Project Report

Suwannee River water Management Area 4 LiDAR Florida State Plane North

Prepared For:

United States Geological Survey

Prepared By:

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TASK ORDER: #G12PD00242

Project Report
LiDAR Collection, Processing, and QA/QC

2012 Suwannee Management LiDAR Task Order

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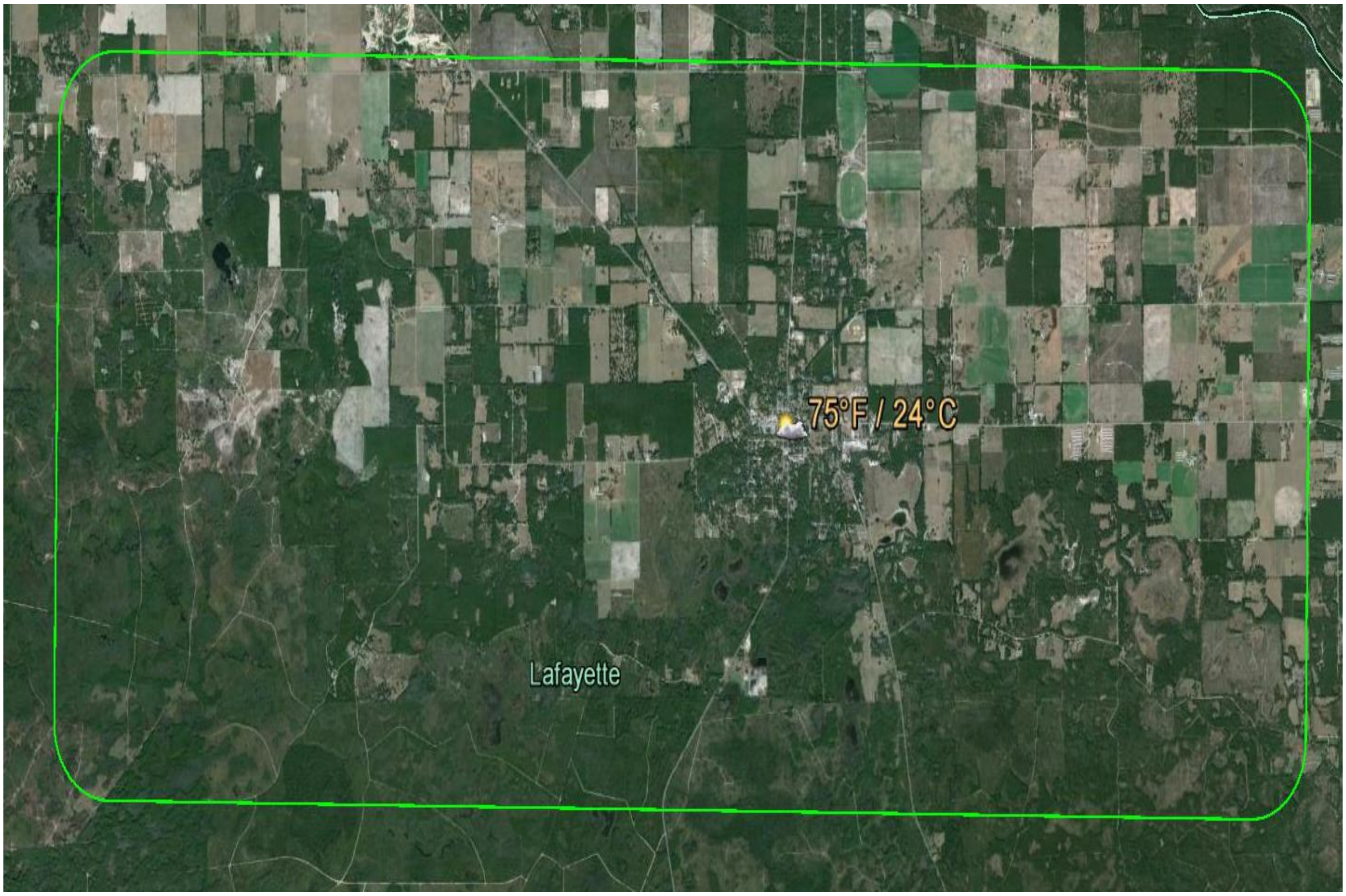
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1 Introduction and Specifications

Digital Aerial Solutions, LLC (DAS) was tasked to collect and process a Light Detection And Ranging (LiDAR) derived elevation dataset for the Suwannee Management, FL. The Suwannee Management survey area encompasses approximately 54 square miles. Aerial LiDAR data was collected utilizing an ALS60. The ALS60 is a discrete return topographic LiDAR mapping system manufactured by Leica Geosystems. LiDAR data collected for the Suwannee Management survey has a nominal pulse spacing of 0.9 meters, and includes up to 4 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, and bare-earth DEM tiles. Point cloud deliverables are stored in the LAS version 1.2 format, point data record format 1. The tiling scheme for tiled deliverables is a 4900 feet x 4900 feet grid. All deliverables were generated in conformance with the *U.S. Geological Survey National Geospatial Program Guidelines and Base Specifications, Version 1.*

2 Spatial Reference System

The spatial reference of the data is as follows.

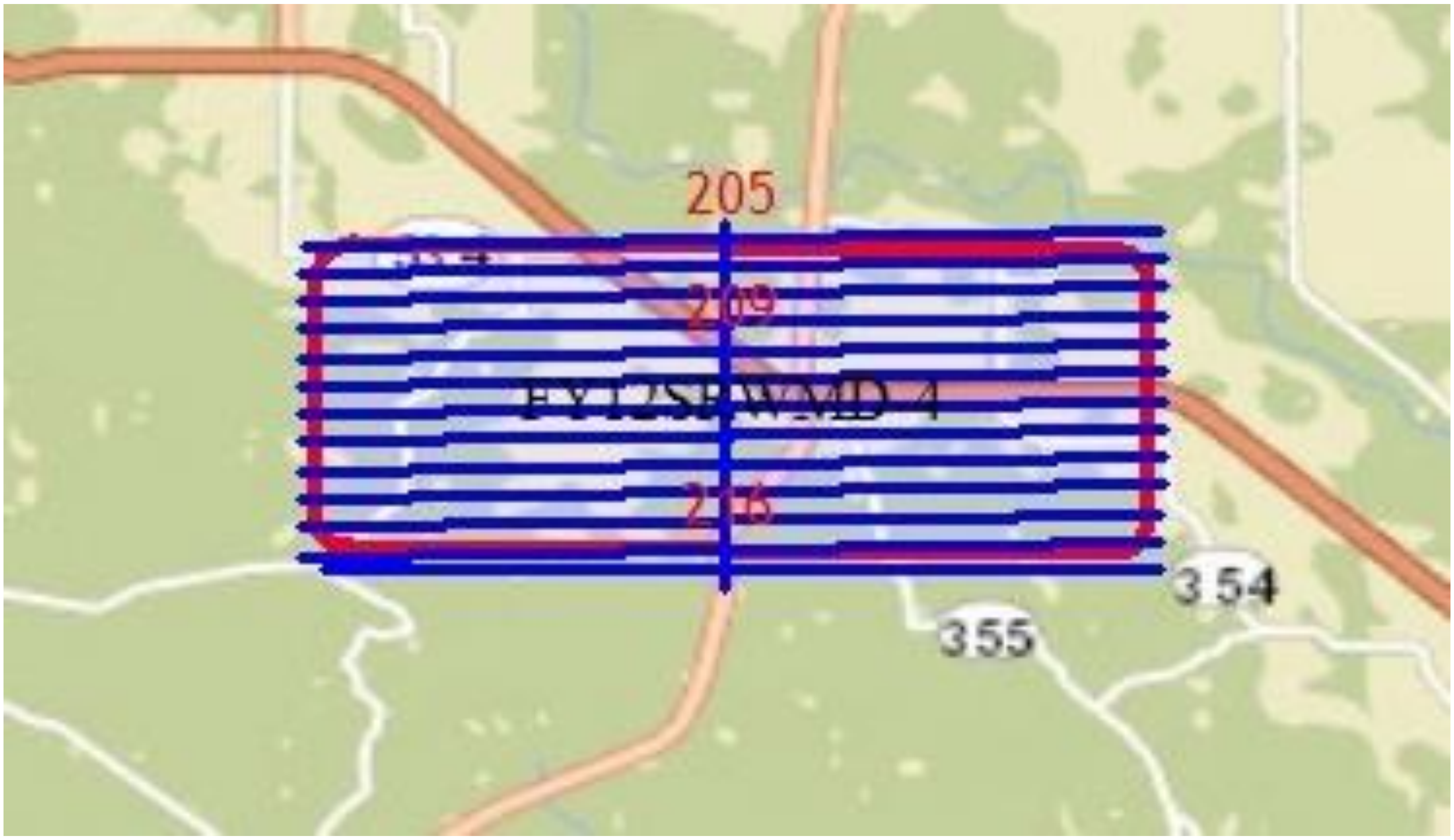
Horizontal Spatial Reference
- Datum: North American Datum of 1983 (National Spatial Reference System 2007)
- Coordinates: Florida State Plane North

