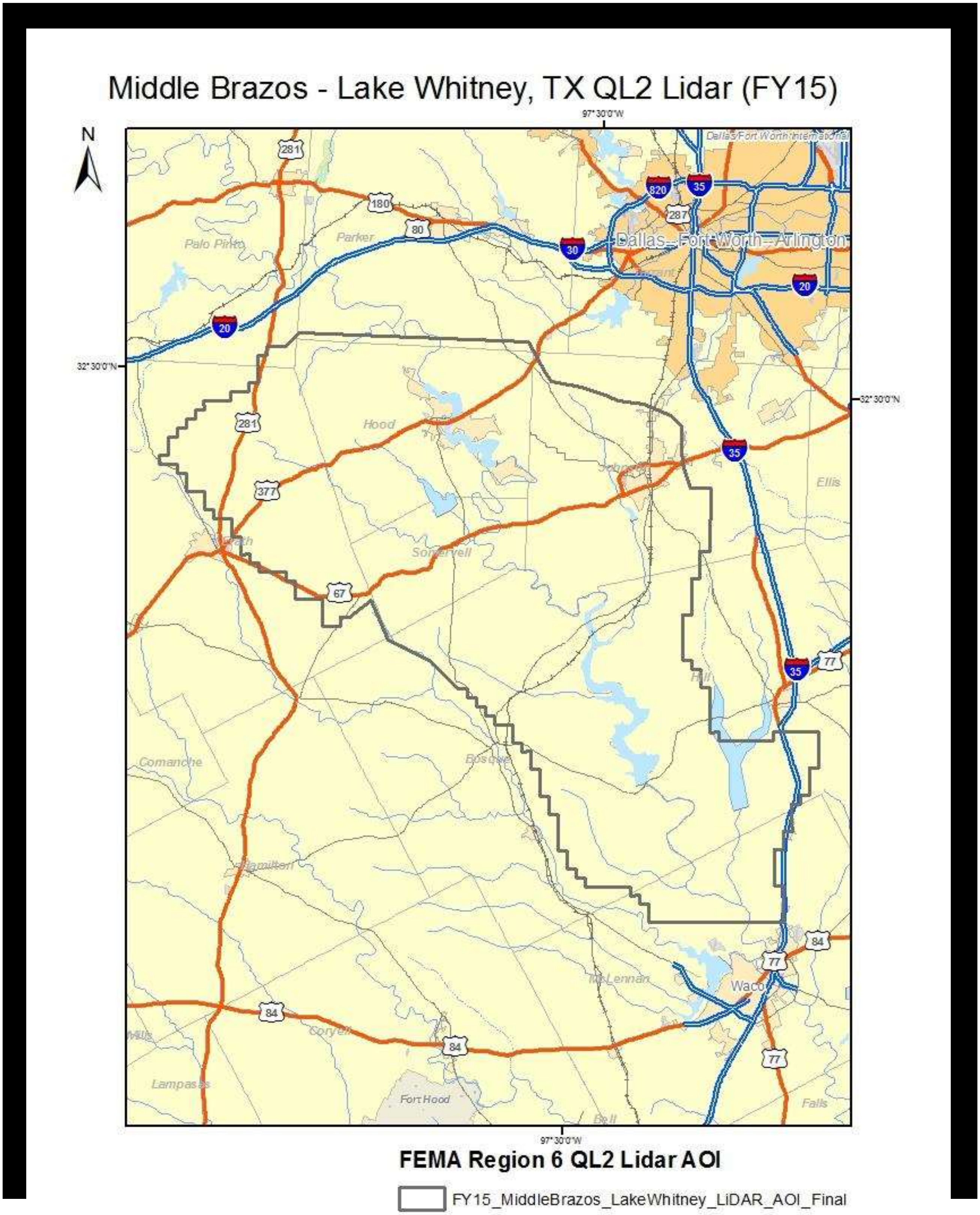
Middle Brazos - Lake Whitney, TX QL2 Lidar (FY15)
97°30'0"W
N
32°30'0"N
Dallas/Fort Worth International
Dallas--Fort Worth--Arlington
Palo Pinto
Parker
Hood
Somervell
Ellis
Hill
Bosque
Comanche
Hamilton
McLennan
Waco
Coryell
Mills
Lampasas
Fort Hood
Bell
Falls
281
180
80
30
820
35
287
20
377
67
77
84
FEMA Region 6 QL2 Lidar AOI
FY15_MiddleBrazos_LakeWhitney_LiDAR_AOI_Final

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1 Introduction and Specifications

Digital Aerial Solutions, LLC (DAS) was tasked to collect and process a Light Detection And Ranging (LiDAR) derived elevation dataset for the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR. The area encompasses approximately 2370 square miles Aerial LiDAR data was collected utilizing an ALS70 and ALS80. The ALS70 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems.
LiDAR data collected for the G16PD00019, Middle Brazos Lake Whitney, TX Lidar survey has a nominal pulse spacing of 0.7 meters, and includes up to 8 discrete returns per pulse, along with intensity values for each return.

LiDAR datasets were post processed to generate elevation point cloud swaths for each flight line. Deliverables include the point cloud swaths, tiled point clouds classified by land cover type, breaklines to support hydro-flattening of digital elevation models (DEM)s, intensity tiles, and bare-earth DEM tiles. Point cloud deliverables are stored in the LAS version 1.4 format, point data record format 6. The tiling scheme for tiled deliverables is a 1500 meters x 1500 meter grid. Tile number is the appropriate cell number values found in the USNG index. All deliverables were generated in conformance with the *U.S. Geological Survey National Geospatial Program Guidelines and Base Specifications, Version 1.2.*

2 Spatial Reference System

The spatial reference of the data is as follows.

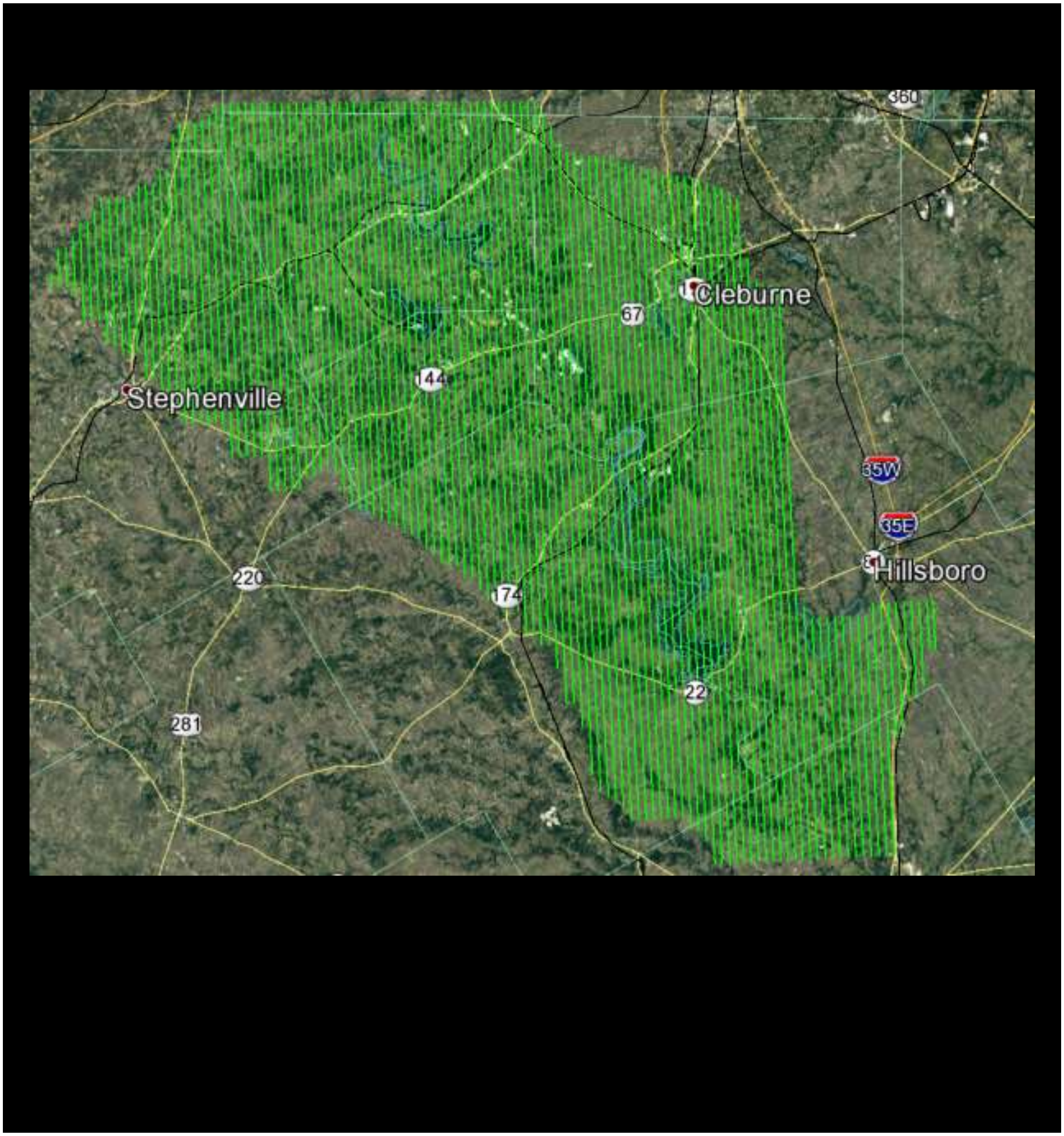
Horizontal Spatial Reference
- Datum: NAVD88, Meters (to 3 decimal places)
- Coordinates: UTM Zone 14, NAD83, Meters (to 2 decimal places);

Vertical Spatial Reference
All datasets are available with orthometric elevation; point cloud datasets are also available with ellipsoid heights
- Datum: North American Vertical Datum of 1983 (GEOID12B)

3 LiDAR Acquisition

3.1 Survey Area

The G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR survey covers approximately 3993 square miles covering Erath, Hood, Johnson, Somerwell, Bosque, Hill and McLennan Counties. The flight plan consisted of 118 survey lines and 3 control lines.



3.2 Acquisition Parameters

Acquisition parameters include the sensor configuration and the flight plan characteristics, and are selected based on a number of project specific criteria. Criteria reviewed include the required accuracies for the final dataset, the land cover types within the project survey area, and the required nominal pulse spacing. Acquisition parameters selected for the Middle Brazos Lake Whitney 2ppsm Lidar project are summarized below.

Parameter	Value
Flying Height Above Ground Level	6230 feet
Nominal Sidelap	30%
Nominal Speed Over Ground	155 knots
Field of View	36°
Laser Rate	132 kHz
Scan Rate	66.2 hz
Maximum Cross Track Spacing	0.78 meters
Maximum Along Track Spacing	0.82 meters
Average Spacing	0.7 meters

3.3 Acquisition Mission

The acquisition mission for G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR survey was coordinated to be acquired in 2 weeks, Collection began on March 1st 2016 and was completed on March 21th, 2016.

