

Airborne Lidar Report



Southern San Luis Basin NP-CO QL2 Lidar

Contract Number: G10PC00057

Task Number: G15PD00915

Contractor: Woolpert, Inc.
Woolpert Project # 75926

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Section 1: Overview

TASK ORDER NAME: Southern San Luis Basin NP-CO QL2 Lidar

Project: # 75926

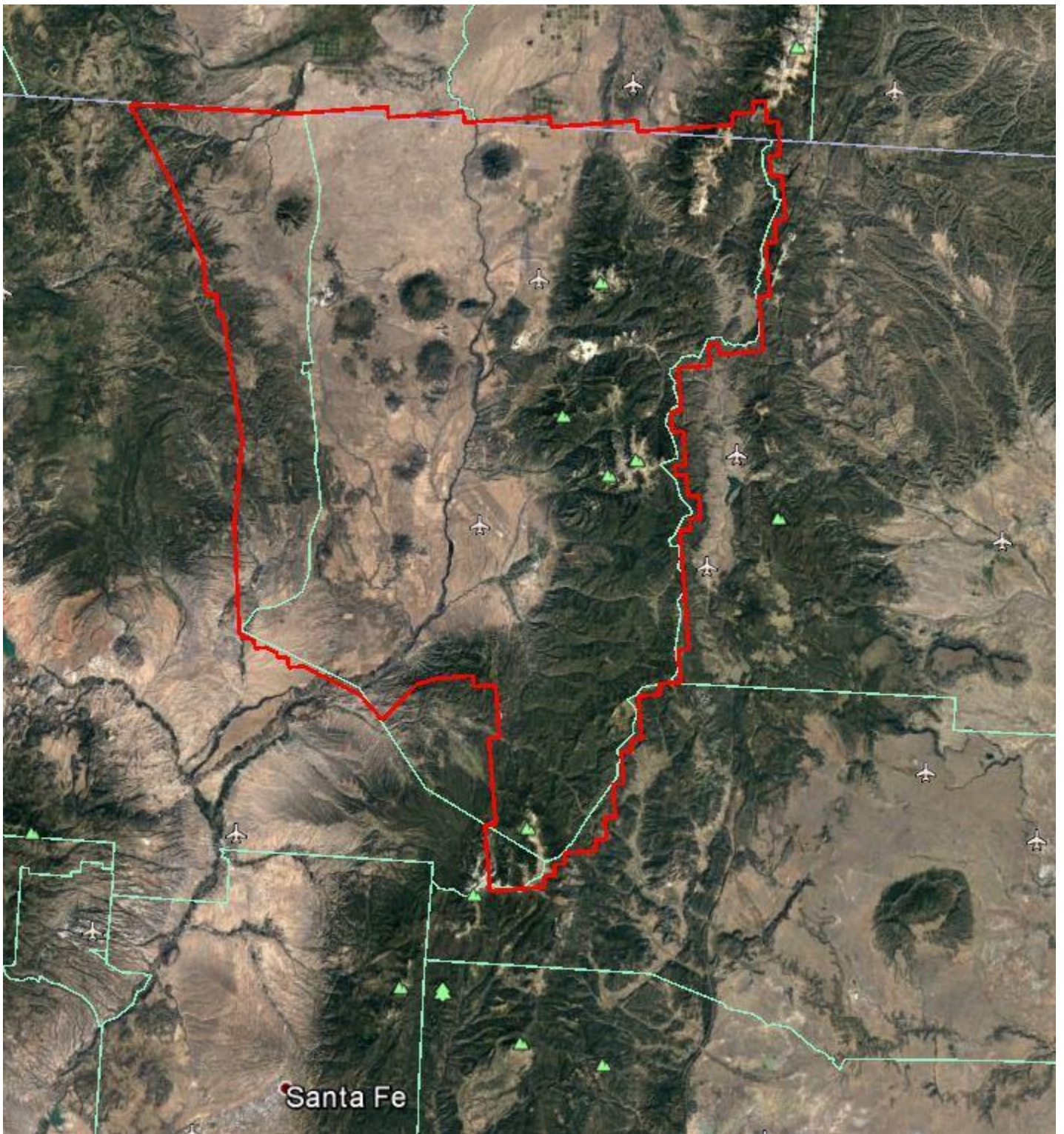
This report contains a comprehensive outline of the Southern San Luis Basin NP-CO QL2 Lidar task order. Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G15PD00915. This task order requires lidar data to be acquired over 2636 square miles of V.1.2 lidar, for the area of interest (AOI) collected at a nominal pulse spacing (NPS) of 0.7 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 three Leica ALS80 HP 1000 kHz Multiple Pulses in Air (MPiA) lidar systems on board Woolpert aircraft. The ALS80 sensor collects up to four returns per pulse, as well as intensity data, for the first three returns. If a fourth return was captured, the system does not record an associated intensity value. The aerial lidar was collected at the following sensor specifications:

Post Spacing	0.70 m
AGL (Above Ground Level) average flying height	1,981 m
Average Ground Speed:	150 knots
Field of View (full)	40 degrees
Pulse Rate	272 kHz
Scan Rate	51 Hz
Side Lap	25%

The horizontal datum used for the task order was referenced to NAD83 (2011), Zone 13, Meters. The vertical datum used for the task order was referenced to NAVD 1988, Meters, GEOID12B.

Figure 1.1: Southern San Luis Basin NP-CO QL2 Lidar Task Order AOI



Section 2: Acquisition

The lidar data was acquired with three Leica ALS80HP 1000 kHz Multiple Pulses in Air (MPiA) Lidar Sensor Systems. The ALS80 HP lidar system, developed by Leica Geosystems of Heerbrugg, Switzerland, includes the simultaneous first, intermediate and last pulse data capture module, the extended altitude range module, and the target signal intensity capture module.

The ALS80HP 1000 kHz Multiple Pulses in Air (MPiA) Lidar System has the following specifications:

Operating Altitude	100 – 7,620 meters
Scan Angle	0 to 72° (variable)
Swath Width	0 to 1.5 X altitude (variable)
Scan Frequency	0 – 200 Hz (variable based on scan angle)
Maximum Pulse Rate	1000 kHz (Effective)
Range Resolution	Better than 1 cm
Elevation Accuracy	6 - 19 cm single shot (one standard deviation)
Horizontal Accuracy	5 – 43 cm (one standard deviation)
Number of Returns per Pulse	Unlimited
Number of Intensities	3 (first, second, third)
Intensity Digitization	8 bit intensity + 8 bit AGC (Automatic Gain Control) level
MPiA (Multiple Pulses in Air)	8 bits @ 1nsec interval @ 50kHz
Laser Beam Divergence	0.22 mrad @ $1/e^2$ (~0.15 mrad @ $1/e$)
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Roll Stabilization	Automatic adaptive, range = 75 degrees minus current FOV
Power Requirements	28 VDC @ 25A
Operating Temperature	0-40°C
Humidity	0-95% non-condensing
Supported GNSS Receivers	Ashtech Z12, Trimble 7400, Novatel Millenium

Prior to mobilizing to the project site, 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 Twenty-two (22) 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. Collection of lidar data took place from September 20 through November 15 of 2016.

Figure 2.1: Lidar Flight Layout, Southern San Luis Basin

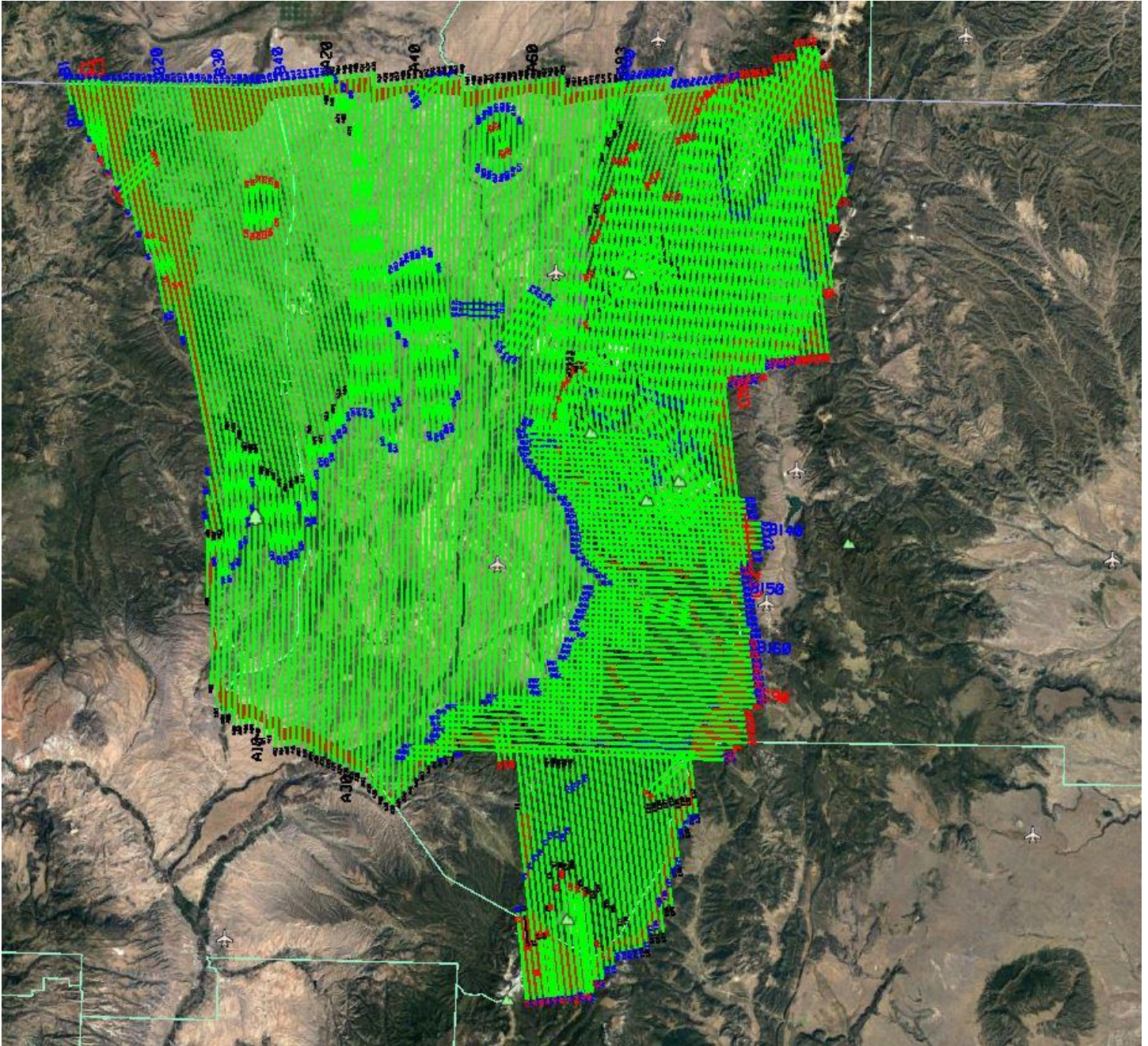


Table 2.3: Airborne Lidar Acquisition Flight Summary

Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down
September 27, 2016_SH8191	60-94	16:00 – 22:22
September 27, 2016_SH8194	53-59	23:08 – 1:15
September 28, 2016_SH8191_A	1-32	15:05 – 21:46
September 28, 2016_SH8191_B	8-19, 29	15:05 – 21:46
September 28, 2016_SH8194	35-52	14:20 – 20:34
September 29, 2016_SH8191	10, 12, 14, 22-51	14:20 – 21:50
September 29, 2016_SH8194	1-28, 30-34	14:50 – 21:38
October 2, 2016_SH8191	1-14	15:08 – 16:27
October 23, 2016_SH8170_A	1-13	19:01 – 21:18
October 23, 2016_SH8170_B	14-33	21:21 – 00:03
October 24, 2016_SH8170	1-37	16:16 – 21:57
October 26, 2016_SH8170	38-44, 72-101	14:43 – 19:30
October 26, 2016_SH8191	45-71	15:18 – 20:42
October 27, 2016_SH8191	52-79	15:38 – 18:30
November 7, 2016_SH8191	80-96, 110-123	16:01 – 22:13
November 7, 2016_SH8194_A	125-139	15:52 – 17:37
November 7, 2016_SH8194_B	139-141	22:43 – 23:30
November 8, 2016_SH8191	96-110, 124, 139-159	16:31 – 22:08
November 9, 2016_SH8191	1-25, 160-181	16:43 – 23:31
November 10, 2016_SH8191	26-32, 141	16:29 – 22:56
November 15, 2016_SH8194	84	19:42 – 00:24

Section 3: LiDAR Data Processing

Applications and Work Flow Overview

1. Resolved kinematic corrections for three subsystems: inertial measurement unit (IMU), sensor orientation information and airborne GPS data. Developed a blending post-processed aircraft position with attitude data using Kalman filtering technology or the smoothed best estimate trajectory (SBET).

