Airborne LiDAR Report

WOOLPERT

October 2016

Airborne LiDAR Report

UNITED STATES GEOLOGICAL SURVEY

FEMA HQ Malheur OR QL1 Lidar

Contract Number: G10PC00057
Task Number: G15PD00642

Woolpert
4454 Idea Center Boulevard
Dayton, Ohio 45430.1500
Phone: 937.461.5660

Table of Contents

List of Figures

List of Tables

Section 1: Overview

TASK ORDER NAME: FEMA HQ Malheur OR QL1 Lidar

Project: #75818

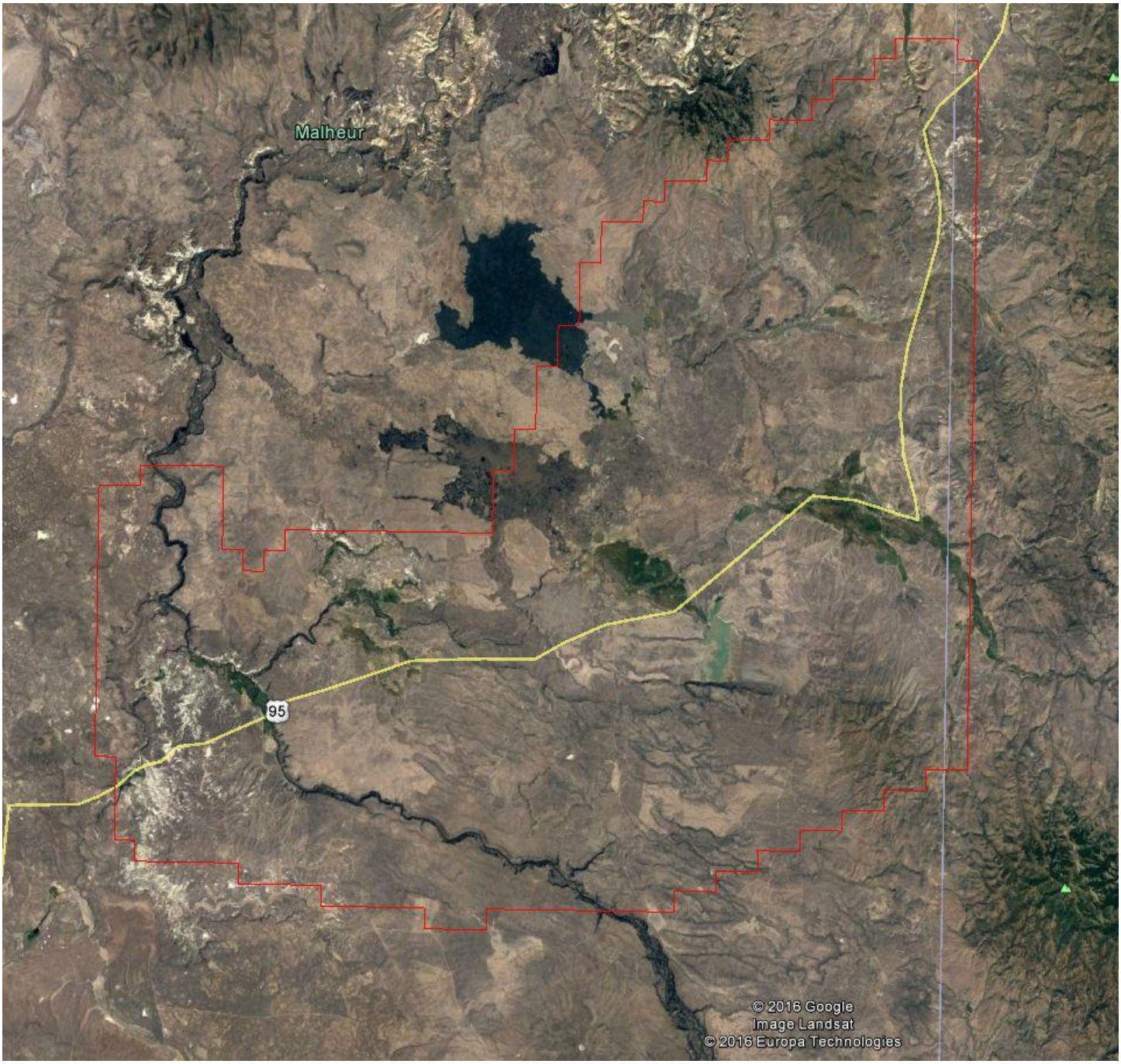
This report contains a comprehensive outline of the FEMA HQ Malheur OR QL1 Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G15PD00642. This task order requires lidar data to be acquired over Malheur County, OR (approximately 863 square miles). The lidar was collected and processed to meet a maximum Nominal Post Spacing (NPS) of 0.35 meters. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The data was collected using a Dual-Head DragonEye (DE) sensor. The sensor was mounted in a Leica PAV100 gyro-stabilized mount integrated with a NovAtel SPAN GNSS and LCI-100C IMU. This sensor collects up to four returns (echo) per pulse, as well as intensity data, for the first three returns. The aerial lidar was collected at the following sensor specifications:

Table 1.1: Dual-Head DragonEye (DE) Specifications	
Post Spacing	0.35 m
AGL (Above Ground Level) average flying height	900 m
Average Ground Speed:	125 knots / 144 mph
Field of View (full)	40 degrees
Pulse Rate	520 kHz
Scan Rate	50 Hz
Side Lap	15%

LiDAR data was produced in NAD83(2011) UTM11N. Coordinate positions were specified in units of meters. The vertical datum used for the project was referenced to NAVD 1988, meters, GEOID12B.

Figure 1.1: Lidar Task Order AOI



Section 2: Acquisition

The LiDAR data was acquired with a Leica Leica Dual-Head DragonEye (DE) sensor, on board Woolpert's Cessna aircraft. The Leica system, developed by Leica of Herrburgg, Switzerland. The innovative dual scanner head design of the DragonEye features a unique oblique scan pattern. In one single pass, each ground target may be illuminated by four laser shots at multiple incidence angles from ±8 to ±20 degrees, maximizing vertical surface definition and minimizing shadows in the survey data.Each topographic laser operates in the infra-red spectrum at 1064nm. Up to 15 returns per pulse are acquired from each laser.

Table 2.1: The Leica DragonEye LiDAR System has the following specifications:

Laser Characterization	
Laser wavelength [6]	1064 nm
Laser divergence	0.5 mrad ($1/e^2$)
Pulse repetition frequency (PRF)	Up to 1 MHz
Return pulses	Programmable up to 15 returns, with full waveform record option
Operation altitude [1]	300 – 1600 m AGL
Scanner pattern	Dual head oblique scanner
Scanner speed	Programmable up to 70 RPS per scanner (i.e., 280 scans/second)
Field of view	±8° and ±20° front/back, ±20° left/right
Swath width	70 % of AGL
Point density [2]	> 16 pts/m^2
Ranging accuracy [2], [3], [4]	2 cm (1σ)
Vertical accuracy [2], [3], [5]	6 cm (1σ)
Horizontal accuracy [2], [3], [5]	25 cm (1σ)

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

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

The LiDAR data was collected in one (25) missions, flown as close together as the weather permitted, to ensure consistent ground conditions across the project area. An initial quality control process was performed immediately on the LiDAR data to review the data coverage, airborne GPS data, and trajectory solution.

Table 2.2: Airborne Lidar Acquisition Flight Summary

Date of Mission	**Lines Flown**	**Mission Time (UTC) Wheels Up/ Wheels Down**
March 23, 2016	**68-85,**	**15:44 - 19:33**
March 23, 2016	**86-99**	**21:41 - 1:26**
March 24, 2016	**100 -105, 143 -152**	**17:30 - 22:06**
March 25, 2016	**21-41**	**14:36 - 19:02**
March 26, 2016	**1-20**	**15:31 - 20:12**
March 26, 2016	**42-60**	**21:48 - 23:59**
March 26, 2016	**61-67, 153-158**	**15:36 - 19:02**
March 30, 2016	**1-6,**	**18:43 -20:18**
March 31, 2016	**159-172**	**14:52 - 19:02**
March 31, 2016	**173 – 188**	**21:03 - 01:15**
March 31, 2016	**189–201, 221-222, 243**	**18:48 - 22:58**
April 2, 2016	**27-42**	**16:49 - 19:48**
April 2, 2016	**106-118, 120-124**	**22:15 - 02:02**
April 3, 2016	**124-142**	**15:40 - 18:35**
April 6, 2016	**244-255**	**22:29 - 01:31**
April 7, 2016	**256-273**	**15:11 - 19:11**
April 7, 2016	**274-285**	**20:40 - 23:55**
April 8, 2016	**281-290, 308-319**	**14:26 - 18:57**
April 8, 2016	**291-307, 320-322**	**20:24 - 00:00**
April 9, 2016	**323-336**	**15:15 - 19:02**
June 8, 2016	**1-6**	**23:59 - 1:20**
June 9, 2016	**1-6**	**20:00 - 23:35**
June 10, 2016	**125-142,479-487**	**14:36 - 18:26**
June 10, 2016	**202-222,488**	**20:20-23:17**
June 15, 2016	**222,481,489-499**	**14:04-16:18**

Figure 2.1: LiDAR Flight Layout, FEMA HQ Malheur OR QL1 Lidar

Section 3: LiDAR Data Processing

Applications and Work Flow Overview

Initial data coverage analysis and quality checks to ensure there were no potential system issues were carried out in the field prior to demobilization of the sensor. In general, data were initially processed in Leica's Lidar Survey Studio (LSS) using final processed trajectory information. LAS files from LSS were imported to a Terrascan project where spatial algorithms were used to remove gross system noise and a basic ground classification was conducted per flight line for Terra Match use. TMatch was then run on the project, and a comparison to the lidar control points was conducted. Final trajectory data were post processed in NovAtel Inertial Explorer. Base station data were converted to GPB format and imported with aircraft GNSS and IMU data. Inertial Explorer accounts for the fixed offset between the reference point and IMU and uses a multi-pass algorithm to compute a tightly-coupled solution. Lidar processing was conducted using the Leica Lidar Survey Studio (LSS) software. Calibration information, along with processed trajectory information were combined with the raw laser data to create an accurately georeferenced lidar point cloud for the entire survey in LAS v1.2 format. All points from the topographic lasers include 16-bit intensity values. Additional QC steps were then performed in LSS prior to import to Terrascan. For example, spot checks were made on the data to ensure the front and back of the scans remained in alignment and no calibration or system issues were apparent prior to further data editing in Terrascan.

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

Equipment

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

The aircraft is configured with a NovAtel SPAN GNSS and LCI-100C IMU.