3.4 Airborne GPS/IMU

Airborne global positioning system (GPS) and inertial measurement unit (IMU) data was collected on the aircraft during the acquisition mission, providing sensor position and orientation information for geo-referencing the LiDAR data. Airborne GPS observations were collected at a frequency of 2Hz, and IMU observations are collected at a frequency of 200Hz.

Aircraft	Sensor	GPS Lever Arm (m)	IMU Lever Arm (m)
C421 – N112MJ	ALS70 – SN1132	x: -0.210, y: -0.060, z: -1.370	x: -0.450, y: -0.159, z: -0.169

In addition, GPS data was collected with ground base stations during the acquisition mission, providing corrections to support differential post-processing of the airborne GPS. One ground base station was setup at an NGS Benchmark as the base of operation. The additional ground base station were selected and place threw the project to ensure complete coverage. Ground GPS observations were collected at a frequency of 2Hz.

4 LiDAR Processing

4.1 Acquisition Post-Processing

Once the acquisition was completed, initial post-processing was performed to generate geo-referenced LiDAR elevation point clouds.

The airborne GPS dataset was differentially corrected using the ground base station GPS datasets collected by DAS in Lecia's INERTIALEXPLORER software. INERTIALEXPLORER computes the GPS dataset corrections in both forward and reverse chronological sequence, obtaining two solutions for the GPS trajectory. The differences between these two solutions were reviewed to ensure a consistent result, and agree within +/- 3cm. The forward and reverse solutions also show good fit between the two different base stations used in the post-processing.

Differentially corrected airborne GPS data was merged with the airborne IMU dataset in Leica's INERTIALEXPLORER software through Kalman filtering techniques. INERTIALEXPLORER applies the reference lever arms for the GPS and IMU measurement systems during processing to determine the trajectory (position and orientation) of
the LiDAR sensor during the acquisition mission. Estimated lever arm values reported posteriori validate the measurements made during sensor installation in the aircraft.

Raw LiDAR sensor ranging data and the final sensor trajectory from INERTIALEXPLORER were processed in Leica's ALSPP software to produce the LiDAR elevation point cloud swaths for each flightline, stored in LAS version 1.4 file format. Quality control of the swath point clouds was performed to validate proper function of the sensor systems, full coverage of the project AOI, and point density consistent with the planned nominal pulse spacing.

Swath point clouds were assigned a unique File Source ID within the LAS file format before further processing. Swath files for the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR project were numbered in chronological order of acquisition.

4.2 Geometric Calibration

Geometric and positional accuracy of the LiDAR swath point clouds is highly dependent on accurate calibration of the various subsystems within the LiDAR sensor system. Sensor calibration parameters fall into two categories, one being those parameters proprietary to the manufacturer's sensor design, and the other being parameters common to most commercial airborne LiDAR sensors, the IMU to laser reference system alignment angles (bore-site), and mirror deformation constants (scaling).

The manufacturer specific calibration parameters are applied in Leica's Cloud Pro software for the ALS80 sensor system. Terrasolid's Terramatch software was used to calculate the IMU bore-site and mirror scale parameters for the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR. Within the TerraMatch software, the Tie- line workflow was used to solve for the parameters. The Tie-line workflow involves automated selection of numerous 'tie-lines', which represent a linear segment fit to the data that should have the same slope, azimuth, position and elevation, within the overlap sections of the survey lines and control lines. The tie- lines provide observations for algorithms within TerraMatch to solve for the bore-site and mirror scale parameters for the lift.

The Tie-line workflow is dependent upon well distributed tie-lines throughout the swath point clouds to effectively solve for bore-site and mirror scale parameters with the automated algorithms.

survey and control lines. Manual estimation of the bore-site and mirror scale parameters was performed using the observed tie-lines in overlap areas.

The final step of geometric calibration is to determine elevation (z) offset corrections to be applied to the swath point clouds. Z values calculated during the course of the acquisition mission can vary at the centimeter level as the GPS satellite constellation observed in the survey area changes with satellites moving through their orbits over the course of the mission. Baseline length from the ground base station GPS to the airborne GPS can also impact the z values calculated for the swath point clouds. Z offset corrections are calculated in two steps; a relative step, where individual lines are corrected one to another using the adjusted tie-lines from the bore-site and mirror scale calculation step; and an absolute step, where groups of lines are leveled to project ground control.

For the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR project, the control lines were used to determine relative z offset corrections in areas of discernible ground. The base station operated by DAS in the survey area provided for minimal baseline lengths, resulting in generally good z agreement between the survey lines and control lines.

The final geometrically calibrated swath point clouds were compared to the bare-earth profile survey data. The data fit the profile surveys within the vertical accuracy tolerance specified for the project. Full documentation of the vertical accuracy checks maybe found in section 5.1.

4.3 Point Cloud Classification

Georeference information was applied to the swath point could LAS files. Geometrically calibrated swath point clouds were cut into USNG index, 1500 meter x 1500 meter LAS 1.4 format tiles for point cloud classification and derived product creation.

Tiled point cloud data was processed in Terrasolid's Terrascan software to assign initial classification values. The Terrascan software provides a number of routines to algorithmically detect and assign points to their appropriate class. Points left unclassified by the algorithmic routine remain as Class 1 – Processed, but unclassified. Automated classification routines assigned points to one of the following classes:

Class 1 – Processed, but unclassified
Class 2 – Bare-earth ground
Class 7 – Low Noise (low, manually identified, if necessary)
Class 9 — Water
Class 10 — Ignored Ground (Breakline Proximity)
Class 17 — Bride Decks
Class 18 – High Noise (high, manually identified, if necessary)

Automated classification results were reviewed for each tiled point cloud, and manual edits made where necessary to correct for misclassified points. Points remaining in Class 1 after the automated classification routines were run were left in Class 1. Points falling outside of a 100 meter buffer of the project AOI polygon were excluded from the tiled point clouds.

4.4 Breakline Collection

Manual breakline collection was performed to support the hydro-flattening requirements of the project's DEM deliverables. Breaklines were collected directly from the classified point clouds and from triangulated irregular network (TIN) surface models built from the classified point clouds, in Terrasolids's Terrascan and Terramodeler software. Breakline features were collected as design file elements in Bentley's Microstation software. Breaklines were converted to ESRI 3D shapefile format for the breakline deliverable, and tiled to USNG index.

The data collected for the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR survey maintained significant point density in the water, limiting the usefulness of point density as guiding factor in breakline placement.

Points classified as Class 2 – Bare-earth ground, falling within a one meter buffer of the collected breaklines, were reassigned to Class 10 – Ignored Ground. These points are excluded from the surface model during DEM generation to preserve the hydro-flattening characteristics of the breaklines.

4.5 DEM Generation

The final classified point clouds and collected breaklines were reviewed for completeness and conformance to the task order scope of work. Within the Terramodeler software, points in Class 2 – Bare-earth ground and the breaklines were combined to generate TIN elevation models for each tile, from which the bare-earth DEM tiles were interpolated and exported as 32 bit raster IMG format.

5 Quality Control

5.1 Point Clouds

Accuracy and completeness of the LiDAR point clouds directly impacts the quality of all other derived LiDAR derived products. Ensuring a quality LiDAR dataset begins with proper mission planning and execution. Ground GPS base stations are located such that GPS baselines between the ground and airborne receivers do not exceed 30km. For the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR project, two base stations were run to meet this requirement, one at the field operations airport and one within the survey area. Static alignment is performed both before take-off and after landing to allow for GPS integer ambiguity resolution. Sensor operators carefully monitor the LiDAR unit and its various subsystems during the acquisition mission to ensure proper function. Airborne GPS positional dilution of precision (PDOP) estimates are monitored to ensure they remain less than 3.The optical system is monitored to ensure there are no ranging errors encountered during the flight lines.

During acquisition post-processing estimates of the trajectory data accuracy are reviewed to ensure they will support the required accuracies of the point cloud data. The trajectory accuracy is a function of the differentially corrected GPS data and the IMU data.

The raw swath point clouds generated from CloudPro are reviewed as another check for proper sensor function. The point clouds are reviewed for full coverage of the AOI, required point density and nominal pulse spacing, clustering, proper intensity values, full swath coverage within the planned field of view, and planned survey line overlap.

Geometric calibration quality control validates that the positional accuracy requirements of the project are met, and includes relative accuracy assessments for intra-swath (within) and inter-swath (between) accuracy, along with absolute accuracy assessments against project ground control.

Relative vertical accuracy assessments are normally made using the tie-lines generated in the Terramatch software, as these lines provide positional observations throughout the extent of individual swaths, and between neighboring swaths.

There is not a systematic method of testing when testing horizontal accuracy in LiDAR. The estimated Horizontal accuracy at one sigma based on the flying height for the project, is between 10cm and 20cm according to manufacturer specifications.

Absolute vertical accuracy assessments for the point cloud data are made against ground check point data. For the G16PD00019, Middle Brazos Lake Whitney, TX QL2 LiDAR, ground check point data consisted of the ground GPS base station, and real-time kinematic (RTK) GPS techniques.

Check point locations were collected at 1 – second intervals during the RTK survey. Points collected during the static pre-initialization and post-initialization were removed from the assessment so as not to bias the assessment.

Local TIN models of the elevation points are built around each ground check points. The tin model elevation is sampled at the horizontal position of the ground check point. The TIN model elevation and ground check point survey elevation values were used to calculate the fundamental vertical accuracy (FVA) of the swath point clouds. The NVA of the TIN tested RMSEz 0.036 meters and 0.070 meters at the 95% confidence level in open terrain. NVA of the DEM tested at an RMSEz of 0.035 meters and 0.069 meters at the 95% confidence level in open terrain. The full calculations for all check points can be found in Appendix B.

FVA of TIN

$RMSE_Z$ =	0.036	meters
NSSDA=	0.070	meters

FVA of DEM

$RMSE_Z$ =	0.035	meters
NSSDA=	0.069	meters

The tiled point cloud products were reviewed for full coverage of the AOI and proper classification. As part of the QC process, TINs are built in the Terramodeler software for each tile using the ground class and the hydro-flattening breaklines. The TINs are reviewed for non-ground features, and edited where necessary to remove any remaining non-ground features. Points were also reviewed for absolute elevation, and points falling below the selected orthometric elevation for water were removed from the ground class.

5.2 Breaklines

The final breaklines in ESRI 3D shapefile format were reviewed for topological consistency and correct elevation. Breaklines features are continuous and do not have overlaps or dangles.

5.3 Digital Elevation Models

Digital elevation models (DEMs) were reviewed for conformance with the SOW and the Base Mapping Specification version 1.2 guidelines. DEM files were loaded in the Global Mapper software and inspected visually for edge matching between tiles, void areas within the project AOI, and proper coding of the NODATA values. DEM file naming was verified for consistency with the USNG index.

