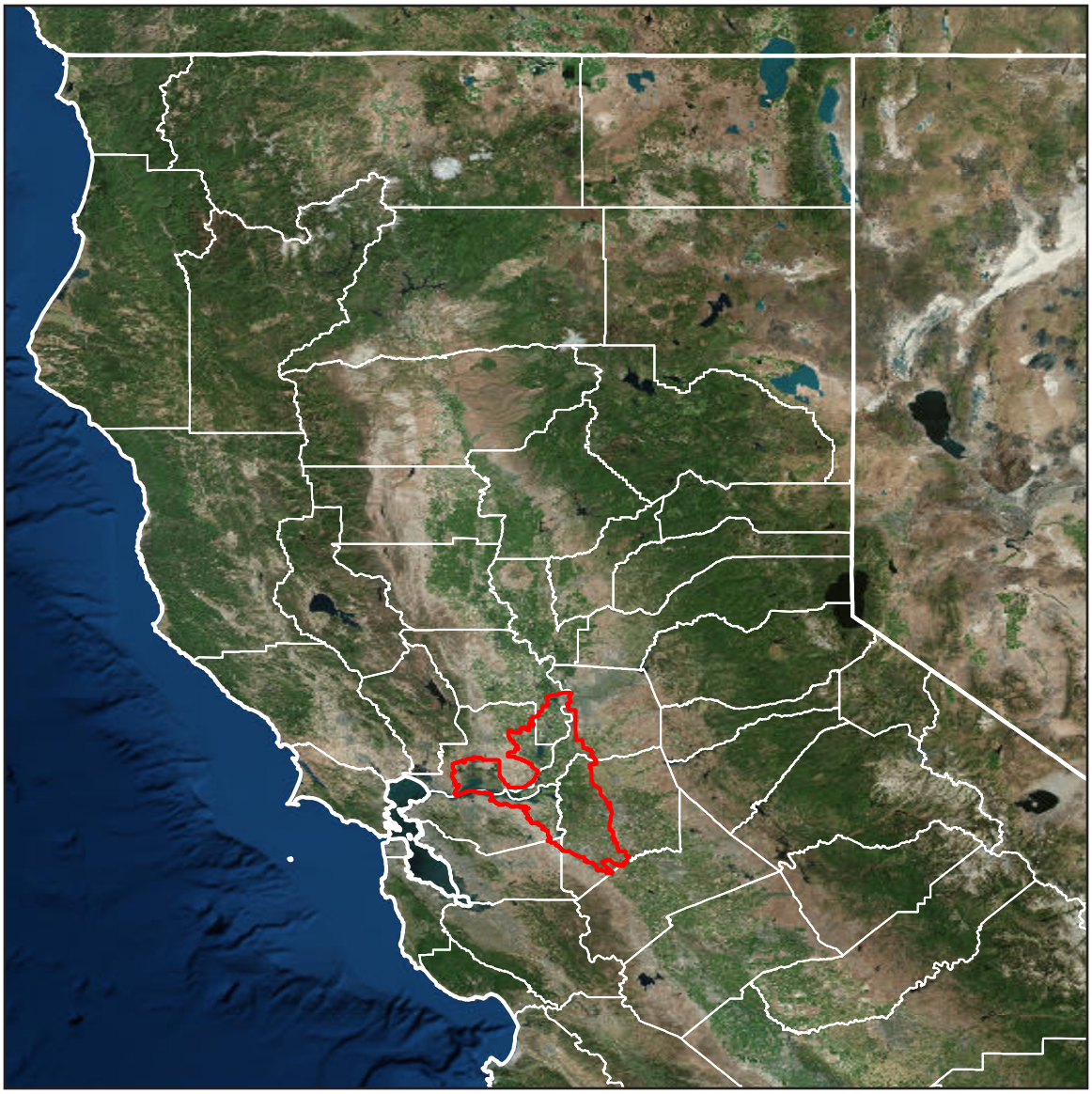
CA Sacramento Lidar 2017 B16

Airborne Lidar Report

June 2019



Contract # G16PC00022
Task Order # G16PD01047

Contractor Woolpert
Project # 76982

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1. Overview

About

This project report contains a comprehensive outline of the lidar portion of the Sacramento Delta portion of the G16PD01047 CA Central Valley Lidar 2016 B16 / G16PD01047 CA Sacramento Lidar 2017 B16 task order issued by the United States Geological Survey's National Geospatial Technical Operations Center (USGS-NGTOC). This task order called for the acquisition and processing of QL1 lidar data over the Sacramento River Delta Area of Interest (approximately 1,312 square miles) in western California.

Data partially covers the following counties:

- Alameda, Contra Costa, Sacramento, San Joaquin, Solano, and Yolo

Purpose

The purpose of this project was to collect data to be used for the following: terrain mapping, conservation planning and design, support of easement/land stewardship programs, support of special emphasis programs, support of soil projects, fill gaps in existing lidar, water resource management.

Specifications

Data for this task order was acquired and produced to meet USGS Lidar Base Specification v1.2 standards and the American Society of Photogrammetry and Remote Sensing (ASPRS) Positional Accuracy Standards for Digital Geospatial Data (Edition 1, Version 1.0).

Spatial Reference

Geospatial data products were produced using the following horizontal and vertical spatial data reference system.

Table 1-1. Spatial Reference System

Area of Interest		
Horizontal	**EPSG Code**	3717
	Datum	NAD83 (NSRS2007) Epoch 2017.95
	Projection	UTM Zone 10N
	Units	Meters
Vertical	**Datum**	NAVD88
	Geoid	GEOID12B
	Units	US Survey Feet
	Height Type	Orthometric

Deliverables

All data products produced as part of this task order are listed below. All tiled deliverables had a tile size of 1,500-meters x 1,500-meters.

Table 1-2. Deliverables

Lidar Data	
Classified lidar point cloud data	Tiles in .las v1.4 format Classes • 1 – Processed, not Classified • 2 – Ground • 7 – Noise • 9 – Water • 10 – Ignored Ground • 17 – Bridge Decks • 18 – High Noise

Breaklines used for hydro-flattening	• Lake and River features as feature classes in an Esri file geodatabase
	  • Water bodies greater than 2 acres as polygon features
	  • Rivers 30.5 meters / 100 feet and greater in width as polyline features
	• Bridges used in DEM generation as point features in Esri shapefile format

Hydro-flattened bare earth digital elevation model (DEM)	0.5-meter pixel size, 32-bit floating-point; no bridges or overpass structures ERDAS IMG format
Intensity Imagery	0.5-meter pixel size, 8-bit gray-scale (linear rescaling from 16-bit intensity) GeoTIFF format
Flight Line Index	Polygon features in Esri shapefile format
Control Data	
Lidar calibration points	Esri shapefile format
Lidar NVA checkpoints	Esri shapefile format
Lidar VVA checkpoints	Esri shapefile format
Other Data	
Data Extent	Esri shapefile format
Delivery Diagram	Esri shapefile format
Tile Index	Esri shapefile format
Metadata and Reports	
Metadata	Project-, deliverable-, and lift-level FGDC CSDGM/USGS MetaParser Compliant metadata in .xml format
Lidar Project Report	Project report with flight logs in .pdf format
Survey Report	Survey report in .pdf format

Figure 1-1. Project Area

2. Acquisition

Flight Planning

Aerial lidar data was collected using the specifications listed below.

Table 2-1. Acquisition Requirements

Specification	Target
Resolution	• 8 points per square meter • 0.35-meter nominal point spacing
Overlap	At contractor's discretion, but enough to ensure there are no data gaps between usable portions of the swath and nominal point density is achieved
Acquisition Window	Winter 2016/2017 (December 1, 2016 – March 7, 2017)
Acquisition Conditions	• Cloud and fog-free between the aircraft and ground • Ground is snow free; very light undrafted snow may be acceptable in special cases, with prior approval • Ground has no unusual flooding or inundation, except in cases where the goal of the collection is to map the inundation • No tidal coordination is required for this project • Preference of vegetation is leaf-off
Base Stations	Minimum of 2 per AOI
Data Voids	Not allowed except • Where caused by water bodies • Where caused by areas of low near infra-red (NIR) reflectivity (i.e. asphalt or composition roofing) • Where appropriately filled-in by another swath
Control	Airborne Global Positioning System (ABGPS) and Inertial Measurement Unit (IMU) data to be used along with differentially-corrected GPS ground control points

Lidar Sensor Information

Aerial lidar data was acquired using the Leica ALS80 lidar sensor system. A total of 268 flight lines were collected.