Base stations were set by acquisition staff and were used to support the LiDAR data acquisition. The base stations used during the LiDAR acquisition missions are listed on the next page:

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

Table 3.1: GNSS Base Station

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
MAN1	43 34 58.78178	116 31 27.08598	755.290
NW0312	42 54 29.68129	117 16 59.16525	1349.625
NW0344	42 52 25.81886	117 30 50.62079	1172.448
NW0133	42 47 20.48320	117 1 49.79613	1501.903
OH0878	43 13 45.39458	117 3 33.02514	1238.082
NW0588	42 58 46.63829	117 3 11.65954	1323.216

LiDAR Data Processing

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

- Processed individual flight lines to derive a raw “Point Cloud” LAS file. Matched overlapping flight lines, generated statistics for evaluation comparisons, and made the necessary adjustments to remove any residual systematic error.
- Calibrated LAS files were imported into the task order tiles and initially filtered to create a ground and non-ground class. Then additional classes were filtered as necessary to meet client specified classes.
- Once all project data was imported and classified, survey ground control data was imported and calculated for an accuracy assessment. As a QC measure, Woolpert has developed a routine to generate accuracy statistical reports by comparisons against the TIN and the DEM using surveyed ground control of higher accuracy. The lidar is adjusted accordingly to meet or exceed the vertical accuracy requirements.
- The lidar tiles were reviewed using a series of proprietary QA/QC procedures to ensure it fulfills the task order requirements. A portion of this requires a manual step to ensure anomalies have been removed from the ground class.
- The lidar LAS files are classified into the Default (Class 1), Ground (Class 2), Low noise (Class 7), Water (Class 9), Ignored ground (Class 10), Bridge Decks (Class 17), High Noise (Class 18) classifications.
- FGDC Compliant metadata was developed for the task order in .xml format per product.
- The horizontal datum used for the task order was referenced to NAD83(2011) UTM11N meters. The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12B.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

FEMA HQ Malheur OR QL1 Lidar processing task order required the compilation of breaklines defining water bodies and rivers. The breaklines were used to perform the hydrologic flattening of water bodies, and gradient hydrologic flattening of double line streams and rivers. Lakes, reservoirs and ponds, at a minimum size of 2-acre or greater, were compiled as closed polygons. The closed water bodies were collected at a constant elevation. Rivers and streams, at a nominal minimum width of 30 meters (100 feet), were compiled in the direction of flow with both sides of the stream maintaining an equal gradient elevation.

LIDAR DATA REVIEW AND PROCESSING

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

1. Woolpert used the newly acquired lidar data to manually draw the hydrologic features in a 2D environment using the lidar intensity and bare earth surface. Open Source imagery was used as reference when necessary.
2. Woolpert utilizes an integrated software approach to combine the lidar data and 2D breaklines. This process “drapes” the 2D breaklines onto the 3D lidar surface model to assign an elevation. A monotonic process is performed to ensure the streams are consistently flowing in a gradient manner. A secondary step within the program verifies an equally matching elevation of both stream edges. The breaklines that characterize the closed water bodies are draped onto the 3D lidar surface and assigned a constant elevation at or just below ground elevation.
3. The lakes, reservoirs and ponds, at a minimum size of 2-acre or greater and streams at a minimum size of 30 meters (100 feet) nominal width, were compiled to meet task order requirements. **Figure 4.1** illustrates an example of 30 meters (100 feet) nominal streams identified and defined with hydrologic breaklines. The breaklines defining rivers and streams, at a nominal minimum width of 30 meters (100 feet), were draped with both sides of the stream maintaining an equal gradient elevation.
4. All ground points were reclassified from inside the hydrologic feature polygons to water, class nine (9).
5. All ground points were reclassified from within a buffer along the hydrologic feature breaklines to buffered ground, class ten (10).
6. The lidar ground points and hydrologic feature breaklines were used to generate a new digital elevation model (DEM).

Figure 4.1: Example Hydrologic Breaklines

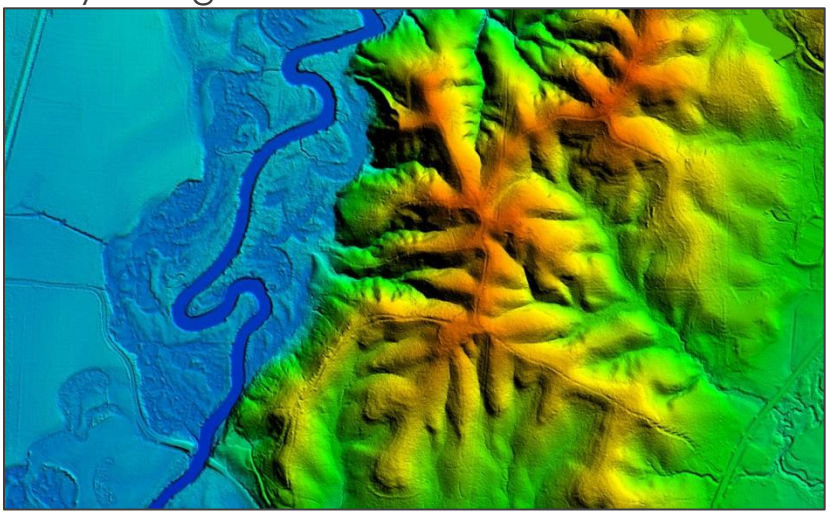


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

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

Figure 4.2

Figure 4.3

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

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

DATA QA/QC

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

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

Section 5: Accuracy Assessment

Final Vertical Accuracy Assessment

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

Table 5.1: Overall Vertical Accuracy Statistics		
Average error	+0.038	meter
Minimum error	-0.035	meter
Maximum error	+0.103	meter
Average magnitude	0.041	meter
Root mean square	0.049	meter
Standard deviation	0.031	meter

Table 5.2: RAW Swath Quality Check Point Analysis NVA

Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	TIN Elevation (meter)	Dz (meter)
2002	453619.467	4755247.349	1146.332	1146.340	0.008
2002A	453619.473	4755276.060	1146.378	1146.400	0.022
2003	456840.947	4746398.211	1169.461	1169.470	0.009
2003A	456799.779	4746385.845	1169.531	1169.550	0.019
2004	449120.732	4743450.540	1030.014	1030.020	0.006
2004A	449109.274	4743470.353	1029.701	1029.710	0.009
2005	447417.225	4748410.329	1172.011	1172.100	0.089
2005A	447413.161	4748396.562	1172.303	1172.390	0.087
2006	439694.361	4739171.334	1092.589	1092.610	0.021
2006A	439708.559	4739187.964	1092.253	1092.230	-0.023
2007	472889.354	4760363.792	1302.940	1302.990	0.050
2007A	472885.802	4760379.309	1303.016	1303.010	-0.006
2008	440505.939	4745470.073	1058.527	1058.530	0.003
2008A	440488.631	4745478.307	1058.250	1058.250	0.000
2009	462857.209	4738203.720	1282.917	1282.950	0.033
2009A	462831.067	4738202.555	1282.749	1282.790	0.041
2010	454825.808	4738485.999	1201.828	1201.840	0.012
2010A	454812.814	4738504.512	1201.775	1201.820	0.045
2011	459708.448	4734084.839	1285.185	1285.220	0.035
2011A	459729.060	4734079.856	1285.136	1285.160	0.024
2012	497921.233	4788717.961	1266.216	1266.240	0.024
2012A	497898.089	4788692.273	1266.135	1266.180	0.045
2013	495867.601	4774862.399	1393.017	1393.020	0.003
2013A	495847.242	4774851.187	1393.022	1393.030	0.008
2014	495582.152	4758100.338	1338.191	1338.260	0.069
2014A	495607.488	4758115.485	1338.276	1338.350	0.074

2015	487417.998	4759171.314	1320.007	1320.070	0.063
2015A	487438.262	4759179.482	1320.061	1320.130	0.069
2016	484475.689	4766285.878	1416.457	1416.540	0.083
2016A	484465.733	4766269.416	1416.698	1416.710	0.012
2017	474815.441	4766638.035	1309.215	1309.230	0.015
2017A	474815.975	4766663.558	1310.399	1310.430	0.031
2018	473096.096	4756306.269	1290.754	1290.770	0.016
2018A	473118.159	4756306.490	1291.048	1291.100	0.052
2019	477171.406	4752248.858	1295.404	1295.460	0.056
2019A	477156.357	4752249.126	1295.174	1295.230	0.056
2020	473919.473	4747019.777	1302.331	1302.410	0.079
2020A	473917.972	4747060.307	1302.618	1302.680	0.062
2020B	472329.562	4755519.588	1289.531	1289.600	0.069
2020C	472313.379	4755527.023	1289.207	1289.270	0.063
2021	463656.482	4738538.223	1264.349	1264.380	0.031
2021A	463675.825	4738529.754	1264.774	1264.810	0.036
2022	492068.435	4788116.732	1339.560	1339.650	0.090
2022A	492137.379	4788117.756	1339.468	1339.530	0.062
2023	461216.116	4751531.844	1190.392	1190.420	0.028
2023A	461199.971	4751529.617	1190.412	1190.450	0.038
2024	483055.499	4755043.979	1341.631	1341.650	0.019
2024A	483065.891	4755031.232	1340.745	1340.710	-0.035
2025	486127.907	4770735.356	1347.639	1347.660	0.021
2025A	486108.149	4770717.392	1347.915	1347.940	0.025
2026	498057.749	4742395.320	1426.693	1426.790	0.097
2026A	498050.107	4742435.219	1425.924	1426.000	0.076
2027B	498215.046	4743466.105	1414.759	1414.790	0.031
2027C	498199.212	4743467.094	1414.457	1414.540	0.083
2029	460696.163	4733808.927	1288.007	1288.090	0.083
2029A	460717.659	4733804.859	1288.220	1288.240	0.020
2030	451071.035	4731783.530	1170.116	1170.150	0.034
2030A	451069.800	4731801.511	1169.363	1169.390	0.027
2031	463882.920	4738678.412	1268.998	1269.050	0.052
2031A	463899.921	4738686.813	1269.018	1269.070	0.052
2032	463895.417	4747512.652	1238.540	1238.560	0.020
2032A	463893.110	4747531.785	1237.923	1237.980	0.057
2033	448772.332	4736811.636	1107.028	1107.080	0.052
2033A	448785.162	4736797.939	1107.567	1107.610	0.043
2034	494268.369	4766292.463	1361.026	1361.010	-0.016
2034A	494294.725	4766274.432	1360.084	1360.120	0.036
2035	474819.182	4778284.471	1432.435	1432.470	0.035
2035A	474788.981	4778281.116	1433.696	1433.750	0.054
2036	481391.481	4774059.437	1337.751	1337.840	0.089
2036A	481409.324	4774071.634	1337.587	1337.690	0.103
2037	487834.963	4774069.036	1358.388	1358.460	0.072