Appendix A. Flight Logs

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project	**TexasQL2 (FY15)**	**ALS80_HP**	SN 8235		**Sensor Operator/s**	
				-	Sam Robinson	
Date/Julian:	3/4/2016	**Disk Drive MM70**	**TAR AIRSPD (KNTS)**	**Base PID:**	**Pilot/s**	
Hobbs End	1259.7	4-808654D	150	CS3188	Mike Millard	
Hobbs ST	1255.7	LIFT: **708**	**TAR ALT AGL (ft):**	**Flight Plan(s):** / **Base Height:**	**Aircraft**	**Airport Idnt:**
Flight Time	4.0	**B**	6600-7600	TXQL2ALS80 / 1.500	421C 112MJ	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B													
	1	X03	160304_211012	21:10	21:17	6,745	270	147	679	17	1.1	0.6	X-STRIP
	2	J036	160304_212138	21:21	21:32	6,950	0	150	673	16	1.3	0.6	
	3	J037	160304_213539	21:35	21:46		180	146	669	15	1.4	0.6	
	4	J038	160304_214935	21:49	22:00		0	150	664	15	1.5	0.6	
	5	J039	160304_220403	22:04	22:15		180	151	659	16	1.3	0.6	
	6	J040	160304_221906	22:19	22:31		0	148	654	17	1.1	0.6	
	7	J041	160304_223408	22:34	22:46		180	151	649	17	1.2	0.6	
	8	J042	160304_224935	22:49	23:01		0	150	644	17	1.1	0.6	
	9	J043	160304_230514	23:05	23:17		180	149	639	17	1.2	0.6	
	10	J044	160304_232009	23:20	23:32		0	150	634	16	1.3	0.6	
	11	J045	160304_233543	23:35	23:48		180	150	629	17	1.2	0.6	
	12	J046	160304_235108	23:51	:3		0	147	624	17	1.4	0.6	
	13	J047	160305_000702	24:07	24:19		180	149	619	17	1.4	0.6	
	14	X02	160305_002945	24:29	24:33	6,965	270	149	617	18	1.2	0.6	X-STRIP

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP SN 8235		Sensor Operator/s
			-	Sam Robinson
Date/Julian:	3/5/2016	Disk Drive MM70	TAR AIRSPD (KNTS)	Base PID:
Hobbs End	1267.4	4-808654D	150	CS3188

Date/Julian:	3/5/2016		Disk Drive MM70	TAR AIRSPD (KNTS)		Base PID:	Pilot/s	
Hobbs End	1267.4		4-808654D	150		CS3188	MWAZ	
Hobbs ST	1263.6	LIFT	708	TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:
Flight Time	3.8	A		6600-7600	TXQL2ALS80	1.500	421C 112MJ	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	HDOP	Comments and Conditions:
A													
	1	X02	160305_145750	14:57	15:03	6,692	270	151	615	16	1.3	0.6	X-STRIP
	2	J087	160305_151225	15:12	15:32	6,495	180	152	607	19	1.1	0.6	
	3	J086	160305_153647	15:36	15:56		0	148	599	21	1.0	0.5	
	4	J079	160305_155951	15:59	16:18		180	151	591	20	1.0	0.5	
	5	J078	160305_162152	16:21	16:41		0	146	584	17	1.3	0.7	
	6	J077	160305_164349	16:43	17:03		180	148	577	18	1.2	0.7	
	7	J076	160305_170551	17:05	17:25		0	148	569	18	1.1	0.6	
	8	J075	160305_172810	17:28	17:47		180	148	561	15	1.2	0.8	
	9	X05	160305_175105	17:51	17:55	6,470	90	155	559	15	1.2	0.7	X-STRIP
	10	J074	160305_180110	18:01	18:19	6,632	0	146	552	15	1.2	0.7	

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP SN 8235		Sensor Operator/s	Sam Robinson
Date/Julian:	3/5/2016	Disk Drive MM70	TAR AIRSPD (KNTS)	Base PID:	Pilot/s
Hobbs End	1270.9	4-808654D	150	CS3188	Mike Millard
Hobbs ST	1267.4	LIFT 708	TAR ALT AGL (ft):	Flight Plan(s):	Base Height:
Flight Time	3.5	B	6600-7600	TXQL2ALS80	1.500

Aircraft	Airport Idnt:
421C 112MJ	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B													
	1	X01	160305_205716	20:57	21:00	6,743	270	149	549	17	1.1	0.6	X-STRIP
	2	J048	160305_210548	21:05	21:18	6,741	180	150	545	16	1.2	0.7	
	3	J049	160305_212140	21:21	21:34		0	150	540	15	1.2	0.6	
	4	J050	160305_213744	21:37	21:50		180	150	534	15	1.4	0.7	
	5	J051	160305_215348	21:53	22:07		0	154	529	16	1.4	0.6	
	6	J052	160305_221026	22:10	22:23		180	146	523	17	1.2	0.6	
	7	J053	160305_222654	22:26	22:40		0	152	518	17	1.2	0.6	
	8	J054	160305_224343	22:43	22:57		180	148	513	17	1.2	0.6	
	9	J055	160305_225957	22:59	23:13		0	147	506	17	1.2	0.6	
	10	J056	160305_231649	23:16	23:30		180	147	501	16	1.2	0.6	
	11	J057	160305_233341	23:33	23:47	6,680	0	148	495	19	1.2	0.6	
	12	X02	160305_235701	23:57	24:00	6,718	270	153	493	18	1.4	0.6	X-STRIP

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project		TexasQL2 (FY15)		ALS80_HP	SN 8235							Sensor Operator/s	
									-			Bertin Evina-Ze	
Date/Julian:		3/15/2016			Disk Drive MM70		TAR AIRSPD (KNTS)				Base PID:	Pilot/s	
Hobbs End		1274.6			4-808654D		150				CS3188	Mike Millard	
Hobbs ST		1270.9		LIFT	706		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:
Flight Time		3.7		A			6600-7600		TXQL2ALS80		1.500	421C 112MJ	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									148				Air Start
	1	X02	160315_234354	23:43	23:49	6,615	270	150	146	17	1.3	0.6	X-STRIP
	2	85	160315_235832	23:58	24:17	6,500	180	155	138	18	1.1	0.6	
	3	84	160316_002107	24:21	24:40		0	154	131	16	1.2	0.7	
	4	83	160316_004316	24:43	1:01		180	151	123	15	1.3	0.8	
	5	82	160316_010506	1:05	1:24		0	150	115	15	1.3	0.8	
	6	81	160316_012753	1:27	1:46		180	154	108	13	1.6	0.9	
	7	80	160316_015024	1:50	2:09		0	150	100	15	1.2	0.8	
	8	73	160316_021308	2:13	2:31		180	150	93	15	1.3	0.7	
	9	X05	160316_023710	2:37	2:40	6,470	90	150	8	16	1.2	0.7	X-STRIP

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP	SN 8235		Sensor Operator/s
				-	Bertin Evina-Ze
Date/Julian:	3/16/2016	Disk Drive MM70	TAR AIRSPD (KNTS)	Base PID:	Pilot/s
Hobbs End	1278.5	4-808654D	150	CS3188	MWAZ
Hobbs ST	1274.6	LIFT / 705	TAR ALT AGL (ft):	Flight Plan(s): / Base Height:	Aircraft / Airport Idnt:
Flight Time	3.9	A	6600-7600	TXQL2ALS80 / 1.500	421C 112MJ / KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									152				Air Start
	1	X01	160316_154805	15:48	15:51	6,800	270	145	150	18	1.2	0.7	X-STRIP
	2	J058	160316_155628	15:56	16:11	6,700	180	149	144	18	1.1	0.6	
	3	J059	160316_161437	16:14	16:29		0	150	147	19	1.1	0.6	
	4	J060	160316_163304	16:33	16:48		180	155	132	18	1.2	0.7	
	5	J061	160316_165145	16:51	17:06		0	147	126	17	1.2	0.7	
	6	J062	160316_171053	17:10	17:26		180	147	120	17	1.2	0.7	
	7	J063	160316_172925	17:29	17:45		0	150	113	18	1.2	0.7	
	8	J064	160316_174924	17:49	18:05		180	146	106	18	1.1	0.6	
	9	J065	160316_180844	18:08	18:25	6,600	0	150	100	14	1.5	0.8	
	10	J066	160316_182922	18:29	18:45		180	151	93	14	1.4	0.8	
	11	X03	160316_185438	18:54	18:56		270	156	92	15	1.1	0.7	X-STRIP

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP	SN 8235		-	Sensor Operator/s: Bertin Evina-Ze
Date/Julian:	3/16/2016	Disk Drive MM70	TAR AIRSPD (KNTS)		Base PID:	Pilot/s
Hobbs End	1282.4	4-808654D	150		CS3188	Mike Millard
Hobbs ST	1278.6	LIFT 704	TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft / Airport Idnt:
Flight Time	3.8	B	6600-7600	TXQL2ALS80	1.500	421C 112MJ / KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B									165				Air Start
	1	J067	160316_222626	22:26	22:43	6,600	180	147	158	17	1.3	0.6	
	2	J068	160316_224759	22:47	23:05		0	145	151	16	1.3	0.6	
	3	J069	160316_230945	23:09	23:27		180	152	144	17	1.3	0.6	
	4	J070	160316_233044	23:30	23:48		0	151	137	17	1.2	0.6	
	5	J071	160316_235202	23:52	24:10		180	153	129	18	1.1	0.6	
	6	J072	160317_001357	24:13	24:32		0	`151	121	16	1.2	0.6	
	7	J088	160317_003825	24:38	24:58		180	152	114	16	1.3	0.6	
	8	J089	160317_010154	1:01	1:22		0	153	105	16	1.2	0.7	
	9	X02	160317_012842	1:28	1:34	6,700	270	152	103	14	1.7	0.8	X-STRIP
	10	X03	160317_014110	1:41	1:47		90	153	102	16	1.2	0.7	X-STRIP

ALS80 LiDAR Flight Log													
Project	TexasQL2 (FY15)			ALS80_HP	SN 8235							Sensor Operator/s	
										-		Bertin Evina-Ze	
Date/Julian:	3/19/2016				Disk Drive MM70		TAR AIRSPD (KNTS)				Base PID:	Pilot/s	
Hobbs End	1286.5				4-808654D		150				CS3188	MWAZ	
Hobbs ST	1282.6		LIFT		706		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:
Flight Time	3.9		A				6600-7600		TXQL2ALS80		1.500	421C 112MJ	KCPT(Cleburne, TX)
Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									493				
	1	X05	160319_152345	15:23	15:26		270	148	491	17	1.3	0.6	X-STRIP
	2	J100	160319_153418	15:34	15:51		0	146	484	17	1.3	0.6	
	3	J099	160319_155539	15:55	16:12		180	152	477	18	1.1	0.6	
	4	J098	160319_161630	16:16	16:33		0	146	470	17	1.1	0.7	
	5	J097	160319_163712	16:37	16:54		180	150	463	15	1.3	0.7	
	6	J096	160319_165837	16:58	17:16		0	145	456	16	1.2	0.7	
	7	J095	160319_172048	17:20	17:40		180	153	448	17	1.2	0.6	
	8	J094	160319_174359	17:44	18:03		0	147	440	16	1.2	0.7	Display freezes
													Air Start
B	1	X04	160319_182152	18:21	18:23		270	150	439	14	1.3	0.7	X-STRIP
	2	J102	160319_182650	18:26	18:34		180	150	436	15	1.3	0.7	
	3	J101	160319_183724	18:37	18:45		0	150	432	16	1.1	0.7	
	4	X04	160319_184829	18:48	18:49		90	150	432	16	1.1	0.7	X-STRIP