Table 2-2. Leica ALS80 Sensor Info

Sensor Specifications	
Operating Altitude (m AGL)	100 - 3,500 at 10% reflective target
Maximum Measurement Rate (kHz)	1,000
Field of view (degrees, full angle, user adjustable)	0 - 72
Roll stabilization (automatic adaptive, degrees)	72 - active FOV
Scan patterns (user selectable)	sine, triangle raster
Maximum Scan Rate (Hz) • Scan • Triangle • Raster	 • 200 • 158 • 120
Number of Returns	unlimited
Number of intensity measurements	3 (first, second, third)
Pulse Mode(s)	2 - 6 pulses in air
Laser Specifications	
Laser Beam Divergence	Dual Divergence: 0.20-0.26 mrad (1/e) and 0.8 mrad (1/e) nominal
Laser Classification	Class IV laser product (FDA CFR 21)
Eye Safe Range	400m single shot depending on laser repetition rate
Accuracy	
Range Resolution	Better than 1 cm
Elevation Accuracy	6 - 19 cm single shot (one standard deviation)
Horizontal Accuracy	1/5,500 x altitude (m AGL)
Physical Specifications	
Size (cm), Weight (kg) • Scanner • Control Electronics	 • 37 W x 68 L x 26 H cm, 47 kg • 45 W x 47 D x 25 H cm, 33 kg
Operating Temperature • Scanner • Control Electronics	 • 0 - 40°C cabin-side temperature • 0 - 40°C
Flight Management	Leica FlightPro
Power Consumption	922 W @ 22.0 – 30.3 VDC

Source: Leica ALS80-HP Product Specifications
https://w3.leica-geosystems.com/downloads123/zz/airborne/als80/product-specification/leica_als80_hp_productspec_en.pdf

GNSS and IMU Equipment

Prior to mobilizing to the project site, flight crews coordinated with the necessary air traffic control personnel to ensure airspace access. Crews were on-site, operating a Global Navigation Satellite System (GNSS) Base Station for the airborne GPS support.

Flight navigation during acquisition was 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.

Base stations were set by acquisition staff and was used to support the aerial data acquisition. See the table below for stations operated during acquisition.

Table 2-3. GNSS Base Stations

Station Name	Latitude (DMS)	Longitude (DMS)	Ellipsoid Height L1 Phase Center (Meters)
P248	37° 58' 32.17992"	121° 52' 07.26094"	230.332
P256	37° 55' 55.06077"	121° 36' 17.37271"	-30.179
P268	38° 28' 24.68319"	121° 38' 47.03080"	-23.451
PLSB	38° 41' 06.13224"	121° 45' 45.14589"	-7.366

Timeline

Lidar data was collected in 19 missions from December 9, 2017 through January 21, 2018. Acquisition specifications are listed in the table below. An initial quality control process was immediately performed on to review the data coverage, airborne GPS data, and trajectory solution.

Table 2-4. Acquisition Specifications

Settings	A Flights	B Flights
Max. Number of Returns	Infinite	Infinite
Nominal Point Spacing	0.35 m	0.35 m
Nominal Point Density	8 ppsm	8 ppsm
Flying Height Above Ground Level	1,524 m	1,829 m
Flight Speed	130 knots	130 knots
Scan Angle	20°	20°
Scan Rate Used	50.0 Hz	58.0 Hz
Pulse Rate Used	371.0 kHz	451.0 kHz
Multi-Pulse in Air	Enabled	Enabled
Swath Width	537 m	455 m
Swath Overlap	25%	25%

For more information, see the Flight Logs in Appendix 1.

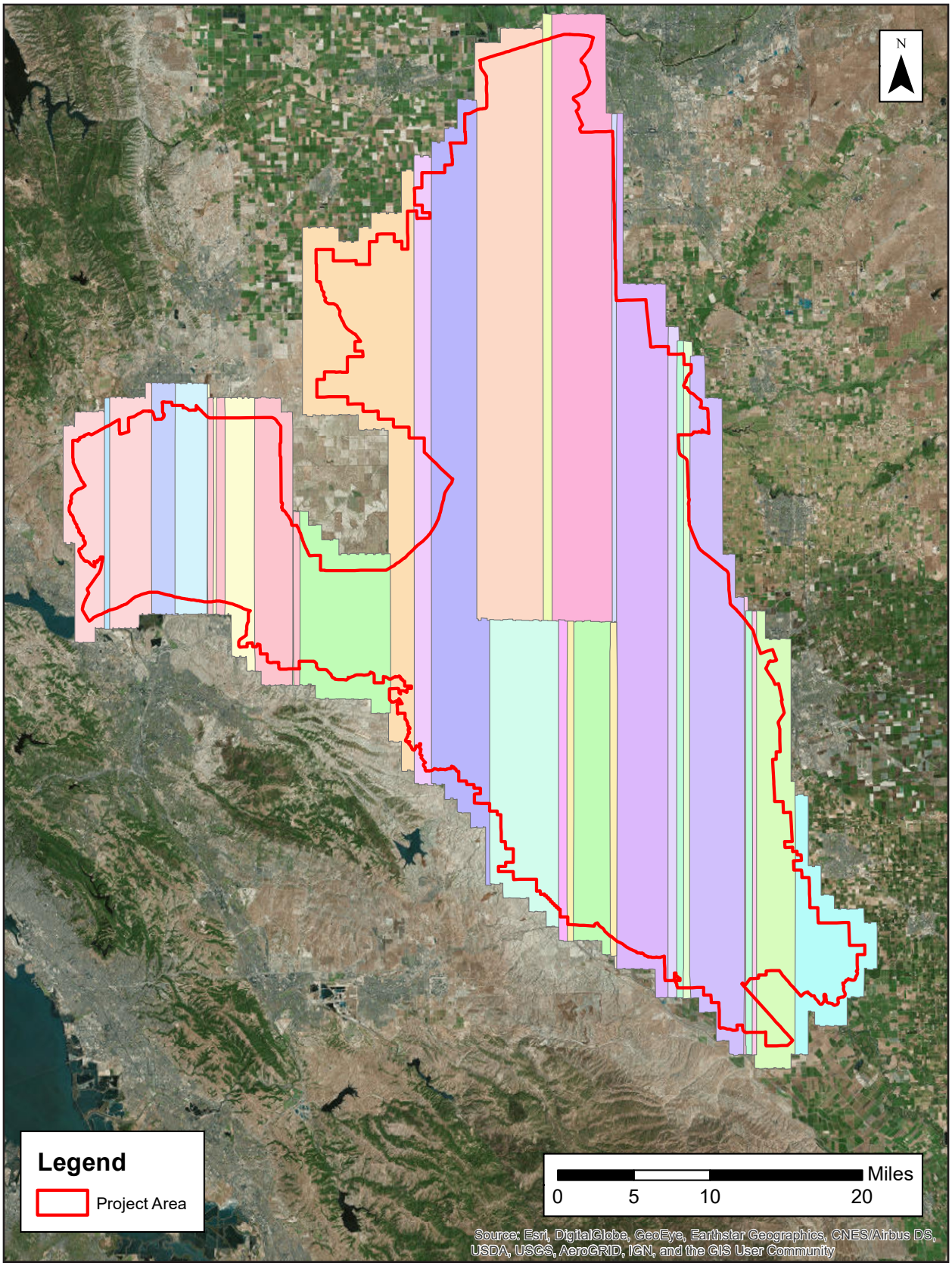
Saturated or partially flooded farm fields were identified following data acquisition. Through technical guidance discussions with USGS and the California Department of Water, it was determined such areas shall not be considered hydrologic features. Intermittently, partially flooded, irregular, and apparently non-agricultural fields were treated as hydrologic features. In all cases, best professional judgement was used in determination of treatment.

Acquisition Quality Assurance

Woolpert developed a quality assurance and validation plan to ensure the acquired lidar data meets the USGS Base Specification Version 1.2. For quality assurance purposes, the lidar data was processed immediately following acquisition to verify the coverage has appropriate density, distribution, and no unacceptable data voids. Accompanying GPS data was post processed using differential and Kalman filter algorithms to derive a best estimate of trajectory. The quality of the solution was verified to be consistent with the accuracy requirements of the task order. Any required re-flights were scheduled at the earliest opportunity.

The spatial distribution of the geometrically usable first return lidar points was reviewed for density requirements as well as regular and uniform point distribution - verifying the lidar data is spaced so that 90% of the cells in a 2*NPS grid placed over the data contain at least one lidar point. The NPS assessment is made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath. Additionally, the data was reviewed for unacceptable data voids – verifying no area greater than or equal to $(4 \times ANPS)^2$ exhibited data coverage gaps.

Figure 2-1: Flown Flight Lines



3. Processing

Processing Summary

Once the lidar data passed initial QC, the dataset was corrected for aircraft orientation and movement. This process used airborne inertial, orientation, and GPS data collected during acquisition along with ground-based GPS data. The data went through a geometric calibration that further corrected each laser point. This calibrated data set was used to create the LAS point cloud. The LAS point data was initially classified into “ground” and “non-ground”, then further refined using the classes specified in this task order. Breaklines were drawn to denote hydrological features. After the hydro-flattening process, the final deliverables products were created.

GNSS-IMU Trajectory Processing

Kinematic corrections for the aircraft position were resolved using aircraft GPS and static ground GPS (1-Hz) for each geodetic control (base station) for three subsystems: inertial measurement unit (IMU), sensor orientation information, and airborne GPS data.

Post-processing of the IMU system data and aircraft position with attitude data was completed to compute an optimally accurate, blended navigation solution based on Kalman filtering technology, or the smoothed best estimate of trajectory (SBET).

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

Trajectory Quality

The GNSS trajectory and 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).

Combination Separation

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

The data for this task order was processed with a goal to maintain a combined separation difference of less than ten (10) centimeters.

Estimated Positional Accuracy

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.

PDOP

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

The data for this task order was processed with a goal 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.