Software: POSPac Software v. 5.3, IPAS Pro v.1.35., Novatel Inertial Explorer v8.60.6129

2. Calculated laser point position by associating the SBET position to each laser point return time, scan angle, intensity, etc. Created raw laser point cloud data for the entire survey in LAS format. Automated line-to-line calibrations were then performed for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift.

Software: ALS Post Processing Software v.2.75 build #25, Proprietary Software, TerraMatch v. 16.01., Add Leica Cloud Pro v1.2.3

3. Imported processed LAS point cloud data into the task order tiles. Resulting data were classified as ground and non-ground points with additional filters created to meet the task order classification specifications. Statistical absolute accuracy was assessed via direct comparisons of ground classified points to ground RTK survey data. Based on the statistical analysis, the lidar data was then adjusted to reduce the vertical bias when compared to the survey ground control.

Software: TerraScan v.16.01.

4. The LAS files were evaluated through a series of manual QA/QC steps to eliminate remaining artifacts from the ground class.

Software: TerraScan v.16.01.

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

Equipment

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.

Base stations were set by acquisition staff and were used to support the Lidar data acquisition. The GNSS base station operated during the Lidar acquisition missions is listed below:

Station (Name)	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height (L1 Phase center) (Meters)
KSKX Airport	36°27'32.83631"	105°40'22.50155"	2135.417
Taos Base	36°27'05.05270"	105°36'07.05326"	2158.736

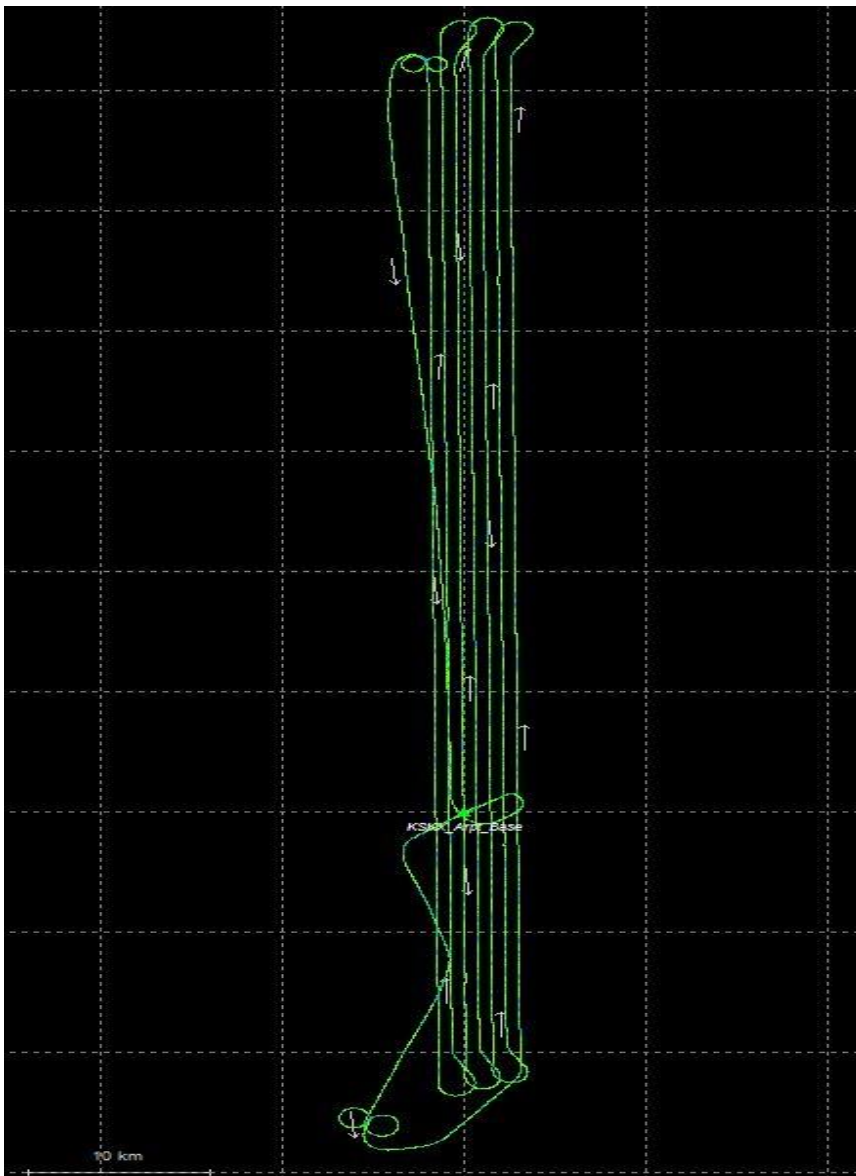
Data Processing

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

Trajectory Quality

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

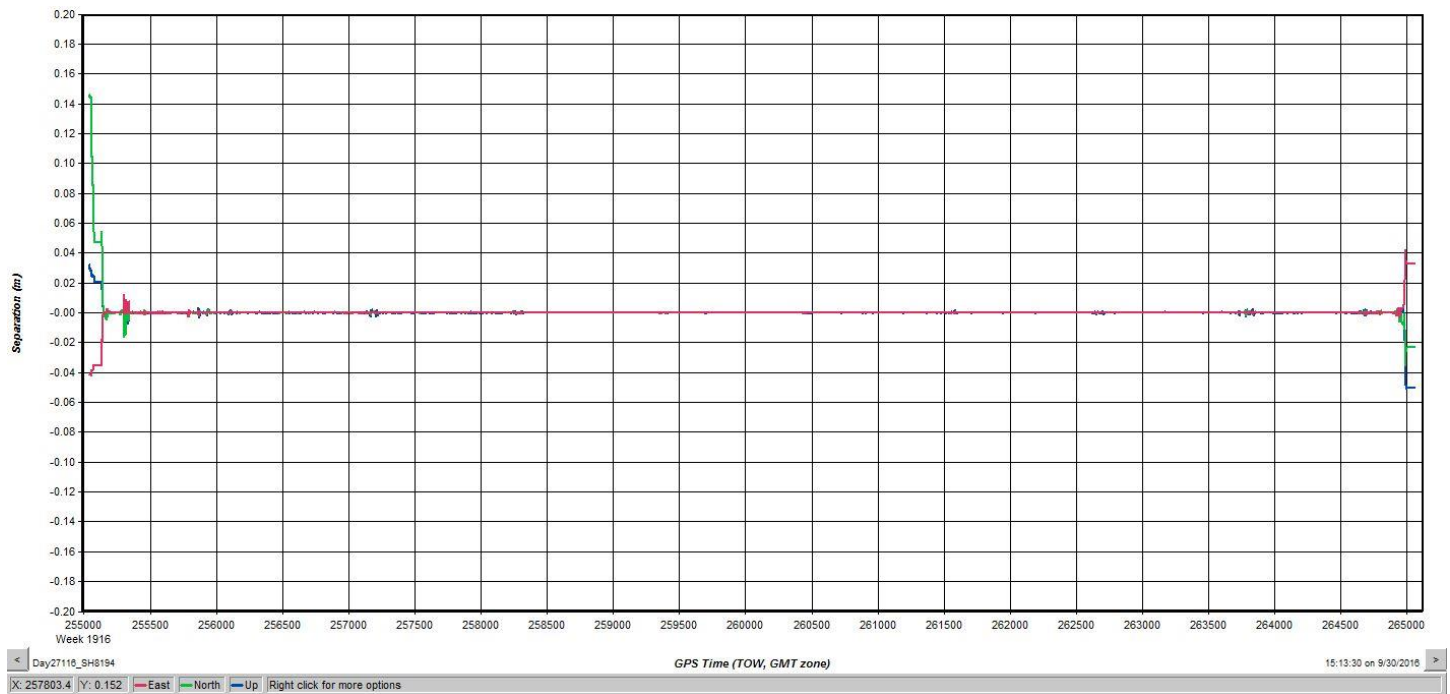
Figure 3.1: Trajectory, Day27116_SH8194



Combination Separation

The Combined Separation is a measure of the difference between the forward run and the backward run solution of the trajectory. The Kalman filter is processed in both directions to remove the combined directional anomalies. In general, when these two solutions match closely, an optimally accurate reliable solution is achieved. Woolpert’s goal is to maintain a Combined Separation Difference of less than ten (10) centimeters. In most cases we achieve results below this threshold.

