USGS Rio Hondo, NM Lidar

USGS/ Rolla, MO

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Section 1: Overview

Project Name: Rio Hondo, NM Lidar Woolpert

Project: # 74713

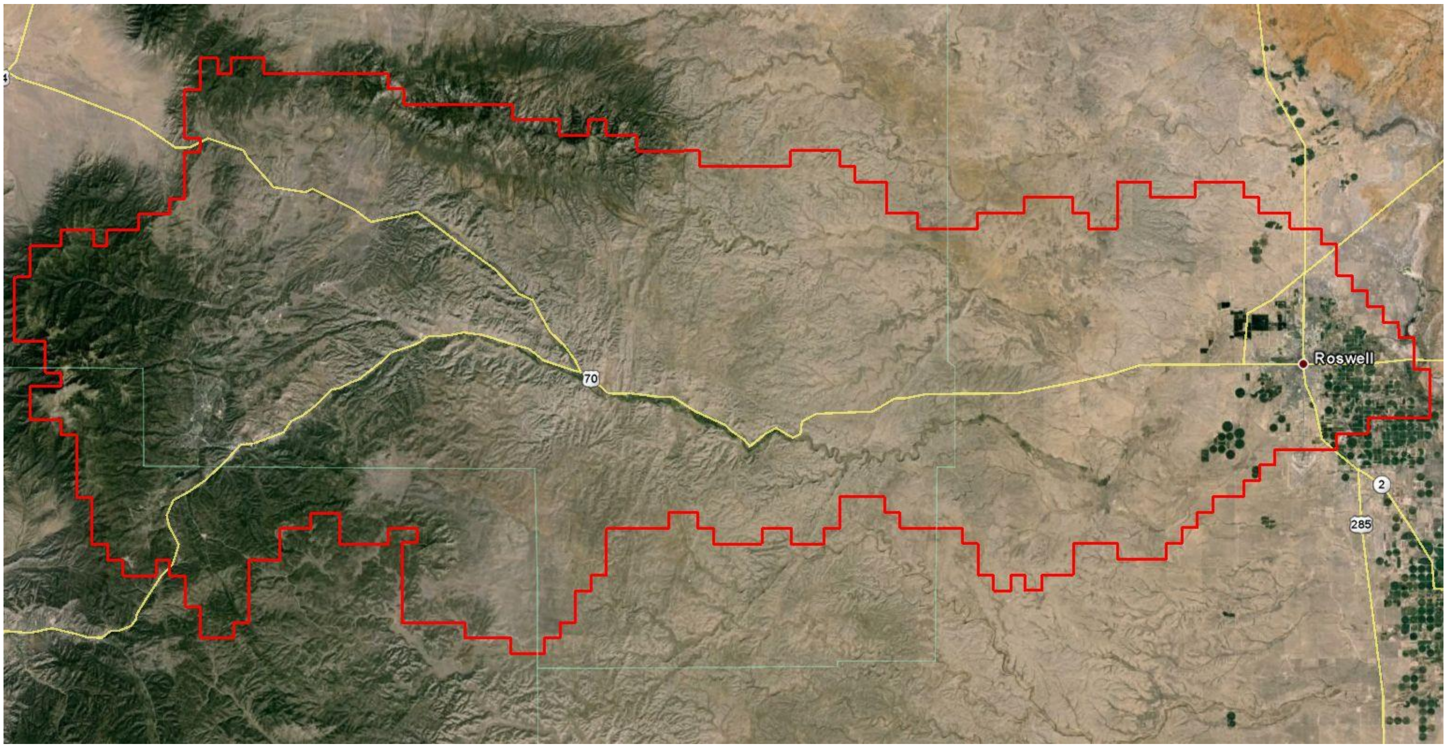
This report contains a comprehensive outline of the Rio Hondo, NM Lidar Processing task order for the United States Geological Survey (USGS). This task is issued under USGS Contract No. G10PC00057, Task Order No. G14PD01094. This task order requires lidar data to be acquired over approximately 1813 square miles of the Rio Hondo Watershed in New Mexico. The lidar was collected and processed to meet a maximum Nominal Post Spacing (NPS) of 0.7 meter. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath.

The data was collected using a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) lidar sensor. The ALS70 sensor collects up to four returns per pulse, as well as intensity data, for the first three returns. If a fourth return was captured, the system does not record an associated intensity value. The aerial lidar was collected at the following sensor specifications:

Table 1.1: ALS70 Specifications	
Post Spacing	2.3ft / 0.7 m
AGL (Above Ground Level) average flying height	6,500 ft / 1,981 m
MSL (Mean Sea Level) average flying height	varies
Average Ground Speed:	150 knots / 173 mph
Field of View (full)	40 degrees
Pulse Rate	272 kHz
Scan Rate	41.5 Hz
Side Lap	25%

The lidar data was processed and projected in UTM, Zone 13, North American Datum of 1983 (2011) in units of meters. The vertical datum used for the task order was referenced to NAVD 1988, GEOID12A, in units of meter.

Figure 1.1: Lidar Task Order AOI



Section 2: Acquisition

The existing lidar data was acquired with a Leica ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar Sensor System, on board Woolpert Cessna aircraft. The ALS70 lidar system, developed by Leica Geosystems of Heerbrugg, Switzerland, includes the simultaneous first, intermediate and last pulse data capture module, the extended altitude range module, and the target signal intensity capture module. The system software is operated on an OC50 Operation Controller aboard the aircraft.

The ALS70 500 kHz Multiple Pulses in Air (MPiA) Lidar System has the following specifications:

Table 2.1: ALS Lidar System Specifications	
Operating Altitude	200 – 3,500 meters
Scan Angle	0 to 75° (variable)
Swath Width	0 to 1.5 X altitude (variable)
Scan Frequency	0 – 200 Hz (variable based on scan angle)
Maximum Pulse Rate	500 kHz (Effective)
Range Resolution	Better than 1 cm
Elevation Accuracy	7 - 16 cm single shot (one standard deviation)
Horizontal Accuracy	5 – 38 cm (one standard deviation)
Number of Returns per Pulse	7 (infinite)
Number of Intensities	3 (first, second, third)
Intensity Digitization	8 bit intensity + 8 bit AGC (Automatic Gain Control) level
MPiA (Multiple Pulses in Air)	8 bits @ 1nsec interval @ 50kHz
Laser Beam Divergence	0.22 mrad @ $1/e^2$ (~0.15 mrad @ 1/e)
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Roll Stabilization	Automatic adaptive, range = 75 degrees minus current FOV
Power Requirements	28 VDC @ 25A
Operating Temperature	0-40°C
Humidity	0-95% non-condensing
Supported GNSS Receivers	Ashtech Z12, Trimble 7400, Novatel Millenium

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

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

The lidar data was collected in fourteen (14) separate missions, flown as close together as the weather permitted, to ensure consistent ground conditions across the project area.

An initial quality control process was performed immediately on the lidar data to review the data coverage, airborne GPS data, and trajectory solution. Any gaps found in the lidar data were relayed to the flight crew, and the area was re-flown.