Geometric Calibration

After the initial phase was complete, a formal reduction process was performed on the data. Laser point position was calculated by associating the SBET position to each laser point return time, scan angle, intensity, etc. Raw laser point cloud data was created for the whole project area 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. Statistical reports were generated for comparison and used to make the necessary adjustments to remove any residual systematic error.

Software: Proprietary Software, TerraMatch v18, Leica CloudPro 1.2.4

Lidar Data Classification

LAS data was 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 of higher accuracy.

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 the following client-specified classes:

- Class 1 – Default / Processed, but not Classified
- Class 2 – Bare Earth Ground
- Class 7 – Low Noise
- Class 9 – Water
- Class 10 – Ignored Ground
- Class 17 – Bridge Decks
- Class 18 – High Noise

Classified LAS files were evaluated through a series of manual QA/QC steps as well as a peer-based review to eliminate remaining artifacts from the ground class. This included a review of the DEM surface to remove artifacts and ensure topographic quality.

For this dataset, the adjusted GPS time value was replaced with the local (Pacific Standard Time) GPS time value. This value was represented using the following format example:

December 1, 2017 at 03:59.59 am would be 20171201035959.xxxxx

Software: Proprietary Software, TerraScan v18

Hydrologic Flattening

The lidar task order required compilation of breaklines defining the following types of water body features:

Lakes, reservoirs, ponds	Minimum of 2-acres or greater Compiled as closed polygons, collected at a constant elevation
Rivers, streams	Nominal width of 30.5 meters / 100 feet Compiled in direction of flow, with both sides maintaining an equal elevation gradient
Bridge breaklines	Breaklines used to enforce a logical terrain surface below a bridge

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. The newly acquired lidar data was utilized to manually compile 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. An integrated software approach was applied 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. All classified ground points from inside the hydrologic feature polygons were reclassified to water, class nine (9).

4. All classified ground points were reclassified from within a buffer along the hydrologic feature breaklines to buffered ground, class ten (10). The buffer distance was approximately the task order designed nominal pulse spacing distance.

5. Breaklines used for bridge removal during the hydrologic flattening were included with the hydrologic breakline geodatabase deliverable. The purpose of these breaklines is for a more aesthetically pleasing DEM appearance.

6. The lidar ground points and breaklines were used to generate a digital elevation model (DEM).

7. QA/QC for this task was performed by reviewing the hydrologically flattened DEM and hydrologic breakline features. Additionally, a combined approach utilizing commercial off the shelf software and proprietary methods were used to review the overall connectivity of the hydrologic breaklines.

TerraScan was used to add the hydrologic breakline vertices and export the lattice models.

Breaklines defining the water bodies greater than 2-acres were provided as polygon features. Rivers and streams with a nominal minimum width of 30.5 meters (100 feet) were provided as polyline features. All lake and river breaklines compiled as part of the flattening process were provided in an Esri file geodatabase.

Breaklines used for DEM generation were provided as point features in Esri shapefile format.

Software: TerraScan v18, TerraModeler v18, Esri ArcMap v10.4, LP360 v2018.1.57.4

Digital Elevation Model

TerraScan was used to add the hydrologic breakline vertices and export the lattice models. Class 2 (ground) lidar points in conjunction with the hydro breaklines and bridge breaklines were used to create 0.5-meter hydro-flattened bare-earth raster DEM files. Using automated scripting routines within ArcMap, an 32-bit floating point raster ERDAS IMG file was created for each tile. Files were clipped to match the task order tiling scheme. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

Intensity Imagery

Lidar intensity data derived from the acquired lidar data was linearly rescaled from 16-bit intensity and provided as 0.5-meter pixel, 8-bit, 256 gray scale GeoTIFF format intensity imagery files. Files were clipped to match the task order tiling scheme.

Software: TerraScan v18

Digital Surface Model

The first return DSM product was created by isolating any first return laser pulses (excluding any points classified as noise) and then creating a gridded raster product derived from the first return data set. The DSM surface is then reviewed using Global Mapper to check for any anomalies or incorrect elevation found within the surface. Files were clipped to match the task order tiling scheme.

Software: TerraScan v18 , Esri ArcMap v10.4

Metadata

FGDC CSDGM/USGS MetaParser-compliant metadata was produced in XML format. The metadata includes a complete description of the task order client information, contractor information, project purpose, lidar acquisition and ground survey collection parameters, lidar acquisition and ground survey collection dates, spatial reference system information, data processing including acquisition quality assurance procedures, GPS and base station processing, geometric calibration, lidar classification, hydrologic flattening, intensity imagery development, and final product development.

Other metadata deliverables included Esri shapefiles of the ground control and QA/QC points, delivery tile index, delivery extent, and delivery diagram. A georeferenced, polygonal representation of the detailed extents of each acquired lidar swath was produced as polygon features in Esri shapefile format.

4. Accuracy Assessment

Results Summary

The tables below show a summary of all test results. The following sections describe the testing methods used.

Software: TerraScan v18, Esri ArcMap v10.4

Table 4-1. Vertical Accuracy Summary

Testing Categories	Target	Measured	Minimum Points	Points Used
Raw Swath NVA RMSEz 95% at Confidence Level	0.196 m	0.107 m	61	75
DEM NVA RMSEz at 95% Confidence Level	0.196 m	0.099 m	61	75
DEM VVA RMSEz at 95th Percentile	0.294 m	0.289 m	49	68

Raw Lidar Swath Testing

This project required Non-Vegetated Vertical Accuracy (NVA) to be tested on the raw lidar point cloud swath data. The dataset was required to meet a target value of 19.6 cm at a 95% confidence level using an RMSEz target value of 10 cm x 1.9600. Testing was assessed and reported using guidelines developed by the National Digital Elevation Program (NDEP) and the American Society for Photogrammetry and Remote Sensing (ASPRS).

The raw NVA was to be calculated with a minimum of 61 independent checkpoints that were not used in the calibration or post processing of the lidar point cloud data. Checkpoints were to be distributed throughout the project area and located in bare earth and urban (non-vegetated) land cover classes.

Testing was performed using TINs created from the final calibrated and controlled swath data. For each NVA checkpoint, an elevation value was derived from the TIN at the point's x,y location. This value was compared to the checkpoint's surveyed elevation value.

The raw NVA was tested using 75 checkpoints. These checkpoints were surveyed using GPS techniques. See the survey report for acquisition methodologies. This dataset was tested to be 0.107 meters using an RMSEz of 0.055 meters x 1.9600.

For full checkpoint results, see the tables in Appendix 2.

Digital Elevation Model Testing

This project required Non-Vegetated Accuracy (NVA) and Vegetated Vertical Accuracy (VVA) testing of the digital elevation model (DEM) dataset. The calculated NVA value was required to meet 19.6 cm at a 95% confidence level using an RMSEz target value of 10 cm x 1.9600. VVA was required to meet 0.294 cm at the 95th percentile error. Testing was assessed and reported using guidelines developed by the National Digital Elevation Program (NDEP) and the American Society for Photogrammetry and Remote Sensing

(ASPRS).

Testing was performed using the bare earth DEM created as part of this task order. For each checkpoint, an elevation value was derived from the DEM at the point's x,y location. This value was compared to the checkpoint's surveyed elevation value.

The NVA was to be calculated with a minimum of 61 independent checkpoints falling on bare earth and urban (non-vegetated) classes. VVA had a minimum of checkpoints requirement of 49 for the falling in brush/tall grass/weeds (vegetated) land cover classes. These points were not used in the calibration or post processing of the lidar point cloud data and distributed throughout the project area. Checkpoints were surveyed using GPS techniques. See the survey report for acquisition methodologies.

The DEM NVA measured 0.99 meters using an RMSEz of 0.051 meters x 1.9600 using 75 checkpoints. VVA tested 0.289 meters at the 95th percentile using 68 checkpoints.

VVA errors larger than the 95th percentile are listed below. All values are in meters.