Figure 3.2: Combined Separation, Day27116_SH8194

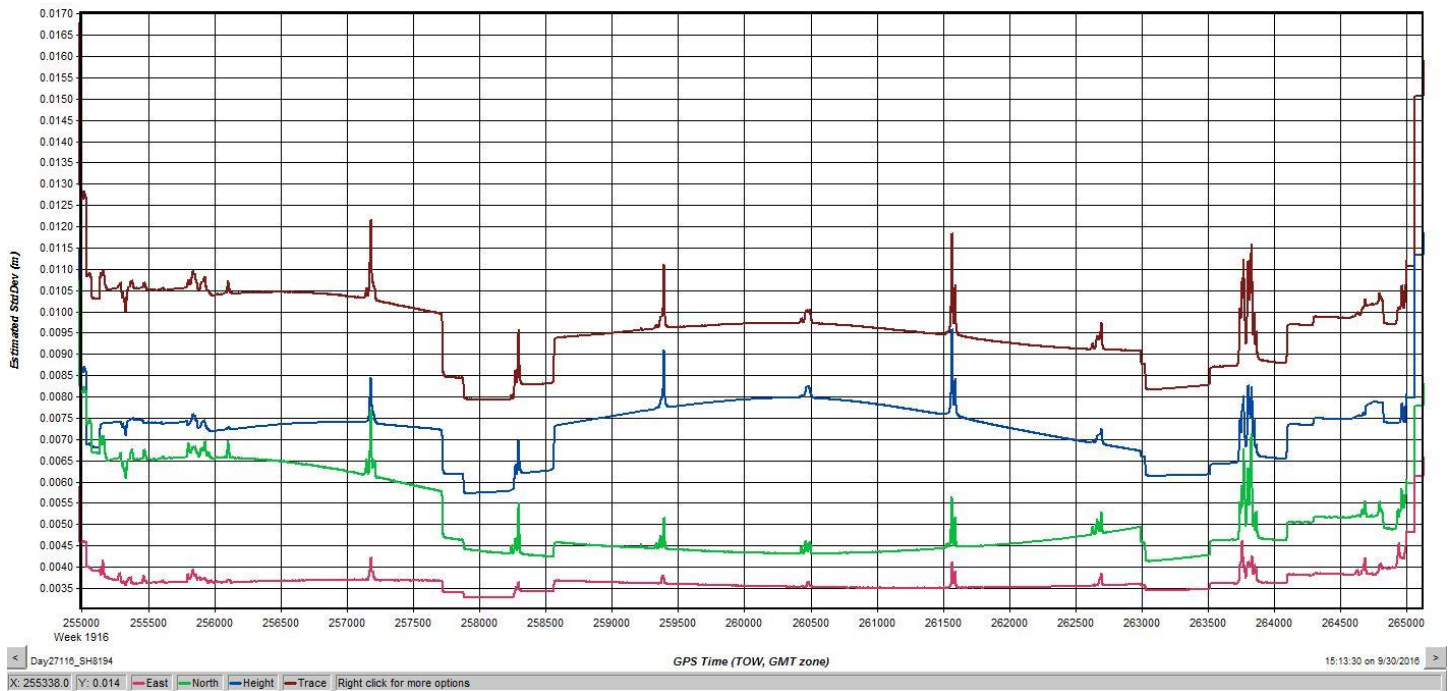


Estimated Positional Accuracy

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

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

Figure 3.3: Estimated Positional Accuracy, Day27116_SH8194

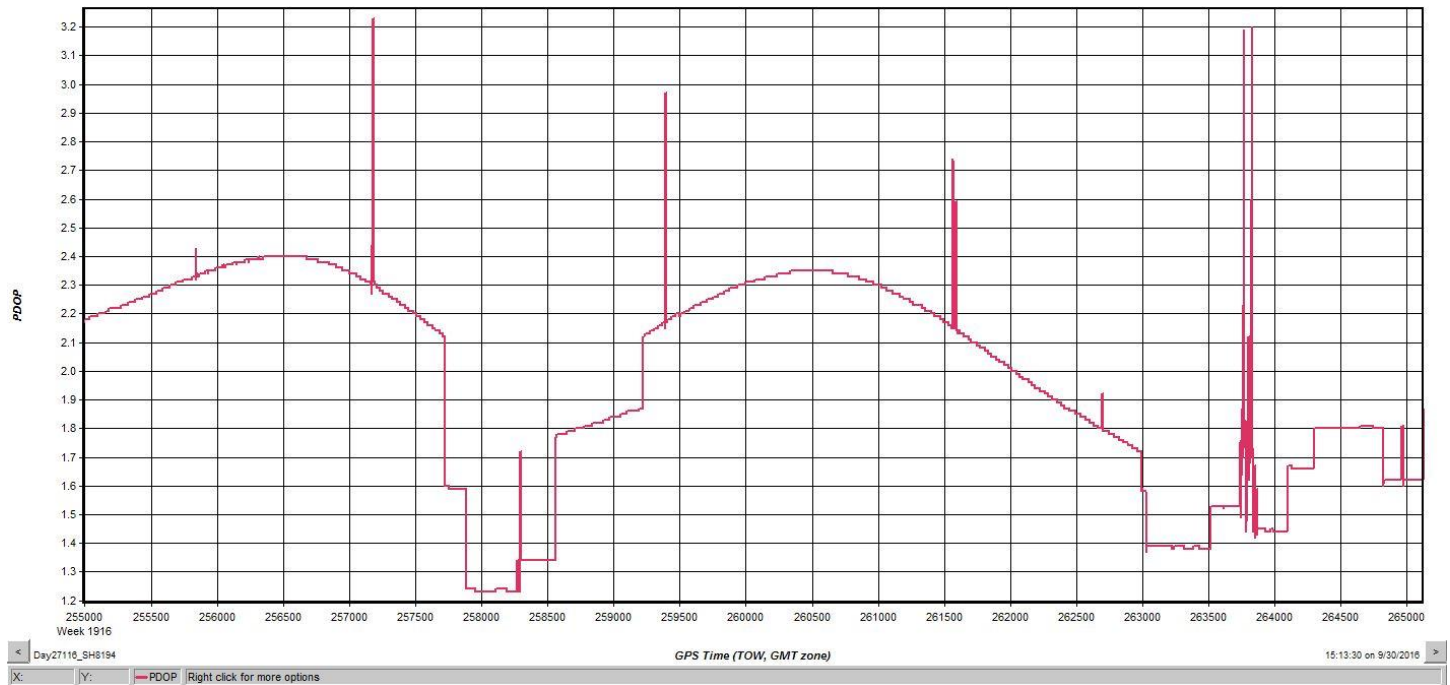


PDOP

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

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

Figure 3.4: PDOP, Day27116_SH8194



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 (Class10), 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), Zone 13, 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

Southern San Luis Basin NP-CO QL2 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

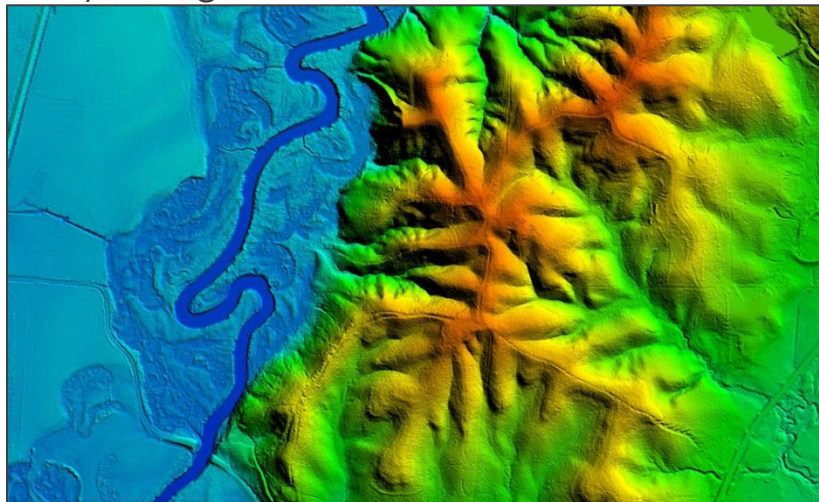


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the “tinning” across the lake surface.

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 in ESRI shapefile format. 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 in geodatabase 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 v17, by reviewing the grids and hydrologic breakline features. Additionally, ESRI software and proprietary methods were used to review the overall connectivity of the hydrologic breaklines.

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

Section 5: ACCURACY ASSESSMENT

Accuracy Assessment

The vertical accuracy statistics were calculated by comparison of all lidar points to the ground surveyed QC points.

Table 5.1: Overall Vertical Accuracy Statistics

Average error	-0.006	Meter
Minimum error	-0.206	Meter
Maximum error	+0.115	Meter
Average magnitude	0.049	Meter
Root mean square	0.060	Meter
Standard deviation	0.060	Meter

Table 5.2: RAW Swath Quality Check Point Analysis NVA

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	TIN Elevation (Meter)	Dz (Meter)
2001	391997.083	4094182.329	2807.310	2807.310	0
2002	388667.079	4088080.104	3041.265	3041.280	0.015
2002_A	388697.081	4088109.340	3039.450	3039.400	-0.05
2003	391833.167	4083853.295	2915.551	2915.570	0.019
2004	398866.116	4068021.950	2844.764	2844.800	0.036
2005	404975.516	4079433.964	2665.751	2665.800	0.049
2006	411378.146	4094249.518	2451.504	2451.550	0.046
2007	478110.207	4088330.119	3024.087	3024.050	-0.037
2007_B	471936.832	4093144.639	3644.887	3644.850	-0.037
2007_C	471972.793	4093149.781	3643.364	3643.400	0.036
2008	412373.682	4066417.868	2506.182	2506.160	-0.022
2010	413018.110	4056564.694	2486.280	2486.110	-0.17
2011	403758.605	4053151.524	2540.785	2540.880	0.095
2012	414247.896	4049937.930	2440.434	2440.430	-0.004
2013	409337.712	4044069.631	2291.821	2291.920	0.099
2014	403505.630	4034853.347	2147.914	2147.870	-0.044
2015	420152.060	4036013.738	2303.475	2303.380	-0.095
2016	411148.006	4031300.785	2072.909	2072.960	0.051
2017	419664.005	4023591.935	2241.253	2241.210	-0.043
2018	469838.210	4029994.065	2776.058	2776.090	0.032
2019	405661.680	4024277.391	1964.706	1964.760	0.054
2020	405657.951	4016518.021	1894.398	1894.450	0.052
2021	445653.608	4002921.018	2387.595	2387.630	0.035
2022	460619.380	3993181.135	2793.248	2793.310	0.062

2023	426568.444	4024405.035	2108.086	2107.880	-0.206
2024	460557.621	4081109.690	2777.225	2777.230	0.005
2025	447710.536	4019520.052	2179.923	2179.980	0.057
2026	451813.999	4026221.606	2211.556	2211.570	0.014
2027	443759.837	4028494.937	2103.921	2103.890	-0.031
2028	468677.151	4061916.963	2955.077	2955.110	0.033
2029	433082.507	4037553.157	2140.698	2140.640	-0.058
2030	431105.534	4046227.517	2185.756	2185.680	-0.076
2031	424678.997	4050818.441	2294.894	2294.830	-0.064
2032	440082.431	4043981.700	2105.515	2105.480	-0.035
2033	440789.431	4050539.546	2217.727	2217.710	-0.017
2034	451229.462	4045134.491	2395.313	2395.330	0.017
2035	449181.316	4062165.546	2278.917	2278.890	-0.027
2036	434794.541	4063285.369	2308.864	2308.910	0.046
2037	422332.745	4068445.782	2374.218	2374.190	-0.028
2038	423685.367	4078479.314	2373.895	2373.840	-0.055
2038_A	423714.530	4078462.229	2373.321	2373.260	-0.061
2039	438188.432	4077677.709	2274.455	2274.460	0.005
2040	444283.021	4071070.153	2295.169	2295.190	0.021
2041	447268.870	4079863.302	2306.011	2306.030	0.019
2041_A	447242.551	4079881.419	2305.675	2305.680	0.005
2042	459841.689	4088372.968	2497.533	2497.600	0.067
2043	453410.127	4093732.115	2373.264	2373.270	0.006
2044	426054.082	4076687.756	2343.793	2343.770	-0.023
2045	434579.769	4068342.068	2332.114	2332.090	-0.024
2046	434649.215	4055858.222	2280.500	2280.460	-0.04
2047	440590.147	4035704.362	2163.096	2163.020	-0.076
2048	439459.019	4024596.982	2063.410	2063.430	0.02
2049	407455.280	4020377.546	1944.653	1944.650	-0.003
2050	418517.136	4030720.686	2283.583	2283.530	-0.053
2051	431388.151	4032120.640	2143.274	2143.180	-0.094
2052	428223.208	4038362.811	2210.065	2209.990	-0.075
2053	424120.415	4044787.034	2297.840	2297.730	-0.11
2054	412305.747	4086436.867	2516.844	2516.900	0.056
2055	400168.513	4087346.317	2712.840	2712.890	0.05
2055_A	400164.233	4087382.740	2712.703	2712.750	0.047
2055_B	400201.581	4087316.690	2712.755	2712.790	0.035
2056	399397.337	4079838.948	2687.766	2687.800	0.034
2057	405772.947	4070268.388	2626.448	2626.410	-0.038
2057_A	405735.731	4070263.244	2627.017	2627.020	0.003
2058	420192.801	4053034.933	2376.914	2376.820	-0.094
2059	416107.336	4044398.212	2392.653	2392.600	-0.053
2059_A	416129.181	4044373.782	2392.381	2392.350	-0.031
2060	407529.669	4056439.084	2688.209	2688.280	0.071
2061	396172.446	4079826.301	2713.150	2713.180	0.03