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project	**TexasQL2 (FY15)**	**ALS80_HP**	SN 8235		-	**Sensor Operator/s** Bertin Evina-Ze
Date/Julian:	3/19/2016		**Disk Drive MM70** 4-808654D	**TAR AIRSPD (KNTS)** 150	**Base PID:** TEMP	**Pilot/s** MWAZ
Hobbs End	1286.5					
Hobbs ST	1282.6	LIFT	**706**	**TAR ALT AGL (ft):** 6600-7600	**Flight Plan(s):** TXQL2ALS80	**Base Height:** 1.500
Flight Time	3.9	**A**			**Aircraft** 421C 112MJ	**Airport Idnt:** KINJ(HILLSBORO, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									493				
	1	X05	160319_152345	15:23	15:26		270	148	491	17	1.3	0.6	**X-STRIP**
	2	J100	160319_153418	15:34	15:51		0	146	484	17	1.3	0.6	
	3	J099	160319_155539	15:55	16:12		180	152	477	18	1.1	0.6	
	4	J098	160319_161630	16:16	16:33		0	146	470	17	1.1	0.7	
	5	J097	160319_163712	16:37	16:54		180	150	463	15	1.3	0.7	
	6	J096	160319_165837	16:58	17:16		0	145	456	16	1.2	0.7	
	7	J095	160319_172048	17:20	17:40		180	153	448	17	1.2	0.6	
	8	J094	160319_174359	17:44	18:03		0	147	440	16	1.2	0.7	**Display freezes**
													Air Start
B	1	X04	160319_182152	18:21	18:23		270	150	439	14	1.3	0.7	**X-STRIP**
	2	J102	160319_182650	18:26	18:34		180	150	436	15	1.3	0.7	
	3	J101	160319_183724	18:37	18:45		0	150	432	16	1.1	0.7	
	4	X04	160319_184829	18:48	18:49		90	150	432	16	1.1	0.7	**X-STRIP**

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP	SN 8235	Sensor Operator/s	Bertin Evina-Ze
Date/Julian:	3/19/2016	Disk Drive MM70	4-808654D	Pilot/s	Mike Millard
Hobbs End	1290.4	TAR AIRSPD (KNTS)	150	Base PID:	TEMP
Hobbs ST	1286.5	LIFT	C	Base Height:	1.500
Flight Time	3.9	706		Aircraft	421C 112MJ
TAR ALT AGL (ft):	6600-7600	Flight Plan(s):	TXQL2ALS80	Airport Idnt:	KINJ(Hillsboro, TX)
			-		

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
C									432				
	1	X04	160319_200458	20:04	20:11	6,600	270	152	429	18	1.1	0.6	X-STRIP
	2	J094	160319_202201	20:22	20:41	6,500	0	148	421	17	1.2	0.6	
	3	J093	160319_204459	20:44	21:04		180	151	413	16	1.4	0.6	
	4	J092	160319_210849	21:08	21:28		0	145	404	18	1.1	0.6	
	5	J091	160319_213156	21:31	21:51		180	152	396	18	1.2	0.6	
	6	J090	160319_215539	21:55	22:15		0	150	388	18	1.1	0.6	
	7	J102	160319_222914	22:29	22:36		180	154	385	19	1.1	0.6	
	8	J103	160319_224010	22:40	22:47		0	157	382	18	1.3	0.6	
	9	J104	160319_225030	22:50	22:57		180	150	379	18	1.3	0.6	
	10	J105	160319_230100	23:01	23:08		0	147	376	18	1.3	0.6	
	11	J106	160319_231102	23:11	23:18		180	154	373	18	1.3	0.6	
	12	X05	160319_232334	23:23	23:27	6,500	270	151	372	18	1.2	0.6	X-STRIP

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	**ALS80_HP**	SN 8235	**Sensor Operator/s**	Bertin Evina-Ze
				-	
Date/Julian:	3/19/2016	**Disk Drive MM70**	4-808654D	**Pilot/s**	Mike Millard
Hobbs End	1282.4	**TAR AIRSPD (KNTS)**	150	**Base PID:**	CS3188
Hobbs ST	1278.6	LIFT	706	**TAR ALT AGL (ft):**	6600-7600
Flight Time	3.8		C	**Flight Plan(s):**	TXQL2ALS80
Base Height:	1.500	**Aircraft**	421C 112MJ	**Airport Idnt:**	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
C									432				
	1	X04	160319_200458	20:04	20:11	6,600	270	152	429	18	1.1	0.6	X-STRIP
	2	J094	160319_202201	20:22	20:41	6,500	0	148	421	17	1.2	0.6	
	3	J093	160319_204459	20:44	21:04		180	151	413	16	1.4	0.6	
	4	J092	160319_210849	21:08	21:28		0	145	404	18	1.1	0.6	
	5	J091	160319_213156	21:31	21:51		180	152	396	18	1.2	0.6	
	6	J090	160319_215539	21:55	22:15		0	150	388	18	1.1	0.6	
	7	J102	160319_222914	22:29	22:36		180	154	385	19	1.1	0.6	
	8	J103	160319_224010	22:40	22:47		0	157	382	18	1.3	0.6	
	9	J104	160319_225030	22:50	22:57		180	150	379	18	1.3	0.6	
	10	J105	160319_230100	23:01	23:08		0	147	376	18	1.3	0.6	
	11	J106	160319_231102	23:11	23:18		180	154	373	18	1.3	0.6	
	12	X05	160319_232334	23:23	23:27	6,500	270	151	372	18	1.2	0.6	X-STRIP

ALS80 LiDAR Flight Log													
Project	TexasQL2 (FY15)			ALS80_HP	SN 8235							Sensor Operator/s	
									-			Bertin Evina-Ze	
Date/Julian:	3/20/2016			Disk Drive MM70			TAR AIRSPD (KNTS)			Base PID:		Pilot/s	
Hobbs End	1293.5			4-808654D			150			TEMP		MWAZ	
Hobbs ST	1290.8		LIFT	706			TAR ALT AGL (ft):		Flight Plan(s):	Base Height:		Aircraft	Airport Idnt:
Flight Time	2.7		A				6600-7600		TXQL2ALS80	1.500		421C 112MJ	KINJ(HILLSBORO, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									370				
	1	X04	160320_154737	15:47	15:50	6,600	270	148	369	18	1.1	0.6	X-STRIP
	2	J107	160320_155459	15:55	16:02	6,500	180	154	366	18	1.1	0.6	
	3	J108	160320_161600	16:16	16:23		0	140	362	18	1.1	0.6	
	4	J109	160320_162711	16:27	16:34		180	153	360	17	1.2	0.7	
	5	J110	160320_163901	16:39	16:47		0	138	356	17	1.3	0.7	
	6	J111	160320_165032	16:50	16:58		180	153	353	17	1.2	0.7	
	7	J112	160320_170545	17:05	17:10		0	139	351	17	1.2	0.6	
	8	J113	160320_171330	17:13	17:17		180	153	350	18	1.1	0.6	
	9	J114	160320_172109	17:21	17:24		0	138	348	18	1.1	0.6	
	10	J115	160320_172808	17:28	17:31		180	153	347	18	1.1	0.6	
	11	J116	160320_173508	17:35	17:38		0	142	346	18	1.1	0.6	
	12	J117	160320_174111	17:41	17:42	6,500	180	155	345	17	1.1	0.6	
	13	J118	160320_174658	17:46	17:48		0	144	345	16	1.1	0.7	
	14	X05	160320_175726	17:57	17:59		270	146	344	16	1.1	0.7	X-STRIP

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP	SN 8235	Sensor Operator/s	Bertin Evina-Ze
				-	
Date/Julian:	3/20/2016	Disk Drive MM70	4-808654D	TAR AIRSPD (KNTS)	150
Base PID:	TEMP	Pilot/s	Mike Millard		
Hobbs End	1293.5				
Hobbs ST	1293.5	LIFT	A		706
TAR ALT AGL (ft):	6600-7600	Flight Plan(s):	TXQL2ALS80	Base Height:	1.500
Aircraft	421C 112MJ	Airport Idnt:	KSEP(Stephensville, TX)		
Flight Time	0.0				

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B									370				
	1	J022	160320_201708	20:17	20:26		270	148	369	18	1.1	0.6	X-STRIP
	2	J021	160320_203022	20:30	20:39		180	154	366	18	1.1	0.6	
	3	J020	160320_204319	20:43	20:43		0						Abort
													Air Start
C													Laser failure
	1	J020	160320_210013	21:00	21:09	7,094	0	150	332	17	1.2	0.6	
	2	J019	160320_211205	21:12	21:20		180	152	328	18	1.1	0.6	
	3	J018	160320_212416	21:24	21:33		0	145	324	18	1.1	0.6	
	4	J017	160320_213705	21:37	21:44		180	153	321	18	1.1	0.6	
	5	J016	160320_214848	21:48	21:56		0	146	318	18	1.1	0.6	
	6	J015	160320_215918	21:59	22:05	7,113	180	153	315	18	1.1	0.6	
	7	J014	160320_221019	22:10	22:16		0	146	313	17	1.2	0.6	
	8	J013	160320_221923	22:19	22:25	7,150	180	151	311	17	1.3	0.6	
	9	J012	160320_222936	22:29	22:34		0	145	309	18	1.2	0.6	
	10	J011	160320_223738	22:37	22:42		180	153	307	18	1.3	0.6	
	11	J010	160320_224613	22:46	22:51	7,200	0	140	305	18	1.3	0.6	
	12	J009	160320_225427	22:54	22:58		180	150	303	18	1.4	0.6	
	13	J008	160320_230318	23:03	23:07		0	145	301	19	1.3	0.6	
	14	X02	160320_231558	23:15	23:20		90	140	299	19	1.1	0.6	X-STRIP

ALS80 LiDAR Flight Log													
Project	TexasQL2 (FY15)		ALS80_HP	SN 8235							Sensor Operator/s		
								-			Bertin Evina-Ze		
Date/Julian:	3/20/2016			Disk Drive MM70		TAR AIRSPD (KNTS)				Base PID:	Pilot/s		
Hobbs End	1297.5			4-808654D		150				TEMP	MWAZ		
Hobbs ST	1293.9		LIFT	706		TAR ALT AGL (ft):		Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
Flight Time	3.6		D			6600-7600		TXQL2ALS80		1.500	421C 112MJ	KSEP(Stephensville, TX)	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
D									300				
	1	J007	160321_003334	24:33	24:37	7,180	0	140	299	16	1.2	0.7	
	2	J006	160321_004120	24:41	24:44	7,296	180	153	298	17	1.2	0.7	
	3	J005	160321_004841	24:48	24:51	7,296	0	140	296	15	1.5	0.8	
	4	J004	160321_005524	24:55	24:57	7,370	180	154	295	14	1.5	0.8	
	5	J003	160321_010055	1:00	1:02	7,400	0	146	294	15	1.8	0.8	
	6	J002	160321_010550	1:05	1:07	7,416	180	145	293	14	1.5	0.8	
	7	J001	160321_011118	1:11	1:12	7,500	0	145	292	14	1.7	0.9	
	8	X02	160321_011651	1:16	1:19	6,714	90	154	291	15	1.7	0.9	X-STRIP
	9	X02	160321_012442	1:24	1:28	6,714	270	152	290	16	1.2	0.9	X-STRIP