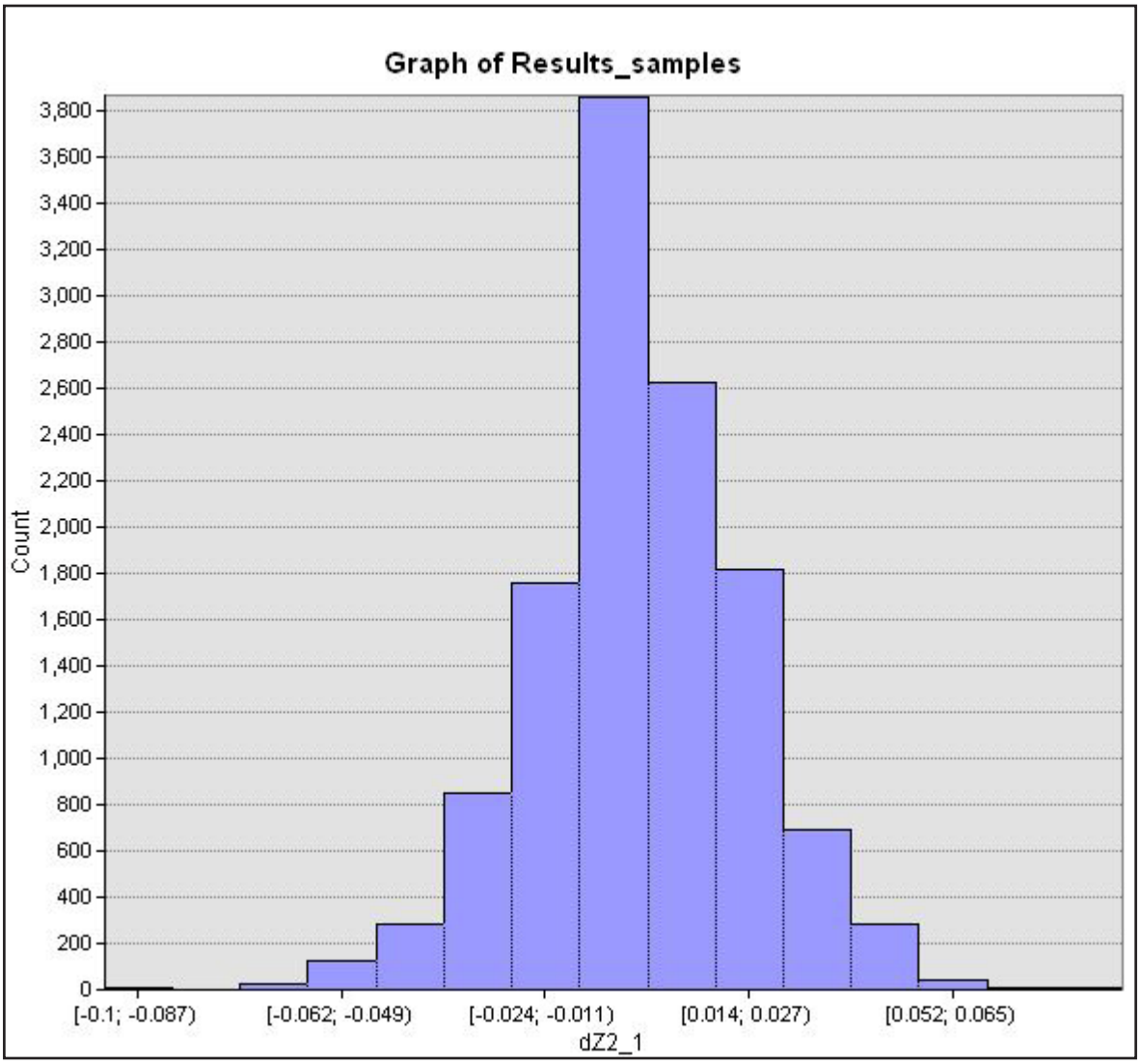
For full checkpoint results, see the tables in Appendix 3 and 4.

Table 4-2. VVA Errors

Point ID	Easting	Northing	Z-Error
3001	576285.557	4229651.826	0.423
3039_A	613532.460	4217704.652	0.338
3044	636454.834	4187011.525	0.301

Inter-Swath Testing

Inter-swath accuracy was tested against well-distributed flight line overlap locations. The relative accuracy for the lidar measured at 0.020 meters RMSE.



Values are in meters.

Approved By	Name	Signature	Date
Associate Member, Lidar Specialist Certified Photogrammetrist #1381	Qian Xiao		June 2019

Appendix 1: Flight Logs

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/9/2017	343	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	739.7	11:11:00	19:11:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	745.4	5:03:00	1:03:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	SAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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:
		↕ Times entered are Zulu / GMT ↕							Verify S-Turns Before Mission: Yes X No
									Take Off: 11:21
41	S	19:34:00	19:49:00	0:15:00	24	1.1	129	6033	
42	N	19:52:00	20:06:00	0:14:00	22	1.3	139	6034	
43	S	20:09:00	20:24:00	0:15:00	25	1	129	6049	
44	N	20:27:00	20:41:00	0:14:00	23	1.1	135	6010	
45	S	20:44:00	20:59:00	0:15:00	22	1.2	134	5962	
46	N	21:01:00	21:16:00	0:15:00	22	1.1	137	5981	
47	S	21:18:00	21:33:00	0:15:00	22	1.2	137	5964	
48	N	21:36:00	21:51:00	0:15:00	22	1.2	131	6050	
49	S	21:54:00	22:08:00	0:14:00	22	1.2	138	5957	
50	N	22:11:00	22:26:00	0:15:00	23	1.1	138	5987	
51	S	22:28:00	22:42:00	0:14:00	22	1.1	141	5929	
52	N	22:45:00	23:00:00	0:15:00	25	1	138	5923	
53	S	23:02:00	23:17:00	0:15:00	23	1.1	133	6009	
54	N	23:19:00	23:34:00	0:15:00	21	1.2	139	5981	
55	S	23:37:00	23:52:00	0:15:00	22	1.1	141	5930	
56	N	23:55:00	0:10:00	0:15:00	18	1.2	141	5987	
57	S	0:12:00	0:27:00	0:15:00	16	1.3	142	6023	
58	N	0:30:00	0:46:00	0:16:00	16	1.2	125	5975	

↑ 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
	12/10/2017	344	76982	12	Sacramento Valley CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	745.4	11:38:00	19:38:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	750.3	7:53:00	0:53:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	SAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
									Take Off: 11:50
59	S	20:09:00	20:25:00	0:16:00	23	1.2	133	5990	
60	N	20:27:00	20:42:00	0:15:00	21	1.3	140	6012	
61	S	20:45:00	21:00:00	0:15:00	23	1.1	136	5958	
62	N	21:03:00	21:18:00	0:15:00	22	1.2	142	5937	
63	S	21:21:00	21:36:00	0:15:00	22	1.2	136	5960	
64	N	21:38:00	21:53:00	0:15:00	22	1.2	139	5992	
65	S	21:55:00	22:11:00	0:16:00	21	1.1	140	5962	
66	N	22:13:00	22:28:00	0:15:00	21	1	138	5991	
67	S	22:30:00	22:46:00	0:16:00	20	1.1	139	5942	
68	N	22:48:00	23:04:00	0:16:00	20	1	141	6014	
69	S	23:07:00	23:22:00	0:15:00	21	1	136	5967	
70	N	23:25:00	23:40:00	0:15:00	21	1.1	139	6028	
71	S	23:44:00	23:57:00	0:13:00	18	1.2	135	5948	
72	N	23:59:00	0:12:00	0:13:00	17	1.2	141	5933	
73	S	0:14:00	0:28:00	0:14:00	15	1.3	132	6037	
↑ 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
	12/11/2017	345	76982	12	Sacramento Delta

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	750.3	10:31:00	18:31:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	755.0	3:35:00	23:35:00	SACR

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	APC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5000	Ft	Yes		No		@	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
									Take Off: 10:53
A1	S	19:23:00	19:26:00	0:03:00	23	1.1	130	4971	
A2	N	19:29:00	19:31:00	0:02:00	23	1.1	139	5001	
A3	S	19:34:00	19:37:00	0:03:00	21	1.3	137	4942	
A4	N	19:40:00	19:42:00	0:02:00	21	1.3	142	4946	
A5	S	19:45:00	19:50:00	0:05:00	22	1.3	127	4940	
A6	N	19:53:00	19:59:00	0:06:00	24	1.1	137	4992	
A7	S	20:01:00	20:07:00	0:06:00	23	1.2	132	4982	
A8	N	20:10:00	20:16:00	0:06:00	23	1.1	131	4966	
A9	S	20:18:00	20:24:00	0:06:00	23	1.1	130	5021	
A10	N	20:26:00	20:32:00	0:06:00	22	1.3	128	5009	
A11	S	20:35:00	20:40:00	0:05:00	24	1.1	133	5042	
A12	N	20:43:00	20:49:00	0:06:00	24	1.1	133	4920	
A13	S	20:51:00	20:56:00	0:05:00	22	1.1	137	5009	
A14	N	20:59:00	21:04:00	0:05:00	22	1.1	136	4954	
A15	S	21:07:00	21:12:00	0:05:00	21	1.1	138	5066	Diminished Returns
A16	N	21:15:00	21:21:00	0:06:00	23	1.1	136	4987	
A17	S	21:23:00	21:30:00	0:07:00	22	1.2	136	4984	
A18	N	21:32:00	21:38:00	0:06:00	22	1.2	130	5025	
A19	S	21:40:00	21:46:00	0:06:00	21	1.2	139	5000	
A20	N	21:48:00	21:54:00	0:06:00	21	1.2	138	4971	
A21	S	21:56:00	22:02:00	0:06:00	23	1.1	128	5026	
A22	N	22:05:00	22:11:00	0:06:00	24	1.1	130	4946	
A23	S	22:13:00	22:19:00	0:06:00	24	1	128	4962	
A24	N	22:21:00	22:27:00	0:06:00	23	1.1	137	4997	
A25	S	22:29:00	22:35:00	0:06:00	22	1	141	4948	
A26	N	22:37:00	22:43:00	0:06:00	23	1	140	4972	
A27	S	22:45:00	22:50:00	0:05:00	22	1	141	4965	
A28	N	22:53:00	22:58:00	0:05:00	21	1.1	136	4983	
A29	S	23:00:00	23:06:00	0:06:00	23	1	135	5015	
A30	N	23:14:00	23:20:00	0:06:00	20	1.1	126	4986	
↑ Times entered are Zulu / GMT ↑				Page		1			Verify S-Turns After Mission: Yes X No