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 1988 (GEOID09)

3 LiDAR Acquisition

3.1 Survey Area

The Suwannee Management Area 4 survey covers approximately 55 square miles located in north central Florida. The flight plan consisted of 13 survey lines and
1 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 Suwannee River water Management Area 4 LiDAR project are summarized below.

Parameter	Value
Flying Height Above Ground Level	5,575 feet
Nominal Sidelap	30%
Nominal Speed Over Ground	140 knots
Field of View	30°
Laser Rate	200 kHz
Scan Rate	68.4 hz
Maximum Cross Track Spacing	0.98 meters
Maximum Along Track Spacing	0.98 meters
Average Spacing	1 meter

3.3 Acquisition Mission

The acquisition mission for the Suwannee Management Area 4 LiDAR survey was coordinated to be acquired in 1 week. Collection began on January 20th 2013 and was completed on January 20th, 2013, A complete flight log for the acquisition mission may be found in Appendix A.

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	ALS60 – SN6130	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 (Keyport) 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 IPAS software. IPAS 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 IPAS software through Kalman filtering techniques. IPAS 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 IPAS were processed in Leica's ALSPP software to produce the LiDAR elevation point cloud swaths for each flightline, stored in LAS version 1.2 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. The LiDAR data collected for the Suwannee Management survey Area4 passed these quality control checks.
Swath point clouds were assigned a unique File Source ID within the LAS file format before further processing. Swath files for the Suwannee Management Area 4 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 ALSPP software for the ALS60 sensor system. Terrasolid's Terramatch software was used to calculate the IMU bore-site and mirror scale parameters for the Suwannee Management's Area 4 LiDAR data. 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. The Suwannee Management survey area did not support this requirement, due to the large water area within the 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 Suwannee Management Area 4 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 4900 x 4900 feet LAS format tiles for point cloud classification and derived product creation. It is important to note that US National Grid tiles are non- orthogonal when stored and displayed in a geographic coordinate system. As a result, tiled vector data does not have overlap, but tiled raster data does have overlap to permit seamless display of the data products.

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 – Noise
- Class 9 – Water
- Class 10 – Ignored Ground
- Class 11 – Withheld
- Class 17 – Reserve
- Class 18 – Reserve

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 105 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 the project US National Grid index.

The data collected for the Suwannee Management LiDAR Area 4 survey maintained significant point density in the water, marsh, and swamp, 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 and the NGP version 1 guidelines. 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 float Arc Grid.

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 Suwannee Management 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 ALSPP 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.

Horizontal accuracy assessments of LiDAR data require the presence of vertical targets such as buildings within in the survey area. Field check points are surveyed at the corners of the building roofs, and the surveyed locations compared to the estimated corner locations in the LiDAR point cloud. The Suwannee Management survey area did not present any accessible buildings for use as vertical targets. From the manufacturer's specifications, the estimated horizontal accuracy at one sigma, based on flying height for the project, is between 10cm and 20cm.

Absolute vertical accuracy assessments for the point cloud data are made against ground check point data. For the Suwannee Management Area 4 survey, 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 as described in NDEP Elevation Guidelines Version 1. The FVA of the TIN tested RMSEz 0.045 Feet and 0.088 Feet at the 95% confidence level in open terrain. FVA of the DEM tested at an RMSEz of 0.049 Feet and 0.095 Feet at the 95% confidence level in open terrain. The full calculations for all check points can be found in Appendix B.

FVA of TIN

$RMSE_Z$ =	0.045	Feet
NSSDA=	0.088	Feet

FVA of DEM

$RMSE_Z$ =	0.049	Feet
NSSDA=	0.095	Feet

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 NGP version 1 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 US National Grid tile index.