Figure 2.1: Lidar Flight Layout, Rio Hondo, NM Lidar

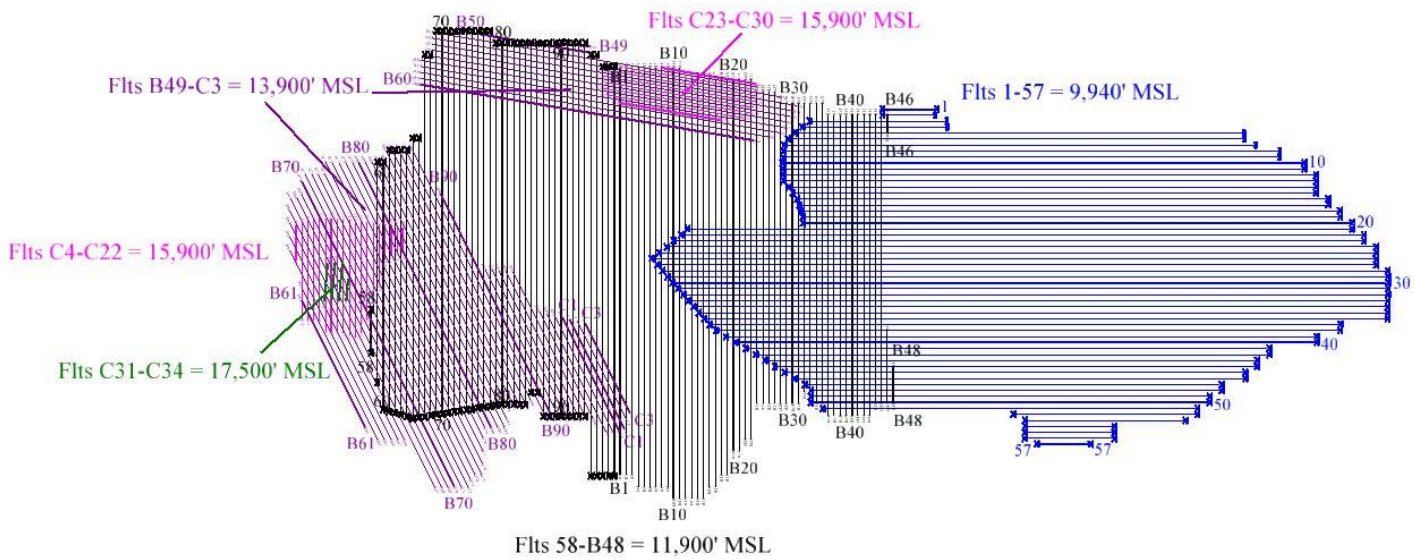


Table 2.2: Airborne Lidar Acquisition Flight Summary			
Date of Mission	Lines Flown	Mission Time (UTC) Wheels Up/ Wheels Down	Mission Time (Local = EDT) Wheels Up/ Wheels Down
October 12, 2014 – Sensor ALS-7108	41-57	19:30 – 23:21	01:30PM – 05:21PM
October 13, 2014 – Sensor ALS-7108	27-40	15:10 – 20:57	09:10AM - 02:57PM
October 14, 2014 – Sensor ALS-7108	11-26	14:20 – 20:20	08:42AM – 02:20PM
October 15, 2014 – Sensor ALS-7108	A1-A10, B33-B48	15:30 – 21:00	09:30AM – 03:00PM
October 15, 2014 – Sensor ALS-7177	59-70	20:45 – 23:22	2:45PM – 5:40PM
October 16, 2014 – Sensor ALS-7177	71-75, B49, C	15:35 – 20:37	09:35AM – 02:37PM
October 16, 2014 – Sensor ALS-7108	A30, B15-B32, C4-C34	13:45 – 19:00	07:45AM – 01:00PM
October 17, 2014 – Sensor ALS-7108	A94-A99, B1-B14	14:48 – 20:20	08:48AM – 2:20AM
October 17, 2014 – Sensor ALS-7177	76-80, B49-B60	14:45 – 19:10	08:45AM – 01:10PM

October 22, 2014 – Sensor ALS-7177	A81-A87, B99, C1-C3	15:00 – 17:35	09:00AM – 11:35AM
October 23, 2014 – Sensor ALS-7177	A74-A75, A96, B60, B91-B99	14:30 – 17:32	08:30PM – 11:32AM
October 24, 2014 – Sensor ALS-7177	C13, C25, B81-B89, A86, A88-A93, A95	14:20 – 18:37	08:20PM – 06:37PM
October 25, 2014 – Sensor ALS-7177	A9, A18, A75, A83, A85, A96-A97, A99, B61-B80	14:40 – 20:24	08:40PM – 02:24PM
October 29, 2014 – Sensor ALS-7177	B76	16:10 – 17:05	10:10PM – 11:05PM

Section 3: Lidar Data Processing

Applications and Work Flow Overview

1. Resolved kinematic corrections for three subsystems: inertial measurement unit (IMU), sensor orientation information and airborne GPS data. Developed a blending post-processed aircraft position with attitude data using Kalman filtering technology or the smoothed best estimate trajectory (SBET).
   Software: POSPac Software v. 5.3, IPAS Pro v.1.35.
2. Calculated laser point position by associating the SBET position to each laser point return time, scan angle, intensity, etc. Created raw laser point cloud data for the entire survey in LAS format. Automated line-to-line calibrations were then performed for system attitude parameters (pitch, roll, heading), mirror flex (scale) and GPS/IMU drift.
   Software: ALS Post Processing Software v.2.75 build #25, Proprietary Software, TerraMatch v. 15.01.
3. Imported processed LAS point cloud data into the task order tiles. Resulting data were classified as ground and non-ground points with additional filters created to meet the task order classification specifications. Statistical absolute accuracy was assessed via direct comparisons of ground classified points to ground RTK survey data. Based on the statistical analysis, the lidar data was then adjusted to reduce the vertical bias when compared to the survey ground control.
   Software: TerraScan v.15.01.
4. The LAS files were evaluated through a series of manual QA/QC steps to eliminate remaining artifacts from the ground class.
   Software: TerraScan v.15.01.

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

Equipment

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

The aircraft are all configured with a NovAtel Millennium 12-channel, L1/L2 dual frequency Global Navigation Satellite System (GNSS) receivers collecting at 2 Hz.

All Woolpert aerial sensors are equipped with a Litton LN200 series Inertial Measurement Unit (IMU) operating at 200 Hz.

A base-station unit was mobilized for each acquisition mission where a CORS station was not utilized, and was operated by a member of the Woolpert acquisition team. Each base-station setup consisted of one Trimble 4000 – 5000 series dual frequency receiver, one Trimble Compact L1/L2 dual frequency antenna, one 2-meter fixed-height tripod, and essential battery power and cabling. Ground planes were used on the base-station antennas. Data was collected at 1 or 2 Hz.

The 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)
KROW_Arpt_Base	33° 18' 14.85022"	-104°31' 39.65229"	1088.765
NGS PID AC7062	33° 27' 40.54734"	-105°31' 59.38392"	2045.258