Additional Comments: Drive #

BLOCK A Flight 1

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/11/2017	345	76982	12	Sacramento Delta Block A Flight 2

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	755.0	4:21:00	22:21:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	756.8	6:33:00	2:33:00	SACR

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	APC
								Arriving	SAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5000	Ft	Yes		No		@	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
									Take Off: 4:33
A31	S	0:43:00	X	X	X	X	X	X	TDC Error
A31	S	0:53:00	0:59:00	0:06:00	19	1.1	134	4941	
A32	N	1:01:00	1:07:00	0:06:00	18	1.2	130	4955	
A33	S	1:10:00	1:15:00	0:05:00	20	1.1	138	4936	
A34	N	1:18:00	1:24:00	0:06:00	20	1.1	139	4963	
A35	S	1:26:00	1:32:00	0:06:00	19	1.2	136	4961	
A36	N	1:34:00	1:40:00	0:06:00	18	1.3	140	4964	
A37	S	1:43:00	1:48:00	0:05:00	18	1.3	143	5032	
A38	N	1:51:00	1:57:00	0:06:00	19	1.2	140	5017	

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission: Yes X No

Additional Comments: BLOCK A Flight 2

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/12/2017	346	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	756.8	10:50:00	18:50:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	762.0	4:19:00	0:19:00	SACR

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	APC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode	Pre-Trigger Dist.
130	Kts		Ft	5000	Ft	Yes		No		@ 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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off: 11:01
X	X	19:05:00	X	X	X	X	X	X	Pilot Display Issue - Restart
A77	N	19:40:00	X	X	X	X	X	X	Eye Safe Error - Restart
A77	N	19:50:00	19:56:00	0:06:00	23	1.3	138	5163	
A76	S	19:59:00	20:06:00	0:07:00	22	1.2	136	5102	
A75	N	20:09:00	20:15:00	0:06:00	22	1.1	139	5119	
A74	S	20:18:00	20:25:00	0:07:00	21	1.3	138	5098	
A73	N	20:27:00	20:34:00	0:07:00	22	1.3	139	4995	
A72	S	20:37:00	20:44:00	0:07:00	23	1.1	134	5017	
A71	N	20:47:00	20:54:00	0:07:00	22	1.1	125	5080	
A70	S	20:57:00	21:04:00	0:07:00	22	1.1	132	5010	
A69	N	21:06:00	21:13:00	0:07:00	22	1.2	135	5052	
A68	S	21:15:00	21:22:00	0:07:00	23	1.1	135	4974	
A67	N	21:25:00	21:32:00	0:07:00	22	1.2	135	5039	
A66	S	21:34:00	21:41:00	0:07:00	22	1.2	142	5029	
A65	N	21:43:00	21:50:00	0:07:00	20	1.2	127	5030	
A64	S	21:52:00	21:59:00	0:07:00	20	1.2	135	5010	
A63	N	22:02:00	22:09:00	0:07:00	22	1	121	5009	
A62	S	22:11:00	22:17:00	0:06:00	22	1	140	4988	
A61	N	22:20:00	22:26:00	0:06:00	20	1.1	133	4960	
A60	S	22:28:00	22:35:00	0:07:00	22	1.1	137	5020	
A59	N	22:37:00	22:44:00	0:07:00	21	1.1	132	5045	
A58	S	22:49:00	22:56:00	0:07:00	22	1	136	4936	
A57	N	22:59:00	23:04:00	0:05:00	21	1.1	139	5030	
A56	S	23:07:00	23:12:00	0:05:00	20	1.1	142	4969	
A55	N	23:00:00	23:19:00	0:19:00	21	1.11	138	4995	
A54	S	23:22:00	23:27:00	0:05:00	21	1.1	143	5065	
A53	N	23:29:00	23:34:00	0:05:00	20	1.1	141	5094	
A52	S	23:36:00	23:42:00	0:06:00	19	1.2	143	5007	
A51	N	23:44:00	23:49:00	0:05:00	18	1.2	135	5040	
A50	S	23:51:00	23:56:00	0:05:00	18	1.2	140	5044	
↑ Times entered are Zulu / GMT ↑			Page		1				Verify S-Turns After Mission Yes X No

Additional Comments:

Drive #: 1.3

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/12/2017	346	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	756.8	10:50:00	18:50:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	762.0	4:19:00	0:19:00	SACR

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	APC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5000	Ft	Yes		No		@	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off: 11:01
A49	N	23:58:00	0:04:00	0:06:00	17	1.3	141	4970	Pilot Display Issue - Restart

↑ Times entered are Zulu / GMT ↑		Page	2	Verify S-Turns After Mission	Yes	X	No	

Additional Comments:

Drive #

1.3

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/12/2017	346	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	762.0	4:48:00	0:48:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	764.0	6:58:00	2:58:00	SACR

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	APC
								Arriving	SAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5000	Ft	Yes		No		@	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off: 4:54
A39	S	1:07:00	1:13:00	0:06:00	19	1.1	137	4890	
A40	N	1:15:00	1:21:00	0:06:00	20	1.1	136	5043	
A41	S	1:23:00	1:29:00	0:06:00	19	1.2	130	5017	
A42	N	1:31:00	1:37:00	0:06:00	18	1.3	135	5042	
A43	S	1:40:00	1:45:00	0:05:00	18	1.3	143	5020	
A44	N	1:48:00	1:53:00	0:05:00	19	1.2	129	5023	
A45	S	1:56:00	2:01:00	0:05:00	20	1.2	136	5027	
A46	N	2:04:00	2:10:00	0:06:00	20	1.1	118	4951	
A47	S	2:12:00	2:18:00	0:06:00	20	1.2	141	5002	
A48	N	2:20:00	2:26:00	0:06:00	19	1.2	127	5023	

↑ 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
	12/12/2017	346	76982	12	USGS Sacramento Delta, CA Flt #2 B Block

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6348.9	10:00:00	18:00:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6360.7	15:25:00	23:25:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSAC
Calm	10	clr	0	9	6	30.37	Haze	Arriving	KSAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000	Ft	6000	Ft	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
				0:00:00					TAKE OFF: 10:12
				0:00:00					CORS FLY OVER: 18:26:07
B31	180.8	18:38:17	18:54:35	0:16:18	19	1	131	6025	FOG 8.20 NMI - 7.09NMI
B32	000.8	18:56:41	19:13:18	0:16:37	23	0.9	130	6005	
B33	180.8	19:15:38	19:32:37	0:16:59	22	1	128	6021	
B34	000.8	19:34:43	19:52:28	0:17:45	21	1.3	128	6011	
B35	180.8	19:55:55	20:14:03	0:18:08	23	1.2	133	5955	
B36	000.8	20:16:21	X	X	X	X	X	X	ABORTED
B36	000.8	20:24:44	20:42:17	0:17:33	23	1.3	127	6026	
B37	180.8	20:45:30	21:04:28	0:18:58	22	1.1	135	5990	
B38	000.8	21:06:11	21:26:15	0:20:04	22	1.2	129	5957	
B39	180.8	21:28:38	21:47:42	0:19:04	22	1.2	132	6038	
B40	000.8	21:50:55	22:10:23	0:19:28	20	1.2	128	5958	
B157	180.8	22:24:21	22:29:52	0:05:31	23	1	129	6005	
B158	000.8	22:32:20	22:37:50	0:05:30	23	1	129	5984	
B159	180.8	22:40:55	22:46:20	0:05:25	21	1.1	134	5986	
B160	000.8	22:50:51	22:57:47	0:06:56	22	1	130	6008	Veered off line a bit looking for traffic
									@ 22:55
									CORS Fly Over: 23:15:38
↑ Times entered are Zulu / GMT ↑				Page		1			Verify S-Turns After Mission: Yes X No

Additional Comments:

Drive #

We flew the single line a few times so the new pilot would get some real-time training, using the pilot display.

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/13/2017	347	76982	12	USGS Sacramento Delta, CA Flt #3 B Block

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6360.7	12:33:00	20:33:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6364.9	16:46:00	0:46:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSAC
340/5	0	clr	5	11	5	3016	Haze	Arriving	KSAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000	Ft	6000	Ft	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
B161	180.8	21:18:05	21:25:09	0:07:04	21	1.2	129	5994	TAKE OFF: 20:46
B162	000.8	21:28:24	21:35:22	0:06:58	21	1.2	133	5933	CORS FLY OVER 20:59:29
B163	180.8	21:37:54	21:44:41	0:06:47	20	1.2	130	5991	
B164	000.8	21:48:14	21:55:42	0:07:28	21	1.1	134	5983	
B165	180.9	21:58:39	22:06:07	0:07:28	22	1	138	5947	
B166	000.9	22:10:01	22:17:42	0:07:41	21	1.2	130	6012	
B167	180.9	22:20:49	22:28:20	0:07:31	21	1.1	131	5937	
B168	000.9	22:31:38	22:38:51	0:07:13	22	0.9	127	6014	
B169	180.9	22:41:00	22:48:13	0:07:13	21	1	130	5965	
B170	000.9	22:50:24	22:58:13	0:07:49	21	1	124	6017	
B171	180.9	23:00:22	23:08:04	0:07:42	19	1	128	6019	
B172	000.9	23:10:06	23:17:45	0:07:39	18	1.1	130	6010	
B173	180.9	23:19:51	23:27:28	0:07:37	18	1.2	133	6016	
B174	000.9	23:29:32	23:37:33	0:08:01	18	1.1	133	6003	
B175	180.9	23:39:38	23:47:41	0:08:03	18	1.2	129	6013	
B176	000.9	23:51:20	23:59:24	0:08:04	18	1.2	131	5992	
B177	180.9	0:02:32	0:10:53	0:08:21	16	1.3	134	6034	
B178	000.9	0:14:20	0:22:38	0:08:18	16	1.3	130	5987	
									CORS Fly Over 00:42:15
↑ 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
	12/14/2017	348	76982	12	Sacramento CA Block B