Appendix A. Flight Logs

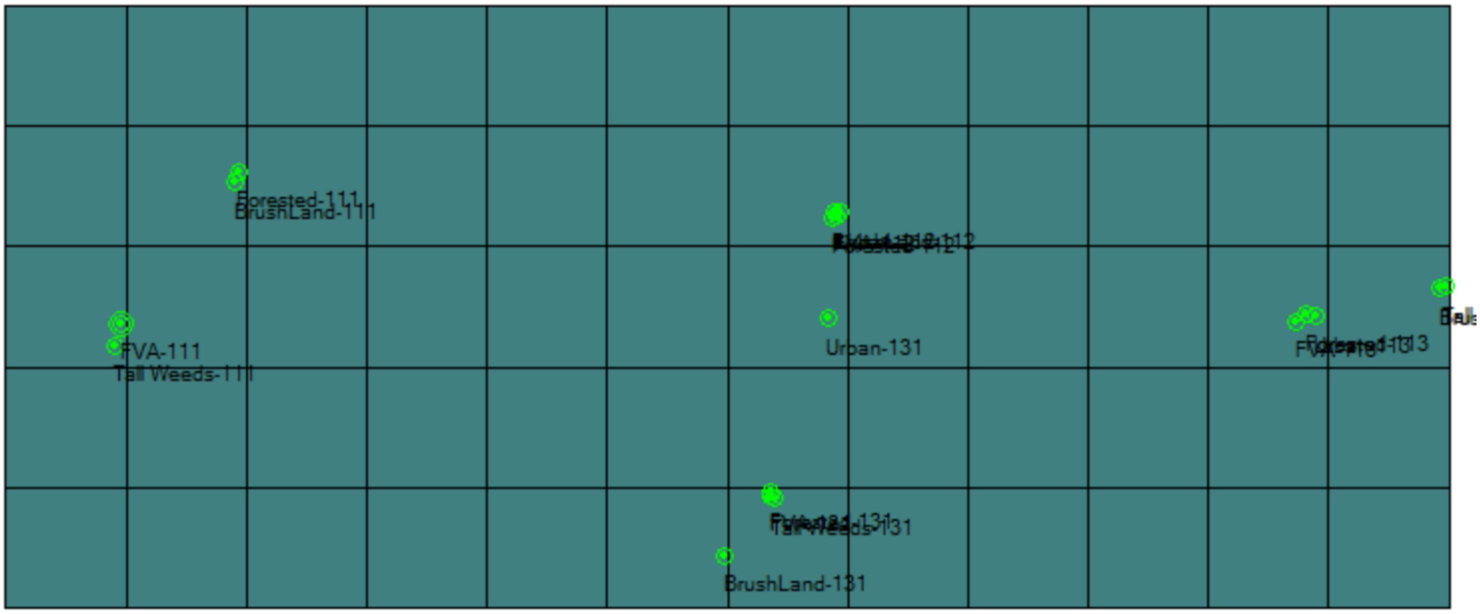
ALS60 LiDAR Flight Log

Project	Suwannee 2013	ALS60	N6130_090724				Sensor Operator/s
					-		Meagan McCall
Date/Julian:	1/20/2013 Suwannee	Mem Drive MM60	Int. Time:	TAR AIRSPD (KNTS)		Base PID:	Pilot/s
Hobbs End	659.1	3-600093051		140		BD2735	MWAZ
Hobbs ST	656.3	LIFT B		TAR ALT AGL (ft):	Flight Plan(s):	Base Height:	Aircraft / Airport Idnt:
Flight Time	2.8			5,575	Block 5 and Block 4	1.500	421C 112MJ / 24J

Lift		Flight Line	Mission Line	UTC time: B:	UTC time: E:	GPS Altitude: ASL:	Direction	Speed: kts:	Memory	S/Vs:	Position Acc. PDOP	Position Acc. HDOP	Comments and Conditions:
B						-	-	-	149				Static Alignment
Block 5		238	130120_231412	23:14	23:16	5,616	90	143	148	16	1.2	0.6	CLEAR
		239	130120_232014	23:20	23:21	5,624	270	127	148	16	1.2	0.6	CLEAR
		240	130120_232440	23:24	23:25	5,591	90	137	148	17	1.1	0.6	CLEAR
		241	130120_232954	23:29	23:31	5,616	0	133	147	17	1.1	0.6	X STRIP
		241	130120_233446	23:34	23:36	5,592	180	137	147	18	1.0	0.6	X STRIP
Block 4		205	130120_234209	23:42	23:46	5,633	270	132	146	19	1.0	0.6	CLEAR
		206	130120_235018	23:50	23:54	5,624	90	138	145	16	1.2	0.7	CLEAR
		207	130121_000012	00:00	00:04	5,703	270	132	144	15	1.3	0.7	CLEAR
		208	130121_001355	00:13	00:18	5,720	90	140	142	16	1.2	0.6	CLEAR
		209	130121_002342	00:23	00:28	5,674	270	134	141	16	1.2	0.6	CLEAR
		210	130121_003200	00:32	00:36	5,695	90	140	140	16	1.2	0.7	CLEAR
		211	130121_004209	00:42	00:46	5,687	270	132	139	17	1.1	0.6	CLEAR
		212	130121_005038	00:50	00:55	5,705	90	139	138	16	1.1	0.6	CLEAR
		213	130121_005901	00:59	01:03	5,697	270	133	136	18	1.0	0.6	CLEAR
		214	130121_010718	01:07	01:11	5,644	90	142	135	16	1.2	0.7	CLEAR
		215	130121_012359	01:23	01:28	5,607	270	136	134	16	1.3	0.7	CLEAR
		216	130121_013156	01:31	01:36	5,580	90	142	133	16	1.3	0.7	CLEAR
		217	130121_014035	01:40	01:45	5,565	270	138	132	16	1.4	0.8	CLEAR
		218	130121_015019	01:50	01:52	5,590	0	139	131	16	1.5	0.8	X STRIP
		218	130121_015648	01:56	01:59	5,567	180	139	131	17	1.2	0.7	X STRIP

Appendix B. Vertical Accuracy Calculations

Tiled-Data Area



LiDAR Accuracy Assessment Summary

LC Type	# of Points	FVA	SVA	CVA
LAS				
ALL	17			0.334
FVA	4	0.088		
Urban	3		0.170	
Tallweeds	3		0.183	
Brushland	4		0.410	
Forested	3		0.291	
Total	17			
DEM				
ALL	18			0.406
FVA	4	0.095		
Urban	3		0.190	
Tallweeds	3		0.170	
Brushland	4		0.341	
Forested	4		0.544	
Total	18			

Units: Feet

Coordinates and Offsets of Analyzed Locations

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					ΔZ DEM	ΔZ LAS	LC Type
1)	☑	FVA-111					
			281446.45	3326544.022	24.89	24.886	24.89
					-0.004	0	FVA
2)	☑	FVA-112					
			290353.925	3327885.214	24.041	24.062	24.057
					0.021	0.016	FVA
3)	☑	FVA-113					
			296095.423	3326565.454	18.804	18.788	18.784
					-0.016	-0.02	FVA
4)	☑	FVA-131					
			289546.226	3324401.927	24.2	24.189	24.209
					-0.011	0.009	FVA
5)	☑	Urban-112					
			290405.368	3327933.599	23.75	23.81	23.804
					0.06	0.054	Urban
6)	☑	Urban-113					
			296336.964	3326635.605	19.042	19.042	19.047
					0	0.005	Urban
7)	☑	Urban-131					
			290247.408	3326602.667	23.691	23.724	23.73
					0.033	0.039	Urban

Coordinates and Offsets of Analyzed Locations (Continued)

		ID					
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					ΔZ DEM	ΔZ LAS	LC Type
8)	☑	Tall Weeds-111					
			281362.65	3326266.323	24.804	24.859	24.863
					0.055	0.059	Tallweeds
9)	☑	Tall Weeds-113					
			297959.915	3327010.52	15.961	15.986	15.988
					0.025	0.027	Tallweeds
10)	☑	Tall Weeds-131					
			289578.6	3324365.268	23.973	23.997	24.004
					0.024	0.031	Tallweeds
11)	☑	BrushLand-111					
			282859.001	3328297.015	24.467	24.506	24.514
					0.039	0.047	Brushland
12)	☑	BrushLand-112					
			290326.514	3327928.701	23.397	23.511	23.536
					0.114	0.139	Brushland
13)	☑	BrushLand-113					
			297893.447	3326982.905	16.24	16.232	16.219
					-0.008	-0.021	Brushland
14)	☑	BrushLand-131					
			288974.012	3323647.128	23.715	23.762	23.753
					0.047	0.038	Brushland

Coordinates and Offsets of Analyzed Locations (Continued)