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project	TexasQL2 (FY15)	ALS80_HP	SN 8235				Sensor Operator/s	
							Bertin Evina-Ze	
Date/Julian:	3/21/2016	Disk Drive MM70		TAR AIRSPD (KNTS)		Base PID:	Pilot/s	
Hobbs End	1303.2	4-808654D		150		CS3188	Mike Millard	
Hobbs ST	1299.1	LIFT	706	TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft	Airport Idnt:
Flight Time	4.1	A		6600-7600	TXQL2ALS80	1.500	421C 112MJ	KCPT(Cleburne, TX)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									290				
	1	X02	160321_170556	17:05	17:10	6,700	270	150	288	18	1.1	0.6	X-STRIP
	2	J073	160321_171920	17:19	17:38	6,600	180	150	280	18	1.1	0.6	
	3	J080	160321_174200	17:42	18:01		0	152	272	16	1.2	0.7	
	4	J081	160321_180456	18:04	18:24		180	151	264	15	1.3	0.7	
	5	J082	160321_182702	18:27	18:46		0	150	257	15	1.2	0.7	Sensor Error
													Autostart
B													
	1	J083	160321_190653	19:06	19:26	6,600	180	152	248	14	1.3	0.7	
	2	J082	160321_192902	19:29	19:48		0	149	242	15	1.2	0.7	Refly
	3	J084	160321_195113	19:51	20:10		180	148	234	18	1.1	0.6	
	4	X05	160321_201555	20:15	20:17		90	150	234	18	1.1	0.6	X-STRIP
	5	J085	160321_202332	20:23	20:42		0	153	226	17	1.2	0.6	
	6	X02	160321_204951	20:49	20:50		270	150	226	16	1.4	0.6	X-STRIP

ALS80 LiDAR Flight Log

Project	**TN3CountyQL2**	**ALS80**	SN 8235	-	**Sensor Operator/s** Bertin Evina-Ze
Date/Julian:	1/5/2016	**Disk Drive MM70**	**TAR AIRSPD (KNTS)**	**Base PID:**	**Pilot/s**
Hobbs End	2964.1	1-808654A	155	FE2752	MWAZ
Hobbs ST	2959.6	LIFT	**TAR ALT AGL (ft):**	**Flight Plan(s):**	**Base Height:**
Flight Time	4.5	**A**	6,300	TN_ALS80	1.500

Aircraft	**Airport Idnt:**
421C 13RF	M08 (Bolivar, TN)

Lift		**Flight Line**	**Mission Line**	**UTC time: B:**	**UTC time: E:**	**GPS Altitude: ASL:**	**Direction**	**Speed: kts:**	**Available MM Space**	**S/Vs:**	**Position Acc. PDOP**	**Position Acc. HDOP**	**Comments and Conditions:**
A									392				
	1	28	160105_180908	18:09	18:19	6,300	180	156	348	18	1.3	0.7	
	2	27	160105_182406	18:24	18:34		0	157	344	19	1.2	0.6	
	3	26	160105_183846	18:38	18:48		180	156	338	20	1.1	0.6	
	4	25	160105_185347	18:53	19:03		0	158	334	20	1.1	0.6	
	5	24	160105_190826	19:08	19:18		180	156	330	20	1.0	0.6	
	6	23	160105_192249	19:22	19:32		0	156	326	19	1.0	0.6	
	7	22	160105_193736	19:37	19:48		180	155	322	21	1.0	0.5	
	8	21	160105_195210	19:52	20:02		0	157	318	20	1.0	0.6	
	9	20	160105_201025	20:11	20:20		180	154	314	19	1.1	0.6	
	10	19	160105_202440	20:24	20:34		0	157	310	18	1.2	0.6	
	11	X01	160105_204121	20:41	20:46		270	155	306	18	1.2	0.7	**X-STRIP**
	12	18	160105_205115	20:51	21:01		180	156	302	17	1.2	0.7	
	13	X04	160105_210758	21:08	21:11		90	156	300	17	1.1	0.7	**X-STRIP**
	14	17	160105_211537	21:15	21:25		0	155	296	19	1.0	0.6	
	15	16	160105_213021	21:30	21:40		180	157	292	18	1.0	0.6	
	16	15	160105_214529	21:45	21:55		0	155	287	16	1.3	0.7	

ALS80 LiDAR Flight Log

Project	TN3CountyQL2		ALS80	SN 8235							Sensor Operator/s	
								-			Bertin Evina-Ze	
Date/Julian:	1/5/2016			Disk Drive MM70		TAR AIRSPD (KNTS)			Base PID:		Pilot/s	
Hobbs End	2964.1			1-808654A		155			FE2752		Mike Millard	
Hobbs ST	2959.6	LIFT				TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:	
Flight Time	4.5	B				6,300	TN_ALS80		1.500	421C 13RF	M08 (Bolivar, TN)	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B									287				
	1	X01	160105_232101	23:21	23:24	6,300	270	157	285	16	1.2	0.7	X-STRIP
	2	1	160105_233017	23:30	23:40		180	155	281	15	1.2	0.7	
	3	2	160105_234532	23:46	23:56		0	156	277	15	1.2	0.7	
	4	3	160106_000131	24:01	24:12		180	159	273	16	1.2	0.6	
	5	4	160106_001658	24:17	24:27		0	155	269	17	1.1	0.6	
	6	5	160106_003250	24:32	24:43		180	160	265	17	1.2	0.7	
	7	6	160106_004841	24:49	24:59		0	156	261	18	1.3	0.6	
	8	7	160106_010529	1:05	1:16		180	143	257	17	1.1	0.6	
	9	8	160106_012134	1:21	1:32		0	156	253	19	1.2	0.6	
	10	9	160106_013810	1:33	1:45		180	158	249	16	1.1	0.6	
	11	10	160106_015330	1:53	2:03		0	156	245	16	1.4	0.6	
	12	11	160106_020908	2:09	2:19		180	160	241	16	1.4	0.6	
	13	12	160106_022406	2:24	2:34		0	157	237	16	1.4	0.6	
	14	13	160106_024012	2:40	2:50		180	152	233	18	1.2	0.6	
	15	X04	160106_025728	2:57	3:01		90	155	229	16	1.3	0.7	X-STRIP
	16	14	160106_030708	3:07	3:17		0	156	225	16	1.3	0.7	

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ALS80 LiDAR Flight Log

Project	TN3CountyQL2	ALS80	SN 8235					Sensor Operator/s	
						-		Bertin Evina-Ze	
Date/Julian:	1/6/2016		Disk Drive MM70	TAR AIRSPD (KNTS)			Base PID:	Pilot/s	
Hobbs End	2968.7		1-808654A	155			FE2752	MWAZ	
Hobbs ST	2964.1	LIFT		TAR ALT AGL (ft):	Flight Plan(s):		Base Height:	Aircraft	Airport Idnt:
Flight Time	4.6	A		6,300	TN_ALS80		1.500	421C 13RF	M08 (Bolivar, TN)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									219				
	1	X01	160106_175005	17:50	17:53	6,300	270	156	217	19	1.2	0.6	X-STRIP
	2	29	160106_175849	17:58	18:08		180	157	213	19	1.2	0.6	
	3	30	160106_181255	18:13	18:23		0	156	209	19	1.2	0.6	
	4	31	160106_182718	18:27	18:37		180	157	205	19	1.2	0.6	
	5	32	160106_184152	18:42	18:51		0	156	200	19	1.1	0.6	
	6	33	160106_185642	18:56	19:06		180	157	195	18	1.1	0.6	
	7	34	160106_191105	19:11	19:21		0	155	190	20	0.9	0.6	
	8	35	160106_192610	19:26	19:36		180	155	186	19	1.0	0.7	
	9	36	160106_194021	19:40	19:50		0	155	181	18	1.1	0.5	
	10	37	160106_195509	19:55	20:05		180	158	177	17	1.1	0.6	
	11	38	160106_200930	20:09	20:19		0	155	172	16	1.0	0.7	
	12	39	160106_202446	20:24	20:34		180	155	167	17	1.2	0.7	
	13	40	160106_203918	20:39	20:49		0	155	162	17	1.3	0.8	
	14	42	160106_205306	20:53	21:04		180	156	157	18	1.1	0.7	
	15	X04	160106_210841	21:08	21:13		270	158	158	16	1.1	0.7	X-STRIP

ALS80 LiDAR Flight Log

Project	TN3CountyQL2	**ALS80**	SN 8235		-	**Sensor Operator/s**	
						Bertin Evina-Ze	
Date/Julian:	1/6/2016	**Disk Drive MM70**	**TAR AIRSPD (KNTS)**		**Base PID:**	**Pilot/s**	
Hobbs End	2968.7	1-808654A	155		FE2752	MWAZ	
Hobbs ST	2964.1	LIFT	**TAR ALT AGL (ft):**	**Flight Plan(s):**	**Base Height:**	**Aircraft**	**Airport Idnt:**
Flight Time	4.6	A	6,300	TN_ALS80	1.500	421C 13RF	M08 (Bolivar, TN)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									219				
	1	28	160106_175005	17:50	17:53	6,300	270	156	217	19	1.2	0.6	X-STRIP
	2	27	160106_175849	17:58	18:08		180	157	213	19	1.2	0.6	
	3	26	160106_181255	18:13	18:23		0	156	209	19	1.2	0.6	
	4	25	160106_182718	18:27	18:37		180	157	205	19	1.2	0.6	
	5	24	160106_184152	18:42	18:51		0	156	200	19	1.1	0.6	
	6	23	160106_185642	18:56	19:06		180	157	195	18	1.1	0.6	
	7	22	160106_191105	19:11	19:21		0	155	190	20	0.9	0.6	
	8	21	160106_192610	19:26	19:36		180	155	186	19	1.0	0.7	
	9	20	160106_194021	19:40	19:50		0	155	181	18	1.1	0.5	
	10	19	160106_195509	19:55	20:05		180	158	177	17	1.1	0.6	
	11	X01	160106_200930	20:09	20:19		0	155	172	16	1.0	0.7	
	12	18	160106_202446	20:24	20:34		180	155	167	17	1.2	0.7	
	13	X04	160106_203918	20:39	20:49		0	155	162	17	1.3	0.8	
	14	17	160106_205306	20:53	21:04		180	156	157	18	1.1	0.7	
	15	16	160106_210841	21:08	21:13		270	158	158	16	1.1	0.7	X-STRIP
	16												