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	764.0	10:48:00	18:48:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	769.4	4:46:00	0:46:00	SAC1/BRIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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: 9:42:00
		↕ Times entered are Zulu / GMT ↕							Verify S-Turns Before Mission Yes X No
									Take Off: 11:44
B133	N	19:45:00	19:50:00	0:05:00	22	1.1	126	6025	
B134	S	19:52:00	19:56:00	0:04:00	22	1.2	126	6024	
B135	N	19:58:00	20:03:00	0:05:00	21	1.2	131	5895	
B136	S	20:06:00	20:10:00	0:04:00	21	1.1	131	6012	
B137	N	20:12:00	20:17:00	0:05:00	20	1.3	121	5955	
B138	S	20:19:00	20:23:00	0:04:00	23	1.2	127	5962	B139 Over Stockton on Flight Plan.
B140	N	20:26:00	20:31:00	0:05:00	23	1.1	117	5939	
B141	S	20:33:00	20:37:00	0:04:00	24	1	131	6019	
B142	N	20:40:00	20:44:00	0:04:00	20	1.1	122	5993	
B143	S	20:47:00	20:51:00	0:04:00	20	1.1	115	5983	
B144	N	20:53:00	20:58:00	0:05:00	19	1.3	129	5960	
B145	S	21:00:00	21:04:00	0:04:00	20	1.2	122	5998	
B146	N	21:06:00	21:10:00	0:04:00	22	1.2	129	5998	
B147	S	21:12:00	21:16:00	0:04:00	21	1.2	116	5994	
B148	N	21:19:00	21:23:00	0:04:00	21	1.2	127	5988	
B149	S	21:25:00	21:29:00	0:04:00	21	1.2	122	6035	
B150	N	21:31:00	21:35:00	0:04:00	20	1.2	130	5951	
B151	S	21:37:00	21:41:00	0:04:00	21	1.2	123	5995	
B152	N	21:44:00	21:48:00	0:04:00	21	1.1	128	5982	
B153	S	21:50:00	21:54:00	0:04:00	21	1.1	121	6015	
B154	N	21:56:00	22:00:00	0:04:00	22	1	128	5955	
B155	S	22:02:00	22:07:00	0:05:00	22	1	125	5962	
B156	N	22:09:00	22:13:00	0:04:00	21	1.1	126	5936	
B180	S	22:20:00	22:29:00	0:09:00	21	1	123	5981	
B181	N	22:40:00	22:40:00	0:00:00	20	1	125	6032	
B182	S	22:43:00	22:51:00	0:08:00	20	1.1	129	5954	
B183	N	22:53:00	23:02:00	0:09:00	19	1.1	129	5948	
B184	S	23:04:00	23:13:00	0:09:00	18	1.2	123	5968	
B185	N	23:15:00	23:24:00	0:09:00	19	1.2	126	5967	
B186	S	23:26:00	23:35:00	0:09:00	18	1.1	125	5983	
↑ Times entered are Zulu / GMT ↑				Page		1			Verify S-Turns After Mission Yes X No

Additional Comments:

Discrapancies between project .kmz and flight plan. B133 is above Stockton, CA on .kmz and on flight plan it is above Pittsburg, CA. B139 is also different on flight plan from .kmz. On flight plan B139 is above Stockton, CA. B139 is between Pittsburg, CA and Antioch, CA on .kmz.

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/14/2017	348	76982	12	Sacramento Delta CA Block B

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6522Q	764.0	10:48:00	18:48:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	769.4	4:46:00	0:46:00	SAC1 / BRIB

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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: 9:42:00
		↕ Times entered are Zulu / GMT ↕							Verify S-Turns Before Mission Yes X No
									Take Off: 11:14
B187	N	23:37:00	23:47:00	0:10:00	17	1.2	125	6029	
B188	S	23:48:00	23:57:00	0:09:00	17	1.4	128	5985	
B189	N	23:59:00	0:08:00	0:09:00	16	1.3	114	6283	
B190	S	0:10:00	0:19:00	0:09:00	15	1.4	127	5963	

↑ Times entered are Zulu / GMT ↑		Page	2	Verify S-Turns After Mission	Yes	x	No	

Additional Comments:

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/15/2017	349	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	769.4	11:33:00	19:33:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	774.8	5:09:00	1:09:00	SAC1

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud		
								Departing	SAC
								Arriving	SAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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: 10:17:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off: 11:43
B74	S	19:53:00	X	0:00:00	X	X	X	X	TDC Error
B74	S	20:02:00	20:24:00	0:22:00	23	1.2	127	5931	
B75	N	20:26:00	20:44:00	0:18:00	24	1.1	127	5988	
B76	S	20:46:00	21:04:00	0:18:00	22	1.2	127	5970	
B77	N	21:07:00	21:25:00	0:18:00	22	1.2	122	5967	
B78	S	21:27:00	21:45:00	0:18:00	21	1.3	124	5918	
B79	N	21:47:00	22:06:00	0:19:00	22	1.2	128	5897	
B80	S	22:08:00	22:26:00	0:18:00	20	1.3	120	5881	
B81	N	22:29:00	22:47:00	0:18:00	22	1.1	131	5982	
B82	S	22:49:00	23:07:00	0:18:00	20	1.2	121	6057	
B83	N	23:11:00	23:30:00	0:19:00	19	1.1	132	6070	
B84	S	23:33:00	23:51:00	0:18:00	17	1.2	127	6048	
B85	N	23:54:00	0:11:00	0:17:00	16	1.3	131	6017	
B86	S	0:14:00	0:32:00	0:18:00	16	1.2	125	5987	
B87	N	0:34:00	0:52:00	0:18:00	17	1.1	124	5961	
↑ 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
	12/15/2017	349	76982	12	USGS Sacramento Delta, CA B Block Flt # 5

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6372.1	11:35:00	19:35:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6375.6	17:19:00	0:19:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KSAC
Calm	6	clr		10	7	3015	Haze	Arriving	KSAC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000	Ft	6000	Ft	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: 10:42:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
									Take Off: 20:04
B114	181.1	22:03:16	22:11:00	0:07:44	21	1.2	129	5982	Missed the end of line.
B113	0001.0	22:14:38	22:26:32	0:11:54	22	1.1	125	6002	
B112	181.1	22:30:14	22:42:03	0:11:49	22	1.1	127	6004	
B111	001.0	22:45:17	22:56:48	0:11:31	22	1.1	124	6028	
B110	181.0	22:58:53	23:10:24	0:11:31	19	1.2	122	6024	
B109	001.0	23:12:31	23:24:07	0:11:36	19	1.1	124	6025	
B108	181.0	23:26:37	23:38:12	0:11:35	18	1.3	125	6016	
B107	001.0	23:40:23	23:52:49	0:12:26	17	1.2	122	6032	
B106	181.0	23:56:05	0:08:46	0:12:41	16	1.3	120	6020	
B105	001.0	0:11:43	0:23:50	0:12:07	16	1.2	120	6059	
B104	181.0	0:26:47	0:39:00	0:12:13	17	1.2	122	5980	
B103	000.1	0:42:13	0:54:51	0:12:38	17	1.2	125	6000	

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission: Yes X No

Additional Comments:

Flew S-turns at the beginning of the mission (flew an ADS mission first). Flew 360s at the end of the mission.