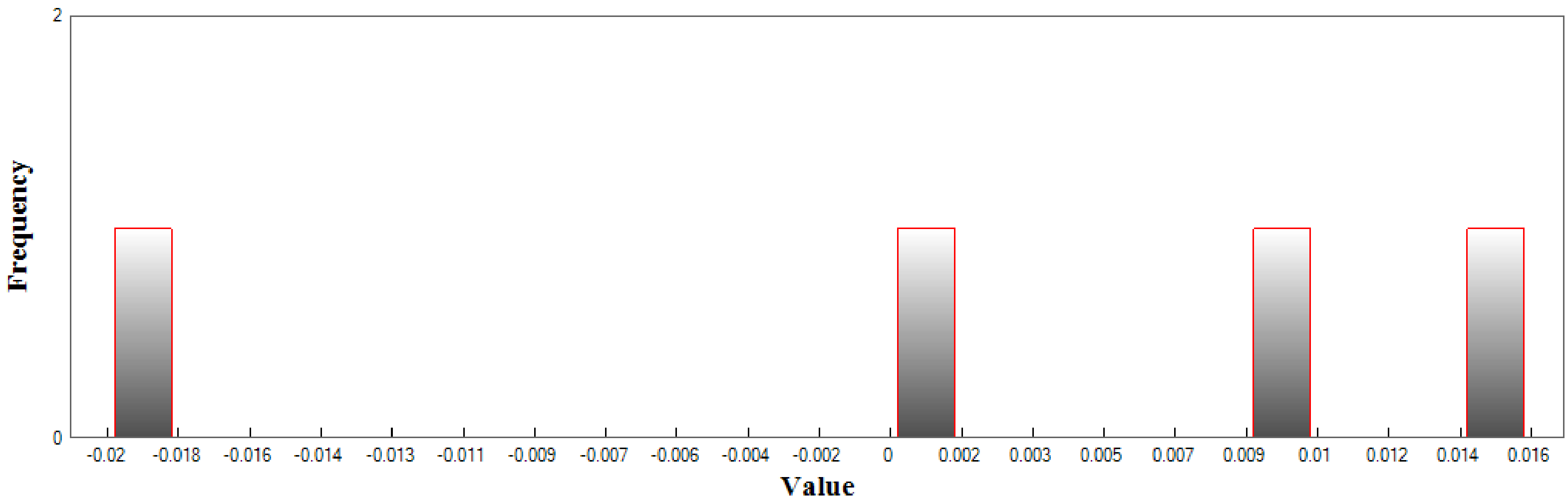
		ID				
			Survey X	Survey Y	Z1	Z DEM	Z LAS
					ΔZ DEM	ΔZ LAS	LC Type
15)	☑	**Forested-111**					
			282898.124	3328438.699	24.296	24.26	24.26
					-0.036	-0.036	Forested
16)	☑	**Forested-112**					
			290316.088	3327866.655	23.54	23.629	23.633
					0.089	0.093	Forested
17)	☑	**Forested-113**					
			296219.468	3326653.269	18.097	18.145	18.147
					0.048	0.05	Forested
18)	☑	**Forested-131**					
			289540.949	3324439.068	24.047	24.227	NaN
					0.18	NaN	Forested

LAS

Fundamental Vertical Accuracy

LandCover Type: FVA
Minimum DZ: -0.065
Maximum DZ: 0.052
Mean DZ: 0.003
Mean Magnitude DZ: 0.347
Number Observations: 4
Standard Deviation DZ: 0.052
RMSE Z: 0.045
95% Confidence Level Z: 0.088
Units: Feet

Histogram



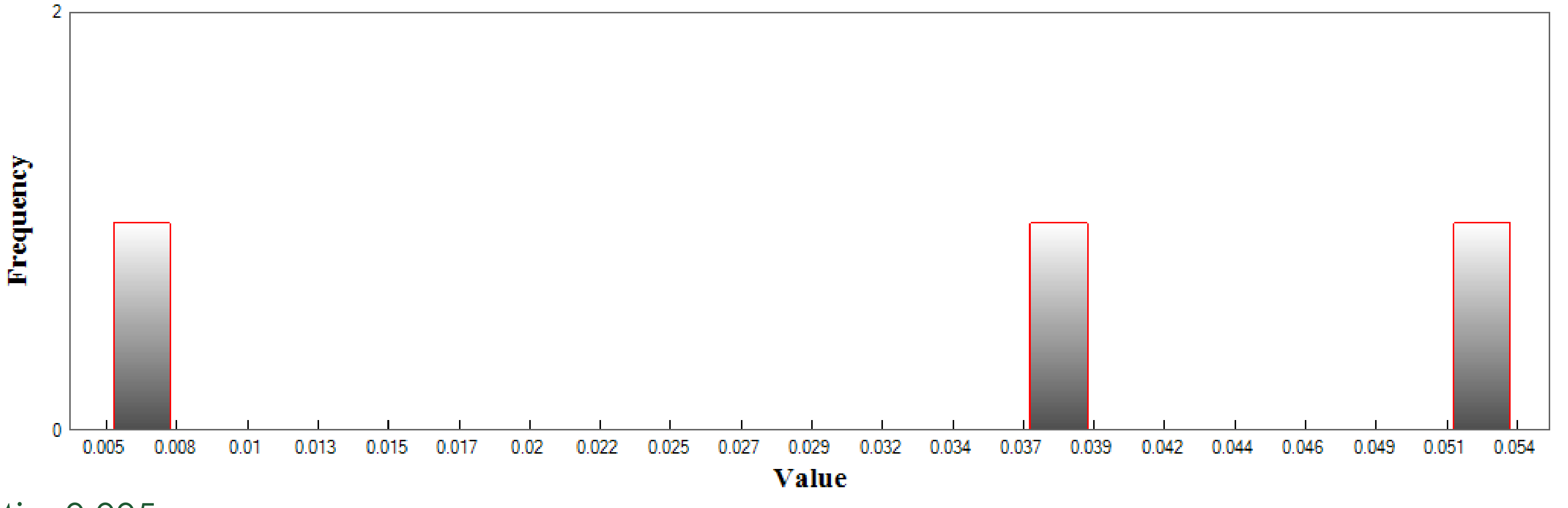
Min: -0.02
Max: 0.016
Number Of Bins: 20
Bin Interval: 0.002

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: Urban
Minimum DZ: 0.016
Maximum DZ: 0.177
Mean DZ: 0.108
Mean Magnitude DZ: 0.593
Number Observations: 3
Standard Deviation DZ: 0.082
RMSE Z: 0.127
95th Percentile: 0.170
Units: Feet

Histogram



Min: 0.005
Max: 0.054
Number Of Bins: 20
Bin Interval: 0.002

LAS (Continued)

Supplemental Vertical Accuracy
LandCover Type: Tallweeds

Minimum DZ: 0.088

Maximum DZ: 0.193

Mean DZ: 0.127

Mean Magnitude DZ: 0.649

Number Observations: 3

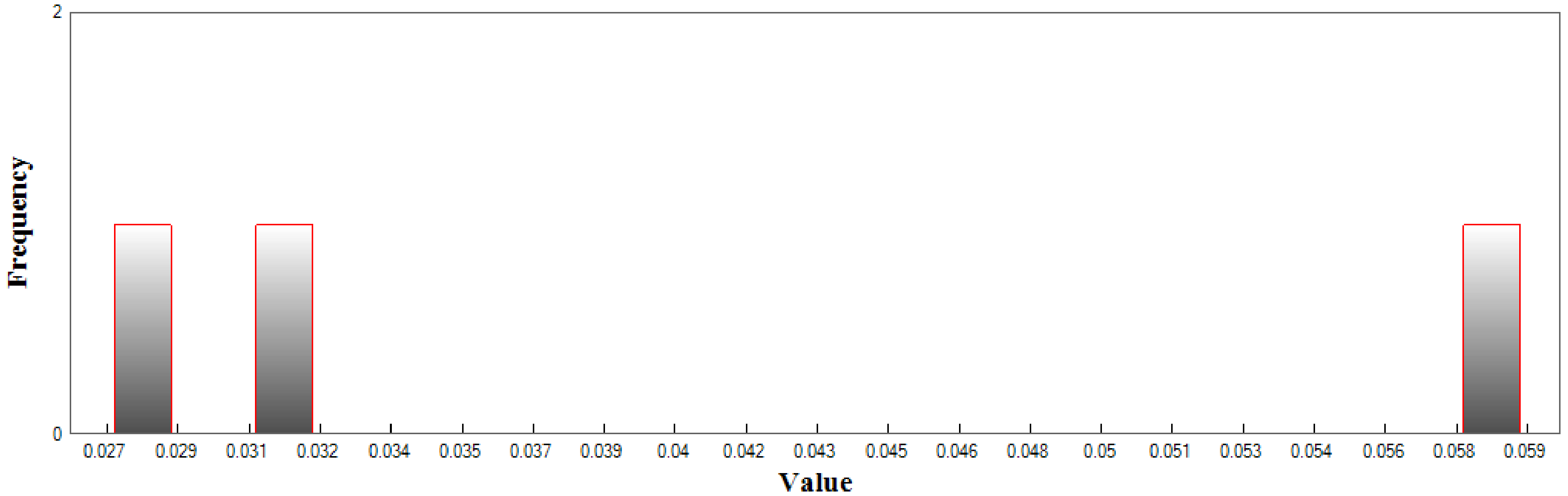
Standard Deviation DZ: 0.055

RMSE Z: 0.137

95th Percentile: 0.183

Units: Feet

Histogram



Min: 0.027

Max: 0.059

Number Of Bins: 20

Bin Interval: 0.002

LAS (Continued)