2062	394055.087	4088961.869	2763.155	2763.150	-0.005
2063	418849.008	4079364.062	2447.685	2447.630	-0.055
2064	425108.508	4064095.261	2334.424	2334.310	-0.114
2065	423142.800	4017338.846	2157.268	2157.210	-0.058
2066	416538.492	4012367.432	2048.216	2048.290	0.074
2066_A	416501.565	4012326.126	2045.569	2045.610	0.041
2067	415114.246	4015962.399	2024.264	2024.310	0.046
2068	445493.927	4024057.841	2109.359	2109.260	-0.099
2069	440526.966	4021567.747	2152.870	2152.810	-0.06
2070	436826.424	4020045.192	2134.469	2134.500	0.031
2070_A	436833.113	4020038.409	2134.808	2134.780	-0.028
2071	433004.514	4017656.555	2132.357	2132.360	0.003
2072	429262.646	4014072.519	1854.394	1854.410	0.016
2073	427351.608	4012966.470	1837.803	1837.820	0.017
2074	433759.050	4021565.111	1910.323	1910.300	-0.023
2074_A	433745.176	4021539.727	1907.266	1907.260	-0.006
2075	432985.524	4029423.410	2100.333	2100.300	-0.033
2076	446689.148	4039254.153	2249.521	2249.450	-0.071
2077	446631.478	4043000.640	2307.061	2307.010	-0.051
2078	451162.515	4041985.924	2444.245	2444.220	-0.025
2079	436146.050	4090769.797	2301.679	2301.790	0.111
2079_A	436026.819	4090784.731	2297.094	2297.120	0.026
2080	407785.337	4083582.241	2624.885	2624.910	0.025
2080_A	407751.078	4083552.859	2625.779	2625.840	0.061
2081	406907.393	4075530.571	2668.925	2669.000	0.075
2082	399358.926	4074363.551	2770.454	2770.360	-0.094
2083	399772.705	4071115.268	2841.312	2841.400	0.088
2084	400300.376	4076661.344	2768.914	2768.940	0.026
2085	410359.475	4063256.711	2559.255	2559.320	0.065
2086	408400.661	4064573.599	2579.774	2579.800	0.026
2086_A	408370.313	4064563.022	2580.708	2580.740	0.032
2087	404402.145	4064580.174	2748.343	2748.320	-0.023
2088	400180.928	4064371.327	2769.920	2769.940	0.02
2089	469816.828	4076479.858	2704.869	2704.790	-0.079
2090	458981.798	4050266.405	2842.530	2842.470	-0.06
2091	465863.957	4024665.182	2594.077	2594.170	0.093
2092	448279.496	4014481.835	2263.085	2263.200	0.115
2093	453984.949	3998397.517	2597.480	2597.410	-0.07
2093_A	453987.404	3998386.178	2596.821	2596.710	-0.111

VERTICAL ACCURACY CONCLUSIONS

Raw Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.117 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 lidar points. 108 NVA points were used in this assessment.

LAS Swath Non-Vegetated Vertical Accuracy (NVA) Tested 0.119 Meters Non vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using $(RMSE_z) \times 1.96000$ 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 lidar points. 108 NVA points were used in this assessment.

Table 5.3: NVA Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
2001	391997.083	4094182.329	2807.310	2807.300	0.010
2002	388667.079	4088080.104	3041.265	3041.260	0.005
2002_A	388697.081	4088109.340	3039.450	3039.360	0.090
2003	391833.167	4083853.295	2915.551	2915.530	0.021
2004	398866.116	4068021.950	2844.764	2844.800	-0.036
2005	404975.516	4079433.964	2665.751	2665.760	-0.009
2006	411378.146	4094249.518	2451.504	2451.530	-0.026
2007	478110.207	4088330.119	3024.087	3024.050	0.037
2007_B	471936.832	4093144.639	3644.887	3644.890	-0.003
2007_C	471972.793	4093149.781	3643.364	3643.410	-0.046
2008	412373.682	4066417.868	2506.182	2506.170	0.012
2010	413018.110	4056564.694	2486.280	2486.140	0.140
2011	403758.605	4053151.524	2540.785	2540.880	-0.095
2012	414247.896	4049937.930	2440.434	2440.400	0.034
2013	409337.712	4044069.631	2291.821	2291.880	-0.059
2014	403505.630	4034853.347	2147.914	2147.900	0.014
2015	420152.060	4036013.738	2303.475	2303.370	0.105
2016	411148.006	4031300.785	2072.909	2072.940	-0.031
2017	419664.005	4023591.935	2241.253	2241.180	0.073
2018	469838.210	4029994.065	2776.058	2776.080	-0.022
2019	405661.680	4024277.391	1964.706	1964.780	-0.074
2020	405657.951	4016518.021	1894.398	1894.450	-0.052
2021	445653.608	4002921.018	2387.595	2387.620	-0.025
2022	460619.380	3993181.135	2793.248	2793.360	-0.112
2023	426568.444	4024405.035	2108.086	2107.920	0.166
2024	460557.621	4081109.690	2777.225	2777.250	-0.025
2025	447710.536	4019520.052	2179.923	2179.960	-0.037
2026	451813.999	4026221.606	2211.556	2211.530	0.026
2027	443759.837	4028494.937	2103.921	2103.860	0.061
2028	468677.151	4061916.963	2955.077	2955.110	-0.033

2029	433082.507	4037553.157	2140.698	2140.630	0.068
2030	431105.534	4046227.517	2185.756	2185.690	0.066
2031	424678.997	4050818.441	2294.894	2294.830	0.064
2032	440082.431	4043981.700	2105.515	2105.460	0.055
2033	440789.431	4050539.546	2217.727	2217.740	-0.013
2034	451229.462	4045134.491	2395.313	2395.300	0.013
2035	449181.316	4062165.546	2278.917	2278.850	0.067
2036	434794.541	4063285.369	2308.864	2308.900	-0.036
2037	422332.745	4068445.782	2374.218	2374.130	0.088
2038	423685.367	4078479.314	2373.895	2373.830	0.065
2038_A	423714.530	4078462.229	2373.321	2373.260	0.061
2039	438188.432	4077677.709	2274.455	2274.370	0.085
2040	444283.021	4071070.153	2295.169	2295.200	-0.031
2041	447268.870	4079863.302	2306.011	2306.020	-0.009
2041_A	447242.551	4079881.419	2305.675	2305.680	-0.005
2042	459841.689	4088372.968	2497.533	2497.550	-0.017
2043	453410.127	4093732.115	2373.264	2373.290	-0.026
2044	426054.082	4076687.756	2343.793	2343.770	0.023
2045	434579.769	4068342.068	2332.114	2332.080	0.034
2046	434649.215	4055858.222	2280.500	2280.460	0.040
2047	440590.147	4035704.362	2163.096	2163.000	0.096
2048	439459.019	4024596.982	2063.410	2063.450	-0.040
2049	407455.280	4020377.546	1944.653	1944.640	0.013
2050	418517.136	4030720.686	2283.583	2283.510	0.073
2051	431388.151	4032120.640	2143.274	2143.180	0.094
2052	428223.208	4038362.811	2210.065	2209.990	0.075
2053	424120.415	4044787.034	2297.840	2297.750	0.090
2054	412305.747	4086436.867	2516.844	2516.880	-0.036
2055	400168.513	4087346.317	2712.840	2712.890	-0.050
2055_A	400164.233	4087382.740	2712.703	2712.680	0.023
2055_B	400201.581	4087316.690	2712.755	2712.740	0.015
2056	399397.337	4079838.948	2687.766	2687.790	-0.024
2057	405772.947	4070268.388	2626.448	2626.390	0.058
2057_A	405735.731	4070263.244	2627.017	2627.010	0.007
2058	420192.801	4053034.933	2376.914	2376.830	0.084
2059	416107.336	4044398.212	2392.653	2392.590	0.063
2059_A	416129.181	4044373.782	2392.381	2392.340	0.041
2060	407529.669	4056439.084	2688.209	2688.260	-0.051
2061	396172.446	4079826.301	2713.150	2713.140	0.010
2062	394055.087	4088961.869	2763.155	2763.140	0.015
2063	418849.008	4079364.062	2447.685	2447.640	0.045
2064	425108.508	4064095.261	2334.424	2334.290	0.134
2065	423142.800	4017338.846	2157.268	2157.210	0.058
2066	416538.492	4012367.432	2048.216	2048.230	-0.014
2066_A	416501.565	4012326.126	2045.569	2045.620	-0.051

2067	415114.246	4015962.399	2024.264	2024.300	-0.036
2068	445493.927	4024057.841	2109.359	2109.270	0.089
2069	440526.966	4021567.747	2152.870	2152.840	0.030
2070	436826.424	4020045.192	2134.469	2134.450	0.019
2070_A	436833.113	4020038.409	2134.808	2134.790	0.018
2071	433004.514	4017656.555	2132.357	2132.350	0.007
2072	429262.646	4014072.519	1854.394	1854.390	0.004
2073	427351.608	4012966.470	1837.803	1837.840	-0.037
2074	433759.050	4021565.111	1910.323	1910.320	0.003
2074_A	433745.176	4021539.727	1907.266	1907.210	0.056
2075	432985.524	4029423.410	2100.333	2100.310	0.023
2076	446689.148	4039254.153	2249.521	2249.450	0.071
2077	446631.478	4043000.640	2307.061	2307.010	0.051
2078	451162.515	4041985.924	2444.245	2444.200	0.045
2079	436146.050	4090769.797	2301.679	2301.750	-0.071
2079_A	436026.819	4090784.731	2297.094	2297.050	0.044
2080	407785.337	4083582.241	2624.885	2624.920	-0.035
2080_A	407751.078	4083552.859	2625.779	2625.820	-0.041
2081	406907.393	4075530.571	2668.925	2669.010	-0.085
2082	399358.926	4074363.551	2770.454	2770.360	0.094
2083	399772.705	4071115.268	2841.312	2841.370	-0.058
2084	400300.376	4076661.344	2768.914	2768.940	-0.026
2085	410359.475	4063256.711	2559.255	2559.280	-0.025
2086	408400.661	4064573.599	2579.774	2579.810	-0.036
2086_A	408370.313	4064563.022	2580.708	2580.760	-0.052
2087	404402.145	4064580.174	2748.343	2748.280	0.063
2088	400180.928	4064371.327	2769.920	2769.950	-0.030
2089	469816.828	4076479.858	2704.869	2704.810	0.059
2090	458981.798	4050266.405	2842.530	2842.480	0.050
2091	465863.957	4024665.182	2594.077	2594.150	-0.073
2092	448279.496	4014481.835	2263.085	2263.210	-0.125
2093	453984.949	3998397.517	2597.480	2597.360	0.120
2093_A	453987.404	3998386.178	2596.821	2596.750	0.071

VERTICAL ACCURACY CONCLUSIONS

Bare-Earth DEM Non-Vegetated Vertical Accuracy (NVA) Tested 0.115 Meters Non-Vegetated vertical accuracy at a 95 percent confidence level, derived according to NSSDA, in open terrain using $(RMSE_z) \times 1.96000$ 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. 108 NVA points were used in this assessment.