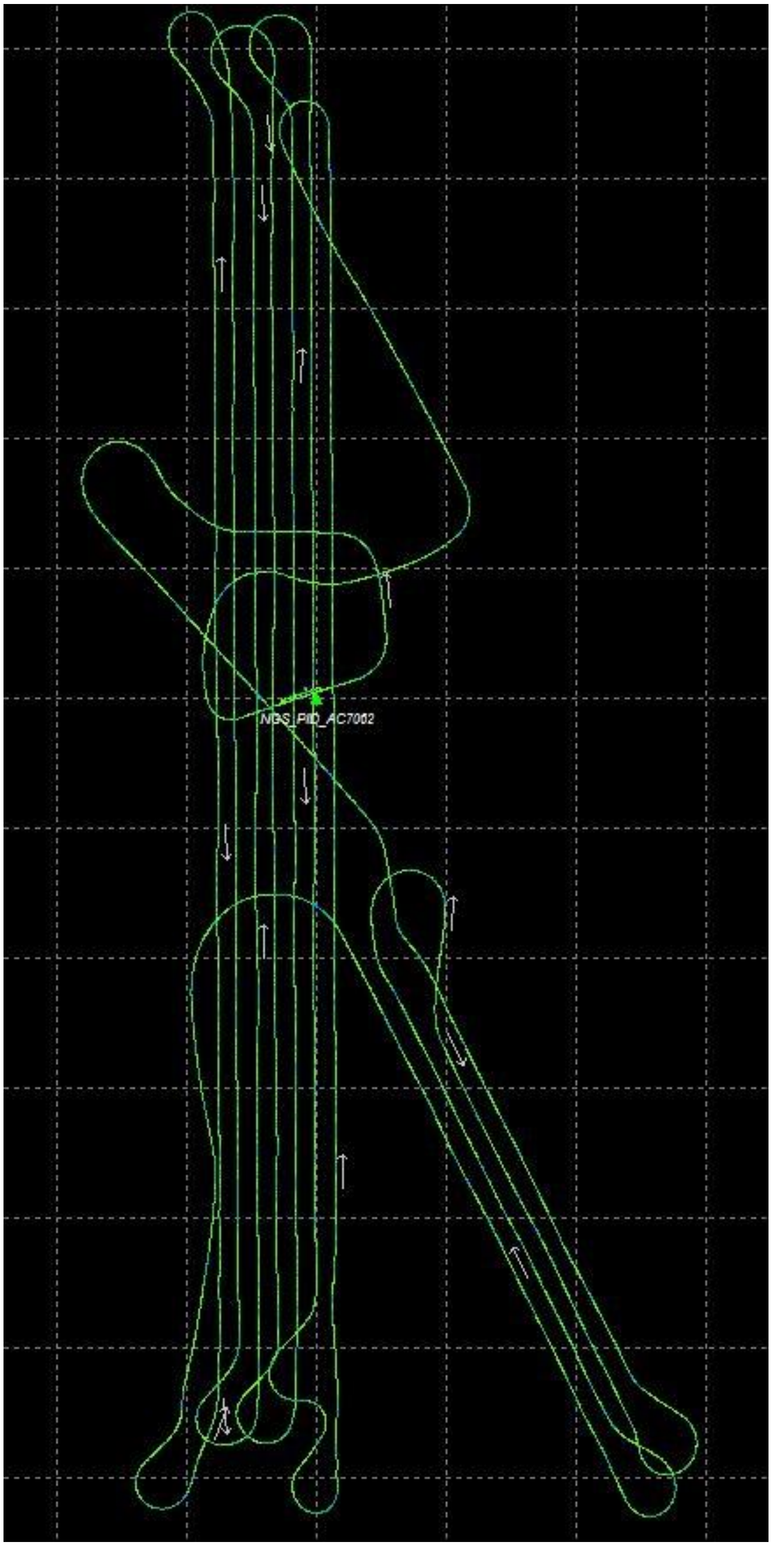
Data Processing

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, Day29514_SH7177

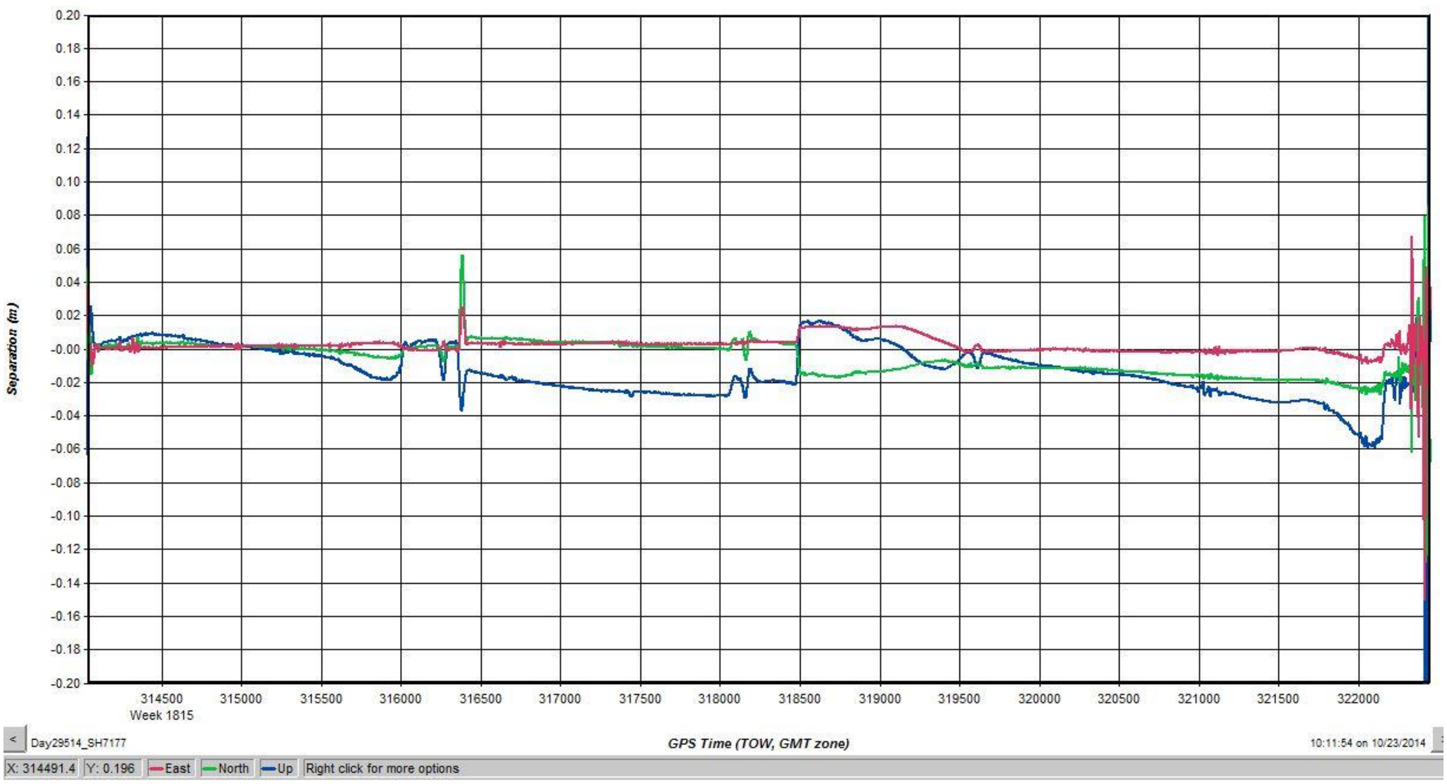


Combination Separation

The Combined Separation is a measure of the difference between the forward run and the backward run solution of the trajectory. The Kalman filter is processed in both directions to remove the combined directional anomalies. In general, when these two solutions match closely, an optimally accurate reliable solution is achieved.

Woolpert's goal is to maintain a Combined Separation Difference of less than ten (10) centimeters. In most cases we achieve results below this threshold.