Supplemental Vertical Accuracy
LandCover Type: Brushland

Minimum DZ: -0.068

Maximum DZ: 0.456

Mean DZ: 0.167

Mean Magnitude DZ: 0.813

Number Observations: 4

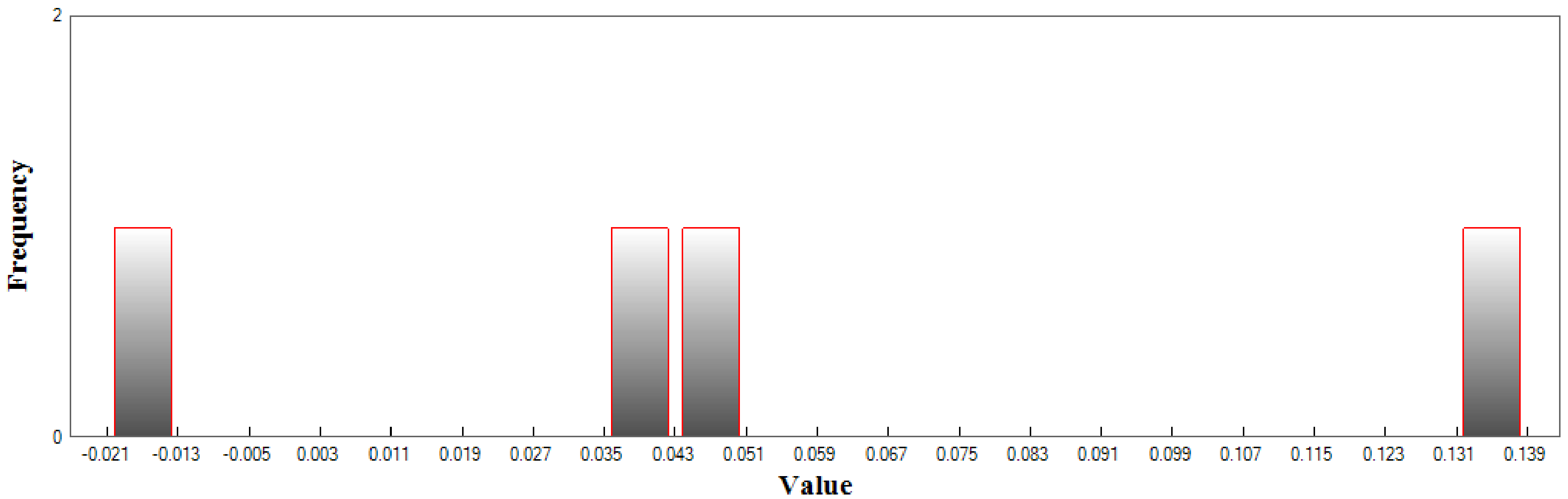
Standard Deviation DZ: 0.216

RMSE Z: 0.252

95th Percentile: 0.410

Units: Feet

Histogram



Min: -0.021

Max: 0.139

Number Of Bins: 20

Bin Interval: 0.008

LAS (Continued)