Table 5.4: VVA Quality Check Point Analysis DEM

Point ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)	DEM Elevation (Meter)	Dz (Meter)
3001	397901.891	4068178.331	2772.013	2771.970	0.043
3002	399390.437	4074359.746	2782.733	2782.740	-0.007
3003	399411.337	4079855.694	2690.034	2690.010	0.024
3004	421975.307	4068176.372	2383.064	2383.040	0.024
3005	434628.828	4055922.396	2280.057	2280.050	0.007
3006	443755.099	4071095.728	2289.827	2290.040	-0.213
3007	459232.497	4088938.497	2488.342	2488.410	-0.068
3008	436118.343	4090802.948	2300.906	2300.970	-0.064
3008_A	436086.875	4090793.001	2299.624	2299.700	-0.076
3009	450865.259	4061537.912	2311.486	2311.470	0.016
3009_A	450890.296	4061513.210	2312.373	2312.410	-0.037
3010	440893.034	4049167.123	2194.728	2195.030	-0.302
3011	451819.384	4026195.330	2210.931	2210.970	-0.039
3012	436840.674	4020011.609	2135.816	2135.910	-0.094
3013	424360.143	4010550.168	1815.520	1815.540	-0.020
3013_A	424325.262	4010516.327	1815.228	1815.240	-0.012
3014	407400.187	4020463.067	1938.944	1938.890	0.054
3015	419766.757	4022796.335	2230.522	2230.420	0.102
3016	416050.546	4044408.843	2394.108	2394.010	0.098
3016_A	416059.024	4044357.465	2393.747	2393.770	-0.023
3017	420179.426	4053069.933	2377.676	2377.580	0.096
3018	390797.442	4094511.195	2852.507	2852.600	-0.093
3018_A	390756.722	4094489.777	2854.348	2854.260	0.088
3018_B	390751.207	4094495.759	2854.729	2854.680	0.049
3019	388534.571	4087668.659	3043.458	3043.460	-0.002
3019_A	388482.040	4087704.928	3046.529	3046.460	0.069
3020	438512.842	4077828.730	2282.248	2282.300	-0.052
3021	424063.642	4078253.711	2367.653	2367.570	0.083
3021_A	424038.800	4078276.308	2367.983	2367.900	0.083
3022	407549.494	4056409.040	2689.863	2689.930	-0.067
3023	403522.019	4034823.638	2147.926	2147.960	-0.034
3024	418544.394	4030737.542	2284.147	2284.160	-0.013
3025	433668.873	4024611.746	2071.015	2071.000	0.015
3025_A	433745.941	4024631.341	2071.177	2071.170	0.007
3026	415086.310	4015938.797	2023.514	2023.510	0.004
3027	447760.308	4019486.853	2186.633	2186.730	-0.097
3028	449021.286	4029549.384	2133.415	2133.480	-0.065
3029	434030.789	4036978.354	2126.706	2126.720	-0.014
3030	412281.981	4086478.920	2513.339	2513.280	0.059
3031	413226.846	4077780.663	2574.694	2574.620	0.074
3032	412364.092	4066115.533	2504.420	2504.220	0.200
3033	447863.524	4079531.021	2315.183	2315.240	-0.057

3033_A	447858.833	4079494.698	2315.537	2315.560	-0.023
3034	432937.805	4029451.010	2099.788	2099.670	0.118
3035	410838.490	4030841.087	2079.087	2079.120	-0.033
3036	451139.039	4041983.667	2441.576	2441.610	-0.034
3037	446521.734	4034970.513	2188.709	2188.630	0.079
3038	434611.021	4068386.532	2331.189	2331.220	-0.031
3039	406956.559	4075512.829	2668.690	2668.740	-0.050
3040	404366.470	4064585.724	2752.125	2752.100	0.025
3040_A	408393.426	4064536.526	2578.230	2578.310	-0.080
3041	410295.702	4063245.625	2562.871	2563.050	-0.179
3042	401537.720	4058469.220	2588.455	2588.550	-0.095
3042_A	401522.885	4058413.277	2574.117	2574.060	0.057
3043	409437.450	4043671.375	2262.504	2262.550	-0.046
3044	416492.453	4012392.300	2046.705	2046.770	-0.065
3044_A	416520.525	4012299.441	2044.060	2044.160	-0.100
3045	429022.802	4013912.323	1839.867	1839.910	-0.043
3046	428249.713	4038363.385	2209.106	2209.040	0.066
3047	431120.096	4046224.474	2184.998	2185.010	-0.012
3048	418861.638	4079394.335	2448.138	2448.100	0.038
3049	407750.205	4083593.110	2624.167	2624.210	-0.043
3049_A	407720.014	4083576.513	2624.305	2624.410	-0.105
3050	472689.614	4084665.346	3477.313	3477.270	0.043
3051	465925.731	4024659.319	2591.801	2591.950	-0.149
3052	391096.408	4083802.093	2927.341	2927.360	-0.019
3053	424123.670	4044808.183	2298.094	2298.000	0.094
3054	426590.254	4024417.031	2107.414	2107.390	0.024
3055	448497.251	4013991.690	2272.718	2272.880	-0.162
3056	405905.442	4017292.541	1912.798	1912.840	-0.042
3057	404129.228	4024262.010	2069.031	2069.080	-0.049
3058	460674.677	4085027.142	2518.722	2518.780	-0.058
3059	443467.023	4027620.196	2059.074	2059.120	-0.046
3060	440567.048	4035705.656	2162.835	2162.790	0.045
3061	440341.066	4043262.275	2078.868	2078.900	-0.032
3062	446657.621	4043009.323	2307.859	2307.870	-0.011
3063	413571.221	4055998.184	2473.783	2473.770	0.013
3064	444846.305	4023489.156	2112.254	2112.250	0.004
3065	470559.415	4076380.375	2712.422	2712.390	0.032
3066	433135.697	4017830.038	2130.785	2130.790	-0.005
3067	402346.116	4052590.175	2654.507	2654.620	-0.113
3068	471733.248	4092944.089	3651.562	3651.560	0.002
3068_A	471700.276	4092921.566	3646.833	3646.880	-0.047
3069	463250.542	4062624.126	2631.671	2631.680	-0.009
3070	457435.024	4050121.667	2742.528	2742.670	-0.142
3071	456183.148	3995914.406	2695.772	2695.780	-0.008
3071_A	456169.454	3995881.494	2698.546	2698.450	0.096

3072	458437.846	4011002.105	3151.434	3151.360	0.074
3072_A	458469.278	4011101.876	3145.256	3145.330	-0.074
3073	445077.832	3993922.388	2698.286	2698.300	-0.014

VERTICAL ACCURACY CONCLUSIONS

Vegetated Vertical Accuracy (VVA) Tested 0.169 Meters at the 95th percentile reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. 90 VVA points were used in this assessment.

VVA Errors larger than 95th percentile include:

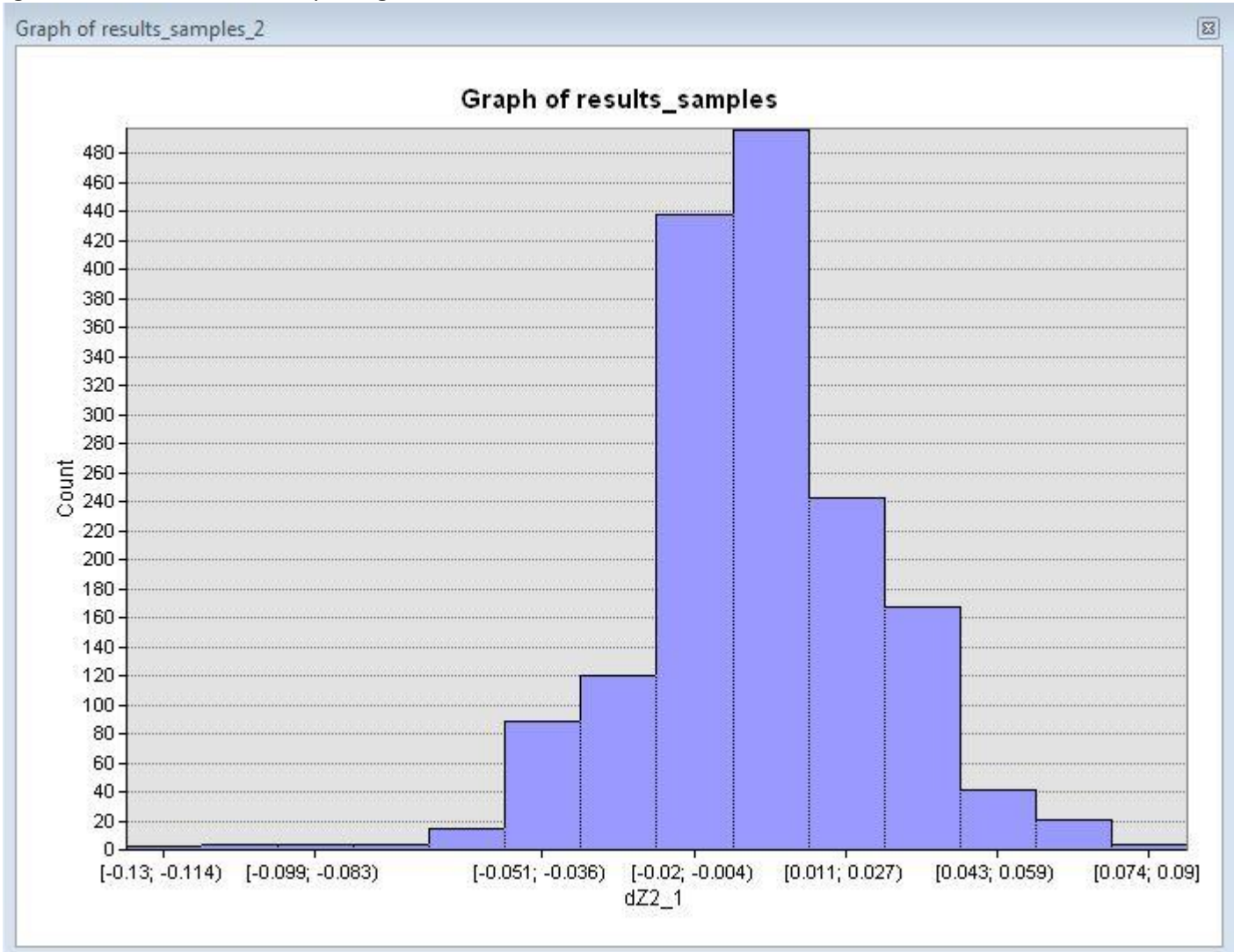
Point 3006, Easting 443755.099, Northing 4071095.728, Z-Error 0.213 Meters

Point 3010, Easting 440893.034, Northing 4049167.123, Z-Error 0.302 Meters

Point 3032, Easting 412364.092, Northing 4066115.533, Z-Error 0.200 Meters


Point 3041, Easting 410295.702, Northing 4063245.625, Z-Error 0.179 Meters

Figure 5.1: Lidar Relative Accuracy Histogram



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 Southern San Luis Basin QL2 Lidar measured at 0.025 Meters RMSDz.