Figure 3.2: Combined Separation, Day29514_SH7177

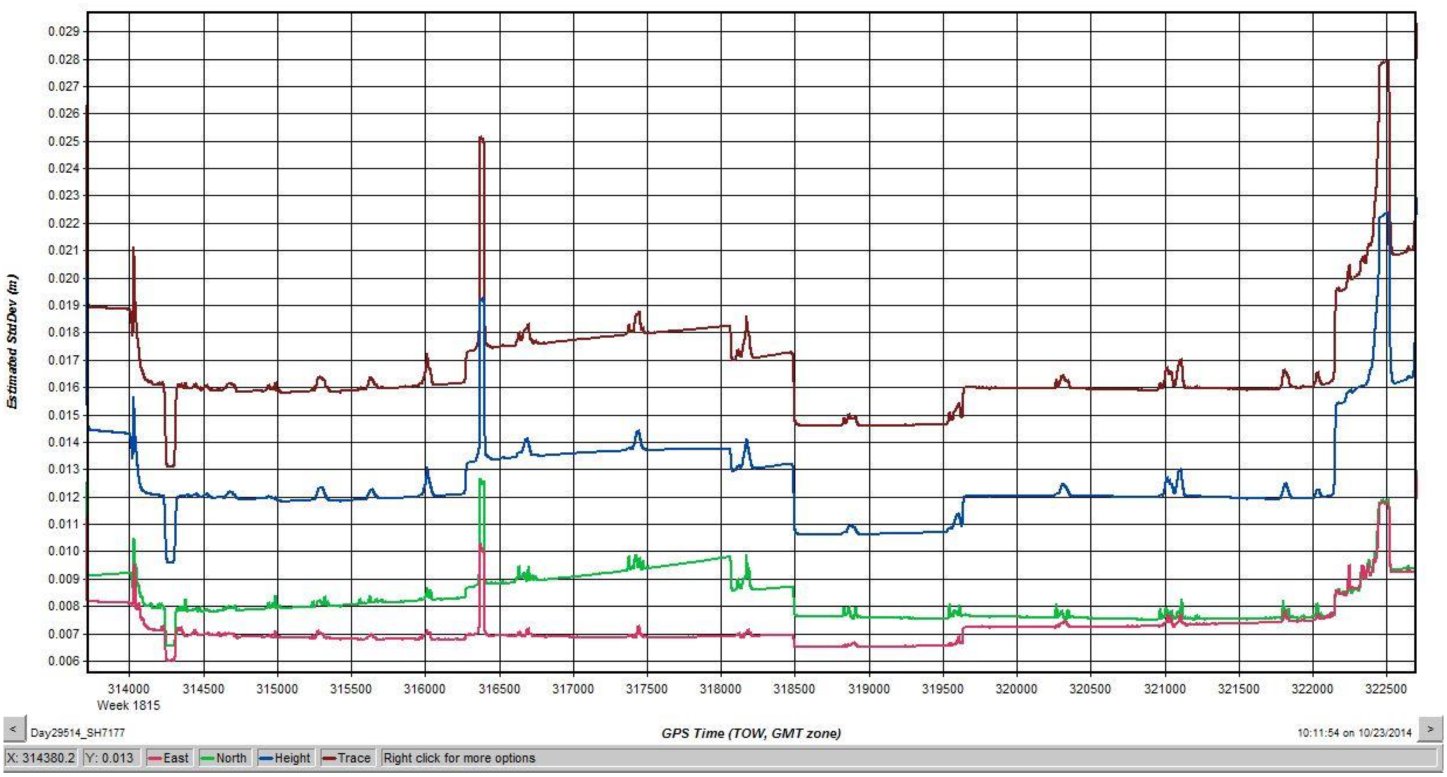


Estimated Positional Accuracy

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

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

Figure 3.3: Estimated Positional Accuracy, Day29514_SH7177

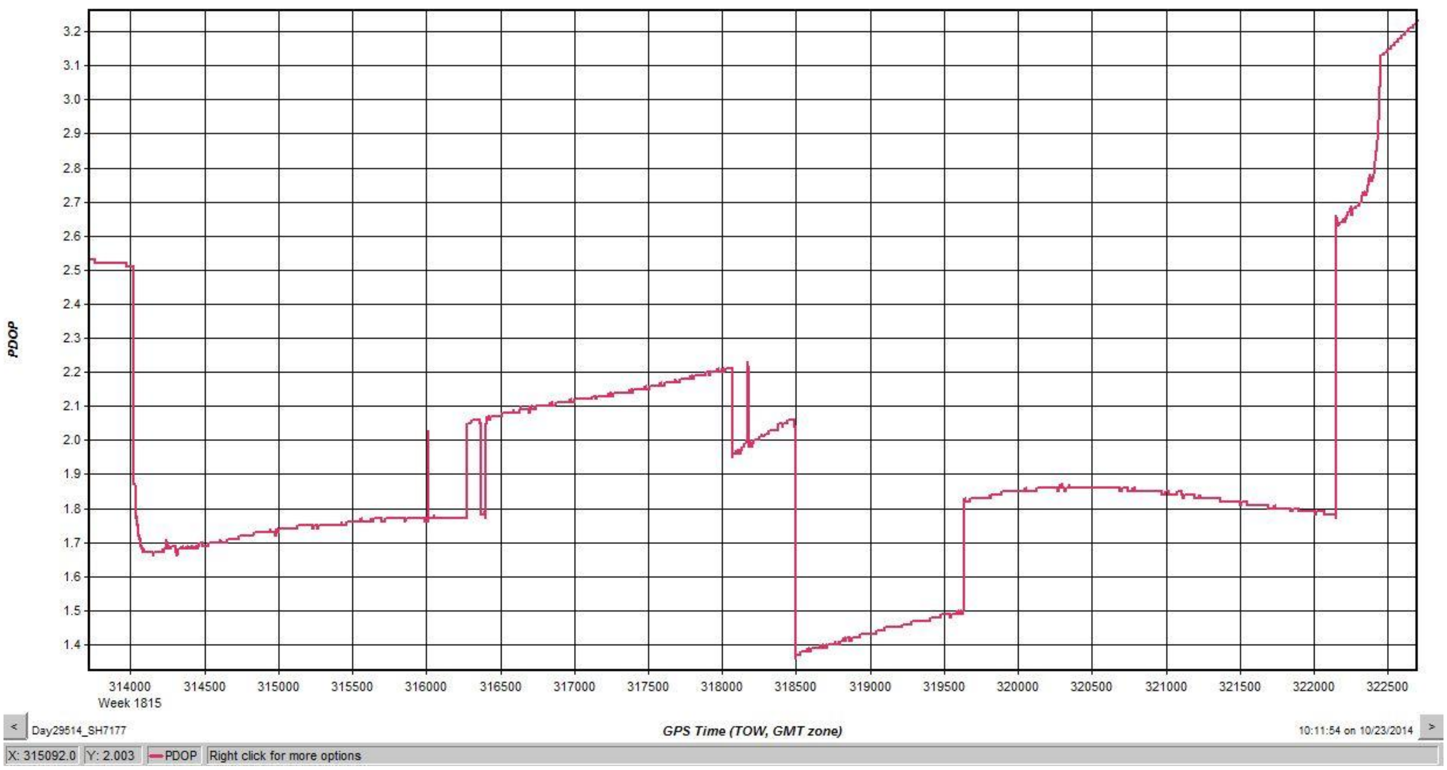


PDOP

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

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

Figure 3.4: PDOP, Day29514_SH7177



Lidar Data Processing

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

- Processed individual flight lines to derive a raw “Point Cloud” LAS file. Matched overlapping flight lines, generated statistics for evaluation comparisons, and made the necessary adjustments to remove any residual systematic error.
- Calibrated LAS files were imported into the task order tiles and initially filtered to create a ground and non-ground class. Then additional classes were filtered as necessary to meet client specified classes.
- Once all project data was imported and classified, survey ground control data was imported and calculated for an accuracy assessment. As a QC measure, Woolpert has developed a routine to generate accuracy statistical reports by comparisons against the TIN and the DEM using surveyed ground control of higher accuracy. The lidar is adjusted accordingly to meet or exceed the vertical accuracy requirements.
- The lidar tiles were reviewed using a series of proprietary QA/QC procedures to ensure it fulfills the task order requirements. A portion of this requires a manual step to ensure anomalies have been removed from the ground class.
- The lidar LAS files are classified into the Default (Class 1), Ground (Class 2), Low Noise (Class 7), Water (Class 9), Ignored Ground (Class 10), Bridge (Class 17) and High Noise (Class 18) classifications.
- FGDC Compliant metadata was developed for the task order in .xml format for the final data products.
- The horizontal datum used for the task order was referenced to UTM13N North American Datum of 1983 (2011). The vertical datum used for the task order was referenced to NAVD 1988, meters, GEOID12A. Coordinate positions were specified in units of meters.

Section 4: Hydrologic Flattening

HYDROLOGIC FLATTENING OF LIDAR DEM DATA

Rio Hondo, NM 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 1-acre or greater and streams at a minimum size of 15 meters (50 feet) nominal width, were compiled to meet task order requirements. **Figure 4.1** illustrates an example of 15 meters (50 feet) nominal streams identified and defined with hydrologic breaklines. The breaklines defining rivers and streams, at a nominal minimum width of 15 meters (50 feet), were draped with both sides of the stream maintaining an equal gradient elevation.
4. All ground points were reclassified from inside the hydrologic feature polygons to water, class nine (9).
5. All ground points were reclassified from within a buffer along the hydrologic feature breaklines to buffered ground, class ten (10).
6. The lidar ground points and hydrologic feature breaklines were used to generate a new digital elevation model (DEM).

Figure 4.1: Example Hydrologic Breaklines

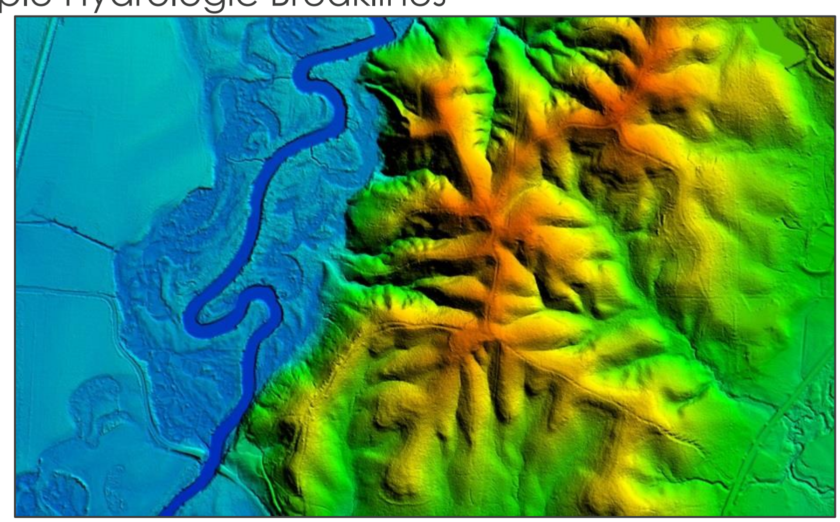


Figure 4.2 reflects a DEM generated from original lidar bare earth point data prior to the hydrologic flattening process. Note the "tinning" across the lake surface.

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

Figure 4.2

Figure 4.3

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

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

DATA QA/QC

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

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

Section 5: ACCURACY ASSESSMENT

Accuracy Assessment

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	0.013	meter
Minimum error	- 0.077	meter
Maximum error	+0.069	meter
Average magnitude	0.192	meter
Root mean square	0.035	meter
Standard deviation	0.033	meter

Table 5.2: Raw Swath Quality Check Point Analysis FVA

Point ID	Easting (meter)	Northing (meter)	TIN Elevation (meter)	Dz (meter)
2001	556394.639	3692373.445	1054.172	0.028
2002	546846.790	3705665.652	1094.469	0.061
2003	519830.801	3710103.600	1307.973	0.027
2004	503403.327	3708438.736	1372.971	-0.001
2005	482986.613	3711936.098	1664.134	0.016
2006	447171.429	3719731.591	2103.941	-0.021
2007	437650.955	3707228.586	2149.210	0.020
2008	438074.347	3697920.952	2212.227	0.003
2009	430417.777	3694201.976	2445.285	0.035
2010	434654.703	3679791.522	2217.994	-0.004
2011	448549.249	3690224.012	1928.486	0.004
2012	459894.682	3677650.351	2434.946	0.014
2013	485109.343	3690837.947	1518.913	-0.013
2014	462894.799	3706729.634	1770.697	-0.077
2015	483474.468	3682402.189	1691.278	0.042
2016	502373.862	3697968.970	1388.489	0.021
2017	514801.156	3692108.209	1318.375	-0.015
2018	538911.417	3690897.294	1115.157	0.063
2019	521001.658	3701975.552	1242.241	0.069
2020	480797.107	3705368.369	1704.518	-0.008
2021	474501.543	3690218.149	1626.180	-0.020
2022	536259.835	3702695.479	1149.173	0.037
2001	556394.639	3692373.445	1054.172	0.028

2002	546846.790	3705665.652	1094.469	0.061
2003	519830.801	3710103.600	1307.973	0.027

VERTICAL ACCURACY CONCLUSIONS

Raw LAS Swath Fundamental Vertical Accuracy (FVA) Tested 0.068 meters fundamental 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 Fundamental Vertical Accuracy (FVA) Tested 0.074 meters fundamental 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.