ALS80 LiDAR Flight Log

Project	TN3CountyQL2	ALS80	SN 8235		-	Sensor Operator/s: Bertin Evina-Ze
Date/Julian:	12/17/2015	Mem Drive MM70	TAR AIRSPD (KNTS)		Base PID:	Pilot/s
Hobbs End	2925.9	1-808654A	155		TEMP	MWAZ
Hobbs ST	2921.1	LIFT	TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft:
Flight Time	4.8	A	6,300	TN_ALS80	1.500	421C 13RF

Airport Idnt: CRX(Corinth, MS)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									744				
	1	69	151217_153730	15:37	15:48	6,300	0	156	739	15	1.3	0.7	
	2	70	151217_155325	15:53	16:04		180	157	735	15	1.2	0.7	
	3	71	151217_160845	16:08	16:19		0	155	730	15	1.2	0.7	
	4	72	151217_162401	16:24	16:34		180	157	725	14	1.2	0.8	
	5	73	151217_163935	16:39	16:50		0	155	720	13	1.5	0.9	
	6	74	151217_165512	16:55	17:05		180	156	715	14	1.3	0.8	
	7	75	151217_171038	17:10	17:20		0	155	710	15	1.2	0.8	
	8	76	151217_172540	17:25	17:34		180	157	706	15	1.3	0.8	
	9	77	151217_173932	17:39	17:48		0	156	702	16	1.3	0.7	
	10	78	151217_175353	17:53	18:02		180	155	697	17	1.1	0.6	
	11	79	151217_180723	18:07	18:15		0	155	693	17	1.2	0.6	
	12	80	151217_182036	18:20	18:28		180	156	690	17	1.2	0.6	
	13	81	151217_183316	18:33	18:39		0	155	687	18	1.1	0.6	
	14	82	151217_184433	18:44	18:50		180	155	684	19	1.0	0.6	
	15	X04	151217_185712	18:57	19:03		270	155	681	17	1.3	0.6	X-STRIP
	16	68	151217_191303	19:13	19:23		0	156	676	18	1.2	0.6	
	17	X02	151217_193126	19:31	19:36		90	160	673	18	1.2	0.6	X-STRIP
	18	83	151217_194144	19:41	19:48		180	158	670	18	1.2	0.6	

ALS80 LiDAR Flight Log

Project	TN3CountyQL2	ALS80	SN 8235	Sensor Operator/s: Bertin Evina-Ze
Date/Julian:	12/17/2015	Disk Drive MM70: 1-808654A	TAR AIRSPD (KNTS): 155	Base PID: TEMP
Hobbs End	2930.7			Pilot/s: MWAZ
Hobbs ST	2925.9	LIFT: B	TAR ALT AGL (ft): 6,300	Flight Plan(s): TN_ALS80
Flight Time	4.8		Base Height: 1.500	Aircraft: 421C 13RF
			Airport Idnt: CRX(Corinth, MS)	

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B									670				
	1	84	151217_213849	21:38	21:46	6,300	0	155	666	18	1.2	0.7	
	2	85	151217_215217	21:52	22:00		180	156	663	17	1.3	0.7	
	3	86	151217_220533	22:05	22:13		0	156	659	16	1.3	0.7	
	4	87	151217_221846	22:18	22:27		180	154	655	17	1.1	0.6	
	5	88	151217_223323	22:33	22:42		0	158	651	17	1.2	0.7	
	6	89	151217_224800	22:48	22:56		180	156	647	18	1.0	0.6	
	7	90	151217_230255	23:03	23:12		0	158	643	15	1.4	0.7	
	8	91	151217_231739	23:18	23:26		180	156	639	17	1.1	0.6	
	9	92	151217_233225	23:32	23:41		0	156	634	15	1.3	0.7	
	10	93	151217_234641	23:46	23:55		180	155	630	16	1.3	0.7	
	11	94	151218_000128	24:01	24:10		0	155	626	16	1.1	0.7	
	12	95	151218_001606	24:16	24:25		180	156	622	16	1.1	0.7	
	13	96	151218_003010	24:30	24:39		0	154	617	16	1.0	0.7	
	14	97	151218_004417	24:44	24:53		180	154	613	13	1.3	0.8	
	15	X04	151218_010237	1:02	1:06		270	154	611	14	1.2	0.8	X-STRIP
	16	98	151218_011539	1:16	1:25		0	155	607	15	1.2	0.7	
	17	X02	151218_013319	1:33	1:37		270	158	605	15	1.2	0.7	X-STRIP
	18	99	151218_014730	1:47	1:58		180	155	601	16	1.2	0.7	

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ALS80 LiDAR Flight Log

Project	**TN3CountyQL2**	**ALS80**	SN 8235		**Sensor Operator/s**
				-	Bertin Evina-Ze
Date/Julian:	12/18/2015	**Disk Drive MM70**	**TAR AIRSPD (KNTS)**	**Base PID:**	**Pilot/s**
Hobbs End	2930.7	1-808654A	155	TEMP	Mike Millard
Hobbs ST	2925.9	LIFT	**TAR ALT AGL (ft):**	**Flight Plan(s):**	**Base Height:**
Flight Time	4.8	**B**	6,400	TN_ALS80	1.500

Aircraft	**Airport Idnt:**
421C 13RF	CRX(Corinth, MS)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B									600				
	1	100	151218_225226	22:52	23:02	6,400	0	150	595	18	1.1	0.6	
	2	101	151218_230820	23:08	23:17		180	156	591	17	1.2	0.7	
	3	102	151218_232328	23:23	23:33		0	154	587	16	1.3	0.7	
	4	103	151218_233843	23:38	23:48		180	155	582	16	1.3	0.7	
	5	104	151218_235358	23:54	24:03		0	154	578	17	1.1	0.6	
	6	105	151219_000839	24:08	24:18		180	158	573	17	1.1	0.6	
	7	106	151219_002559	24:26	24:35		0	152	569	18	1.0	0.6	
	8	107	151219_004155	24:41	24:51		180	155	564	14	1.3	0.8	
	9	108	151219_005741	24:57	1:07		0	155	560	15	1.2	0.7	
	10	109	151219_011232	1:12	1:22		180	158	556	16	1.2	0.7	
	11	110	151219_012838	1:28	1:38		0	154	551	16	1.2	0.7	
	12	X01	151219_014321	1:43	1:47		180	151	550	17	1.2	0.6	X-STRIP
	13	111	151219_015417	1:54	2:03		0	155	545	16	1.3	0.7	
	14	X04	151219_021000	2:10	2:13		270	153	544	17	1.3	0.7	X-STRIP
	15	112	151219_022136	2:21	2:31		0	155	539	19	1.1	0.6	

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ALS80 LiDAR Flight Log

Project	TN3CountyQL2	ALS80	SN 8235				Sensor Operator/s
					-		Bertin Evina-Ze
Date/Julian:	12/19/2015		Disk Drive MM70	TAR AIRSPD (KNTS)		Base PID:	Pilot/s
Hobbs End	2939.0		1-808654A	155		TEMP	MWAZ
Hobbs ST	2935.0	LIFT		TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft: 421C 13RF / Airport Idnt:
Flight Time	4.0	A		6,350	TN_ALS80	1.500	Aircraft: 421C 13RF / Airport Idnt: CRX(Corinth, MS)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									539				
	1	X04	151219_152023	15:20	15:22	6,350	90	156	538	17	1.3	0.7	X-STRIP
	2	113	151219_152756	15:27	15:37		0	155	534	16	1.3	0.7	
	3	114	151219_154219	15:42	15:52		180	156	529	16	1.2	0.7	
	4	115	151219_155633	15:56	16:06		0	155	525	16	1.2	0.7	
	5	116	151219_161024	16:10	16:20		180	158	521	15	1.2	0.8	
	6	117	151219_162546	16:25	16:35		0	155	516	15	1.2	0.8	
	7	X01	151219_164114	16:41	16:45		90	155	514	15	1.0	0.8	X-STRIP
	8	X03	151219_165133	16:51	16:55		250	153	512	16	1.1	0.7	X-STRIP
	9	118	151219_165940	16:59	17:02		0	157	511	16	1.1	0.7	
	10	119	151219_170744	17:07	17:11		180	154	509	16	1.1	0.7	
	11	120	151219_171536	17:15	17:18		0	155	508	16	1.2	0.7	
	12	121	151219_172340	17:23	17:27		180	157	507	17	1.2	0.7	
	13	122	151219_173151	17:31	17:34		0	154	505	18	1.1	0.6	
	14	123	151219_173928	17:39	17:42		180	157	504	18	1.1	0.6	
	15	124	151219_174738	17:47	17:50		0	154	502	19	1.1	0.6	
	16	125	151219_175538	17:55	17:58		180	157	501	19	1.1	0.6	
	17	126	151219_180239	18:02	18:05		0	157	500	19	1.1	0.6	
	18	127	151219_181011	18:10	18:12		180	156	499	19	1.1	0.6	
	19	128	151219_181800	18:18	18:20		0	154	498	19	1.1	0.6	
	20	129	151219_182518	18:25	18:27		180	157	497	21	1.1	0.6	
	21	130	151219_183241	18:32	18:32		0	154	496	21	1.0	0.6	
	22	131	151219_183901	18:39	18:40		180	155	496	20	1.0	0.6	

ALS80 LiDAR Flight Log

Project		**TN3CountyQL2**			**ALS80**	SN 8235							**Sensor Operator/s**
										-			Bertin Evina-Ze
Date/Julian:		12/19/2015				**Disk Drive MM70**		**TAR AIRSPD (KNTS)**				**Base PID:**	**Pilot/s**
Hobbs End		2943.6				1-808654A		155				TEMP	Mike Millard
Hobbs ST		2939.0		LIFT				**TAR ALT AGL (ft):**		**Flight Plan(s):**		**Base Height:**	**Aircraft** / **Airport Idnt:**
Flight Time		4.6		A				6,300		TN_ALS80		1.500	421C 13RF / CRX(Corinth, MS)
Lift		**Flight Line**	**Mission Line**	**UTC time: B:**	**UTC time: E:**	**GPS Altitude: ASL:**	**Direction**	**Speed: kts:**	**Available MM Space**	**S/Vs:**	**Position Acc. PDOP**	**Position Acc. HDOP**	**Comments and Conditions:**
A									495				
	1	67	151219_213244	21:32	21:43	6,300	0	156	490	17	1.1	0.7	
	2	66	151219_214858	21:49	21:59		180	154	485	16	1.3	0.7	
	3	65	151219_220532	22:05	22:16		0	157	480	16	1.1	0.6	
	4	64	151219_222148	22:21	22:33		180	157	475	16	1.1	0.6	
	5	63	151219_223817	22:38	22:49		0	155	470	15	1.1	0.6	
	6	62	151219_225533	22:55	23:07		180	157	465	15	1.2	0.7	
	7	61	151219_231217	23:12	23:24		0	158	460	15	1.1	0.6	
	8	60	151219_232840	23:28	23:40		180	156	455	16	1.3	0.7	
	9	59	151219_234449	23:44	23:56		0	155	450	16	1.2	0.7	
	10	58	151220_000137	24:01	24:13		180	153	445	16	1.1	0.6	
	11	X04	151220_002018	24:20	24:23		270	154	440	16	1.0	0.6	X-STRIP
	12	57	151220_002912	24:29	24:41		0	154	435	17	1.2	0.7	
	13	X01	151220_004858	24:49	24:52		270	158	433	18	1.2	0.7	X-STRIP
	14	56	151220_005904	24:59	1:10		180	156	428	18	1.2	0.7	
	15	55	151220_011538	1:15	1:27		0	156	422	19	1.2	0.7	