Supplemental Vertical Accuracy
LandCover Type: Forested

Minimum DZ: -0.118

Maximum DZ: 0.305

Mean DZ: 0.118

Mean Magnitude DZ: 0.803

Number Observations: 3

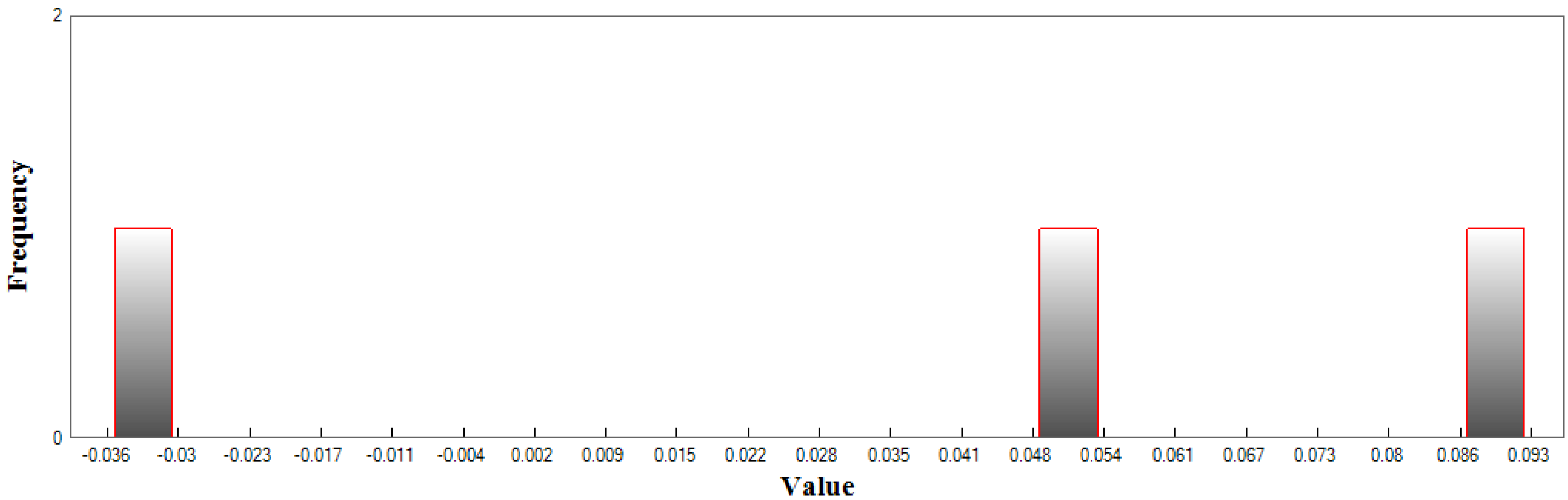
Standard Deviation DZ: 0.216

RMSE Z: 0.213

95th Percentile: 0.291

Units: Feet

Histogram



Min: -0.036

Max: 0.093

Number Of Bins: 20

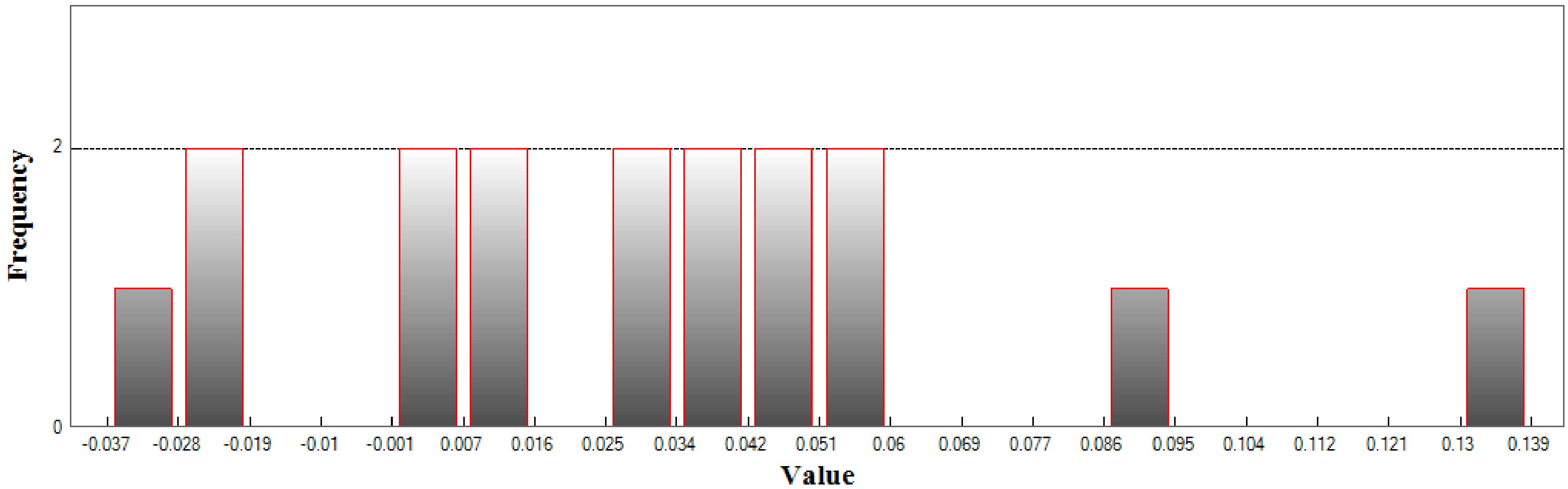
Bin Interval: 0.006

LAS (Continued)

Consolidated Vertical Accuracy

LandCover Type: ALL
Minimum DZ: -0.118
Maximum DZ: 0.456
Mean DZ: 0.101
Mean Magnitude DZ: 0.659
Number Observations: 17
Standard Deviation DZ: 0.141
RMSE Z: 0.170
95th Percentile: 0.334
Units: Feet

Histogram



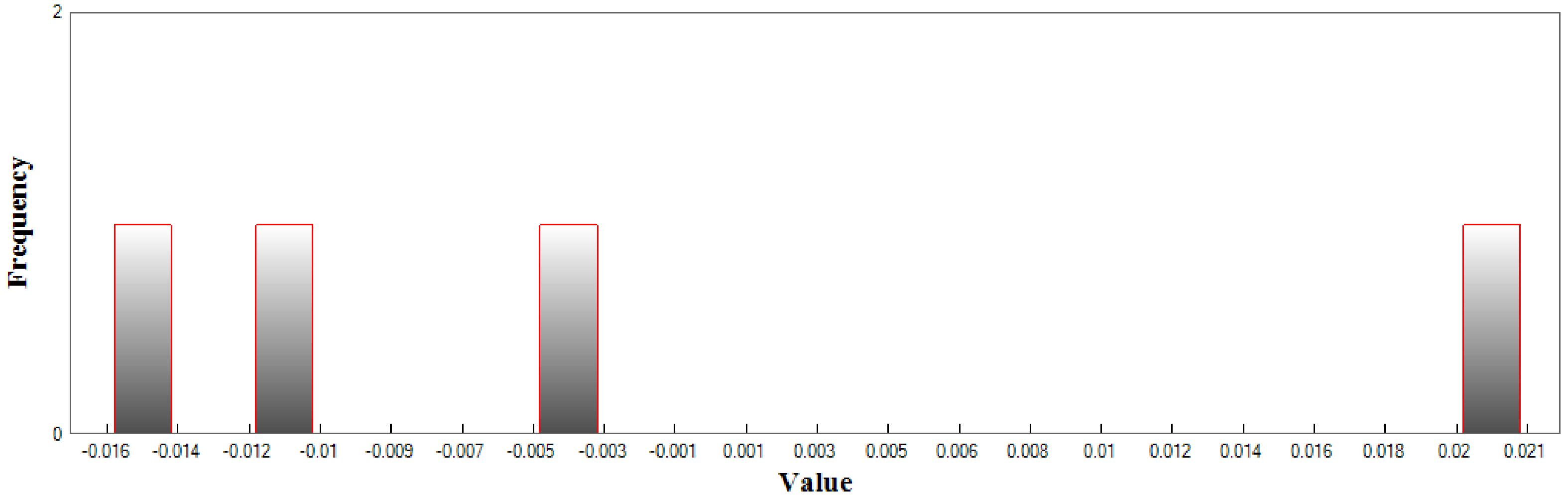
Min: -0.036
Max: 0.139
Number Of Bins: 20
Bin Interval: 0.009

DEM

Fundamental Vertical Accuracy

LandCover Type: FVA
Minimum DZ: -0.052
Maximum DZ: 0.068
Mean DZ: -0.009
Mean Magnitude DZ: 0.377
Number Observations: 4
Standard Deviation DZ: 0.055
RMSE Z: 0.049
95% Confidence Level Z: 0.095
Units: Feet

Histogram



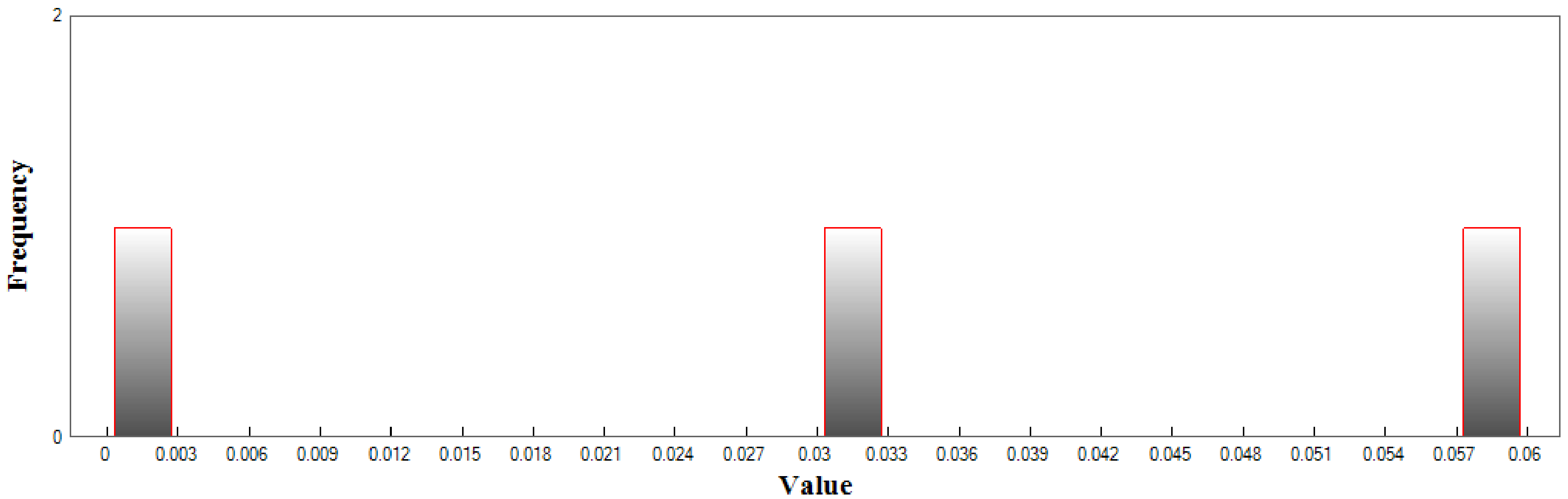
Min: -0.016
Max: 0.021
Number Of Bins: 20
Bin Interval: 0.002