Bare-Earth DEM Fundamental Vertical Accuracy (FVA) Tested 0.082 meters fundamental 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.

SUPPLEMENTAL VERTICAL ACCURACY ASSESSMENTS

Table 5.3: Sage/Steppe Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
4001	556366.212	3692379.675	1054.190	0.095
4002	546814.713	3705684.765	1094.860	0.111
4003	519802.409	3710092.333	1308.190	0.112
4004	503419.597	3708412.923	1372.410	-0.063
4005	482963.27	3711943.915	1664.690	0.121
4006	447152.949	3719801.749	2106.150	-0.057
4007	437637.182	3707219.302	2148.660	0.090
4008	438126.984	3697908.310	2210.040	0.064
4009	430427.522	3694227.705	2442.610	0.122
4010	434629.757	3679801.880	2215.220	0.058
4011	448644.526	3690126.470	1929.690	-0.045
4012	459899.063	3677715.858	2432.500	0.160
4013	485132.005	3690826.767	1518.670	-0.047
4014	462895.987	3706761.195	1769.410	-0.008
4015	483454.322	3682389.774	1693.870	0.029
4016	502379.961	3697935.960	1392.090	0.114
4017	514769.614	3692099.820	1318.210	-0.019

4018	538896.734	3690841.095	1115.610	0.151
4019	521023.9	3701975.807	1242.800	0.131
4020	480795.734	3705393.725	1703.360	0.007
4021	474512.058	3690201.272	1626.120	0.068
4022	536240.457	3702673.619	1149.270	0.042

VERTICAL ACCURACY CONCLUSIONS

Sage/Steppe Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.150 meters supplemental vertical accuracy at the 95th percentile in the Sage/Steppe supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. Sage/Steppe Errors larger than 95th percentile include:

- Point 4012, Easting 459899.063, Northing 3677715.858, Z-Error 0.160 meters
- Point 4018, Easting 538896.734, Northing 3690841.095, Z-Error 0.151 meters

Table 5.4: Brushlands and Trees Quality Check Point Analysis SVA

Point ID	Easting (meter)	Northing (meter)	DEM Elevation (meter)	Dz (meter)
5001	555911.185	3692899.504	1055.320	0.198
5002	484511.04	3709769.895	1631.130	-0.083
5003	436492.654	3695783.522	2235.280	-0.030
5004	437424.688	3703400.970	2188.020	0.070
5005	482981.865	3711919.266	1666.170	0.026
5006	447110.933	3719760.449	2106.480	-0.037
5007	437583.226	3707186.440	2145.820	0.032
5008	438107.709	3697845.578	2214.460	0.015
5009	430450.668	3694174.973	2448.520	0.171
5010	434595.799	3679777.548	2215.970	-0.008
5011	448649.314	3690100.536	1932.920	-0.063
5012	459860.809	3677678.826	2431.500	-0.062
5013	485101.224	3690818.415	1517.850	-0.085
5014	462952.466	3706720.056	1768.310	-0.068
5015	483520.937	3682397.326	1687.880	0.082
5016	502343.047	3698016.031	1384.550	0.024
5017	453924.007	3694017.541	1819.080	-0.185
5018	448567.255	3701891.606	2079.160	0.036
5019	447986.664	3722712.195	2062.510	-0.046
5020	467127.978	3710696.640	1935.150	-0.029
5021	438756.883	3684521.361	2064.730	0.056
5022	439983.014	3705608.524	2114.860	0.123

VERTICAL ACCURACY CONCLUSIONS

Brushlands and Trees Land Cover Classification Supplemental Vertical Accuracy (SVA) Tested 0.184 meters supplemental vertical accuracy at the 95th percentile in the Brushlands and Trees Land supplemental class reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. Brushlands and Trees Land Errors at the 95th percentile include:

- Point 5001, Easting 555911.185, Northing 3692899.504, Z-Error 0.198 meters
- Point 5017, Easting 453924.007, Northing 3694017.541, Z-Error 0.185 meters

CONSOLIDATED VERTICAL ACCURACY ASSESSMENT AND CONCLUSION

Consolidated Vertical Accuracy (CVA) Tested 0.157 meters consolidated vertical accuracy at the 95th percentile level; reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines and tested against the DEM. CVA is based on the 95th percentile error in all land cover categories combined.

- Point 4012, Easting 459899.063, Northing 3677715.858, Z-Error 0.160 meters
- Point 5001, Easting 555911.185, Northing 3692899.504, Z-Error 0.198 meters
- Point 5009, Easting 430450.668, Northing 3694174.973, Z-Error 0.171 meters
- Point 5017, Easting 453924.007, Northing 3694017.541, Z-Error 0.185 meters

Approved by:	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		August 2015

Section 6: Flight Logs

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

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/12/2014	285	74713	2	Rio Hondo ALS Lidar

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
BURKE	N111SD	2658.2	13:13:20	19:13:30	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**ZULU Stop Time**	**PID**
LaROCQUE	ALS-7108	2661.8	17:21:00	23:21:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
240/18 G32	10	CLR	0	28	3	29.74 Dropping	N/A	Departing	KROW
								Arriving	KROW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi	X	B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	Kts	6500	Ft	9934	Ft	Yes		No	X	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	GS	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	12:45:00
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission	Yes X No
57	262	19:30:43		###########				Abort offline	
57	82	19:35:08	19:36:42	0:01:34	16	141	1.2		
56	262	19:40:47	19:43:14	0:02:27	17	144	1		
55	82	19:46:26	19:49:50	0:03:24	17	150	1.1		
54	262	19:51:43	19:54:22	0:02:39	17	133	1.1		
53	82	19:57:27	20:01:43	0:04:16	17	155	1.1		
52	262	20:05:08	20:10:18	0:05:10	18	158	1.2		
51	82	20:18:48	20:28:35	0:09:47	17	158	1.3		
50	262	20:31:58	20:43:18	0:11:20	16	151	1.3		
49	82	20:46:41	20:57:01	0:10:20	15	157	1.4		
48	262	21:00:07	21:12:33	0:12:26	15	138	1.3		
47	82	21:15:32	21:26:07	0:10:35	15	159	1.3		
46	262	21:28:57	21:41:36	0:12:39	14	149	1.3		
45	82	21:45:20	21:57:23	0:12:03	14	158	1.2		
44	262	22:00:35	22:14:18	0:13:43	15	142	1.1		
43	82	22:17:50	22:30:14	0:12:24	14	150	1.3		
42	262	22:33:27	22:47:58	0:14:31	13	146	1.5		
41	82	22:51:46	23:05:14	0:13:28	15	157	1.2		
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #
Choppy air effected pitch and roll, up and down drafts affected airspeed and altitude. Pilot did his best to maintain airspeed in the green zone and altitude within + 100' of desired.	783516

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/13/2014	286	74713	2	Rio Hondo ALS Lidar