DAS Digital Aerial Solutions

ALS80 LiDAR Flight Log

Project	TN3CountyQL2	ALS80	SN 8235	Sensor Operator/s	Bertin Evina-Ze
			-		
Date/Julian:	12/20/2015	Disk Drive MM70	1-808654A	Pilot/s	MWAZ
Hobbs End	2948.0	TAR AIRSPD (KNTS)	155	Base PID:	TEMP
Hobbs ST	2943.6	LIFT	A	Flight Plan(s):	TN_ALS80
Flight Time	4.4	TAR ALT AGL (ft):	6,300	Base Height:	1.500
		Aircraft	421C 13RF	Airport Idnt:	CRX(Corinth, MS)

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Available MM Space	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
A									422				
	1	X04	151220_153304	15:33	15:37	6,300	270	157	420	17	1.3	0.7	X-STRIP
	2	41	151220_154152	15:41	15:52		0	156	415	16	1.2	0.7	
	3	X01	151220_155900	15:59	16:04		90	156	412	16	1.1	0.7	X-STRIP
	4	54	151220_161029	16:10	16:22		180	152	407	16	1.2	0.8	
	5	53	151220_162709	16:27	16:38		0	156	402	15	1.4	0.8	
	6	52	151220_164347	16:43	16:55		180	154	397	15	1.1	0.7	
	7	51	151220_165959	17:00	17:10		0	158	392	15	1.1	0.7	
	8	50	151220_171619	17:16	17:27		180	152	387	16	1.2	0.7	
	9	49	151220_173129	17:31	177:42		0	157	382	18	1.1	0.6	
	10	48	151220_174738	17:47	17:58		180	156	377	19	1.1	0.6	
	11	47	151220_180257	18:03	18:13		0	157	372	19	1.1	0.6	
	12	46	151220_181846	18:18	18:30		180	153	367	21	1.0	0.5	
	13	45	151220_183405	18:34	18:44		0	155	362	20	1.0	0.6	
	14	44	151220_185032	18:50	19:01		180	152	357	18	1.3	0.6	
	15	43	151220_190557	19:05	19:36		0	157	352	18	1.3	0.6	
	16												

Appendix B. Vertical Accuracy Calculations

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TerraSolid LiDAR Accuracy

ID	Easting	Northing	Ortho_Z	Laser_Z	Dz_LAS	NVA/VVA	Land_Cover_Type
01.FVA.BG.01	679896.009	3504632.39	161.347	161.35	0.003	NVA	Bare Ground
03.FVA.BG.01	668752.685	3509444.343	134.359	134.38	0.021	NVA	Bare Ground
04.FVA.BG.01	682186.691	3529138.289	216.391	216.4	0.009	NVA	Bare Ground
05.FVA.BG.01	678369.878	3536872.041	185.414	185.42	0.006	NVA	Bare Ground
08.FVA.BG.01	661762.797	3569014.87	255.551	255.57	0.019	NVA	Bare Ground
09.FVA.BG.01	657185.752	3585703.351	277.286	277.27	-0.016	NVA	Bare Ground
11.FVA.BG.01	624563.925	3603771.825	341.716	341.71	-0.006	NVA	Bare Ground
12.FVA.BG.01	616663.064	3603761.4	276.027	276.04	0.013	NVA	Bare Ground
13.FVA.BG.01	610473.95	3603845.485	243.345	243.35	0.005	NVA	Bare Ground
14.FVA.BG.01	600798.74	3602030.409	277.992	278.08	0.088	NVA	Bare Ground
15.FVA.BG.01	651751.97	3593037.295	276.364	276.35	-0.014	NVA	Bare Ground
16.FVA.BG.01	638509.42	3591080.313	282.122	282.09	-0.032	NVA	Bare Ground
18.FVA.BG.01	589558.261	3598774.51	281.733	281.77	0.037	NVA	Bare Ground
20.FVA.BG.01	578237.685	3583761.845	320.929	320.93	0.001	NVA	Bare Ground
22.FVA.BG.01	575614.89	3571128.789	432.408	432.46	0.052	NVA	Bare Ground
24.FVA.BG.01	618177.42	3547284.008	273.711	273.75	0.039	NVA	Bare Ground
25.FVA.BG.01	653056.595	3525688.68	187.413	187.44	0.027	NVA	Bare Ground
26.FVA.BG.01	658995.964	3523699.39	151.337	151.36	0.023	NVA	Bare Ground
27.FVA.BG.01	591890.661	3579753.382	274.643	274.65	0.007	NVA	Bare Ground
31.FVA.BG.01	599304.309	3596002.81	266.407	266.45	0.043	NVA	Bare Ground
32.FVA.BG.01	601172.063	3583934.166	309.117	309.14	0.023	NVA	Bare Ground
34.FVA.BG.01	615853.256	3566818.966	203.917	203.92	0.003	NVA	Bare Ground
35.FVA.BG.01	630783.127	3572580.606	259.959	259.88	-0.079	NVA	Bare Ground
38.FVA.BG.01	668455.033	3524889.652	157.794	157.8	0.006	NVA	Bare Ground
39.FVA.BG.01	658891.84	3503369.347	186.601	186.65	0.049	NVA	Bare Ground
40.FVA.BG.01	636144.385	3530694.876	267.086	267.14	0.054	NVA	Bare Ground
42.FVA.BG.01	641717.404	3549077.345	171.604	171.6	-0.004	NVA	Bare Ground
43.FVA.BG.01	651023.124	3557521.514	177.616	177.65	0.034	NVA	Bare Ground
44.FVA.BG.01	652651.873	3536260.678	184.931	184.97	0.039	NVA	Bare Ground
46.FVA.BG.01	623158.989	3583172.255	216.012	216.03	0.018	NVA	Bare Ground
51.FVA.BG.01	647714.891	3580126.295	255.409	255.41	0.001	NVA	Bare Ground

52.FVA.BG.01	616375.926	3588773.939	221.356	221.36	0.004	NVA	Bare Ground
53.FVA.BG.01	623275.822	3582860.206	212.185	212.21	0.025	NVA	Bare Ground
04.FVA.HP.01	682189.707	3529151.556	216.391	216.38	-0.011	NVA	Hard Pavement
06.FVA.HP.01	664916.213	3538983.804	175.471	175.42	-0.051	NVA	Hard Pavement
10.FVA.HP.01	629657.098	3600045.106	315.852	315.81	-0.042	NVA	Hard Pavement
12.FVA.HP.01	616645.736	3603756.877	276.216	276.26	0.044	NVA	Hard Pavement
14.FVA.HP.01	600804.942	3602048.035	278.491	278.57	0.079	NVA	Hard Pavement
16.FVA.HP.01	638520.436	3591025.679	281.517	281.5	-0.017	NVA	Hard Pavement
18.FVA.HP.01	589540.546	3598766.22	281.803	281.83	0.027	NVA	Hard Pavement
19.FVA.HP.01	581439.025	3596571.517	346.821	346.86	0.039	NVA	Hard Pavement
21.FVA.HP.01	565023.796	3579331.352	443.197	443.22	0.023	NVA	Hard Pavement
22.FVA.HP.01	575592.933	3571145.817	432.422	432.43	0.008	NVA	Hard Pavement
24.FVA.HP.01	618192.206	3547303.871	274.285	274.28	-0.005	NVA	Hard Pavement
34.FVA.HP.01	615834.429	3566842.063	204.61	204.59	-0.02	NVA	Hard Pavement
35.FVA.HP.01	630753.284	3572649.269	255.868	255.8	-0.068	NVA	Hard Pavement
37.FVA.HP.01	659175.854	3536130.292	177.615	177.57	-0.045	NVA	Hard Pavement
39.FVA.HP.01	658934.967	3503359.847	187.274	187.31	0.036	NVA	Hard Pavement
41.FVA.HP.01	631441.618	3543830.304	243.192	243.21	0.018	NVA	Hard Pavement
43.FVA.HP.01	650993.748	3557537.244	177.836	177.86	0.024	NVA	Hard Pavement
44.FVA.HP.01	652662.347	3536260.001	185.192	185.26	0.068	NVA	Hard Pavement
52.FVA.HP.01	616396.03	3588792.172	221.13	221.1	-0.03	NVA	Hard Pavement
02.FVA.PS.01	675185.6	3504979.463	153.532	153.51	-0.022	NVA	Packed Sand
03.FVA.PS.01	668750.247	3509482.51	134.425	134.36	-0.065	NVA	Packed Sand
04.FVA.PS.01	682177.974	3529179.988	217.242	217.24	-0.002	NVA	Packed Sand
05.FVA.PS.01	678322.19	3536870.947	185.492	185.51	0.018	NVA	Packed Sand
09.FVA.PS.01	657187.646	3585660.53	277.221	277.21	-0.011	NVA	Packed Sand
10.FVA.PS.01	629640.432	3600048.527	315.097	315.12	0.023	NVA	Packed Sand
11.FVA.PS.01	624598.64	3603787.711	341.865	341.88	0.015	NVA	Packed Sand
12.FVA.PS.01	616681.15	3603765.257	275.469	275.51	0.041	NVA	Packed Sand
13.FVA.PS.01	610485.346	3603863.963	243.174	243.21	0.036	NVA	Packed Sand
14.FVA.PS.01	600769.744	3602030.755	278.441	278.48	0.039	NVA	Packed Sand
15.FVA.PS.01	651760.972	3593016.469	277.002	276.98	-0.022	NVA	Packed Sand
16.FVA.PS.01	638527.313	3591043.842	282.187	282.14	-0.047	NVA	Packed Sand