2037A	487836.263	4774034.649	1357.638	1357.730	0.092
2038	497560.270	4751598.853	1390.186	1390.190	0.004
2038A	497571.011	4751586.808	1390.056	1390.090	0.034
2039	445977.136	4735788.080	1189.857	1189.850	-0.007
2039A	445979.760	4735809.832	1189.750	1189.730	-0.020
2041	480216.951	4774514.033	1337.006	1337.030	0.024
2041A	480209.778	4774527.256	1336.831	1336.890	0.059
2042	480552.719	4761493.858	1337.082	1337.060	-0.022
2042A	480578.038	4761473.666	1336.422	1336.410	-0.012
2043	470120.701	4748630.803	1303.278	1303.280	0.002
2043A	470118.207	4748643.596	1303.052	1303.080	0.028
2044	444644.239	4741168.565	1118.337	1118.340	0.003
2044A	444630.107	4741177.658	1118.592	1118.590	-0.002
2045	446812.921	4746415.157	1030.161	1030.230	0.069
2045A	446822.885	4746427.323	1030.972	1031.040	0.068
2046	457126.107	4751351.610	1138.661	1138.690	0.029
2046A	457112.895	4751352.214	1137.795	1137.840	0.045
2047	473467.413	4762797.839	1305.907	1305.920	0.013
2047A	473448.683	4762803.968	1306.025	1306.020	-0.005
2048	477261.903	4773300.269	1395.352	1395.420	0.068
2048A	477248.494	4773282.505	1394.901	1394.970	0.069
2049	487377.479	4767362.523	1383.816	1383.900	0.084
2049A	487365.529	4767342.744	1384.525	1384.610	0.085
2050	485665.268	4757610.966	1330.395	1330.430	0.035
2050A	485657.795	4757623.509	1329.952	1330.020	0.068
2051	496802.930	4782277.476	1271.454	1271.500	0.046
2051A	496812.333	4782252.481	1271.974	1272.010	0.036
2052	490975.999	4757092.339	1327.114	1327.180	0.066
2052A	491009.279	4757092.388	1327.288	1327.360	0.072
2053	472275.188	4753062.520	1307.300	1307.350	0.050
2053A	472275.437	4753026.869	1307.618	1307.640	0.022
2054	441545.937	4744040.015	1111.187	1111.180	-0.007
2055	443530.774	4744336.526	1057.829	1057.820	-0.009
2056	458314.113	4734437.972	1253.494	1253.530	0.036
2057	467856.290	4730079.708	1389.482	1389.530	0.048

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.096 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using all points.

LAS Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.072 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data

Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the TIN using ground points.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	DEM Elevation (meter)	Dz (meter)
2002	453619.467	4755247.349	1146.332	1146.310	0.022
2002A	453619.473	4755276.06	1146.378	1146.380	-0.002
2003	456840.947	4746398.211	1169.461	1169.460	0.001
2003A	456799.779	4746385.845	1169.531	1169.560	-0.029
2004	449120.732	4743450.54	1030.014	1030.020	-0.006
2004A	449109.274	4743470.353	1029.701	1029.710	-0.009
2005	447417.225	4748410.329	1172.011	1172.080	-0.069
2005A	447413.161	4748396.562	1172.303	1172.350	-0.047
2006	439694.361	4739171.334	1092.589	1092.600	-0.011
2006A	439708.559	4739187.964	1092.253	1092.230	0.023
2007	472889.354	4760363.792	1302.94	1302.940	0
2007A	472885.802	4760379.309	1303.016	1303.000	0.016
2008	440505.939	4745470.073	1058.527	1058.510	0.017
2008A	440488.631	4745478.307	1058.25	1058.240	0.01
2009	462857.209	4738203.72	1282.917	1282.930	-0.013
2009A	462831.067	4738202.555	1282.749	1282.760	-0.011
2010	454825.808	4738485.999	1201.828	1201.850	-0.022
2010A	454812.814	4738504.512	1201.775	1201.790	-0.015
2011	459708.448	4734084.839	1285.185	1285.200	-0.015
2011A	459729.06	4734079.856	1285.136	1285.150	-0.014
2012	497921.233	4788717.961	1266.216	1266.210	0.006
2012A	497898.089	4788692.273	1266.135	1266.160	-0.025
2013	495867.601	4774862.399	1393.017	1392.990	0.027
2013A	495847.242	4774851.187	1393.022	1393.010	0.012
2014	495582.152	4758100.338	1338.191	1338.250	-0.059
2014A	495607.488	4758115.485	1338.276	1338.340	-0.064
2015	487417.998	4759171.314	1320.007	1320.040	-0.033
2015A	487438.262	4759179.482	1320.061	1320.110	-0.049
2016	484475.689	4766285.878	1416.457	1416.460	-0.003
2016A	484465.733	4766269.416	1416.698	1416.650	0.048
2017	474815.441	4766638.035	1309.215	1309.220	-0.005
2017A	474815.975	4766663.558	1310.399	1310.410	-0.011
2018	473096.096	4756306.269	1290.754	1290.750	0.004
2018A	473118.159	4756306.49	1291.048	1291.010	0.038
2019	477171.406	4752248.858	1295.404	1295.420	-0.016
2019A	477156.357	4752249.126	1295.174	1295.180	-0.006
2020	473919.473	4747019.777	1302.331	1302.370	-0.039
2020A	473917.972	4747060.307	1302.618	1302.630	-0.012
2020B	472329.562	4755519.588	1289.531	1289.550	-0.019
2020C	472313.379	4755527.023	1289.207	1289.200	0.007
2021	463656.482	4738538.223	1264.349	1264.380	-0.031
2021A	463675.825	4738529.754	1264.774	1264.740	0.034
2022	492068.435	4788116.732	1339.56	1339.640	-0.08
2022A	492137.379	4788117.756	1339.468	1339.500	-0.032

2023	461216.116	4751531.844	1190.392	1190.410	-0.018
2023A	461199.971	4751529.617	1190.412	1190.450	-0.038
2024	483055.499	4755043.979	1341.631	1341.640	-0.009
2024A	483065.891	4755031.232	1340.745	1340.680	0.065
2025	486127.907	4770735.356	1347.639	1347.640	-0.001
2025A	486108.149	4770717.392	1347.915	1347.920	-0.005
2026	498057.749	4742395.32	1426.693	1426.740	-0.047
2026A	498050.107	4742435.219	1425.924	1425.960	-0.036
2027B	498215.046	4743466.105	1414.759	1414.770	-0.011
2027C	498199.212	4743467.094	1414.457	1414.530	-0.073
2029	460696.163	4733808.927	1288.007	1288.020	-0.013
2029A	460717.659	4733804.859	1288.22	1288.220	0
2030	451071.035	4731783.53	1170.116	1170.130	-0.014
2030A	451069.8	4731801.511	1169.363	1169.380	-0.017
2031	463882.92	4738678.412	1268.998	1269.010	-0.012
2031A	463899.921	4738686.813	1269.018	1269.050	-0.032
2032	463895.417	4747512.652	1238.54	1238.470	0.07
2032A	463893.11	4747531.785	1237.923	1237.900	0.023
2033	448772.332	4736811.636	1107.028	1107.030	-0.002
2033A	448785.162	4736797.939	1107.567	1107.550	0.017
2034	494268.369	4766292.463	1361.026	1361.010	0.016
2034A	494294.725	4766274.432	1360.084	1360.110	-0.026
2035	474819.182	4778284.471	1432.435	1432.470	-0.035
2035A	474788.981	4778281.116	1433.696	1433.740	-0.044
2036	481391.481	4774059.437	1337.751	1337.810	-0.059
2036A	481409.324	4774071.634	1337.587	1337.650	-0.063
2037	487834.963	4774069.036	1358.388	1358.460	-0.072
2037A	487836.263	4774034.649	1357.638	1357.720	-0.082
2038	497560.27	4751598.853	1390.186	1390.180	0.006
2038A	497571.011	4751586.808	1390.056	1390.080	-0.024
2039	445977.136	4735788.08	1189.857	1189.790	0.067
2039A	445979.76	4735809.832	1189.75	1189.690	0.06
2041	480216.951	4774514.033	1337.006	1337.050	-0.044
2041A	480209.778	4774527.256	1336.831	1336.870	-0.039
2042	480552.719	4761493.858	1337.082	1337.050	0.032
2042A	480578.038	4761473.666	1336.422	1336.420	0.002
2043	470120.701	4748630.803	1303.278	1303.270	0.008
2043A	470118.207	4748643.596	1303.052	1303.070	-0.018
2044	444644.239	4741168.565	1118.337	1118.340	-0.003
2044A	444630.107	4741177.658	1118.592	1118.590	0.002
2045	446812.921	4746415.157	1030.161	1030.190	-0.029
2045A	446822.885	4746427.323	1030.972	1031.000	-0.028
2046	457126.107	4751351.61	1138.661	1138.640	0.021
2046A	457112.895	4751352.214	1137.795	1137.810	-0.015
2047	473467.413	4762797.839	1305.907	1305.900	0.007
2047A	473448.683	4762803.968	1306.025	1306.010	0.015
2048	477261.903	4773300.269	1395.352	1395.410	-0.058
2048A	477248.494	4773282.505	1394.901	1394.960	-0.059
2049	487377.479	4767362.523	1383.816	1383.890	-0.074
2049A	487365.529	4767342.744	1384.525	1384.590	-0.065
2050	485665.268	4757610.966	1330.395	1330.420	-0.025
2050A	485657.795	4757623.509	1329.952	1330.020	-0.068

2051	496802.93	4782277.476	1271.454	1271.480	-0.026
2051A	496812.333	4782252.481	1271.974	1271.990	-0.016
2052	490975.999	4757092.339	1327.114	1327.160	-0.046
2052A	491009.279	4757092.388	1327.288	1327.350	-0.062
2053	472275.188	4753062.52	1307.3	1307.290	0.01
2053A	472275.437	4753026.869	1307.618	1307.520	0.098
2054	441545.937	4744040.015	1111.187	1111.190	-0.003
2055	443530.774	4744336.526	1057.829	1057.780	0.049
2056	458314.113	4734437.972	1253.494	1253.520	-0.026
2057	467856.29	4730079.708	1389.482	1389.520	-0.038

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.072 Meters Non-Vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using (RMSEz) x 1.96000 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM.