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
BURKE	N111SD	2661.4	9:10:30	15:10:30	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**ZULU Stop Time**	**PID**
LaROCQUE	ALS-7108	2666.9	14:57:40	20:57:40	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
340/7	10	CLR	0	14	1	30.2		Departing	KROW
								Arriving	KROW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi	x	B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	9934	Ft	Yes		No	X	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	GS	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	12:45:00
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission	Yes X No
40	262	15:38:03	15:53:37	0:15:34	14	147	1.2		
39	82	15:56:54	16:12:33	0:15:39	14	154	1.4		
38	262	16:15:45	16:32:30	0:16:45	15	153	1.4		
37	82	16:35:41	16:52:29	0:16:48	16	151	1.2		
36	262	16:56:20	17:14:34	0:18:14	17	155	1.2		
35	82	17:18:01	17:36:10	0:18:09	16	156	1.3	In-Flt Evaluation list line with 0.20 nmi GNSS Error	
34	262	17:39:07	17:57:35	0:18:28	16	154	1.2		
33	82	18:00:45	18:19:22	0:18:37	16	156	1.2		
35	262	18:22:32	18:24:45	0:02:13	16	153	1.3	Add buffer east and west of GNSS Error flew 5.3 miles patch	
32	262	18:30:47	18:49:57	0:19:10	16	151	1.3		
31	82	18:53:09	19:11:49	0:18:40	15	156	1.4		
30	262	19:14:54	19:34:24	0:19:30	16	154	1.2		
29	82	19:37:37	19:56:45	0:19:08	18	157	1		
28	262	19:59:25	20:19:05	0:19:40	15	154	1.2		
27	82	20:22:18	20:41:18	0:19:00	16	156	1.3		
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #
West end of lines ALS Warning Approaching Min Range Gate this is in the overlap area 5-6 miles from end of line % returns remained high though the majority of overlap area.	783516

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/14/2014	287	74713	2	Rio Hondo ALS Lidar

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
BURKE	N111SD	2666.9	8:42:15	14:42:15	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**ZULU Stop Time**	**PID**
LaROCQUE	ALS-7108	2672.3	14:20:15	20:20:15	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KROW
160/8	10	CLR	0	6	1	30.27		Arriving	KROW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	X	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi	X	B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	9934	Ft	Yes		No	X	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	GS	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 8:15:00
↕ Times entered are Zulu / GMT ↕								Verify S-Turns Before Mission Yes X No
26	262	15:04:51	15:24:07	0:19:16	16	148	1.1	
25	82	15:27:02	15:45:54	0:18:52	14	154	1.3	
24	262	15:48:56	16:07:41	0:18:45	15	157	1.2	
23	82	16:10:37	16:29:05	0:18:28	15	155	1.4	
22	262	16:31:57	16:50:02	0:18:05	16	156	1.4	
21	82	16:53:02	17:10:37	0:17:35	17	155	1.2	
20	262	17:13:40	17:28:15	0:14:35	16	154	1.3	
19	82	17:31:29	17:45:32	0:14:03	15	157	1.4	
18	262	17:48:31	18:02:53	0:14:22	17	151	1.1	
17	82	18:05:53	18:19:48	0:13:55	16	153	1.3	
16	262	18:22:45	18:36:46	0:14:01	16	155	1.3	
15	82	18:39:48	18:53:32	0:13:44	14	153	1.5	
14	262	18:56:37	19:11:00	0:14:23	14	155	1.5	
13	82	19:13:51	19:27:43	0:13:52	16	157	1.2	
12	262	19:30:51	19:45:16	0:14:25	16	154	1.2	
11	82	19:48:22	20:02:03	0:13:41	16	155	1.2	
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes X No

Additional Comments:	Drive #
West end of lines 26-21 ALS Warning Approaching Min Range Gate this is in the overlap area 5-6 miles from end of line % returns remained high though the majority of overlap area. Lines 20-11 ALS Warning Approaching Min Range Percent returns remained at 100% - Warning west end last 30 seconds of line. May be able to adjust flight plan and reduce the length of the north south comnmon area lines.	**783516**

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Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/15/2014	288	74713	2	USGS - Rio Hondo NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SIMMONS	N111SD	2672.3	9:30:00	15:30:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
LaROCQUE	ALS-7108	2677.6	15:00:00	21:00:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KROW
010 @ 04	10	CLR		11	3	3020		Arriving	KROW

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
				Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi		B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
	Kts		Ft		Ft	Yes		No	X	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	
⇕ Times entered are Zulu / GMT ⇕								Verify S-Turns Before Mission	Yes X No
A10	W	15:55:00	16:08:00	8:37:00					
A09	E	16:12:00	16:25:00	0:00:00					
A08	W	16:28:00	16:42:00	0:00:00					
A07	E	16:45:00	16:57:00	0:00:00					
A06	W	17:01:00	17:13:00	0:00:00					
A05	E	17:16:00	17:28:00	0:00:00					
A04	W	17:37:00	17:41:00	0:00:00					
A03	E	17:43:00	17:47:00	0:00:00					
A02	W	17:50:00	17:52:00	0:00:00					
A01	E	17:55:00	17:56:00	0:00:00					
B46	N	18:04:00	18:04:00	0:00:00					
B45	S	18:07:00	18:15:00	0:00:00					
B47	N	18:18:00	18:20:00	0:00:00					
B48	S	18:24:00	18:25:00	0:00:00					
B44	N	18:28:00	18:36:00	0:00:00					
B43	S	18:39:00	18:47:00	0:00:00					
B42	N	18:50:00	18:58:00	0:00:00					
B41	S	19:00:00	19:09:00	0:00:00					
B40	N	19:11:00	19:20:00	0:00:00					
B39	S	19:22:00	19:31:00	0:00:00					
B38	N	19:33:00	19:41:00	0:00:00					
B37	S	19:44:00	19:52:00	0:00:00					
B36	N	19:55:00	20:03:00	0:00:00					
B35	S	20:06:00	20:14:00	0:00:00					
B34	N	20:17:00	20:25:00	0:00:00					
B33	S	20:28:00	20:36:00	0:00:00					
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				0:00:00					
				0:00:00					
				0:00:00					
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #

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Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/15/2014	288	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3392.2	2:45:00	20:45:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3394.7	5:22:00	23:22:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
030 7	10	CLEAR	0	23	0	3025		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	20:51:25
		⇩ Times entered are Zulu / GMT ⇩						Verify S-Turns Before Mission	Yes X No
59	S	21:08:57	21:14:54	18:35:33	13	0.8	1.3	B49-C3 = 13,900	
58	N	21:17:08	21:18:25	0:00:00	13	0.8	1.3	C4-C30 = 15,900	
60	N	21:24:00	21:30:34	0:00:00	13	0.8	1.3	C31-C34 = 17,500	
61	S	21:33:23	21:40:24	0:00:00	13	0.8	1.3	Offline	
62	N	21:42:29	21:49:30	0:00:00	15	0.7	1.2	Numerous dropouts due to	
63	S	21:52:32	21:59:38	0:00:00	16	0.7	1.1	volitile terrain features on both	
64	N	22:01:42	22:08:58	0:00:00	15	0.7	1.1	ends of the range gate	
65	S	22:11:54	22:19:29	0:00:00	15	0.9	1.1		
66	N	22:21:50	22:29:20	0:00:00	13	0.7	1.6		
67	S	22:33:57	22:44:50	0:00:00	15	0.7	1.2		
68	N	22:45:55	22:55:40	0:00:00	16	0.7	1.3		
69	S	22:58:54	23:09:12	0:00:00	16	0.7	1.1		
70	N	23:11:12	23:21:29	0:00:00	16	0.7	1.1		
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↑ 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
10/16/2014	289	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3394.7	9:35:00	15:35:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3399.4	2:37:00	20:37:00	SSR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
CALM	10	CLEAR	0	17	-2	3026		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	15:41:27
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission	Yes X No
C34	S	16:11:45	16:12:23	8:31:28	14	0.7	1.5	B49-C3 = 13,900	
C33	N	16:15:10	16:16:18	0:00:00	15	0.8	1.5	C4-C30 = 15,900	
C32	S	16:20:00	16:21:14	0:00:00	14	0.7	1.5	C31-C34 = 17,500	
C31	N	16:23:48	16:24:51	0:00:00	14	0.7	1.5		
C4	S	16:30:03	16:31:07	0:00:00	15	0.7	1.3	Numerous dropouts due to	
C5	N	16:35:24	16:38:04	0:00:00	15	0.6	1.5	volitile terrain features on both	
C6	S	16:41:25	16:44:20	0:00:00	15	0.6	1.5	ends of the range gate	
C7	N	16:47:57	16:50:52	0:00:00	15	0.6	1.5		
C8	S	16:54:10	16:57:10	0:00:00	15	0.7	1.3		
C9	N	17:00:17	17:03:22	0:00:00	15	0.7	1.3		
C10	S	17:06:56	17:10:18	0:00:00	15	0.7	1.3		
C11	N	17:12;57	17:15:57	0:00:00	15	0.7	1.4		
C12	S	17:19:07	17:22:13	0:00:00	14	0.7	1.3		
C13	N	17:24:57	17:28:11	0:00:00	16	0.7	1.2	Manual Start(Late?)	
C14	S	17:31:37	17:34:47	0:00:00	16	0.7	1.3	speed is excessive very high winds	
C15	N	17:37;20	17:40:19	0:00:00	15	0.7	1.2		
C16	S	17:43:45	17:46:23	0:00:00	14	0.7	1.3		
C17	N	17:49:34	17:51:49	0:00:00	16	0.7	1.2		
C18	S	17:54:27	17:56:09	0:00:00	16	0.7	1.2		
C19	N	17:59:20	18:00:21	0:00:00	14	0.7	1.3		
C20	S	18:03:27	18:04:18	0:00:00	14	0.7	1.3		
C21	N	18:06:51	18:07:42'	0:00:00	15	0.7	1.6		
C22	S	18:10:45	18:11:29	0:00:00	14	0.7	1.6		
C23	N	18:20:39	18:23:13	0:00:00	15	0.7	1.4		
C24	S	18:25:35	18:29:15	0:00:00	14	0.7	1.4		
C25	N	18:32:16	18:36:38	0:00:00	13	0.9	1.7	GPS GAP	
C26	S	18:38:36	18:42:50	0:00:00	14	0.8	1.6		
C27	S	18:45:25	18:49:35	0:00:00	14	0.8	1.5		
C28	N	18:51:41	18:55:48	0:00:00	13	0.8	1.6		
C29	S	18:58:00	19:01:52	0:00:00	14	0.8	1.6		
C30	N	19:04:44	19:07:33	0:00:00	14	0.8	1.3	Continued on Page #2	
↑ 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
	10/16/2014	289	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3394.7	9:35:00	15:35:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3399.4	2:37:00	20:37:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
Calm	10	clear	0	17	-3	3026		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL						Waveform Mode		Pre-Trigger Dist.
150	Kts	6500	Ft	VARIES	Ft	Yes		No	X	@	NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 15:41:27
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission Yes X No
B49	W	19:11;40	19:12:38	14:51:12	16	0.6	1.1	Wrong Altitude manual start
71	S	19:20:30	19:30:42	0:00:00	15	0.7	1.1	refly B49
72	N	19:32:50	19:43:20	0:00:00	17	0.7	1.3	
73	S	19:45:40	19:56:02	0:00:00	17	0.6	1.1	
74	N	19:58:32	20:08:40	0:00:00	17	0.6	1.1	GPS GAP
75	S	20:10:36	20:20:45	0:00:00	17	0.6	1.1	Manual Start GPS GAP
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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↑ Times entered are Zulu / GMT ↑				Page		2		Verify S-Turns After Mission Yes No