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		April 2017

Section 6: Flight Logs

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

Woolpert

Leica LIDAR															
MM/DD/YYYY		Day of Year		Project #		Phase #		Project Name							
9/27/2016		271		75926		2		USGS_San_Luis_Lidar_2016							
Operator			Aircraft			HOBS Start			Local Start Time		ZULU Start Time		Base		
DENHAM			N404CP			5565.8			10:00:00		16:00:00		WOOLPERT PI		
Pilot			Sensor type			HOBS END			Local End Time		Zulu End Time		PID		
RADER			ALS-8191			5572.0			16:20:00		22:22:00		KSKX		
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point		Pressure			
010/7		DEN		12000		CLEAR		14		0		30.41			
Scan Angle (FOV)		Scan Frequency (Hz)			Pulse Rate (kHz)		Laser Power %			Fixed Gain		Mode			
40		51			272		100			Gain - Course/Up		Single			
										Gain - Fine/Down		Multi			
Air Speed		AGL		MSL		Waveform Used			Waveform Mode		Pre-Trigger Dist				
150		Kts 6500		Ft 12360		Yes No			@ NS						
Line #	Dir.	Line Start Time		Line End Time		Time On Line		SV's	PDOP	Kts	Alt.	Line Notes/Comments			
Test	n/a					n/a		n/a	n/a	n/a	n/a	GPS Began Logging At:			
↓ Times entered are Zulu / GMT ↓												Verify S-Turns Before Mission	Yes	<input checked="" type="checkbox"/>	No
												Take Off: 10:05			
93	E	16:42:00	16:43:00	0:00:00					1.1						
94	E	16:50:00	16:51:00	0:00:00					1.2						
89	S	16:54:00	16:56:00	0:00:00					1.3						
88	N	16:58:00	17:01:00	0:00:00					1.1						
87	S	17:03:00	17:05:00	0:00:00					1.1						
86	N	17:08:00	17:10:00	0:00:00					1.1						
85	S	17:14:00	17:17:00	0:00:00					1.1						
84	N	17:19:00	17:22:00	0:00:00					1.1						
82	S	17:24:00	17:27:00	0:00:00					1.1						
80	N	17:30:00	17:34:00	0:00:00					1.1						
78	S	17:37:00	17:42:00	0:00:00					1.3						
76	N	17:44:00	17:52:00	0:00:00					1.3						
74	S	17:54:00	18:01:00	0:00:00					1.3						
72	N	18:04:00	18:11:00	0:00:00					1.3						
70	S	18:14:00	18:22:00	0:00:00					1.2						
68	N	18:24:00	18:32:00	0:00:00					1.3						
69	N	18:35:00	18:43:00	0:00:00					1.1						
71	S	18:46:00	18:54:00	0:00:00					1.2						
92	E	18:56:00	18:58:00	0:00:00					1.1						
91	W	19:00:00	19:01:00	0:00:00					1.1						
90	E	19:03:00	19:04:00	0:00:00					1.1						
67	N	19:08:00	19:16:00	0:00:00					1.1						
73	S	19:18:00	19:21:00	0:00:00					1.1						
75	N	19:24:00	19:27:00	0:00:00					1.1						
77	S	19:30:00	19:32:00	0:00:00					1.1						
79	N	19:34:00	19:36:00	0:00:00					1.1						
81	S	19:39:00	19:40:00	0:00:00					1.2						
83	N	19:42:00	19:43:00	0:00:00					1.2						
66	S	19:46:00	20:05:00	0:00:00					1.2						
65	N	20:07:00	20:26:00	0:00:00					1.1						
↑ Times entered are Zulu / GMT ↑										Page		1			
												Verify S-Turns After Mission	Yes	<input type="checkbox"/>	No
Additional Comments:													Drive		
Lidar Returns had some dramatic fluctuations due to the terrain. Also had Military inference in the area so we could not start the D block flights. The rest of the lines are on page 2.															

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Leica LIDAR	MM/DD/YEAR		Day of Year		Project #		Phase #		Project Name		
	9/28/2016		272		75926		2		USGS_San_Luis_Lidar_2016 Block D Lines 1-32		
Operator		Aircraft		HOBBBS Start		Local Start Time		ZULU Start Time		Base	
DENHAM		N404CP		5572.0		9:05:00		15:05:00		WOOLPERT PI	
Pilot		Sensor Type		HOBBBS END		Local End Time		Zulu End Time		PID	
RADER		ALS-8191		5578.6		3:50:00		21:46:00		KSKX	
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point	
360		10		12000		FEW		22		-2	
								Pressure		Haze/Fire/Cloud	
								30.42			
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		Mode	
40		51		272		100				Threshold	
								Gain - Course/Up		Single	
								Gain - Fine/Down		Multi	
Air Speed		AGL		MSL		Waveform Used		Waveform Mode		Pre-Trigger Dist	
150		6500		18360		Yes No		@		NS	
Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments		
Test	n/a			n/a	n/a	n/a	n/a	n/a	GPS Began Logging At:		
↓ Times entered are Zulu / GMT ↓									Verify S-Turns Before Mission Yes <input checked="" type="checkbox"/> No		
									Take Off: 9:06		
1	N	15:25:00	15:26:00	0:00:00		1.3					
2	S	15:33:00	15:34:00	0:00:00		1.4					
3	N	15:37:00	15:39:00	0:00:00		1.6					
4	S	15:42:00	15:45:00	0:00:00		1.6					
5	N	15:53:00	15:56:00	0:00:00		1.2					
6	S	16:00:00	16:05:00	0:00:00		1.3					
7	N	16:08:00	16:12:00	0:00:00		1.3					
8	S	16:16:00	16:20:00	0:00:00		1.4					
17	S	16:24:00	16:25:00	0:00:00		1.4					
18	N	16:28:00	16:29:00	0:00:00		1.4					
9	S	16:34:00	16:36:00	0:00:00		1.1					
10	N	16:38:00	16:40:00	0:00:00		1.2					
11	S	16:43:00	16:45:00	0:00:00		1.2					
12	N	16:47:00	16:49:00	0:00:00		1.1					
13	S	16:52:00	16:54:00	0:00:00		1.2					
14	N	16:56:00	16:58:00	0:00:00		1.1					
15	S	17:00:00	17:01:00	0:00:00		1.1					
16	N	17:03:00	17:04:00	0:00:00		1.1					
19	S	17:09:00	17:12:00	0:00:00		1.1					
20	N	17:14:00	17:18:00	0:00:00		1.2					
21	S	17:21:00	17:25:00	0:00:00		1.2					
22	N	17:27:00	17:30:00	0:00:00		1.2					
23	S	17:34:00	17:37:00	0:00:00		1.3					
24	N	17:39:00	17:41:00	0:00:00		1.3					
25	S	17:45:00	17:47:00	0:00:00		1.3					
26	N	17:50:00	17:51:00	0:00:00		1.3					
27	S	17:56:00	18:01:00	0:00:00		1.2					
28	N	18:03:00	18:05:00	0:00:00		1.3					
31	S	18:08:00	18:09:00	0:00:00		1.2					
32	N	18:11:00	18:13:00	0:00:00		1.1					
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission		Yes <input checked="" type="checkbox"/> No	
Additional Comments:											
After Completing Line 29 (on next page) got two warnings "ALS WARNING: SOW NOT UPDATING" and "SYSTEM CONTROLLER NOT RECEIVED PROPER TIME RECOVERY MESSAGE (TMIB) FROM INS/GNSS MODULE". After getting these we flew line 30 and line 29 then shut the system down before proceeding to Block A flight. Probably want to check lines 29 and 30. Rest of lines are on page 2.											

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Leica LIDAR															
MM/DD/YEAR		Day of Year		Project #		Phase #		Project Name							
9/29/2016		273		75926		2		USGS San Luis Lidar 2016							
Operator			Aircraft			HOBBBS Start			Local Start Time		ZULU Start Time		Base		
DENHAM			N404CP			5578.6			8:20:00		14:20:00		WOOLPERT PI		
Pilot			Sensor Type			HOBBBS END			Local End Time		Zulu End Time		PID		
RADER			ALS-8191			5585.9			3:50:00		21:50:00		KSKX		
Wind Dir/Speed		Visibility	Ceiling		Cloud Cover %		Temp	Dew Point		Pressure		Haze/Fire/Cloud			
020/4		10	12000		SCATTERED		10	-3		30.53					
Scan Angle (FOV)		Scan Frequency (Hz)			Pulse Rate (kHz)		Laser Power %			Fixed Gain		Mode	Threshold		
40		51			272		100			Gain - Course/Up		Single	A		
										Gain - Fine/Down		Multi	B		
Air Speed		AGL		MSL		Waveform Used			Waveform Mode		Pre-Trigger Dist				
150		Kts 6500		Ft 14350		Yes No			@		NS				
Line #	Dir.	Line Start Time		Line End Time		Time On Line		SV's	PDOP	Kts	Alt.	Line Notes/Comments			
Test	n/a					n/a		n/a	n/a	n/a	n/a	GPS Began Logging At: 8:00:			
↓ Times entered are Zulu / GMT ↓												Verify S-Turns Before Mission	Yes	No	
												Take Off:			
51	N	14:46:00	14:53:00	0:00:00					1.2						
50	S	14:55:00	15:02:00	0:00:00					1.2						
49	N	15:06:00	15:15:00	0:00:00					1.3						
48	S	15:18:00	15:27:00	0:00:00					1.3						
47	N	15:30:00	15:40:00	0:00:00					1.3						
46	S	15:43:00	15:53:00	0:00:00					1.1						
45	N	15:56:00	16:06:00	0:00:00					1.3						
44	S	16:08:00	16:17:00	0:00:00					1.3						
43	N	16:20:00	16:29:00	0:00:00					1.4						
42	S	16:31:00	16:40:00	0:00:00					1.1						
41	N	16:43:00	16:52:00	0:00:00					1.2						
40	S	16:54:00	17:04:00	0:00:00					1.2						
39	N	17:06:00	17:16:00	0:00:00					1.2						
38	S	17:18:00	17:28:00	0:00:00					1.3						
37	N	17:30:00	17:40:00	0:00:00					1.3						
36	S	17:42:00	17:52:00	0:00:00					1.3						
35	N	17:55:00	18:05:00	0:00:00					1.2						
34	S	18:08:00	18:18:00	0:00:00					1.3						
33	N	18:21:00	18:32:00	0:00:00					1.2						
32	S	18:34:00	18:45:00	0:00:00					1.1						
31	N	18:48:00	18:59:00	0:00:00					1.1						
30	S	19:02:00	19:14:00	0:00:00					1						
29	N	19:16:00	19:28:00	0:00:00					1						
28	S	19:32:00	19:44:00	0:00:00					1.1						
27	N	19:46:00	19:59:00	0:00:00					1.1						
26	S	20:02:00	20:15:00	0:00:00					1.2						
25	N	20:17:00	20:31:00	0:00:00					1.1						
24	S	20:33:00	20:46:00	0:00:00					1.1						
23	N	20:49:00	21:02:00	0:00:00					1.1						
22	S	21:05:00	21:16:00	0:00:00					1.1						
↑ Times entered are Zulu / GMT ↑										Page 1		Verify S-Turns After Mission	Yes	X	No
Additional Comments:													Drive		