Table 5.4: VVA Quality Check Point Analysis DEM

Point ID	Easting (meter)	Northing (meter)	Elevation (meter)	DEM Elevation (meter)	Dz (meter)
3002	453624.178	4755240.752	1146.514	1146.530	-0.016
3002A	453624.565	4755269.864	1145.853	1145.910	-0.057
3003	456838.699	4746410.790	1168.284	1168.350	-0.066
3003A	456789.772	4746390.284	1168.886	1168.960	-0.074
3004	449125.148	4743456.947	1030.158	1030.200	-0.042
3004A	449093.239	4743464.361	1029.450	1029.470	-0.020
3005	447433.751	4748407.453	1172.769	1172.830	-0.061
3005A	447421.651	4748394.467	1172.632	1172.690	-0.058
3006	439699.307	4739145.143	1091.571	1091.670	-0.099
3006A	439720.023	4739171.426	1091.145	1091.200	-0.055
3007	494541.595	4762445.589	1377.041	1377.130	-0.089
3007A	494541.219	4762461.044	1376.811	1376.930	-0.119
3008	440511.643	4745474.759	1058.668	1058.680	-0.012
3008A	440521.736	4745465.338	1058.970	1058.990	-0.020
3009	462857.277	4738213.561	1282.728	1282.730	-0.002
3009A	462831.394	4738212.359	1282.603	1282.670	-0.067
3010	454838.429	4738485.919	1202.133	1202.170	-0.037
3010A	454824.260	4738508.191	1202.012	1202.080	-0.068
3011	459706.090	4734074.325	1285.339	1285.440	-0.101
3011A	459725.156	4734070.615	1285.302	1285.350	-0.048
3012	497901.094	4788666.343	1265.520	1265.600	-0.080
3012A	497938.151	4788693.456	1265.337	1265.400	-0.063
3013	495875.171	4774855.161	1392.328	1392.370	-0.042
3013A	495847.141	4774874.341	1393.639	1393.660	-0.021
3014	495596.202	4758102.844	1337.608	1337.740	-0.132
3014A	495619.315	4758107.323	1337.711	1337.840	-0.129
3015	487425.668	4759144.605	1317.781	1317.900	-0.119

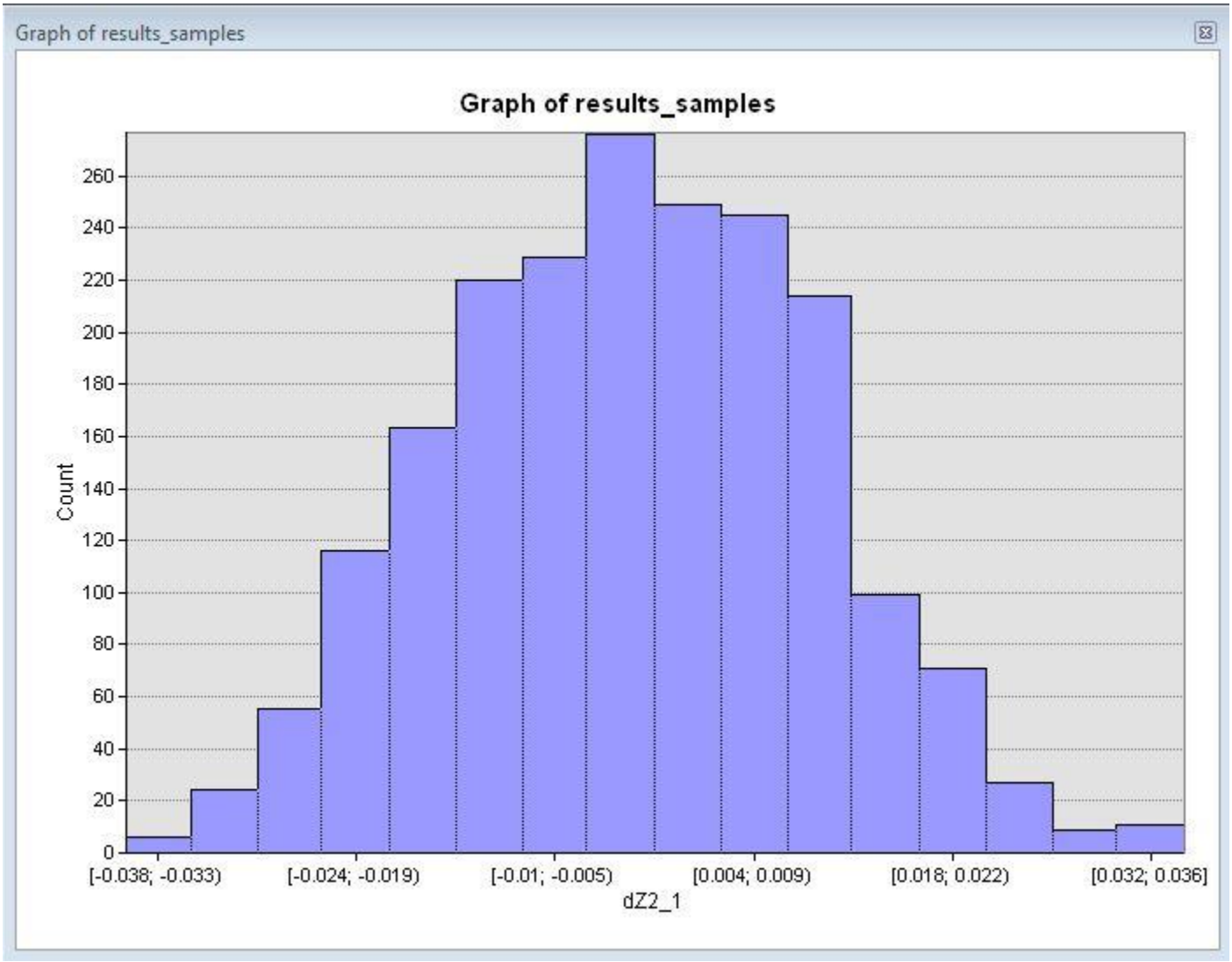
3015A	487445.545	4759169.045	1317.900	1318.040	-0.140
3016	484466.342	4766286.302	1416.242	1416.320	-0.078
3016A	484458.283	4766267.619	1416.754	1416.840	-0.086
3017	474808.340	4766650.041	1309.449	1309.470	-0.021
3017A	474822.089	4766667.388	1310.669	1310.680	-0.011
3018	473117.726	4756320.968	1290.935	1290.960	-0.025
3018A	473103.060	4756330.158	1290.778	1290.810	-0.032
3019	477163.173	4752255.868	1294.735	1294.790	-0.055
3019A	477183.443	4752252.584	1295.016	1295.100	-0.084
3020	473931.417	4747021.516	1302.070	1302.130	-0.060
3020A	473902.005	4747045.781	1302.302	1302.340	-0.038
3020B	444464.022	4745163.707	1042.449	1042.500	-0.051
3020C	444479.565	4745175.311	1042.135	1042.150	-0.015
3021	487810.762	4771449.715	1367.409	1367.490	-0.081
3021A	487798.082	4771439.950	1367.143	1367.280	-0.137
3022	492074.726	4788134.987	1339.028	1339.170	-0.142
3022A	492096.621	4788105.427	1339.142	1339.200	-0.058
3024	483057.020	4755028.192	1340.409	1340.510	-0.101
3024A	483073.686	4755042.435	1340.876	1340.960	-0.084
3025	490209.278	4757113.651	1326.117	1326.210	-0.093
3026	498053.684	4742461.135	1425.356	1425.490	-0.134
3026A	498042.052	4742435.108	1425.758	1425.940	-0.182
3028	477766.450	4776987.527	1434.842	1434.990	-0.148
3028A	477754.956	4776969.654	1434.695	1434.800	-0.105
3029	460704.916	4733817.824	1287.760	1287.710	0.050
3029A	460717.961	4733815.847	1287.738	1287.770	-0.032
3030	451084.696	4731778.671	1170.527	1170.560	-0.033
3030A	451082.468	4731801.055	1169.607	1169.640	-0.033
3031	453407.542	4745036.908	1189.625	1189.640	-0.015
3031A	453424.625	4745041.067	1190.513	1190.660	-0.147
3032	463886.380	4747519.593	1238.317	1238.260	0.057
3032A	463903.404	4747535.254	1237.936	1237.930	0.006
3032B	480647.233	4750655.425	1320.485	1320.540	-0.055
3032C	480671.355	4750658.344	1319.866	1319.900	-0.034
3033	448777.235	4736819.804	1106.763	1106.790	-0.027
3033A	448791.609	4736807.368	1107.210	1107.250	-0.040
3034	494282.830	4766301.698	1362.101	1362.190	-0.089
3034A	494302.051	4766281.979	1361.350	1361.440	-0.090
3035	474818.617	4778270.428	1432.768	1432.840	-0.072
3035A	474793.212	4778269.446	1433.658	1433.720	-0.062
3036	496096.124	4784599.280	1251.050	1251.140	-0.090
3036A	496091.977	4784616.171	1250.990	1251.160	-0.170
3037	487848.145	4774067.666	1358.579	1358.670	-0.091
3037A	487850.115	4774037.808	1358.165	1358.300	-0.135
3037B	498205.163	4743473.098	1414.401	1414.470	-0.069
3037C	498191.233	4743456.707	1415.081	1415.150	-0.069
3038	497568.466	4751608.624	1390.264	1390.280	-0.016
3038A	497562.017	4751575.792	1390.055	1390.100	-0.045
3039	445988.311	4735787.044	1190.116	1190.090	0.026
3039A	445990.783	4735807.626	1190.038	1189.970	0.068
3041	480218.879	4774502.241	1336.641	1336.720	-0.079
3041A	480195.657	4774521.674	1336.809	1336.880	-0.071

3042	480547.581	4761482.351	1335.339	1335.320	0.019
3042A	480571.962	4761464.109	1334.228	1334.260	-0.032
3043	470122.187	4748612.883	1302.633	1302.710	-0.077
3043A	470128.180	4748651.491	1302.762	1302.870	-0.108
3044	441572.928	4744022.001	1111.187	1111.190	-0.003
3045	443550.653	4744316.746	1057.274	1057.290	-0.016
3046	467870.864	4730086.078	1389.547	1389.640	-0.093
3047	458329.519	4734451.923	1252.967	1253.020	-0.053

Vertical Accuracy Conclusions

Vegetated Vertical Accuracy (VVA) Tested 0.145 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. VVA Errors larger than 95th percentile include:
Point 3026A, Easting 498042.052, Northing 4742435.108, Z-Error 0.182 Meters
Point 3028, Easting 477766.450, Northing 4776987.527, Z-Error 0.148 Meters
Point 3031A, Easting 453424.625, Northing 4745041.067, Z-Error 0.147 Meters
Point 3036A, Easting 496091.977, Northing 4784616.171, Z-Error 0.170 Meters

Figure 5.1: LIDAR Relative Accuracy Histogram for FEMA HQ Malheur OR QL1 Lidar



Relative Accuracy Assessment and Conclusion

Relative accuracy also known as "between swath" accuracy was tested through a series of well distributed flight line overlap locations. The relative accuracy for the FEMA HQ Malheur OR QL1 Lidar measured at 0.024 feet RMSDz.

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

Section 6: LiDAR Acquisition Flight Logs

This section contains the Flight Log(s) covering the project. Flight Logs list mission specific details such as crew members, airports, weather conditions, real time PDOP values and document any issues encountered during the mission. Flight Logs are filled out by the sensor operator during the acquisition flight.