Raw Point cloud

Supplemental Vertical Accuracy

LandCover Type: Urban
Minimum DZ: 0
Maximum DZ: 0.196
Mean DZ: 0.101
Mean Magnitude DZ: 0.580
Number Observations: 3
Standard Deviation DZ: 0.098
RMSE Z: 0.131
95th Percentile: 0.190
Units: Feet

Histogram



Min: 0
Max: 0.06
Number Of Bins: 20
Bin Interval: 0.003

Raw Point cloud

Supplemental Vertical Accuracy
LandCover Type: Tallweeds

Minimum DZ: 0.078

Maximum DZ: 0.180

Mean DZ: 0.114

Mean Magnitude DZ: 0.610

Number Observations: 3

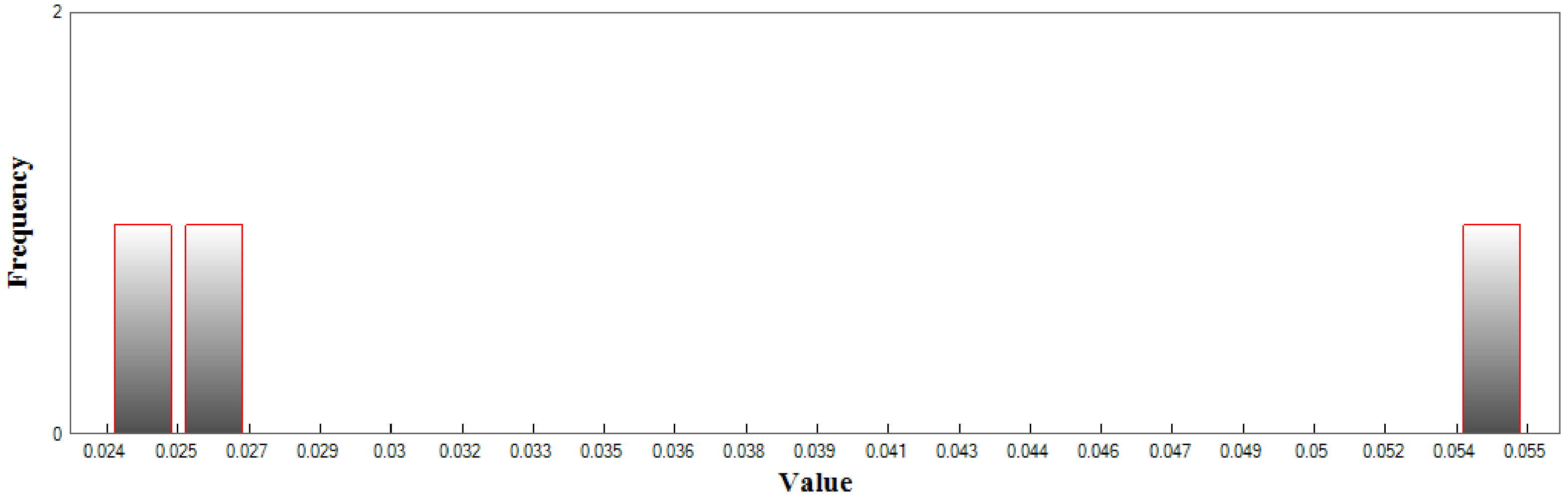
Standard Deviation DZ: 0.059

RMSE Z: 0.121

95th Percentile: 0.170

Units: Feet

Histogram



Min: 0.024

Max: 0.055

Number Of Bins: 20

Bin Interval: 0.002

Raw Point cloud

Supplemental Vertical Accuracy
LandCover Type: Brushland

Minimum DZ: -0.026

Maximum DZ: 0.374

Mean DZ: 0.157

Mean Magnitude DZ: 0.748

Number Observations: 4

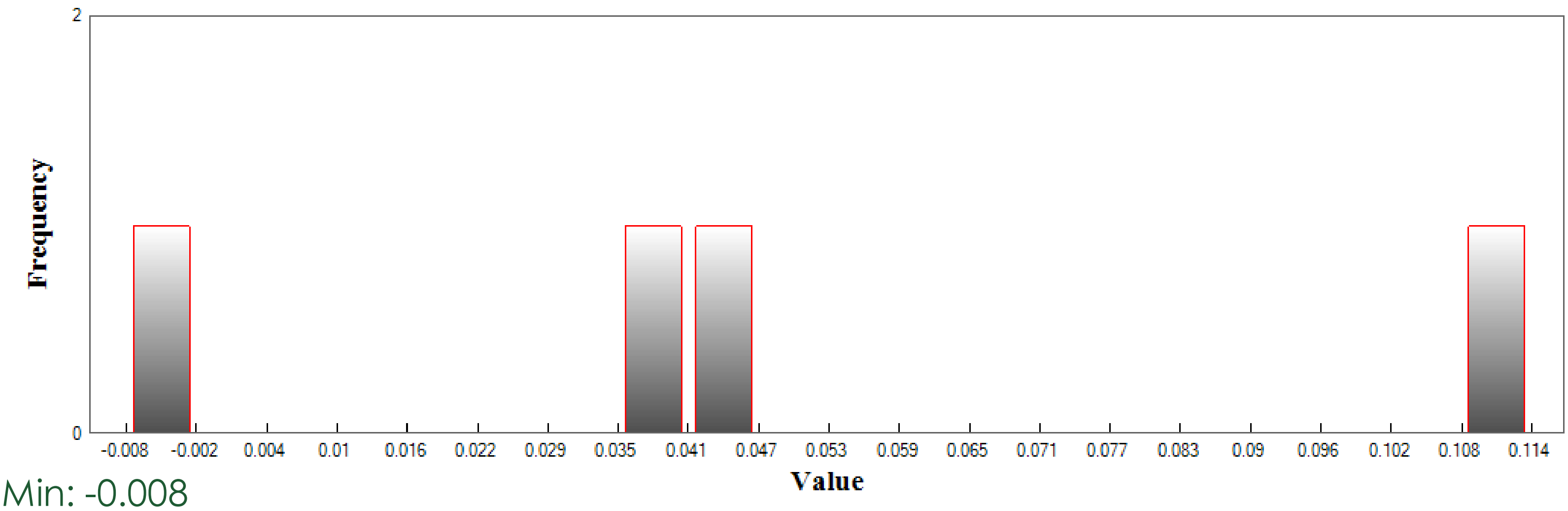
Standard Deviation DZ: 0.164

RMSE Z: 0.213

95th Percentile: 0.341

Units: Feet

Histogram



Min: -0.008

Max: 0.114

Number Of Bins: 20

Bin Interval: 0.006

Raw Point cloud

Supplemental Vertical Accuracy
LandCover Type: Forested

Minimum DZ: -0.118

Maximum DZ: 0.590

Mean DZ: 0.229

Mean Magnitude DZ: 0.974

Number Observations: 4

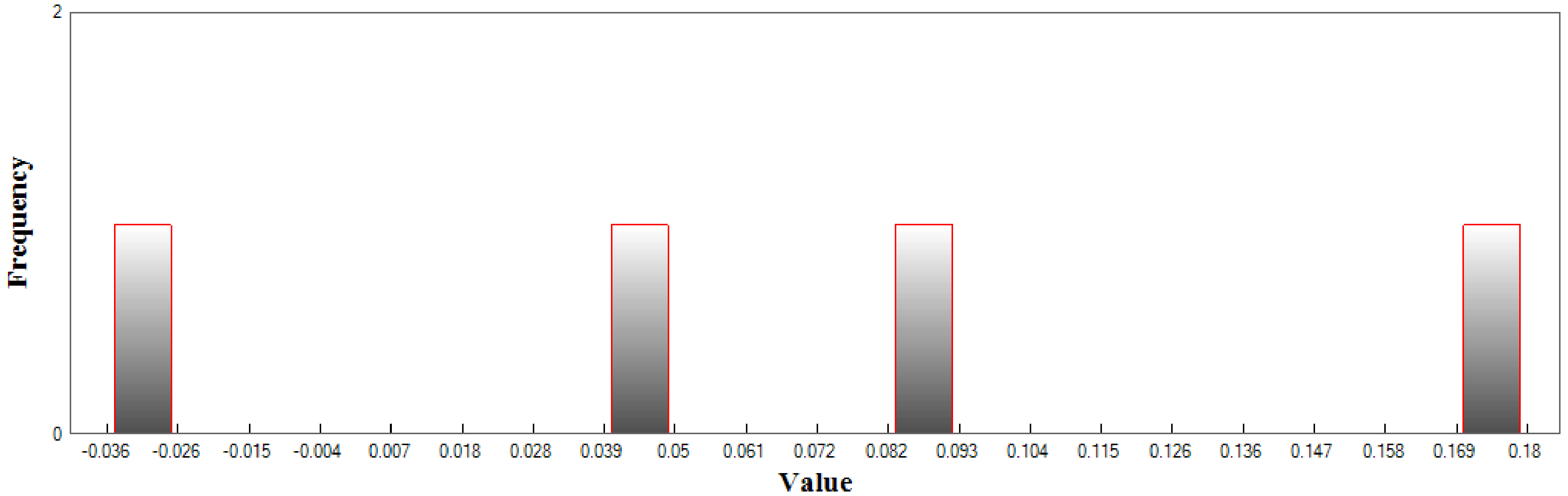
Standard Deviation DZ: 0.295

RMSE Z: 0.344

95th Percentile: 0.544

Units: Feet

Histogram



Min: -0.036

Max: 0.18

Number Of Bins: 20

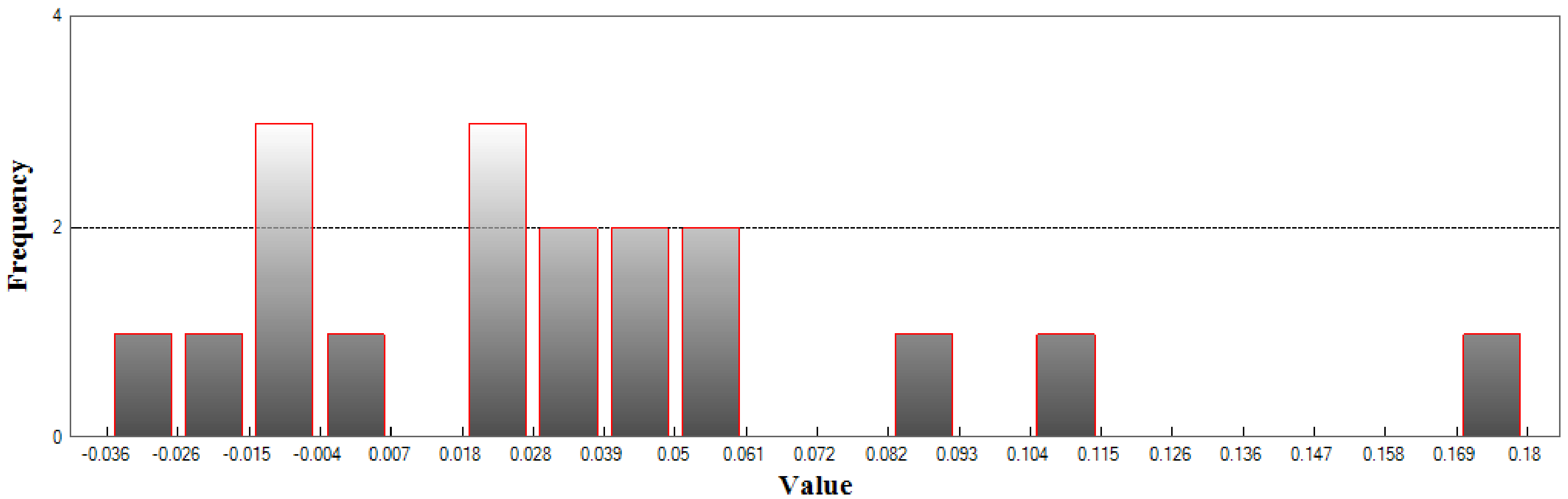
Bin Interval: 0.011

Raw Point cloud

Consolidated Vertical Accuracy

LandCover Type: ALL
Minimum DZ: -0.118
Maximum DZ: 0.590
Mean DZ: 0.121
Mean Magnitude DZ: 0.695
Number Observations: 18
Standard Deviation DZ: 0.170
RMSE Z: 0.206
95th Percentile: 0.406
Units: Feet

Histogram



Min: -0.036
Max: 0.18
Number Of Bins: 20
Bin Interval: 0.011

Raw Point cloud

Control Point Report (LP360, QCoherent Software, LLC)
Generated by common (06/28/13 14:11:42)

--------- Report Disclaimer ---------