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Leica LIDAR	MM/DD/YEAR		Day of Year		Project #		Phase #		Project Name												
	3/29/2016		27316		75926		2		San Luis, New Mexico Block												
Operator		Aircraft		HOBBBS Start		Local Start Time		ZULU Start Time		Base											
GALAMBOS		N475RC		599.7		8:50:00		14:50:00		WOOLPERT PIN											
Pilot		Sensor Type		HOBBBS END		Local End Time		Zulu End Time		PID											
SWAIN		OTHER		607.0		3:38:00		21:38:00		KSKX											
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point		Pressure		Haze/Fire/Cloud		Departing		KSKX			
010 4		10+		Clear				10		-3		30.53				Arriving		KSKX			
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		255		Mode		Threshold Values							
40		51		272		100		Gain - Course/Up		Single		A									
								Gain - Fine/Down		Multi		X		B							
Air Speed		AGL		MSL		Waveform Used		Waveform Mode				Pre-Trigger Dist.									
150		Kts 6500		Ft varies		Ft Yes No		@		NS		Ft									
Line #		Dir.		Line Start Time		Line End Time		Time On Line		SV's		HDOP		PDOP		Line Notes/Comments					
Test		n/a						n/a		n/a		n/a		n/a		GPS Began Logging At: 14:25:13					
↓ Times entered are Zulu / GMT ↓														Verify S-Turns Before Mission		Yes No					
34		S		14:50:23		15:08:29		#VALUE!		15		0.7		1.3		Sensor 8194/ Takeoff: 14:32					
33		N		15:11:06		15:29:19		0:00:00		15		0.7		1.3		"A" Block					
32		S		15:31:23		15:49:34		0:00:00		15		0.7		1.3							
31		N		15:52:15		16:09:41		0:00:00		15		0.7		1.3							
30		S		16:11:52		16:29:47		0:00:00		16		0.7		1.2							
27		N		16:33:20		16:42:46		0:00:00		19		0.6		1.1							
25		S		16:45:48		16:54:47		0:00:00		19		0.6		1.1							
23		N		16:57:06		17:05:47		0:00:00		19		0.6		1.1							
21		S		17:08:23		17:16:32		0:00:00		17		0.6		1.2							
7		N		17:19:46		17:27:07		0:00:00		17		0.6		1.2							
6		S		17:29:15		17:36:50		0:00:00		17		0.6		1.2							
5		N		17:39:13		17:46:42		0:00:00		18		0.7		1.3							
4		S		17:48:50		17:56:23		0:00:00		19		0.7		1.3							
3		S		17:58:48		18:03:15		0:00:00		19		0.7		1.3							
2		N		18:05:45		18:09:37		0:00:00		19		0.7		1.3							
1		S		18:14:21		18:16:03		0:00:00		17		0.7		1.3							
28		N		18:26:37		18:28:11		0:00:00		17		0.7		1.3							
26		S		18:30:14		18:31:28		0:00:00		17		0.7		1.3							
24		N		18:33:28		18:34:36		0:00:00		18		0.6		1.1							
22		S		18:37:03		18:37:45		0:00:00		18		0.6		1.1							
20		S		18:42:40		18:43:18		0:00:00		18		0.6		1.1							
20		SE		18:51:57		19:03:36		0:00:00		19		0.6		1.1		"B" Block					
19		NW		19:06:23		19:18:38		0:00:00		19		0.6		1.1		Altitude 14354 GPS					
18		SE		19:20:53		19:33:13		0:00:00		20		0.6		1.1							
17		NW		19:35:58		19:48:51		0:00:00		20		0.6		1.1							
16		SE		19:51:51		20:05:00		0:00:00		20		0.6		1.1							
15		NW		20:12:06		20:19:04		0:00:00		17		0.7		1.2							
13		SE		20:22:11		20:28:25		0:00:00		19		0.6		1		Landing 21:49					
11		NW		20:31:21		20:37:29		0:00:00		19		0.6		1							
9		SE		20:40:33		20:45:08		0:00:00		19		0.6		1							
8		NW		20:48:06		20:45:08		0:00:00		19		0.6		1		Go to Page #2					
↑ Times entered are Zulu / GMT ↑														Page		1		Verify S-Turns After Mission		Yes X No	
Additional Comments:														Drive #		164					

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Leica LIDAR															
MM/DD/YYYY		Day of Year		Project #		Phase #		Project Name							
10/23/2016		297		75926		2		San Luis, NM SH8170 Blk F Flt #2							
Operator			Aircraft			HOBBS Start			Local Start Time		ZULU Start Time		Base		
SWAIN, J.			N6255Q			217.1			15:21:00		21:21:00		WOOLPERT PI		
Pilot			Sensor Type			HOBBS END			Local End Time		Zulu End Time		PID		
SWAIN, D.			ALS-8170			221.9			18:03:00		0:03:00				
Wind Dir/Speed		Visibility	Ceiling		Cloud Cover %	Temp	Dew Point		Pressure		Haze/Fire/Cloud		Departing		
270/7		10	clr below 12K		15	21	-3		30.36				Arriving		
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		255	Mode		Threshold		
40		51		272		100		Gain - Course/Up			Single	A			
								Gain - Fine/Down			Multi	X B			
Air Speed		AGL		MSL		Waveform Used			Waveform Mode		Pre-Trigger Dist.				
150		Kts	6500	Ft	16,145	Ft	Yes	No	X	@		NS			
Line #	Dir.	Line Start Time		Line End Time		Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments				
Test	n/a					n/a	n/a	n/a	n/a	n/a	GPS Began Logging At:	11:41:00			
↓ Times entered are Zulu / GMT ↓											Verify S-Turns Before Mission		Yes	X	No
14	163	21:35:21	21:40:41	0:05:20	18	1.1	157	16038							
15	343	21:42:55	21:47:53	0:04:58	19	1.2	160	16074							
16	163	21:51:03	21:56:54	0:05:51	20	1.1	153	16084							
17	343	21:59:09	22:04:40	0:05:31	19	1.2	163	16103							
18	163	22:07:19	22:12:54	0:05:35	19	1.2	151	16063							
19	343	22:15:18	22:28:30	0:13:12	19	1.2	152	16072							
20	163	22:23:03	22:28:30	0:05:27	19	1.2	152	16051							
21	343	22:30:41	22:36:00	0:05:19	17	1.4	162	16076							
22	163	22:38:24	22:43:35	0:05:11	18	1.4	152	16059							
23	343	22:46:02	22:50:41	0:04:39	18	1.4	159	16076							
24	163	22:53:26	22:58:04	0:04:38	21	1	152	16052							
25	344	23:00:19	23:04:16	0:03:57	22	1.1	158	16076							
26	163	23:06:49	23:10:36	0:03:47	22	1.1	156	16074							
27	344	23:12:53	23:16:20	0:03:27	21	1.2	157	16097							
28	163	23:18:39	23:21:50	0:03:11	22	1.1	155	16029							
29	344	23:24:03	23:26:54	0:02:51	22	1.1	155	16084							
30	163	23:29:07	23:31:15	0:02:08	23	1.1	153	16080							
31	344	23:33:27	23:35:24	0:01:57	23	1.1	156	16053							
32	164	23:37:35	23:39:20	0:01:45	23	1	160	16090							
33	344	23:41:29	23:43:15	0:01:46	23	1	156	16056							
				0:00:00											
				0:00:00											
				0:00:00											
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				0:00:00											
				0:00:00											
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission		Yes	X	No			
Additional Comments:												Drive			

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Leica LIDAR																		
MM/DD/YYYY		Day of Year		Project #		Phase #		Project Name										
10/24/2016		298		75926		2		san Luis NM sh8170 Blk c fit #1										
Operator			Aircraft			HOBBS Start			Local Start Time		ZULU Start Time		Base					
SWAIN, J.			N6255Q			221.9			10:16:00		16:16:00		WOOLPERT PI					
Pilot			Sensor Type			HOBBS END			Local End Time		Zulu End Time		PID					
SWAIN, D.			ALS-8170			227.3			15:57:00		21:57:00							
Wind Dir/Speed		Visibility	Ceiling		Cloud Cover %	Temp	Dew Point		Pressure			Haze/Fire/Cloud	Departing	Arriving				
calm		10	clr below 12K		20	15	-4		30.47									
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		255	Mode		Threshold					
40		51		272		100		Gain - Course/Up			Single		A					
								Gain - Fine/Down			Multi	X	B					
Air Speed		AGL		MSL		Waveform Used			Waveform Mode		Pre-Trigger Dist.							
150		Kts	6500	Ft	16,360	Ft	Yes	No	X	@		NS						
Line #	Dir.	Line Start Time		Line End Time		Time On Line	SV's	PDOP	Kts	Alt.	Line Notes/Comments							
Test	n/a					n/a	n/a	n/a	n/a	n/a	GPS Began Logging At:	9:15:0						
↑ Times entered are Zulu / GMT ↓											Verify S-Turns Before Mission		Yes	X	No			
											Take Off 16:29z							
1	163	16:53:55	16:55:44	0:01:49	19	1	155	16270										
2	343	16:58:37	17:00:43	0:02:06	18	1.1	160	16277										
3	163	17:03:38	17:06:03	0:02:25	19	1.1	157	16249										
4	034	17:08:56	17:10:12	0:01:16	17	1.1	158	16245										
5	214	17:12:51	17:14:11	0:01:20	17	1.1	151	16254										
6	034	17:17:07	17:18:24	0:01:17	18	1.2	149	16290										
7	146	17:22:02	17:23:12	0:01:10	18	1.1	152	16244										
8	326	17:26:26	17:27:25	0:00:59	18	1.2	158	16281										
9	146	17:30:02	17:31:13	0:01:11	19	1.1	159	16248										
10	350	17:34:23	17:35:30	0:01:07	19	1.1	156	16244										
11	170	17:38:35	17:39:50	0:01:15	19	1.1	160	16256										
12	350	17:42:43	17:44:04	0:01:21	19	1.1	159	16261										
13	170	17:46:57	17:48:15	0:01:18	19	1.1	159	16266										
14	350	17:51:03	17:52:12	0:01:09	19	1.1	160	16275										
15	170	17:54:58	17:55:44	0:00:46	19	1.1	161	16224										
16	145	18:03:49	18:04:22	0:00:33	18	1.1	162	16216										
17	325	18:07:31	18:08:12	0:00:41	18	1.1	149	16277										
18	163	18:17:01	18:17:45	0:00:44	18	1.1	157	16275										
19	343	18:20:26	18:21:58	0:01:32	17	1.2	158	16266										
20	163	18:24:29	18:26:40	0:02:11	17	1.2	153	16253										
21	343	18:29:19	18:31:45	0:02:26	16	1.2	157	16274										
22	163	18:34:41	18:37:32	0:02:51	17	1.1	160	16228										
23	343	18:41:50	18:46:45	0:04:55	17	1.1	159	16274										
24	163	18:49:30	18:54:21	0:04:51	17	1.1	160	16219										
25	343	18:57:05	19:03:10	0:06:05	18	1	154	16261										
26	163	19:07:00	19:14:21	0:07:21	17	1.1	152	16216										
27	343	19:17:03	19:24:42	0:07:39	17	1.1	155	16244										
28	163	19:28:34	19:36:53	0:08:19	17	1.1	150	16227										
29	344	19:39:02	19:47:45	0:08:43	16	1.3	156	16246										
30	163	19:50:42	19:59:37	0:08:55	16	1.4	163	16223										
↑ Times entered are Zulu / GMT ↑											Page		1	Verify S-Turns After Mission		Yes	X	No
Additional Comments:																		
Intermittant Range Gate and AG/BG% returns.																		