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 04	**DATE:**	23 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Johan E.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Cloudy
BASE STATION:	NW0312	**WIND:**	15kts @ 240°

ENGINE START:	15:35	**ENGINE OFF:**	19:35	**ENGINE TIME:**	04:00
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:44	**TOUCHDOWN:**	19:33	**AIR TIME**	03:49

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	15:55:00					Initialise GNSS over NW0312
	16:11:00					Dataset: 20160323_161148
000_FL143	16:11:48	16:11:59	260	37/33	-	Laser Test
001_FL143	16:12:08	16:13:21	260	37/33	-	Laser Test
002_FL143	16:13:31	16:13:33	260	37/33	-	Abort due to clouds
						Dataset: 20160323_161555
000_FL82	16:15:55	16:22:27	260	37/33	-	
001_FL83	16:25:41	16:32:16	260	37/33	-	
002_FL84	16:35:18	16:42:16	260	37/33	-	
003_FL85	16:45:35	16:52:01	260	37/33	-	
004_FL81	16:54:11	17:00:46	260	37/33	-	
005_FL80	17:04:22	17:10:38	260	37/33	-	
006_FL79	17:13:14	17:19:40	260	37/33	-	
007_FL78	17:22:22	17:28:37	260	37/33	-	
008_FL77	17:31:33	17:37:47	260	37/33	-	
009_FL76	17:40:14	17:46:24	260	37/33	-	
010_FL75	17:50:43	17:56:53	260	37/33	-	
011_FL74	17:59:31	18:05:32	260	37/33	-	
012_FL73	18:08:32	18:14:35	260	37/33	-	
013_FL72	18:17:40	18:23:30	260	37/33	-	
014_FL71	18:26:27	18:32:24	260	37/33	-	
015_FL70	18:34:58	18:40:39	260	37/33	-	
016_FL69	18:43:35	18:49:22	260	37/33	-	
017_FL68	18:52:16	18:58:05	260	37/33	-	
018_FL85	19:01:40	19:09:17	260	37/33	-	Refly
	19:05:00					Close GNSS over NW0312

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 04	**DATE:**	23 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Cloudy
BASE STATION:	NW0312	**WIND:**	15kts @ 240°

ENGINE START:	21:35	**ENGINE OFF:**	01:28	**ENGINE TIME:**	03:53
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	21:41	**TOUCHDOWN:**	01:26	**AIR TIME**	03:45

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	22:00:00					Initialise GNSS over NW0312
	22:11:00					Dataset: 20160323_221143
000_FL86	22:11:43	22:19:16	260	37/33	-	
001_FL87	22:22:02	22:30:09	260	37/33	-	
002_FL88	22:32:57	22:41:12	260	37/33	-	
003_FL89	22:44:29	22:53:04	260	37/33	-	
004_FL90	22:55:52	23:04:48	260	37/33	-	
005_FL91	23:07:24	23:16:32	260	37/33	-	
006_FL92	23:19:18	23:28:48	260	37/33	-	
007_FL93	23:31:41	23:41:21	260	37/33	-	
008_FL94	23:43:31	23:53:43	260	37/33	-	
009_FL95	23:56:27	00:06:46	260	37/33	-	
010_FL96	00:09:12	00:19:33	260	37/33	-	
011_FL97	00:22:42	00:33:51	260	37/33	-	
012_FL98	00:36:07	00:47:22	260	37/33	-	
013_FL99	00:50:14	01:01:48	260	37/33	-	
	01:55:00					Close GNSS over NW0312

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 04 & 07	**DATE:**	24 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Cloudy
BASE STATION:	NW0312	**WIND:**	25-30kts @ 270°

ENGINE START:	17:20	**ENGINE OFF:**	22:08	**ENGINE TIME:**	04:48
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	17:30	**TOUCHDOWN:**	22:06	**AIR TIME**	04:36

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	17:50:00					Initialise GNSS over NW0312
	18:02:00					Dataset: 20160324_180243
000_FL100	18:02:43	18:14:22	260	37/33	-	
001_FL101	18:17:29	18:30:00	260	37/33	-	
002_FL102	18:32:49	18:45:49	260	37/33	-	
003_FL103	18:48:21	19:01:24	260	37/33	-	
004_FL104	19:04:17	19:17:24	260	37/33	-	
005_FL105	19:20:03	19:32:55	260	37/33	-	
006_FL145	19:36:14	19:46:38	260	37/33	-	
007_FL144	19:49:39	19:57:11	260	37/33	-	
008_FL143	20:01:14	20:05:57	260	37/33	-	
009_FL146	20:09:24	20:20:17	260	37/33	-	
010_FL147	20:23:20	20:34:14	260	37/33	-	
011_FL148	20:37:22	20:48:16	260	37/33	-	
012_FL149	20:51:09	21:02:19	260	37/33	-	
013_FL150	21:04:52	21:15:38	260	37/33	-	
014_FL151	21:18:51	21:29:57	260	37/33		
015_FL152	21:32:11	21:42:53	260	37/33		
	21:45:00					Close GNSS over NW0312

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 01	**DATE:**	25 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Partly Cloudy
BASE STATION:	NW0344	**WIND:**	10-15kts @ 300°

ENGINE START:	14:26	**ENGINE OFF:**	19:03	**ENGINE TIME:**	04:37
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:36	**TOUCHDOWN:**	19:02	**AIR TIME**	04:26

FL #	START TIME	END TIME	TOPO PRF	TOPO PWR	BATHY PWR CHII	REMARKS
	15:00:00					Initialise GNSS over NW0344
	15:09:00					Dataset: 20160325_150916
000_FL21	15:09:16	15:15:31	260	37/33	-	
001_FL22	15:18:43	15:25:01	260	37/33	-	
002_FL23	15:28:21	15:34:44	260	37/33	-	
003_FL24	15:37:35	15:44:05	260	37/33	-	
004_FL25	15:47:09	15:53:42	260	37/33	-	
005_FL26	15:56:30	16:03:09	260	37/33	-	
006_FL27	16:05:54	16:12:50	260	37/33	-	
007_FL28	16:15:35	16:22:37	260	37/33	-	
008_FL29	16:25:04	16:32:10	260	37/33	-	
009_FL30	16:35:01	16:42:06	260	37/33	-	
010_FL31	16:44:55	16:52:02	260	37/33	-	
011_FL32	16:55:11	17:02:30	260	37/33	-	
012_FL33	17:05:42	17:13:17	260	37/33	-	
013_FL34	17:16:08	17:23:35	260	37/33	-	
014_FL35	17:26:22	17:33:44	260	37/33	-	
015_FL36	17:36:35	17:44:06	260	37/33	-	
016_FL37	17:46:47	17:54:05	260	37/33	-	
017_FL38	17:56:44	18:04:09	260	37/33	-	
018_FL39	18:06:55	18:14:18	260	37/33	-	
019_FL40	18:17:24	18:24:54	260	37/33	-	
020_FL41	18:27:40	18:35:05	260	37/33	-	
	18:40:00					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 01	**DATE:**	26 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Partly Cloudy
BASE STATION:	NW0344	**WIND:**	10-15kts @ 160°

ENGINE START:	15:31	**ENGINE OFF:**	20:14	**ENGINE TIME:**	04:43
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:44	**TOUCHDOWN:**	20:12	**AIR TIME**	04:28

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	16:10:00					Initialise GNSS over NW0344
	16:18:00					Dataset: 20160326_161806
000_FL20	16:18:06	16:18:06	260	37/32	-	
001_FL19	16:28:01	16:28:01	260	37/32	-	
002_FL18	16:38:34	16:38:34	260	37/32	-	
003_FL17	16:49:27	16:49:27	260	37/32	-	
004_FL16	17:00:32	17:00:32	260	37/32	-	
005_FL15	17:11:46	17:11:46	260	37/32	-	
006_FL14	17:22:52	17:22:52	260	37/32	-	
007_FL13	17:34:07	17:34:07	260	37/32	-	
008_FL12	17:45:13	17:45:13	260	37/32	-	
009_FL11	17:56:06	17:56:06	260	37/32	-	
010_FL10	18:07:06	18:07:06	260	37/32	-	
011_FL9	18:18:03	18:18:03	260	37/32	-	
012_FL8	18:28:59	18:28:59	260	37/32	-	
013_FL7	18:39:59	18:39:59	260	37/32	-	
014_FL6	18:50:26	18:50:26	260	37/32	-	
015_FL5	19:01:11	19:01:11	260	37/32	-	
016_FL4	19:11:26	19:11:26	260	37/32	-	
017_FL3	19:21:38	19:21:38	260	37/32	-	
018_FL2	19:31:22	19:31:22	260	37/32	-	
019_FL1	19:40:26	19:40:26	260	37/32	-	
	19:50:00					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 01 & 02	**DATE:**	26 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Partly Cloudy
BASE STATION:	NW0344	**WIND:**	10-15kts @ 175°

ENGINE START:	21:42	**ENGINE OFF:**	23:59	**ENGINE TIME:**	03:38
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	21:48	**TOUCHDOWN:**	23:59	**AIR TIME**	03:30

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	22:15:00					Initialise GNSS over NW0344
	22:22:00					Dataset: 20160326_222255
000_FL42	22:22:55	22:30:39	260	37/32	-	
001_FL43	22:33:23	22:41:20	260	37/32	-	
002_FL44	22:43:59	22:51:46	260	37/32	-	
003_FL45	22:54:17	23:02:10	260	37/32	-	
004_FL46	23:04:44	23:12:33	260	37/32	-	
005_FL47	23:15:22	23:23:08	260	37/32	-	
006_FL48	23:25:55	23:33:51	260	37/32	-	
007_FL49	23:38:39	23:43:36	260	37/32	-	
008_FL50	23:46:22	23:51:17	260	37/32	-	
009_FL51	23:53:58	23:58:33	260	37/32	-	
010_FL52	00:01:30	00:05:49	260	37/32	-	
011_FL53	00:08:19	00:12:20	260	37/32	-	
012_FL54	00:15:15	00:19:02	260	37/32	-	
013_FL55	00:21:39	00:25:05	260	37/32	-	
014_FL56	00:28:47	00:32:00	260	37/32	-	
015_FL57	00:34:28	00:37:21	260	37/32	-	
016_FL58	00:40:13	00:42:46	260	37/32	-	
017_FL59	00:45:24	00:47:40	260	37/32	-	
018_FL60	00:51:01	00:52:49	260	37/32	-	
	00:56:00					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa, ID (MAN)
LOCATION / AREA:	Malheur County, OR / Block 03 & 07	**DATE:**	26 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A. / Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Partly Cloudy
BASE STATION:	NW0312	**WIND:**	10-15kts @ 160°

ENGINE START:	15:25	**ENGINE OFF:**	19:04	**ENGINE TIME:**	03:39
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:36	**TOUCHDOWN:**	19:02	**AIR TIME**	03:26

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	15:55:00					Initialise GNSS over NW0312
	16:04:00					Dataset: 20160328_160414
000_FL61	16:04:14	16:09:28	260	37/32	-	
001_FL62	16:12:43	16:18:13	260	37/32	-	
002_FL63	16:26:18	16:31:45	260	37/32	-	
003_FL64	16:34:27	16:40:05	260	37/32	-	
004_FL65	16:43:06	16:48:38	260	37/32	-	
005_FL66	16:51:14	16:56:49	260	37/32	-	
006_FL67	16:59:32	17:04:50	260	37/32	-	
007_FL153	17:07:37	17:18:52	260	37/32	-	
008_FL154	17:21:24	17:32:31	260	37/32	-	Offline at towards end of line
009_FL155	17:35:33	17:46:38	260	37/32	-	
010_FL156	17:49:23	18:00:23	260	37/32	-	
011_FL157	18:03:51	18:15:07	260	37/32	-	
012_FL158	18:17:39	18:28:27	260	37/32	-	
013_FL154	18:31:16	18:35:13	260	37/32	-	Refly southern section
	18:45:00					Close GNSS over NW0312