18.FVA.PS.01	589550.688	3598754.942	281.569	281.57	0.001	NVA	Packed Sand
20.FVA.PS.01	578249.854	3583786.911	321.551	321.54	-0.011	NVA	Packed Sand
25.FVA.PS.01	653038.977	3525752.78	184.353	184.35	-0.003	NVA	Packed Sand
26.FVA.PS.01	658997.533	3523687.422	151.625	151.65	0.025	NVA	Packed Sand
27.FVA.PS.01	591853.574	3579716.868	275.52	275.57	0.05	NVA	Packed Sand
28.FVA.PS.01	613036.63	3590005.169	226.024	226.03	0.006	NVA	Packed Sand
30.FVA.PS.01	608453.544	3596436.178	227.305	227.36	0.055	NVA	Packed Sand
31.FVA.PS.01	599311.537	3595978.566	266.695	266.74	0.045	NVA	Packed Sand
32.FVA.PS.01	601144.017	3583942.443	309.351	309.4	0.049	NVA	Packed Sand
37.FVA.PS.01	659161.585	3536122.21	177.579	177.55	-0.029	NVA	Packed Sand
38.FVA.PS.01	668456.651	3524872.702	157.946	157.87	-0.076	NVA	Packed Sand
39.FVA.PS.01	658900.922	3503359.251	186.905	186.9	-0.005	NVA	Packed Sand
40.FVA.PS.01	636160.49	3530667.726	268.219	268.32	0.101	NVA	Packed Sand
41.FVA.PS.01	631465.852	3543821.988	243.658	243.66	0.002	NVA	Packed Sand
42.FVA.PS.01	641723.823	3549152.363	172.737	172.75	0.013	NVA	Packed Sand
44.FVA.PS.01	652648.73	3536267.616	185.031	185.05	0.019	NVA	Packed Sand
45.FVA.PS.01	642429.613	3544060.536	164.294	164.24	-0.054	NVA	Packed Sand
46.FVA.PS.01	623157.561	3583146.466	215.818	215.83	0.012	NVA	Packed Sand
51.FVA.PS.01	647695.528	3580160.544	255.542	255.54	-0.002	NVA	Packed Sand
52.FVA.PS.01	616391.958	3588783.108	221.018	221.03	0.012	NVA	Packed Sand
02.SVA.HV.01	675142.608	3505004.643	151.186	151.12	-0.066	VVA	High Vegetation
03.SVA.HV.01	668707.088	3509462.482	133.986	134.04	0.054	VVA	High Vegetation
05.SVA.HV.01	678403.872	3536868.148	185.105	185.12	0.015	VVA	High Vegetation
08.SVA.HV.01	661800.196	3569090.35	256.592	256.58	-0.012	VVA	High Vegetation
09.SVA.HV.01	657229.486	3585710.278	278.042	278	-0.042	VVA	High Vegetation
10.SVA.HV.01	629633.16	3600017.85	314.909	314.86	-0.049	VVA	High Vegetation
12.SVA.HV.01	616678.463	3603781.178	275.168	275.16	-0.008	VVA	High Vegetation
13.SVA.HV.01	610489.518	3603847.343	242.935	242.96	0.025	VVA	High Vegetation
15.SVA.HV.01	651774.956	3593027.296	276.707	276.67	-0.037	VVA	High Vegetation
16.SVA.HV.01	638468.438	3591095.831	281.253	281.21	-0.043	VVA	High Vegetation
18.SVA.HV.01	589551.484	3598725.236	281.594	281.63	0.036	VVA	High Vegetation
20.SVA.HV.01	578234.203	3583752.805	320.695	320.66	-0.035	VVA	High Vegetation
21.SVA.HV.01	565045.542	3579335.16	443.134	443.18	0.046	VVA	High Vegetation

24.SVA.HV.01	618191.708	3547339.267	275.041	275.08	0.039	VVA	High Vegetation
25.SVA.HV.01	653057.651	3525724.742	185.653	185.65	-0.003	VVA	High Vegetation
28.SVA.HV.01	613013.601	3590022.129	226.817	226.81	-0.007	VVA	High Vegetation
32.SVA.HV.01	601093.553	3583916.445	308.548	308.56	0.012	VVA	High Vegetation
34.SVA.HV.01	615842.36	3566808.757	203.534	203.38	-0.154	VVA	High Vegetation
38.SVA.HV.01	668436.081	3524906.458	157.247	157.27	0.023	VVA	High Vegetation
40.SVA.HV.01	636188.403	3530672.236	267.692	267.83	0.138	VVA	High Vegetation
42.SVA.HV.01	641741.578	3549095.701	171.529	171.57	0.041	VVA	High Vegetation
43.SVA.HV.01	651013.235	3557522.463	177.771	177.76	-0.011	VVA	High Vegetation
44.SVA.HV.01	652644.557	3536313.575	184.969	185.05	0.081	VVA	High Vegetation
46.SVA.HV.01	623141.455	3583153.372	215.747	215.76	0.013	VVA	High Vegetation
52.SVA.HV.01	616391.027	3588816.045	221.97	221.98	0.01	VVA	High Vegetation
01.SVA.LV.01	679882.024	3504640.988	161.932	162.11	0.178	VVA	Low Vegetation
02.SVA.LV.01	675186.311	3504990.252	153.748	153.73	-0.018	VVA	Low Vegetation
03.SVA.LV.01	668721.488	3509469.653	134.066	134.03	-0.036	VVA	Low Vegetation
05.SVA.LV.01	678389.886	3536864.432	185.2	185.27	0.07	VVA	Low Vegetation
08.SVA.LV.01	661790.794	3569085.171	256.539	256.59	0.051	VVA	Low Vegetation
09.SVA.LV.01	657183.944	3585678.149	277.66	277.69	0.03	VVA	Low Vegetation
11.SVA.LV.01	624540.861	3603754.1	341.977	341.98	0.003	VVA	Low Vegetation
12.SVA.LV.01	616654.224	3603769.885	276.206	276.33	0.124	VVA	Low Vegetation
22.SVA.LV.01	575589.055	3571135.402	432.137	432.25	0.113	VVA	Low Vegetation
24.SVA.LV.01	618207.941	3547342.366	274.668	274.75	0.082	VVA	Low Vegetation
32.SVA.LV.01	601075.623	3583909.659	308.272	308.42	0.148	VVA	Low Vegetation
35.SVA.LV.01	630793.769	3572610.703	259.02	258.94	-0.08	VVA	Low Vegetation
37.SVA.LV.01	659137.779	3536135.899	177.344	177.38	0.036	VVA	Low Vegetation
38.SVA.LV.01	668442.269	3524893.097	157.565	157.61	0.045	VVA	Low Vegetation
44.SVA.LV.01	652654.114	3536318.247	185.256	185.34	0.084	VVA	Low Vegetation
45.SVA.LV.01	642419.135	3544088.884	163.989	164.02	0.031	VVA	Low Vegetation
01.SVA.MV.01	679902.791	3504652.69	161.464	161.47	0.006	VVA	Medium Vegetation
02.SVA.MV.01	675169.727	3505009.974	152.859	152.81	-0.049	VVA	Medium Vegetation
08.SVA.MV.01	661819.863	3569075.347	256.189	256.29	0.101	VVA	Medium Vegetation
09.SVA.MV.01	657240.151	3585695.164	279.402	279.38	-0.022	VVA	Medium Vegetation
10.SVA.MV.01	629624.393	3599996.887	314.396	314.38	-0.016	VVA	Medium Vegetation

14.SVA.MV.01	600768.949	3602046.969	278.88	278.92	0.04	VVA	Medium Vegetation
15.SVA.MV.01	651752.131	3593050.773	275.947	275.95	0.003	VVA	Medium Vegetation
22.SVA.MV.01	575599.892	3571131.378	432.316	432.39	0.074	VVA	Medium Vegetation
25.SVA.MV.01	653019.705	3525748.487	183.862	183.82	-0.042	VVA	Medium Vegetation
26.SVA.MV.01	659016.18	3523680.214	151.31	151.31	0	VVA	Medium Vegetation
27.SVA.MV.01	591858.163	3579733.624	274.787	274.96	0.173	VVA	Medium Vegetation
28.SVA.MV.01	613019.402	3590044.044	226.637	226.68	0.043	VVA	Medium Vegetation
30.SVA.MV.01	608491.87	3596428.301	231.309	231.38	0.071	VVA	Medium Vegetation
31.SVA.MV.01	599313.59	3595999.054	266.471	266.55	0.079	VVA	Medium Vegetation
34.SVA.MV.01	615852.418	3566860.196	205.8	205.95	0.15	VVA	Medium Vegetation
35.SVA.MV.01	630770.948	3572610.935	257.874	257.78	-0.094	VVA	Medium Vegetation
37.SVA.MV.01	659167.603	3536138.871	177.648	177.63	-0.018	VVA	Medium Vegetation
39.SVA.MV.01	658956.991	3503362.565	187.609	187.74	0.131	VVA	Medium Vegetation
41.SVA.MV.01	631432.163	3543841.388	242.993	243.03	0.037	VVA	Medium Vegetation
42.SVA.MV.01	641743.038	3549115.958	171.781	171.78	-0.001	VVA	Medium Vegetation
44.SVA.MV.01	652632.321	3536299.777	184.647	184.75	0.103	VVA	Medium Vegetation

All Units in Meters

All Points	
Average dz	0.017
Minimum dz	-0.154
Maximum dz	0.178
# of Observations	146
RSMEz	0.054
Std deviation	0.051

Terrasolid NVA	Meters	
# of Observations	84	
Root mean square	0.0362	3.62 cm
Std deviation	0.0351	
95% Confidence Level	0.0709	7.09 cm
Terrasolid VVA	Meters	
# of Observations	62	
Root mean square	0.0714	7.14 cm
Std deviation	0.0665	
95% Percentile	0.1475	14.75 cm

NVA By Land Type		
Bare Ground	Meters	
# of Observations	33	
RSMEz	0.0325	3.25 cm
95% Confidence Level	0.0638	6.38 cm
Hard Pavement	Meters	
# of Observations	19	
RSMEz	0.0401	4.01 cm
95% Confidence Level	0.0786	7.86 cm
Packed Sand	Meters	
# of Observations	32	
RSMEz	0.0373	3.73 cm
95% Confidence Level	0.0730	7.3 cm

VVA By Land Type		
High Vegetation	Meters	
# of Observations	25	
RSMEz	0.0544	5.44 cm
95% Percentile	0.0756	7.56 cm
Low Vegetation	Meters	
# of Observations	16	
RSMEz	0.0852	8.52 cm
95% Percentile	0.1555	15.55 cm
Medium Vegetation	Meters	
# of Observations	21	
RSMEz	0.0775	7.75 cm
95% Percentile	0.1500	15 cm

LAS	NVA	BG	HP	PS	VVA	HV	LV	MV
RSMEz	3.62 cm	3.25 cm	4.01 cm	3.73 cm	7.14 cm	5.44 cm	8.52 cm	7.75 cm
95% Confidence Level	7.09 cm	6.38 cm	7.86 cm	7.3 cm	------------	------------	------------	------------
95% Percentile	------------	------------	------------	------------	14.75 cm	7.56 cm	15.55 cm	15 cm
DEM	NVA	BG	HP	PS	VVA	HV	LV	MV
RSMEz	3.55 cm	3.37 cm	3.89 cm	3.53 cm	7.17 cm	5.13 cm	8.74 cm	7.9 cm
95% Confidence Level	6.97 cm	6.61 cm	7.63 cm	6.91 cm	------------	------------	------------	------------
95% Percentile	------------	------------	------------	------------	13.75 cm	7.96 cm	16.24 cm	12.37 cm