Additional Comments:	Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/17/2014	290	74713	2	USGS - Rio Hondo NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SIMMONS	N111SD	2682.8	8:48:00	14:48:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
LaROCQUE	ALS-7108	2688.3	14:20:00	20:20:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
080 @ 04	10	CLR		14	5	3024		Departing	KSRR
								Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
				Gain - Course/Up		Single		A	160
				Gain - Fine/Down		Multi		B	160

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
	Kts		Ft		Ft	Yes		No	X	@	NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission Yes X No
B14	N	15:12:00	15:23:00	7:03:00				
B13	S	15:26:00	15:37:00	0:00:00				
B12	N	15:41:00	15:52:00	0:00:00				
B11	S	15:55:00	16:07:00	0:00:00				
B10	N	16:10:00	16:22:00	0:00:00				
B9	S	16:25:00	16:36:00	0:00:00				
B8	N	16:40:00	16:51:00	0:00:00				
B7	S	16:54:00	17:05:00	0:00:00				
B6	N	17:08:00	17:19:00	0:00:00				
B5	S	17:23:00	17:34:00	0:00:00				
B4	N	17:37:00	17:48:00	0:00:00				
B3	S	17:51:00	18:03:00	0:00:00				
B2	N	18:06:00	18:16:00	0:00:00				
B1	S	18:20:00	18:31:00	0:00:00				
A99	N	18:34:00	18:45:00	0:00:00				
A98	S	18:48:00	18:59:00	0:00:00				
A97	N	19:02:00	19:13:00	0:00:00				
A96	S	19:16:00	19:28:00	0:00:00				
A95	N	19:31:00	19:42:00	0:00:00				
A94	S	19:48:00	19:59:00	0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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				0:00:00				
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes X No

Additional Comments:	Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/17/2014	290	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3399.4	9:45:00	14:45:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3403.4	1:10:00	19:10:00	SSR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
070 3	10	CLEAR	0	15	5	3024		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@	NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	15:58:48
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission	Yes X No
76	N	15:18:09	15:28:15	7:11:48	13	0.8	1.3	B49-C3 = 13,900	
77	S	15:30:48	15:41:00	0:00:00	14	0.7	1.4	C4-C30 = 15,900	
78	N	15:43:37	15:53:37	0:00:00	14	0.7	1.4.1.5	C31-C34 = 17,500	
79	S	15:56:20	16:06:11	0:00:00	14	0.8	1.6	Takeoff: 15:07	
80	N	16:08:45	16:18:33	0:00:00	15	0.8	1.3	Numerous dropouts due to	
B49	E	16:27:02	16:27:33	0:00:00	14	0.7	1.3	volitile terrain features on both	
B50	W	16:30:20	16:33:51	0:00:00	15	0.7	1.3	ends of the range gate	
B51	E	16:37:00	16:45:54	0:00:00	15	0.7	1.3		
B52	W	16:48:46	16:58:19	0:00:00	15	0.7	1.3		
B53	E	17:00:49	17:10:50	0:00:00	15	0.7	1.3		
B54	W	17:13:28	17:23:24	0:00:00	15	0.7	1.3		
B55	E	17:25:40	17:35:41	0:00:00	15	0.7	1.2		
B56	W	17:37:50	17:47:54	0:00:00	16	0.6	1.2		
B57	E	17:50:08	18:00:15	0:00:00	15	0.7	1.5		
B58	W	18:02:34	18:12:23	0:00:00	16	0.8	1.3		
B59	E	18:14;40	18:24:13	0:00:00	16	0.7	1.3		
B60	W	18:27:00	18:36:09	0:00:00	15	0.7	1.3	Over Flew Base 1842:15 to 18:47:14	
				0:00:00				GPS Jamming from whilte sands	
				0:00:00				Landing @ KALM 1:05 (L)	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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				0:00:00				Continued on Page #2	
↑ 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
	10/22/2014	295	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3404.5	9:00:00	15:00:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177		11:35:00	17:35:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
300 4	10	clear	10%	11	9	30.27		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	15:10:00
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission	Yes X No
C3	SE	15:30:38	15:33:25	7:14:28	15	0.8	1.3	B49-C3 = 13,900	
C2	NW	15:35:40	15:38:48	0:00:00	15	0.8	1.1	C4-C30 = 15,900	
C1	SE	15:42:12	15:45:32	0:00:00	15	0.8	1.1	C31-C34 = 17,500	
B99	NW	15:47;55	15:51:29	0:00:00	15	0.8	1.5	Takeoff: 15:20/POSSIBLE THIN 9,6	
A81	N	15:59:26	16:09:12	0:00:00	15	0.8	1.4		
A82	S	16:11:35	16:21:27	0:00:00	16	0.8	1.1	POSSIBLE THIN WPT 3	
A83	N	16:23:42	16:33:24	0:00:00	16	0.7	1.2	cloud wpt 3	
A84	S	16:35;38	16:45:13	0:00:00	15	0.7	1.4	cloud wpt 3, 4	
A85	N	16:47:45	16:57:14	0:00:00	15	0.6	1.5	cloud wpts 1-4	
A86	S	16:59:37	17:09:06	0:00:00	16	0.6	1.3	clouds wpts 1-5	
A87	N	17:12:45	17:22:52	0:00:00	15	0.6	1.1	clouds wpts 1-5, 26, 47 - 42	
				0:00:00				flew 400 feet low start of line	
				0:00:00					
				0:00:00				Takeoff: 15:20	
				0:00:00				Landing: 17:31:30	
				0:00:00					
				0:00:00				Static:17:35:12	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes X No