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Scappoose (SPB)
LOCATION / AREA:	Scappoose, OR / SPB Calibration Site	**DATE:**	30 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A. / Joshua P.
MISSION ID:	Various (see remarks)	**CLOUDS:**	Clear
BASE STATION:	1S4 D	**WIND:**	5kts @ 130°

ENGINE START:	18:32	**ENGINE OFF:**	20:22	**ENGINE TIME:**	01:50
GNSS START:	18:34	**GNSS START:**	20:22		
TAKEOFF:	18:43	**TOUCHDOWN:**	20:18	**AIR TIME**	01:35

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	18:54:00					Mission: CALIBRATION-SPB_1500m
	18:54:00					Dataset: 20160330_185459
000_FL1	18:54:59	18:56:54	160	63/58	-	
001_FL2	18:59:18	19:01:10	160	63/58	-	
002_FL3	19:04:16	19:05:52	160	63/58	-	
003_FL4	19:08:30	19:10:02	160	63/58	-	
004_FL5	19:12:59	19:14:29	160	63/58	-	
005_FL6	19:18:30	19:20:00	160	63/58	-	
006_FL6	19:24:39	19:25:20	250	38/35	-	BAD: Test line for 1000m
	19:26:00					Mission: CALIBRATION-SPB_1000m
	19:26:00					Dataset: 20160330_192601
000_FL1	19:26:01	19:27:33	250	38/35	-	
001_FL2	19:30:24	19:31:53	250	38/35	-	
002_FL3	19:35:01	19:36:29	250	38/35	-	
003_FL4	19:39:13	19:40:38	250	38/35	-	
004_FL5	19:43:29	19:44:55	250	38/35	-	
005_FL6	19:49:11	19:50:36	250	38/35	-	
006_FL6	19:54:11	19:54:22	400	17/12	-	BAD: Test line for 500m
007_FL6	19:54:38	19:54:56	400	17/12	-	BAD: Test line for 500m
	19:55:00					Mission: CALIBRATION-SPB_500m
	19:55:00					Dataset: 20160330_195515
000_FL1	19:55:15	19:56:25	400	17/12	-	
001_FL2	19:59:09	20:00:17	400	17/12	-	
002_FL3	20:03:02	20:04:03	400	17/12	-	
003_FL4	20:06:52	20:07:54	400	17/12	-	
004_FL5	20:10:30	20:11:32	400	17/12	-	
005_FL6	20:15:30	20:16:32	400	17/12	-	

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Scappoose (SPB)
LOCATION / AREA:	Malheur County, OR / Block 7	**DATE:**	31 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0312	**WIND:**	8kts @ 350°

ENGINE START:	14:41	**ENGINE OFF:**	19:03	**ENGINE TIME:**	04:22
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:52	**TOUCHDOWN:**	19:02	**AIR TIME**	04:10

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
		15:13:37				Initialize GNSS over NW0312
		15:19:00				Dataset: 20160401_071239
000_FL159	15:21:12	15:32:25	260	37 / 32	N/A	
001_FL160	15:35:09	15:46:18	260	37 / 32	N/A	
001_FL161	15:49:23	16:00:40	260	37 / 32	N/A	
001_FL162	16:03:26	16:14:39	260	37 / 32	N/A	
001_FL163	16:17:38	16:28:59	260	37 / 32	N/A	
001_FL164	16:31:48	16:42:57	260	37 / 32	N/A	
001_FL165	16:45:59	16:57:20	260	37 / 32	N/A	
001_FL166	17:00:09	17:11:16	260	37 / 32	N/A	
001_FL167	17:14:35	17:26:11	260	37 / 32	N/A	
001_FL168	17:28:55	17:40:16	260	37 / 32	N/A	
001_FL169	17:43:15	17:54:41	260	37 / 32	N/A	
001_FL170	17:57:14	18:08:42	260	37 / 32	N/A	
001_FL171	18:11:51	18:23:13	260	37 / 32	N/A	
001_FL172	18:25:58	18:36:40	260	37 / 32	N/A	
		18:39:00				Close GNSS over NW0312

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Scappoose (SPB)
LOCATION / AREA:	Malheur County, OR / Block 7	**DATE:**	31 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0588	**WIND:**	8kts @ 350°

ENGINE START:	20:58	**ENGINE OFF:**	01:16	**ENGINE TIME:**	04:18
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	21:03	**TOUCHDOWN:**	01:15	**AIR TIME**	04:12

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	21:20:00					Initialize GNSS over NW0588
						Dataset:
000_FL173	21:28:41	21:39:53	260	37 / 32		
001_FL174	21:42:27	21:53:18	260	37 / 32		
002_FL175	21:56:28	22:06:49	260	37 / 32		
003_FL176	22:09:16	22:18:57	260	37 / 32		
004_FL177	22:22:00	22:31:37	260	37 / 32		
005_FL178	22:34:11	22:43:44	260	37 / 32		
006_FL179	22:46:49	22:56:45	260	37 / 32		
007_FL180	22:59:16	23:08:39	260	37 / 32		
008_FL181	23:11:07	23:20:57	260	37 / 32		
009_FL182	23:23:18	23:32:50	260	37 / 32		
010_FL183	23:35:45	23:45:33	260	37 / 32		
000_FL184	23:52:02	00:01:40	260	37 / 32		
001_FL185	00:04:28	00:14:28	260	37 / 32		
002_FL186	00:17:12	00:27:06	260	37 / 32		
003_FL187	00:29:52	00:40:13	260	37 / 32		
004_FL188	00:42:39	00:52:53	260	37 / 32		
	00:56:00					Close GNSS over NW0588

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Scappoose (SPB)
LOCATION / AREA:	Malheur County, OR / Block	**DATE:**	31 March 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Ptly Cldy
BASE STATION:	NW0588	**WIND:**	5kts @ 140°

ENGINE START:	18:35	**ENGINE OFF:**	23:03	**ENGINE TIME:**	04:28
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	18:48	**TOUCHDOWN:**	22:58	**AIR TIME**	04:10

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	19:07:00					Initialize GNSS over NW0588
000_FL189	19:19:38	19:30:03				Dataset:
001_FL190	19:32:41	19:43:28				
002_FL191	19:45:56	19:56:47				
003_FL192	19:59:06	20:10:10				
004_FL193	20:12:33	20:23:36				
005_FL194	20:26:03	20:37:14				
006_FL195	20:39:42	20:50:38				
007_FL196	20:52:57	21:03:59				
008_FL197	21:06:40	21:17:44				
009_FL198	21:20:08	21:31:03				
010_FL199	21:33:40	21:44:36				
011_FL200	21:46:47	21:58:09				
012_FL201	22:00:33	22:11:19				
013_FL243	22:16:36	22:21:01				
014_FL222	22:23:08	22:25:57				
015_FL221	22:28:28	22:31:30				
	22:34:00					Close GNSS over NW0588

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 9 & 10	**DATE:**	02-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	OH0878	**WIND:**	9kts @ 214°

ENGINE START:	16:35	**ENGINE OFF:**	19:53	**ENGINE TIME:**	03:18
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	16:49	**TOUCHDOWN:**	19:48	**AIR TIME**	02:59

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	17:03:00					Initialize GNSS over OH0878
000_FL242	17:11:37	17:16:04				Dataset:
001_FL241	17:18:30	17:23:05				
002_FL240	17:25:30	17:30:08				
003_FL239	17:32:37	17:37:17				
004_FL238	17:39:36	17:44:16				
005_FL237	17:46:28	17:50:59				
006_FL236	17:53:48	17:58:00				
007_FL235	18:00:20	18:04:20				
008_FL234	18:06:50	18:10:31				
009_FL233	18:12:59	18:16:25				
010_FL232	18:18:36	18:21:44				
011_FL231	18:24:20	18:27:07				
012_FL230	18:29:24	18:31:51				
013_FL229	18:34:10	18:36:16				
014_FL228	18:38:33	18:40:16				
015_FL223	18:42:45	18:49:51				
016_FL224	18:52:26	18:59:23				
017_FL225	19:01:47	19:08:56				
018_FL226	19:11:47	19:18:57				
019_FL227	19:21:07	19:28:14				
	19:32:00					Close GNSS over NW0588

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 5	**DATE:**	02-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0133	**WIND:**	10kts @ 270°

ENGINE START:	22:12	**ENGINE OFF:**	02:06	**ENGINE TIME:**	03:54
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	22:15	**TOUCHDOWN:**	02:02	**AIR TIME**	03:47

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	22:36:00					Initialize GNSS over NW0133
000_FL124	22:46:22	22:47:54				Dataset:
001_FL124	22:48:10	22:52:04				
002_FL123	22:54:36	23:00:17				
003_FL122	23:03:17	23:09:00				
004_FL121	23:11:33	23:17:04				
005_FL120	23:21:48	23:29:52				
006_FL118	23:32:12	23:40:08				
007_FL115	23:42:56	23:51:20				
008_FL114	23:56:03	00:06:39				
009_FL113	00:09:02	00:17:17				
010_FL119	00:19:47	00:25:15				
011_FL117	00:27:46	00:33:12				
012_FL116	00:35:52	00:41:15				
013_FL112	00:43:37	00:48:42				
014_FL111	00:51:15	00:56:20				
015_FL110	00:58:57	01:03:57				
016_FL109	01:06:27	01:11:23				
017_FL108	01:13:57	01:18:57				
018_FL107	01:21:26	01:26:25				
019_FL106	01:29:03	01:33:59				
	01:38:00					Close GNSS over NW0588

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 6	**DATE:**	03-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0133	**WIND:**	12kts @ 273°

ENGINE START:	15:34	**ENGINE OFF:**	18:39	**ENGINE TIME:**	03:05
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:40	**TOUCHDOWN:**	18:35	**AIR TIME**	02:55

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	16:02:00					Initialize GNSS over NW0133
000_FL124	16:12:30	16:13:02				Dataset: 20160403_161230 reject
001_FL124	16:20:07	16:25:35				
002_FL125	16:32:03	16:35:15				refly due to snow
003_FL126	16:37:33	16:40:40				refly due to snow
004_FL127	16:43:09	16:46:16				refly due to snow
005_FL128	16:48:42	16:51:55				refly due to snow
006_FL129	16:54:21	16:57:25				refly due to snow
007_FL130	17:00:01	17:03:04				refly due to snow
008_FL131	17:05:46	17:08:53				refly due to snow
009_FL132	17:11:35	17:14:50				refly due to snow
010_FL133	17:17:24	17:20:38				refly due to snow
011_FL134	17:22:59	17:26:16				refly due to snow
012_FL135	17:28:35	17:31:52				refly due to snow
013_FL136	17:34:11	17:37:03				refly due to snow
014_FL137	17:39:46	17:42:36				refly due to snow
015_FL138	17:44:51	17:47:41				refly due to snow
016_FL139	17:50:30	17:53:15				refly due to snow
017_FL140	17:55:33	17:58:12				refly due to snow
018_FL141	18:00:55	18:03:20				refly due to snow
019_FL142	18:05:37	18:08:23				refly due to snow
	18:12:00					Close GNSS over NW0588