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Leica LIDAR																			
MM/DD/YYYY		Day of Year		Project #		Phase #		Project Name											
10/26/2016		300		75926		2		San Luis, NM SH8170 Blk C Flt #2											
Operator			Aircraft			HOBBS Start			Local Start Time		ZULU Start Time		Base						
SWAIN, J.			N6255Q			227.3			8:43:00		14:43:00		WOOLPERT PIN						
Pilot			Sensor Type			HOBBS END			Local End Time		Zulu End Time		PID						
SWAIN, D.			ALS-8170			231.8			13:30:00		19:30:00								
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point		Pressure		Haze/Fire/Cloud	Departing	KCKX			
360/4		10		clr below 12k		0		4		-2		30.47			Arriving	KCKX			
Scan Angle (FOV)			Scan Frequency (Hz)			Pulse Rate (kHz)			Laser Power %			Fixed Gain		Mode	Threshold Values				
40			51			272			100			255			A	215			
												Gain - Course/Up		Single	B	195			
												Gain - Fine/Down		Multi	X				
Air Speed		AGL		MSL		Waveform Used			Waveform Mode			Pre-Trigger Dist.							
150		Kts		6500		Ft		16,360			Yes	No	X	@	NS	Ft			
Line #	Dir.	Line Start Time		Line End Time		Time On Line		SV's	PDOP	Kts	Alt.	Line Notes/Comments							
Test	n/a					n/a		n/a	n/a	n/a	n/a	GPS Began Logging At:		7:40:00					
↓ Times entered are Zulu / GMT ↓												Verify S-Turns Before Mission		Yes	X	No			
38	163	15:11:56		15:21:57		0:10:01		18	1.1	149	16229	Take Off 14:52z							
39	344	15:24:16		15:34:10		0:09:54		19	1.1	159	16299								
40	163	15:36:46		15:46:22		0:09:36		17	1.2	163	16225								
41	344	15:49:35		15:59:45		0:10:10		17	1.3	164	16289								
42	164	16:02:22		16:12:35		0:10:13		16	1.3	156	16268								
43	344	16:15:08		16:25:14		0:10:06		16	1.3	163	16298								
44	164	16:29:04		16:40:16		0:11:12		17	1.2	157	16247								
						0:00:00													
72	344	16:42:52		16:44:16		0:01:24		18	1.1	157	16297								
73	280	16:49:10		16:49:40		0:00:30		18	1.1	159	16293								
74	100	16:51:43		16:52:22		0:00:39		18	1.1	152	16290								
75	280	16:54:53		16:56:07		0:01:14		18	1.1	161	16297								
76	100	16:59:38		17:00:04		0:00:26		18	1.1	159	16293								
77	280	17:02:12		17:03:38		0:01:26		18	1.1	161	16309								
78	163	17:09:13		17:09:57		0:00:44		19	1.1	161	16317								
79	343	17:12:16		17:13:21		0:01:05		18	1.1	150	16293								
80	163	17:15:46		17:16:51		0:01:05		17	1.2	157	16282								
						0:00:00													
101	082	17:19:54		17:22:49		0:02:55		18	1.2	156	16264								
100	263	17:25:34		17:28:35		0:03:01		20	1.1	160	16303								
99	083	17:31:18		17:34:29		0:03:11		20	1.1	158	16278								
98	263	17:36:46		17:40:03		0:03:17		20	1.1	159	16309								
97	083	17:42:38		17:45:28		0:02:50		20	1.1	163	16270								
96	263	17:47:45		17:51:20		0:03:35		20	1.1	161	16304								
95	082	17:53:44		17:57:37		0:03:53		19	1.1	157	16288								
94	263	18:00:00		18:03:34		0:03:34		19	1.1	157	16251								
93	083	18:06:01		18:09:08		0:03:07		19	1.1	154	16259								
92	263	18:11:24		18:14:22		0:02:58		19	1.1	160	16259								
91	083	18:17:22		18:19:16		0:01:54		17	1.3	157	16243								
90	263	18:21:26		18:24:59		0:03:33		17	1.2	159	16233								
89	082	18:27:28		18:30:59		0:03:31		18	1.1	163	16247								
↑ Times entered are Zulu / GMT ↑												Page		1	Verify S-Turns After Mission		Yes	X	No
Additional Comments:													Drive #						

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Woolpert																	
Leica LIDAR		MM/DD/YEAR		Day of Year		Project #		Phase #		Project Name							
		11/7/2016		312		75926		2		san luis block b							
Operator			Aircraft			HOBBS Start			Local Start Time		ZULU Start Time		Base				
SMITH			N404CP			5658.4			9:01:00		16:01:00						
Pilot			Sensor Type			HOBBS END			Local End Time		Zulu End Time		PID				
GEBHART			OTHER			5664.7			3:13:00		22:13:00						
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point		Pressure	Haze/Fire/Cloud	Departing	SKX		
330/5		10						4		-1		3040		Arriving	SKX		
Scan Angle (FOV)			Scan Frequency (Hz)			Pulse Rate (kHz)			Laser Power %			Fixed Gain		Mode	Threshold Values		
40			51			272			100					Single	A		
												Gain - Course/Up		Multi	B		
												Gain - Fine/Down		X			
Air Speed		AGL		MSL		Waveform Used			Waveform Mode			Pre-Trigger Dist.					
150		Kts		6500		Ft		14354			Ft		Yes	No	@	NS	Ft
Line #	Dir.	Line Start Time		Line End Time		Time On Line		SV's	HDOP	PDOP		Line Notes/Comments					
Test	n/a					n/a		n/a	n/a	n/a		GPS Began Logging At:					
↓ Times entered are Zulu / GMT ↓												Verify S-Turns Before Mission		Yes	X	No	
80	n	16:13:00	16:23:00				19	0.6	1.1								
81	s	16:26:00	16:37:00				19	0.6	1.1								
82	n	16:42:00	16:53:00				19	0.6	1.2								
83	s	16:56:00	17:06:00				19	0.6	1.2								
84	n	17:09:00	17:20:00				18	0.6	1.2	clds wp 25							
85	s	17:23:00	17:33:00				16	0.6	1.2								
86	n	17:35:00	17:45:00				16	0.6	1.2								
87	s	17:48:00	17:59:00				16	0.6	1.1								
88	n	18:01:00	18:11:00				17	0.6	1.1								
89	s	18:14:00	18:23:00				16	0.6	1.2								
90	n	18:25:00	18:34:00				16	0.6	1.1								
91	s	18:37:00	18:46:00				16	0.6	1.1								
92	n	18:49:00	18:59:00				16	0.6	1.3								
93	s	19:01:00	19:11:00				16	0.6	1.2								
94	n	19:13:00	19:23:00				16	0.6	1.2								
95	s	19:26:00	19:36:00				17	0.6	1.1								
123	n	19:43:00	19:45:00				16	0.6	1.2								
122	s	19:47:00	19:49:00				16	0.6	1.1								
121	n	19:52:00	19:55:00				15	0.6	1.3								
120	s	20:00:00	20:02:00				16	0.6	1.2								
119	n	20:08:00	20:10:00				17	0.6	1.1								
118	s	20:13:00	20:16:00				16	0.6	1.2								
117	n	20:19:00	20:25:00				16	0.6	1.2								
116	s	20:28:00	20:34:00				17	0.6	1.1								
115	n	20:37:00	20:43:00				17	0.6	1.1								
114	s	20:46:00	20:53:00				19	0.6	1.1								
113	n	20:56:00	21:03:00				18	0.6	1.2								
112	s	21:06:00	21:13:00				18	0.6	1.3								
111	n	21:18:00	21:28:00				18	0.6	1.3	clds wp 34							
110	s	21:30:00	21:38:00				16	0.6	1.6	clds wp 28							
96	n	21:43:00	21:51:00				18	0.6	1.3	clds wp 36,29,7,6							
↑ Times entered are Zulu / GMT ↑							Page			1		Verify S-Turns After Mission		Yes	X	No	
Additional Comments:												Drive #					

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Leica LIDAR	MM/DD/YEAR		Day of Year		Project #		Phase #		Project Name		
	11/8/2016		313		75926		2		san luis block b		
Operator		Aircraft		HOBBS Start		Local Start Time		ZULU Start Time		Base	
SMITH		N404CP		5664.7		9:31:00		16:31:00			
Pilot		Sensor Type		HOBBS END		Local End Time		Zulu End Time		PID	
GEBHART		OTHER		5670.3		3:08:00		22:08:00			
Wind Dir/Speed		Visibility		Ceiling		Cloud Cover %		Temp		Dew Point	
calm		10						7		-3	
										3059	
Pressure		Haze/Fire/Cloud		Departing		Arriving		SKX		SKX	
Scan Angle (FOV)		Scan Frequency (Hz)		Pulse Rate (kHz)		Laser Power %		Fixed Gain		Mode	
40		51		272		100				Single	
								Gain - Course/Up		A	
								Gain - Fine/Down		B	
								Multi		X	
Air Speed		AGL		MSL		Waveform Used		Waveform Mode		Pre-Trigger Dist.	
150		Kts 6500		Ft 14354		Yes No		@		NS Ft	
Line #		Dir.		Line Start Time		Line End Time		Time On Line		SV's	
Test		n/a						n/a		n/a	
										n/a	
										GPS Began Logging At:	
										Verify S-Turns Before Mission Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
96		n		16:45:00		16:55:00		20		0.6	
97		s		16:58:00		17:07:00		19		0.6	
98		n		17:09:00		17:18:00		19		0.6	
99		s		17:21:00		17:30:00		16		0.6	
100		n		17:33:00		17:40:00		17		0.6	
101		s		17:42:00		17:48:00		17		0.6	
102		n		17:51:00		17:57:00		16		0.6	
103		s		18:00:00		18:06:00		17		0.6	
104		n		18:09:00		18:14:00		17		0.6	
105		s		18:18:00		18:23:00		17		0.6	
106		n		18:27:00		18:33:00		16		0.6	
107		s		18:36:00		18:42:00		15		0.6	
108		n		18:45:00		18:52:00		16		0.6	
109		s		18:55:00		19:01:00		16		0.6	
110		n		19:04:00		19:11:00		16		0.6	
124		e		19:13:00		19:14:00		16		0.6	
139		w		19:25:00		19:30:00		17		0.6	
140		e		19:33:00		19:38:00		16		0.6	
141		w		19:41:00		19:46:00		16		0.6	
142		e		19:49:00		19:54:00		17		0.6	
143		w		19:57:00		20:02:00		15		0.6	
144		e		20:05:00		20:10:00		15		0.6	
145		w		20:12:00		20:17:00		16		0.6	
146		e		20:20:00		20:24:00		17		0.6	
147		w		20:27:00		20:31:00		17		0.6	
148		e		20:35:00		20:39:00		17		0.6	
149		w		20:42:00		20:46:00		18		0.6	
150		e		20:48:00		20:52:00		19		0.6	
151		w		20:54:00		20:58:00		19		0.6	
152		e		21:01:00		21:05:00		18		0.6	
153		w		21:08:00		21:12:00		18		0.6	
↑ Times entered are Zulu / GMT ↑								Page		1	
										Verify S-Turns After Mission Yes <input checked="" type="checkbox"/> No <input type="checkbox"/>	
Additional Comments:										Drive #	

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 in ESRI Geodatabase
- Bridge Breaklines in ESRI Geodatabase
- Digital Elevation Model in ERDAS .IMG format
- 8-bit gray scale intensity images in .TIF format
- Tile layout 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