Additional Comments:	Drive #
	00096

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/23/2014	29614	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3406.7	8:30:00	14:30:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3409.5	11:32:00	17:32:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
220 4	10	clear	0	13	5	30.34		Departing	KSRR
								Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@	NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	14:32:19
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission	Yes x No
B60	W	14:53:40	15:03:03	6:24:25	14	0.8	1.3	B49-C3 = 13,900 - FL 60 REFLIGHT	
B99	SE	15:10:27	15:13:58	0:00:00	14	0.8	1.3	C4-C30 = 15,900 - FL99 REFLIGHT	
B98	NW	15:16:48	15:20:32	0:00:00	14	0.8	1.3	C31-C34 = 17,500	
B97	SE	15:23:10	15:26:45	0:00:00	14	0.8	1.3	takeoff:1440z/8:40 (L)	
B96	NW	15:29:18	15:32:42	0:00:00	14	0.8	1.3		
B95	SE	15:36;17	15:40:39	0:00:00	15	0.7	1.2		
B94	NW	15:43:27	15:47:58	0:00:00	15	0.7	1.2		
B93	SE	15:50:12	15:54:34	0:00:00	15	0.7	1.2		
B92	NW	15:57:20	16:01:55	0:00:00	16	0.7	1.2		
B91	SE	16:04:22	16:08:45	0:00:00	16	0.6	1.2		
B90	NW	16:11:30	16:18:20	0:00:00	16	0.6	1.2	F-16's in MOA	
A75	N	16:25:20	16:35;10	0:00:00	16	0.6	1.3	wpt 29 cloud	
A74	S	16:37:58	16:48:04	0:00:00	16	0.7	1.3		
A87	N	16:51:07	17:01:12	0:00:00	14	0.7	1.6	wpt 26 very thin cloud	
A96	S	17:05:10	17:11:35	0:00:00	16	0.6	1.2	wpt 22 cloud	
				0:00:00				Landing: 17:27:40	
				0:00:00				Static: 17:29:28 - 17:31:28	
				0:00:00					
				0:00:00					
				0:00:00					
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes x No

Additional Comments:	Drive #
	00096

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/24/2014	297	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
GALAMBOS	N7079F	3409.5	8:20:00	14:20:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3413.4	12:37:00	18:37:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
240 5	10	clear	0	13	2	30.39		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@	NS		Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At: 14:31:50
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission Yes x No
C25	W	14:57:25	15:01:39	6:22:59	15	0.7	1.2	B49-C3 = 13,900 - Reflight
C13	S	15:10:42	15:12:17	0:00:00	14	0.7	1.4	C4-C30 = 15,900/wpts 12-15 manual st
B89	SE	15:21:24	15:29:24	0:00:00	15	0.8	1.4	C31-C34 = 17,500
B88	NW	15:32:27	15:39:59	0:00:00	15	0.7	1.4	Takeoff: 14:41z / 8:41:(L)
B87	SE	15:42:27	16:50:01	0:00:00	15	0.8	1.5	Range Gate can be exceeded on
B86	NW	15:52:30	16:00:12	0:00:00	15	0.7	1.5	each line at each end of the
B85	SE	16:02:29	16:10:08	0:00:00	16	0.8	1.2	range gate
B84	NW	16:12:32	16:20:00	0:00:00	16	0.7	1.2	
B83	SE	16:22:29	16:30:14	0:00:00	16	0.7	1.2	
B82	N	16:33:43	16:41:40	0:00:00	16	0.7	1.2	
B81	S	16:43:40	16:51:45	0:00:00	15	0.7	1.2	
A88	N	16:56:55	17:07:00	0:00:00	15	0.6	1.2	
A89	S	17:09:35	17:19:41	0:00:00	15	0.8	1.2	
A90	N	17:21:45	17:31:51	0:00:00	15	0.8	1.2	
A91	S	17:34:14	17:44:30	0:00:00	15	0.8	1.2	
A92	N	17:46:22	17:56:30	0:00:00	14	0.8	1.2	
A93	S	17:58:37	18:08:37	0:00:00	14	0.8	1.6	
A95	N	18:12:03	18:23:27	0:00:00	14	0.8	1.5	
A86	S	18:26:36	18:30:00	0:00:00	15	0.8	1.6	wpts 1-8 reflight
				0:00:00				Landing 18:35:00
				0:00:00				static: 18:37:00
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
				0:00:00				
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				0:00:00				
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission Yes x No

Additional Comments:	Drive #
	00096

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	10/25/2014	29814	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	14:40	Base
GALAMBOS	N7079F	3413.4	8:40:00	14:40:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
RADER	ALS-7177	3418.8	2:24:00	20:24:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
230 6	10	clear	0	14	5	30.4		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
150	Kts	6500	Ft	Varies	Ft	Yes		No	x	@	NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	14:43:29
		⇕ Times entered are Zulu / GMT ⇕						Verify S-Turns Before Mission	Yes x No
B80	NW	15:08:07	15:16:16	6:44:59	14	0.7	1.3	B49-C3 = 13,900	
B79	SE	15:18:24	15:26:35	0:00:00	14	0.8	1.5	C4-C30 = 15,900	
B78	NW	15:29:04	15:37:21	0:00:00	14	0.8	1.6	C31-C34 = 17,500	
B77	SE	15:39:47	15:48:29	0:00:00	13	0.8	1.8	Takeoff: 14:54Z	
B76	NW	15:50:36	15:59:44	0:00:00	16	0.8	1.2		
B75	SE	16:01:48	16:11:18	0:00:00	16	0.8	1.3	numermous dropouts to due	
B74	NW	16:13:36	16:22:40	0:00:00	16	0.7	1.3	volitile terrian on both ends	
B73	SE	16:24:48	16:34:11	0:00:00	16	0.7	1.3	17	
B72	NW	16:36:07	16:45:34	0:00:00	16	0.7	1.3		
B71	SE	16:47:40	16:57:09	0:00:00	16	0.7	1.3		
B70	NW	16:59:21	17:08:35	0:00:00	16	0.7	1.3		
B69	SE	17:10:59	17:19:45	0:00:00	16	0.7	1.3		
B68	NW	17:21:44	17:31:00	0:00:00	16	0.7	1.3		
B67	SE	17:32:44	17:41:28	0:00:00	16	0.7	1.3		
B66	NW	17:44:00	17:50:57	0:00:00	16	0.7	1.4		
B65	SE	17:53;20	17:59:56	0:00:00	16	0.7	1.3		
B64	NW	18:01:48	18:07:59	0:00:00	15	0.7	1.6		
B63	SE	18:10;20	18:16:06	0:00:00	14	0.7	1.4		
B62	NW	18:18;04	18:22:47	0:00:00	16	0.7	1.3	offline	
B61	SE	18:25:08	18:29:00	0:00:00	15	0.7	1.4		
A75	S	18:36:25	18:37:36	0:00:00	15	0.6	1.3	11,900 wpts 26-30 Manual UL001	
A85	N	18:42:31	18:44:49	0:00:00	15	0.6	1	Manual Start wpts 9-1, UL002	
A83	S	18:47:02	18:48:31	0:00:00	18	0.6	1.1	wpts 1-7	
A96	N	18:54:39	18:56:22	0:00:00	18	0.6	1.1	Manual Start wpts 20-25 UL003	
A97	S	19:01:42	19:12:43	0:00:00	18	0.6	1	Reflights	
A99	N	19:14;15	19:26:00	0:00:00	19	0.6	1		
A9	E	19:35:35	19:49:14	0:00:00	18	0.6	1.1	9934'	
A18	W	19:53:03	20:07:46	0:00:00	15	0.7	1.4		
				0:00:00				Landing: 2018z 2:18 (L)	
				0:00:00				Static: 20:22:25 - 20:24:25	
				0:00:00					
↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes x No

Additional Comments:	Drive #
	00096

Woolpert

Leica LIDAR

MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
10/29/2014	30214	74713	2	Rio Hondo, NM

Operator	Aircraft	HOBBS Start	Local Start Time	14:40	Base
GALAMBOS	N7079F	3420>8	10:10:00	16:10:00	NGS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN	ALS-7177	3421.4	11:05:00	17:05:00	SRR A 1996

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSRR
calm	10	clear	0	15	0	30.36		Arriving	KSRR

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
40	41.5	272	100	Gain - Course/Up		Single		A	170
				Gain - Fine/Down		Multi		B	150

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
150	Kts	6500	Ft	14,900	Ft	Yes		No	x	@ NS	Ft

Line #	Dir.	Line Start Time	Line End Time	Time On Line	SV's	HDOP	PDOP	Line Notes/Comments	
Test	n/a			n/a	n/a	n/a	n/a	GPS Began Logging At:	16:17:44
⇕ Times entered are Zulu / GMT ⇕								Verify S-Turns Before Mission	Yes x No
B76	SE	16:45:23	16:47:00	0:00:00	17	0.6	1.1	TAKEOFF: 16:26Z 10:26(l)	
				0:00:00				14,900 GPS Altitude	
				0:00:00				16:58:42 Landing	
				0:00:00				Static: 17:02:49 - 17:04:49	
				0:00:00					
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↑ Times entered are Zulu / GMT ↑				Page		1		Verify S-Turns After Mission	Yes x No

Additional Comments:	Drive #
	00096

Section 7: Final Deliverables

The final lidar deliverables are listed below.

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