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Malheur County, OR / Block 11	**DATE:**	06 April 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	Calm

ENGINE START:	22:12	**ENGINE OFF:**	01:34	**ENGINE TIME:**	03:22
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	22:29	**TOUCHDOWN:**	01:31	**AIR TIME**	03:02

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	22:54:00					Initialize GNSS over NW0344
000_FL244	23:02:52	23:09:22	260	32 / 37	-	Dataset: 20160406_230252
001_FL245	23:11:42	23:18:49	260	32 / 37	-	
002_FL246	23:21:32	23:29:06	260	32 / 37	-	
003_FL247	23:31:31	23:39:22	260	32 / 37	-	
004_FL248	23:41:49	23:49:38	260	32 / 37	-	
005_FL249	23:51:48	23:59:45	260	32 / 37	-	
006_FL250	00:02:06	00:10:13	260	32 / 37	-	
007_FL251	00:12:18	00:20:27	260	32 / 37	-	
008_FL252	00:23:02	00:31:15	260	32 / 37	-	
009_FL253	00:33:17	00:41:34	260	32 / 37	-	
010_FL254	00:44:00	00:52:19	260	32 / 37	-	
011_FL255	00:54:42	01:03:11	260	32 / 37	-	
	01:06:47					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (NAM)
LOCATION / AREA:	Malheur County, OR / Block 11	**DATE:**	07 April 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	Calm

ENGINE START:	15:04	**ENGINE OFF:**	19:15	**ENGINE TIME:**	04:11
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:11	**TOUCHDOWN:**	19:11	**AIR TIME**	04:00

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	15:35:04					Initialize GNSS over NW0344
000_FL256	15:44:03	15:52:34	260	32/37	-	Dataset: 20160407_154403
001_FL257	15:54:46	16:03:17	260	32/37	-	
002_FL258	16:05:49	16:14:29	260	32/37	-	
003_FL259	16:16:57	16:25:42	260	32/37	-	
004_FL260	16:28:04	16:36:50	260	32/37	-	
005_FL261	16:39:32	16:47:41	260	32/37	-	
006_FL262	16:50:07	16:57:39	260	32/37	-	
007_FL263	17:00:09	17:07:03	260	32/37	-	
008_FL264	17:09:23	17:15:55	260	32/37	-	
009_FL265	17:18:15	17:24:52	260	32/37	-	
010_FL266	17:27:01	17:33:45	260	32/37	-	
011_FL267	17:36:04	17:42:58	260	32/37	-	
012_FL268	17:45:07	17:52:05	260	32/37	-	
013_FL269	17:54:28	18:01:34	260	32/37	-	
014_FL270	18:03:52	18:10:59	260	32/37	-	
015_FL271	18:13:21	18:20:43	260	32/37	-	
016_FL272	18:23:08	18:30:27	260	32/37	-	
017_FL273	18:32:52	18:40:26	260	32/37	-	
	18:43:38					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (NAM)
LOCATION / AREA:	Malheur County, OR / Block 11	**DATE:**	07 April 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	11knts. @ Az. 78

ENGINE START:	20:35	**ENGINE OFF:**	23:59	**ENGINE TIME:**	03:24
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	20:40	**TOUCHDOWN:**	23:55	**AIR TIME**	03:15

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	21:04:33					Initialize GNSS over NW0344
000_FL274	21:15:53	21:23:29	260	32/37	-	Dataset: 20160407_211553
001_FL275	21:25:57	21:33:52	260	32/37	-	
002_FL276	21:36:11	21:43:58	260	32/37	-	
003_FL277	21:46:22	21:54:31	260	32/37	-	
004_FL278	21:57:01	22:04:48	260	32/37	-	
005_FL279	22:07:18	22:15:16	260	32/37	-	
006_FL280	22:17:29	22:25:19	260	32/37	-	
007_FL281	22:27:55	22:35:51	260	32/37	-	
008_FL282	22:38:16	22:46:18	260	32/37	-	
009_FL283	22:48:36	22:56:34	260	32/37	-	
010_FL284	22:58:55	23:07:08	260	32/37	-	
000_FL285	23:11:05	23:19:02	260	32/37	-	
	23:26:00					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 6	**DATE:**	08-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	11knts. @ Az. 78

ENGINE START:	14:18	**ENGINE OFF:**	19:01	**ENGINE TIME:**	04:43
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:26	**TOUCHDOWN:**	18:57	**AIR TIME**	04:31

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	14:49:28					Initialize GNSS over NW0344
000_FL281	15:00:46	15:08:37	260	37 / 32	-	Dataset: 20160408_150046
001_FL282	15:10:45	15:18:40	260	37 / 32	-	
002_FL283	15:20:59	15:28:54	260	37 / 32	-	
003_FL284	15:31:03	15:39:04	260	37 / 32	-	
004_FL285	15:40:58	15:48:56	260	37 / 32	-	
005_FL286	15:51:03	15:59:04	260	37 / 32	-	
006_FL287	16:01:01	16:09:01	260	37 / 32	-	
007_FL288	16:11:12	16:19:16	260	37 / 32	-	
008_FL289	16:21:35	16:29:43	260	37 / 32	-	
009_FL290	16:31:57	16:40:09	260	37 / 32	-	
010_FL308	16:42:29	16:48:33	260	37 / 32	-	
011_FL309	16:50:42	16:57:02	260	37 / 32	-	
012_FL310	16:59:11	17:05:23	260	37 / 32	-	
013_FL311	17:07:34	17:13:59	260	37 / 32	-	
014_FL312	17:16:07	17:22:24	260	37 / 32	-	
015_FL313	17:24:42	17:31:07	260	37 / 32	-	
016_FL314	17:33:13	17:39:37	260	37 / 32	-	
017_FL315	17:41:44	17:48:19	260	37 / 32	-	
018_FL316	17:50:36	17:57:07	260	37 / 32	-	
019_FL317	17:59:18	18:05:57	260	37 / 32	-	
020_FL318	18:08:07	18:14:44	260	37 / 32	-	
021_FL319	18:17:01	18:23:44	260	37 / 32	-	
022_FL309	18:25:58	18:27:57	260	37 / 32	-	
	18:27:15					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 6	**DATE:**	08-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	25knts. @ Az. 83

ENGINE START:	20:18	**ENGINE OFF:**	00:05	**ENGINE TIME:**	03:47
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	20:24	**TOUCHDOWN:**	00:00	**AIR TIME**	03:36

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	20:49:01					Initialize GNSS over NW0344
000_FL301	21:00:21	21:02:25	260	37 / 32	-	Dataset: 20160408_210021
001_FL300	21:04:56	21:07:20	260	37 / 32	-	
002_FL299	21:10:13	21:13:02	260	37 / 32	-	
003_FL298	21:15:34	21:18:37	260	37 / 32	-	
004_FL297	21:21:22	21:24:51	260	37 / 32	-	
005_FL296	21:27:12	21:30:49	260	37 / 32	-	
006_FL295	21:33:28	21:37:32	260	37 / 32	-	
007_FL294	21:40:03	21:44:27	260	37 / 32	-	
008_FL293	21:47:08	21:51:50	260	37 / 32	-	
009_FL292	21:54:19	21:59:12	260	37 / 32	-	
010_FL291	22:02:01	22:07:11	260	37 / 32	-	
011_FL307	22:11:04	22:16:46	260	37 / 32	-	
012_FL306	22:19:07	22:24:51	260	37 / 32	-	
013_FL305	22:27:21	22:33:14	260	37 / 32	-	
014_FL304	22:35:47	22:41:32	260	37 / 32	-	
015_FL303	22:44:05	22:49:48	260	37 / 32	-	
016_FL302	22:52:05	22:57:43	260	37 / 32	-	
017_FL320	23:02:12	23:08:53	260	37 / 32	-	
018_FL321	23:11:54	23:18:38	260	37 / 32	-	
019_FL322	23:21:23	23:28:10	260	37 / 32	-	
	23:30:00					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa
LOCATION / AREA:	Malheur County, OR / Block 6	**DATE:**	09-Apr-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Dave S.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Joshua P.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0344	**WIND:**	Calm

ENGINE START:	15:09	**ENGINE OFF:**	19:04	**ENGINE TIME:**	03:55
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	15:15	**TOUCHDOWN:**	19:02	**AIR TIME**	03:47

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	15:40:00					Initialize GNSS over NW0344
000_FL323	15:49:58	15:57:07	260	37 / 32	-	Dataset: 20160409_154958
001_FL324	15:59:59	16:07:29	260	37 / 32	-	
002_FL325	16:09:52	16:17:35	260	37 / 32	-	
003_FL326	16:20:11	16:28:14	260	37 / 32	-	
004_FL327	16:30:42	16:39:02	260	37 / 32	-	
005_FL328	16:41:41	16:50:19	260	37 / 32	-	
006_FL329	16:52:45	17:01:40	260	37 / 32	-	
007_FL330	17:04:13	17:13:31	260	37 / 32	-	
008_FL331	17:16:06	17:25:35	260	37 / 32	-	
009_FL332	17:28:16	17:38:07	260	37 / 32	-	
010_FL333	17:40:43	17:50:47	260	37 / 32	-	
011_FL334	17:53:27	18:03:49	260	37 / 32	-	
012_FL335	18:06:20	18:17:01	260	37 / 32	-	
013_FL336	18:19:45	18:30:54	260	37 / 32	-	
	18:34:30					Close GNSS over NW0344

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Scappoose (SPB)
LOCATION / AREA:	Scappoose, OR / SPB Calibration Site	**DATE:**	08 June 2016
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A. / Ben H.
MISSION ID:	Various (see remarks)	**CLOUDS:**	Cloudy
BASE STATION:	1S4 D	**WIND:**	10kts @ 275°

ENGINE START:	23:46	**ENGINE OFF:**	01:28	**ENGINE TIME:**	01:42
GNSS START:	23:49	**GNSS START:**	01:23		
TAKEOFF:	23:59	**TOUCHDOWN:**	01:20	**AIR TIME**	01:21