This report does not guarantee accuracy. The report only reflects one statistical representation of the control points, LIDAR data and surface used. This report does not replace a thorough quality control process.

--------- Report Summary ---------

Error Mean: 0.017
Error Range: [-0.011,0.051]
Skew: 0.304
RMSE(z): 0.028
NMAS/VMAS
Accuracy(z) (90% CI): ±0.046
ASPRS/NSSDA
Accuracy(z) (95% CI): ±0.055

4 control points included in summary out of 21
- 0 control points turned off
- 17 control points returned no-data

--------- End Report Summary ---------

--------- Surface Definition ---------

Surface Method: Triangulation (TIN)

Raw Point cloud

Classification Filter Used:

-ALL classification values used in filter

Return Combination Filter Used:

-ALL return combinations used in filter

--------- End Surface Definition ---------

--------- Control Points ---------

Name	Control X	Control Y	Control Z	Surface Z	Error
FVA-101	239862.378	3376355.113	26.626	No-Data	---
FVA-102	239319.534	3367271.011	24.724	No-Data	---
FVA-103	250631.994	3365608.869	28.853	No-Data	---
FVA-104	251057.124	3376411.507	31.295	No-Data	---
FVA-105	263474.967	3375505.639	48.843	No-Data	---
FVA-106	261949.185	3365556.972	53.652	No-Data	---
FVA-107	295191.325	3360816.703	27.237	No-Data	---
FVA-108	307643.188	3361153.813	47.077	No-Data	---
FVA-109	302436.397	3356866.002	31.019	No-Data	---
FVA-110	304750.853	3352142.705	29.524	No-Data	---
FVA-111	281446.450	3326544.022	24.890	24.901	-0.011
FVA-112	290353.925	3327885.214	24.041	24.023	0.018
FVA-113	296095.423	3326565.454	18.804	18.753	0.051
FVA-114	331183.998	3317779.652	17.175	No-Data	---
FVA-115	330236.225	3326726.012	26.201	No-Data	---
FVA-116	341910.527	3325424.802	25.912	No-Data	---
FVA-117	344402.119	3319162.777	29.470	No-Data	---
FVA-118	336278.731	3313767.226	22.934	No-Data	---
FVA-119	338173.149	3302670.717	15.426	No-Data	---
FVA-131	289546.226	3324401.927	24.200	24.188	0.012
FVA-132	335173.195	3320407.810	23.761	No-Data	---