Drive #

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/16/2017	350	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	774.8	10:35:00	18:35:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	776.5	12:31:00	20:31:00	SAC1

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	SAC
								Arriving	

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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: 10:26:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off:
B88	S	18:56:00	X	X	X	X	X	X	TDC Error
B88	S	19:04:00	19:21:00	0:17:00	22	1.1	131	5961	
B89	N	19:23:00	19:41:00	0:18:00	21	1.3	130	6058	
B90	N	19:56:00	20:13:00	0:17:00	23	1.2	131	6069	

↑ 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
	12/17/2017	351	76982	12	Sacramento Delta CA

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	776.6	10:08:00	18:08:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS-8170	781.0	2:48:00	22:48:00	MCC

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	MCC
								Arriving	MCC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	6000	Ft	Yes		No		@	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: 9:23:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission Yes X No
									Take Off: 10:17
B91	S	18:36:00	X	X	X	X	X	X	TDC Error
B91	S	18:43:00	X	X	X	X	X	X	TDC Error
B91	S	18:50:00	19:07:00	0:17:00	23	1.1	130	5934	
B92	N	19:09:00	19:26:00	0:17:00	21	1.3	131	6034	
B93	S	19:29:00	19:46:00	0:17:00	21	1.3	128	5890	
B94	N	19:48:00	20:05:00	0:17:00	22	1.1	126	6038	
B95	S	20:07:00	20:23:00	0:16:00	22	1.2	131	5977	
B96	N	20:26:00	20:42:00	0:16:00	21	1.1	129	6038	
B97	S	20:44:00	21:01:00	0:17:00	21	1.2	133	6008	
B98	N	21:06:00	21:19:00	0:13:00	22	1.2	127	6025	
B99	S	21:22:00	21:35:00	0:13:00	21	1.2	128	5924	
B100	N	21:37:00	21:50:00	0:13:00	21	1.1	1.1	127	
B101	S	21:53:00	22:05:00	0:12:00	22	1	118	5932	
B102	N	22:08:00	22:20:00	0:12:00	22	1	124	5986	
↑ 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
	11/17/2017	351	76982	12	USGS Sacramento Delta, CA B Block Flt #8

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6382.1	13:52:00	21:52:00	WOOLPERT PIN
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6382.5	15:24:00	23:24:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KMCC
060/3	+10	CLR Below 12000	0	10	-4	3009	Haze	Arriving	KMCC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	58	451	100	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	6000	Ft	6000	Ft	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:	9:23:00
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission	Yes X No
191	271.0	22:28:37	22:37:43	0:09:06	21	1	127	6034	Take Off: 10:14	
192	090.8	22:45:35	22:54:41	0:09:06	18	1.2	126	6015		

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission	Yes X No

Additional Comments: Drive #

No Web Cam available. Fly over base station 22:10:18.

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	12/20/2017	354	76982	12	USGS Sacramento Delta, CA A Block Flt #1 Re-flight

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
SWAIN, J.	N404CP	6384.6	10:24:00	18:24:00	CORS
Pilot	**Sensor Type**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
SWAIN, D.	ALS-8191	6385.5	12:43:00	20:43:00	

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KMCC
260/7	+10	clr below 12k	2	10	3	3024	Haze	Arriving	KMCC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain	255	Mode		Threshold Values	
20	50	371	100	Gain - Course/Up		Single		A	215
				Gain - Fine/Down		Multi	X	B	195

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts	5000	Ft	5000	Ft	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:
↕ Times entered are Zulu / GMT ↕									Verify S-Turns Before Mission: Yes X No
				0:00:00					Take Off: 18:43
A15	000.6	20:05:37	20:12:02	0:06:25	21	1.1	125	4995	

↑ Times entered are Zulu / GMT ↑		Page	1	Verify S-Turns After Mission: Yes X No

Additional Comments: Drive #

Flew over CORS 18:53 Flew over CORS at end of mission 20:31

Woolpert

Leica LIDAR	MM/DD/YEAR	Day of Year	Project #	Phase #	Project Name
	1/20/2018	20	76982	12	Sacramento Delta CA Block A/ Block B

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	793.8	12:52:00	20:52:00	WOOLPERT PIN
Pilot	**Sensor Type/Number**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS 8170	797.6	4:58	0:58	KMCC

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KMCC
								Arriving	KMCC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.	
130	Kts		Ft	5000/6000	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: 12:44:00
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission: Yes X No
77	S	21:22:00	X	X	X	X	X	TDC Error/NiDAQ Buffer
77	S	21:31:00	21:38:00	0:07:00	15	0.8	1.6	Block A
76	N	21:40:00	21:47:00	0:07:00	16	0.8	1.4	Block A
75	S	21:49:00	21:57:00	0:08:00	18	0.8	1.4	Block A
74	N	21:59:00	22:06:00	0:07:00	19	0.7	1.2	Block A
134	S	22:13:00	22:17:00	0:04:00	20	0.6	1.1	Block B
73	N	22:20:00	22:28:00	0:08:00	18	0.7	1.2	Block A
72	S	22:31:00	22:38:00	0:07:00	20	0.6	1.1	Block A
71	N	22:40:00	22:48:00	0:08:00	19	0.7	1.2	Block A
70	S	22:50:00	22:58:00	0:08:00	18	0.7	1.3	Block A
69	N	23:00:00	23:08:00	0:08:00	18	0.7	1.3	Block A
68	S	23:10:00	23:18:00	0:08:00	19	0.7	1.2	Block A
67	N	23:20:00	23:27:00	0:07:00	20	0.6	1.1	Block A
66	S	23:29:00	23:37:00	0:08:00	20	0.7	1.1	Block A
54	N	23:41:00	23:46:00	0:05:00	22	0.6	1	Block A
53	S	23:48:00	23:54:00	0:06:00	21	0.6	1	Block A
50	N	23:56:00	0:02:00	0:06:00	21	0.6	1.1	Block A
179	S	0:14:00	0:21:00	0:07:00	20	0.6	1.2	Block B (Acrobatic Area)
189	N	0:24:00	0:32:00	0:08:00	20	0.6	1.3	Block B (Acrobatic Area)
		↑ 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
	1/21/2018	21	76982	12	Sacramento Delta Block B

Operator	Aircraft	HOBBS Start	Local Start Time	ZULU Start Time	Base
Denham	N6255Q	797.6	9:09:00	17:09:00	WOOLPERT PIN
Pilot	**Sensor Type/Number**	**HOBBS END**	**Local End Time**	**Zulu End Time**	**PID**
Brown	ALS 8170	799	10:53	18:53	KMCC

Wind Dir/Speed	Visibility	Ceiling	Cloud Cover %	Temp	Dew Point	Pressure	Haze/Fire/Cloud	Departing	KMCC
								Arriving	KMCC

Scan Angle (FOV)	Scan Frequency (Hz)	Pulse Rate (kHz)	Laser Power %	Fixed Gain		Mode		Threshold Values	
20	50	371	99	Gain - Course/Up		Single		A	
				Gain - Fine/Down		Multi		B	

Air Speed		AGL		MSL		Waveform Used				Waveform Mode		Pre-Trigger Dist.
130	Kts		Ft	6000	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: 9:04:00
		↕ Times entered are Zulu / GMT ↕						Verify S-Turns Before Mission: Yes X No
104	S	17:46:00	x	X	x	x	x	TDC Error
104	S	17:55:00	18:07:00	0:12:00	25	0.6	1.1	
88	N	18:14:00	18:31:00	0:17:00	24	0.6	1.1	

		↑ Times entered are Zulu / GMT ↑		Page	1			Verify S-Turns After Mission: Yes x No

Additional Comments:

Drive #

Appendix 2: Raw Swath NVA Checkpoint Results

Coordinate values are listed in the following spatial reference system:

Horizontal: NAD83 (NSRS2007) UTM Zone 10, Meters (EPSG 3717)

Vertical: NAVD88 (GEOID12B) US Survey Feet (with summary values also listed in meters)

Summary	
Point Count	75
Average dZ	0.062 ft / 0.189 m
Minimum dZ	0.255 ft / 0.078 m
Maximum dZ	0.559 ft / 0.170 m
Average Magnitude	0.137 ft / 0.042 m
Root Mean Square	0.183 ft / 0.055 m
Standard Deviation	0.173 ft / 0.053 m

Point ID	Easting	Northing	Known Z	Laser Z	dZ
2001_J	576384.831	4229739.764	12.346	12.380	0.034
2002	583822.496	4232069.073	4.875	5.050	0.175
2003	596686.137	4231278.633	12.011	12.170	0.159
2004	589660.619	4227263.943	10.659	10.810	0.151
2005	591603.246	4219703.515	7.539	7.640	0.101
2005_A	591580.873	4219679.106	7.585	7.780	0.195
2006	600285.922	4216437.446	25.285	25.340	0.055
2007	593724.317	4208092.963	144.471	144.350	-0.121
2008	596602.075	4206984.316	145.872	145.800	-0.072
2009	602553.599	4205321.500	109.682	109.680	-0.002
2010	608427.682	4205014.314	134.298	134.550	0.252
2011	612282.645	4196180.755	143.504	143.580	0.076
2012	612875.143	4206395.675	18.871	18.870	-0.001
2013	619340.511	4208489.402	1.398	1.360	-0.038
2014	620743.603	4194578.071	13.422	13.320	-0.102
2015	627245.977	4183582.744	55.141	55.220	0.079
2017	635771.271	4177978.191	44.062	43.840	-0.222
2018	655774.750	4171812.606	31.312	31.400	0.088
2019	652785.852	4183121.976	20.098	20.230	0.132