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	18:54:00					Mission: CALIBRATION-SPB_1000m
	18:54:00					Dataset: 20160609_000930
000_FL1	00:09:30	00:10:58	250	36/35	-	
001_FL2	00:13:31	00:15:05	250	36/35	-	
002_FL3	00:17:46	00:19:17	250	36/35	-	
003_FL4	00:22:00	00:23:28	250	36/35	-	
004_FL5	00:26:57	00:28:23	250	36/35	-	
005_FL6	00:32:14	00:33:46	250	36/35	-	
	19:26:00					Mission: CALIBRATION-SPB_RCD30
	19:26:00					Dataset: 20160609_003640
000_FL1	00:36:40	00:38:29	250	36/35	-	
001_FL2	00:41:15	00:43:04	250	36/35	-	
002_FL3	00:46:26	00:48:21	250	36/35	-	
003_FL4	00:51:31	00:53:29	250	36/35	-	
	00:57:00				-	Mission: CALIBRATION-SPB_500m
	00:57:00				-	Dataset: 20160609_005735
000_FL1	00:57:35	00:58:46	400	16/14	-	
001_FL2	01:01:37	01:02:46	400	14/12	-	
002_FL3	01:05:47	01:06:49	400	14/12	-	
003_FL4	01:09:22	01:10:28	400	14/12	-	
004_FL5	01:13:18	01:14:19	400	14/12	-	
005_FL6	01:17:58	01:19:00	400	14/12	-	

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Nampa, ID / MAN Calibration Site	**DATE:**	09-Jun-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Ben H.
MISSION ID:	Various (see remarks)	**CLOUDS:**	Clear
BASE STATION:	MAN1	**WIND:**	Calm

ENGINE START:	21:47	**ENGINE OFF:**	23:43	**ENGINE TIME:**	01:56
GNSS START:	21:49	**GNSS START:**	23:38		
TAKEOFF:	22:00	**TOUCHDOWN:**	23:35	**AIR TIME**	01:35

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
						Mission: CALIBRATION-MAN_1500m
						Dataset: 20160609_220928
000_FL1	22:09:28	22:11:02	160	60 / 59	-	
001_FL2	22:13:55	22:15:30	160	61 / 59	-	
002_FL3	22:18:26	22:19:54	160	61 / 59	-	
003_FL4	22:23:10	22:24:35	160	61 / 59	-	
004_FL5	22:27:37	22:29:06	160	61 / 59	-	
005_FL6	22:33:30	22:34:56	160	61 / 59	-	
						Mission: CALIBRATION-MAN_1000m
						Dataset: 20160609_223910
000_FL1	22:39:10	22:40:58	250	35 / 34	-	
001_FL2	22:44:05	22:45:47	250	35 / 33	-	
002_FL3	22:49:16	22:50:51	250	35 / 33	-	
003_FL4	22:53:47	22:55:29	250	35 / 33	-	
004_FL5	22:58:04	22:59:46	250	35 / 33	-	
005_FL6	23:04:34	23:06:12	250	35 / 33	-	
					-	Mission: CALIBRATION-MAN_500m
					-	Dataset: 20160609_231017
000_FL1	23:10:17	23:11:32	400	15 / 14	-	
001_FL2	23:14:36	23:15:52	400	14 / 12	-	
002_FL3	23:18:57	23:20:09	400	14 / 12	-	
003_FL4	23:23:11	23:24:27	400	14 / 12	-	
004_FL5	23:27:21	23:28:35	400	14 / 12	-	
005_FL6	23:32:52	23:34:05	400	14 / 12	-	
						Nore: Approximately 2 minute time
						offset between MMD and UTC
						(MMD ahead of UTC)

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Malheur County, OR / BL04, BL06, BL07, BL23	**DATE:**	10-Jun-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Ben H.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0312	**WIND:**	15kts @ 190°

ENGINE START:	14:11	**ENGINE OFF:**	18:29	**ENGINE TIME:**	04:18
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:36	**TOUCHDOWN:**	18:26	**AIR TIME**	03:50

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	14:59:20					Initialize GNSS over NW0312
000_FL479	15:08:43	15:13:06	280	34 / 32	-	Dataset: 20160610_150843, Block 23
001_FL480	15:16:13	15:20:40	280	35 / 32	-	
002_FL481	15:23:26	15:27:53	280	35 / 32	-	
003_FL482	15:30:20	15:34:56	280	35 / 32	-	
004_FL483	15:37:27	15:41:57	280	35 / 32	-	Forced stop warning at EOL
005_FL484	15:44:31	15:49:05	280	35 / 32	-	
006_FL485	15:51:49	15:56:08	280	35 / 32	-	Completed Block 23 reflights
007_FL486	16:00:28	16:02:18	280	35 / 32	-	Block 4 reflight
008_FL487	16:06:54	16:08:41	280	35 / 32	-	Block 7 reflight
009_FL125	16:13:08	16:16:28	280	35 / 32	-	Block 6
010_FL126	16:19:31	16:22:48	280	35 / 32	-	
011_FL127	16:25:45	16:29:01	280	35 / 32	-	
012_FL128	16:32:36	16:35:54	280	35 / 32	-	
013_FL129	16:39:05	16:42:22	280	35 / 32	-	
014_FL130	16:45:24	16:48:37	280	35 / 32	-	
015_FL131	16:51:33	16:54:43	280	35 / 32	-	
016_FL132	16:57:49	17:01:11	280	35 / 32	-	
017_FL133	17:03:59	17:07:21	280	35 / 32	-	
018_FL134	17:10:29	17:13:53	280	35 / 32	-	
019_FL135	17:16:39	17:19:53	280	35 / 32	-	
020_FL136	17:23:30	17:26:30	280	35 / 32	-	
021_FL137	17:29:00	17:31:43	280	35 / 32	-	
022_FL138	17:35:42	17:38:47	280	35 / 32	-	
023_FL139	17:41:04	17:43:59	280	35 / 32	-	
024_FL140	17:47:26	17:50:16	280	35 / 32	-	
025_FL141	17:52:57	17:55:35	280	35 / 32	-	
026_FL142	17:59:06	18:01:54	280	35 / 32	-	Completed Block 6

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Malheur County, OR / BL04, BL06, BL07, BL23	**DATE:**	10-Jun-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Ben H.

MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Clear
BASE STATION:	NW0312	**WIND:**	15kts @ 190°

ENGINE START:	14:11	**ENGINE OFF:**	18:29	**ENGINE TIME:**	04:18
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:36	**TOUCHDOWN:**	18:26	**AIR TIME**	03:50

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	18:05:00					Close GNSS over NW0312
						Nore: Approximately 2 minute time
						offset between MMD and UTC
						(MMD ahead of UTC)

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Malheur County, OR / BL08, BL27	**DATE:**	10-Jun-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Ben H.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	High clouds
BASE STATION:	NW0588	**WIND:**	18kts @ 220°

ENGINE START:	20:15	**ENGINE OFF:**	23:18	**ENGINE TIME:**	03:03
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	20:20	**TOUCHDOWN:**	23:17	**AIR TIME**	02:57

FL #	START TIME	END TIME	TOPO PRF | PWR		BATHY PWR CHII	REMARKS
	14:59:20					Initialize GNSS over NW0588
000_FL488	20:47:31	20:49:22	280	34 / 32	-	Dataset: 20160610_204731, RF BL 27
001_FL222	20:54:23	20:57:28	280	35 / 32	-	Block 8
002_FL221	20:59:58	21:02:54	280	35 / 32	-	Light to moderate turbulence,
003_FL220	21:05:41	21:08:35	280	35 / 32	-	difficult to maintain altitude
004_FL219	21:11:20	21:14:19	280	35 / 32	-	
005_FL218	21:17:31	21:20:39	280	35 / 32	-	
006_FL217	21:23:53	21:26:50	280	35 / 32	-	
007_FL216	21:29:59	21:33:03	280	35 / 32	-	
008_FL215	21:35:21	21:38:22	280	35 / 32	-	
009_FL214	21:40:50	21:43:57	280	35 / 32	-	
010_FL213	21:46:46	21:50:05	280	35 / 32	-	
011_FL212	21:52:43	21:55:51	280	35 / 32	-	
012_FL211	21:59:17	22:02:24	280	35 / 32	-	
013_FL210	22:05:02	22:08:25	280	35 / 32	-	
014_FL209	22:10:54	22:14:10	280	35 / 32	-	
015_FL208	22:17:21	22:20:30	280	35 / 32	-	
016_FL207	22:23:02	22:26:13	280	35 / 32	-	
017_FL206	22:29:02	22:32:08	280	35 / 32	-	
018_FL205	22:35:05	22:38:07	280	35 / 32	-	
019_FL204	22:40:42	22:43:35	280	35 / 32	-	
020_FL203	22:46:44	22:49:37	280	35 / 32	-	
021_FL202	22:52:39	22:55:24	280	35 / 32	-	Complete Block 8
						Close GNSS over NW0588
						Nore: Approximately 2 minute time
						offset between MMD and UTC
						(MMD ahead of UTC)

GEOMATICS DATA SOLUTIONS

FLIGHT LOG

PROJECT NAME:	P2015.024 - Malheur County - QL1 Lidar	**BASE AIRPORT:**	Nampa (MAN)
LOCATION / AREA:	Malheur County, OR / BL04, BL06, BL07, BL23	**DATE:**	15-Jun-16
AIRCRAFT:	Cessna 401 - N6255Q	**PILOT:**	Ray L.
SYSTEM:	Dual DragonEye	**OPERATOR:**	Dushan A.
MISSION ID:	P2015-024-MalheurOR_900m	**CLOUDS:**	Cloudy
BASE STATION:	NW0588	**WIND:**	10kts @ 170°

ENGINE START:	13:54	**ENGINE OFF:**	16:20	**ENGINE TIME:**	02:26
GNSS START:	-	**GNSS START:**	-		
TAKEOFF:	14:04	**TOUCHDOWN:**	16:18	**AIR TIME**	02:14

FL #	START TIME	END TIME	TOPO PRF	TOPO PWR	BATHY PWR CHII	REMARKS
	14:22:00					Initialize GNSS over NW0588
000_FL489	14:25:44	14:28:17	280	33	-	Dataset: 20160615_142827 (BL06)
001_FL490	14:30:49	14:33:25	280	33	-	
002_FL491	14:36:13	14:39:02	280	33	-	
003_FL492	14:41:46	14:44:30	280	33	-	
004_FL493	14:47:31	14:49:58	280	33	-	
						Block 23
005_FL481	14:54:39	14:59:08	280	30	-	
						Block 08
006_FL222	15:14:29	15:17:30	280	33	-	
007_FL494	15:22:10	15:24:51	280	33	-	
008_FL495	15:27:47	15:30:17	280	33	-	
009_FL496	15:33:42	15:36:17	280	33	-	
010_FL497	15:39:15	15:41:37	280	33	-	
011_FL498	15:44:53	15:47:05	280	33	-	
012_FL499	15:49:40	15:51:38	280	33	-	
	16:00:00					Close GNSS over NW0588

Section 7: Final Deliverables

The final lidar deliverables are listed below.

- LAS v1.4 classified point cloud
- LAS v1.4 raw unclassified point cloud flight line strips.
- Hydro Breaklines as ESRI shapefile
- Bridge Breaklines as ESRI shapefile
- Digital Elevation Model in ERDAS .IMG format
- 8-bit intensity images in .TIF format
- Tile Index provided as ESRI shapefile
- Control Points provided as ESRI shapefile
- FGDC compliant metadata per product in XML format
- Lidar processing report in pdf format
- Survey report in pdf format