Point ID	Easting	Northing	Known Z	Laser Z	dZ
2020	648881.631	4195788.640	8.665	8.720	0.055
2021	642437.864	4213299.936	4.455	4.470	0.015
2022	637618.070	4232142.046	12.310	12.210	-0.1
2023	632536.786	4252016.660	17.428	17.430	0.002
2024	624622.011	4267251.565	11.194	11.320	0.126
2024_A	624670.788	4267262.477	11.355	11.370	0.015
2025	606909.534	4249500.483	30.285	30.390	0.105
2026	612613.108	4228272.417	15.561	15.760	0.199
2027	644477.722	4172728.398	81.650	81.510	-0.14
2028	644563.525	4204483.864	0.285	0.310	0.025
2029	621943.432	4224575.714	-1.089	-1.060	0.029
2030	625196.478	4243398.713	6.775	6.880	0.105
2031	578324.818	4215402.636	11.217	11.110	-0.107
2031_A	578353.100	4215470.816	13.064	12.980	-0.084
2032	629859.828	4234014.483	3.783	3.900	0.117
2033	649715.687	4202206.674	15.663	15.740	0.077
2034	657359.701	4175117.654	35.925	36.480	0.555
2035	644565.189	4167519.582	179.678	179.690	0.012
2036	602785.138	4249017.685	44.130	44.440	0.31
2036_A	602759.647	4249051.245	43.809	44.140	0.331
2037	617172.916	4262344.847	24.255	24.220	-0.035
2038	622205.364	4230536.284	-2.612	-2.530	0.082
2039	613435.551	4217489.485	17.687	17.880	0.193
2040	637774.830	4199733.263	11.401	11.370	-0.031
2041	645228.176	4179640.604	23.018	23.520	0.502
2041_A	645226.965	4179641.074	23.635	23.630	-0.005
2041_B	645195.993	4179635.707	24.268	24.070	-0.198
2042	602276.421	4215330.643	40.049	40.320	0.271
2043	602888.866	4235077.292	20.436	20.570	0.134
2044	614912.420	4246632.822	19.902	19.940	0.038
2045	614016.369	4254378.803	23.799	23.800	0.001
2045_A	613985.053	4254380.105	21.870	21.640	-0.23
2046	623616.017	4258831.367	30.863	30.850	-0.013
2047	636484.331	4187017.987	23.271	23.310	0.039

Point ID	Easting	Northing	Known Z	Laser Z	dZ
2048	641406.865	4193405.963	3.937	4.150	0.213
2049	631961.214	4190469.951	-2.385	-2.640	-0.255
2050	631797.727	4211711.699	11.227	11.000	-0.227
2051	624734.357	4205144.399	9.226	9.340	0.114
2051_A	624721.857	4205091.266	10.528	10.620	0.092
2052	618293.058	4202840.770	19.550	19.360	-0.19
2052_A	618294.377	4202872.763	19.390	19.320	-0.07
2053	629102.993	4203185.872	12.867	12.750	-0.117
2053_A	629141.242	4203238.406	13.097	12.920	-0.177
2054	635850.420	4224424.569	1.030	1.290	0.26
2055	630623.592	4227446.068	-9.360	-9.430	-0.07
2056	638922.686	4211857.796	13.852	13.750	-0.102
2057	629457.901	4221600.222	-13.967	-13.880	0.087
2057_A	629419.242	4221611.779	-13.245	-13.200	0.045
2058	619307.338	4211812.208	12.421	12.330	-0.091
2059	634362.598	4215947.780	11.683	11.670	-0.013
2060	623762.712	4251498.769	2.927	3.070	0.143
2061	614224.214	4240602.497	24.501	25.060	0.559
2061_A	614224.546	4240568.492	24.071	24.430	0.359
2062	623417.667	4237605.794	24.262	24.540	0.278
2063	635791.116	4244122.505	19.987	20.320	0.333
2064	647604.486	4190418.453	27.585	27.740	0.155

Appendix 3: DEM NVA Checkpoint Results

Coordinate values are listed in the following spatial reference system:

Horizontal: NAD83 (NSRS2007) UTM Zone 10, Meters (EPSG 3717)

Vertical: NAVD88 (GEOID12B) US Survey Feet (with summary values also listed in meters)

Summary	
Point Count	75
Root Mean Square Error	0.168 ft / 0.051 m
95% Confidence Level	0.325 ft / 0.099 m
Mean of Residuals	0.126 ft / 0.038 m
Standard Deviation	0.111 ft / 0.034 m

Point ID	Easting	Northing	Known Z	DEM Z	dZ
2001	576384.906	4229739.683	12.346	12.380	-0.034
2002	583822.571	4232068.993	4.875	5.010	-0.135
2003	596686.212	4231278.553	12.011	12.190	-0.179
2004	589660.695	4227263.862	10.659	10.700	-0.041
2005	591603.322	4219703.435	7.539	7.620	-0.081
2005_A	591580.949	4219679.026	7.585	7.650	-0.065
2006	600285.998	4216437.367	25.285	25.350	-0.065
2007	593724.392	4208092.878	144.471	144.360	0.111
2008	596602.149	4206984.230	145.872	145.820	0.052
2009	602553.674	4205321.416	109.682	109.740	-0.058
2010	608427.761	4205014.243	134.298	134.550	-0.252
2011	612282.724	4196180.684	143.504	143.530	-0.026
2012	612875.221	4206395.604	18.871	18.920	-0.049
2013	619340.589	4208489.332	1.398	1.380	0.018
2014	620743.683	4194578.000	13.422	13.320	0.102
2015	627246.057	4183582.674	55.141	55.180	-0.039
2017	635771.348	4177978.112	44.062	43.810	0.252
2018	655774.827	4171812.529	31.312	31.360	-0.048
2019	652785.933	4183121.907	20.098	20.200	-0.102
2020	648881.711	4195788.571	8.665	8.730	-0.065

Point ID	Easting	Northing	Known Z	DEM Z	dZ
2021	642437.942	4213299.866	4.455	4.480	-0.025
2022	637618.155	4232141.981	12.310	12.130	0.180
2023	632536.870	4252016.595	17.428	17.450	-0.022
2024	624622.095	4267251.500	11.194	11.350	-0.156
2024_A	624670.872	4267262.412	11.355	11.420	-0.065
2025	606909.618	4249500.417	30.285	30.310	-0.025
2026	612613.183	4228272.338	15.561	15.730	-0.169
2027	644477.799	4172728.320	81.650	81.500	0.150
2028	644563.605	4204483.795	0.285	0.260	0.025
2029	621943.510	4224575.643	-1.089	-1.100	0.011
2030	625196.562	4243398.648	6.775	6.860	-0.085
2031	578324.892	4215402.550	11.217	11.110	0.107
2031_A	578353.174	4215470.730	13.064	12.970	0.094
2032	629859.914	4234014.418	3.783	3.890	-0.107
2033	649715.766	4202206.605	15.663	15.700	-0.037
2034	657359.773	4175117.583	35.925	36.470	-0.545
2035	644565.267	4167519.504	179.678	179.670	0.008
2036	602785.222	4249017.619	44.130	44.410	-0.280
2036_A	602759.731	4249051.178	43.809	44.130	-0.321
2037	617173.000	4262344.782	24.255	24.190	0.065
2038	622205.450	4230536.218	-2.612	-2.530	-0.082
2039	613435.629	4217489.415	17.687	17.760	-0.073
2040	637774.909	4199733.194	11.401	11.360	0.041
2041	645228.248	4179640.533	23.018	23.500	-0.482
2041_A	645227.042	4179640.996	23.635	23.570	0.065
2041_B	645196.070	4179635.629	24.268	24.020	0.248
2042	602276.498	4215330.563	40.049	40.290	-0.241
2043	602888.951	4235077.225	20.436	20.570	-0.134
2044	614912.504	4246632.756	19.902	19.920	-0.018
2045	614016.453	4254378.738	23.799	23.800	-0.001
2045_A	613985.137	4254380.039	21.870	21.700	0.170
2046	623616.101	4258831.302	30.863	30.820	0.043
2047	636484.411	4187017.917	23.271	23.330	-0.059
2048	641406.945	4193405.894	3.937	4.110	-0.173

Point ID	Easting	Northing	Known Z	DEM Z	dZ
2049	631961.294	4190469.881	-2.385	-2.690	0.305
2050	631797.805	4211711.629	11.227	10.990	0.237
2051	624734.436	4205144.328	9.226	9.340	-0.114
2051_A	624721.936	4205091.195	10.528	10.630	-0.102
2052	618293.137	4202840.700	19.550	19.320	0.230
2052_A	618294.455	4202872.692	19.390	19.340	0.050
2053	629103.072	4203185.802	12.867	12.740	0.127
2053_A	629141.321	4203238.336	13.097	12.920	0.177
2054	635850.498	4224424.500	1.030	1.260	-0.230
2055	630623.670	4227445.998	-9.360	-9.400	0.040
2056	638922.765	4211857.727	13.852	13.710	0.142
2057	629457.979	4221600.152	-13.967	-13.910	-0.057
2057_A	629419.320	4221611.709	-13.245	-13.250	0.005
2058	619307.416	4211812.138	12.421	12.310	0.111
2059	634362.677	4215947.710	11.683	11.640	0.043
2060	623762.796	4251498.704	2.927	3.050	-0.123
2061	614224.298	4240602.431	24.501	24.940	-0.439
2061_A	614224.631	4240568.426	24.071	24.330	-0.259
2062	623417.752	4237605.729	24.262	24.460	-0.198
2063	635791.201	4244122.441	19.987	20.280	-0.293
2064	647604.566	4190418.383	27.585	27.700	-0.115

Appendix 4: DEM VVA Checkpoint Results

Coordinate values are listed in the following spatial reference system:

Horizontal: NAD83 (NSRS2007) UTM Zone 10, Meters (EPSG 3717)

Vertical: NAVD88 (GEOID12B) US Survey Feet (with summary values also listed in meters)

Summary	
Point Count	68
Root Mean Square Error	0.531 ft / 0.162 m
95th Percentile	0.948 ft / 0.289 m
Mean of Residuals	0.393 ft / 0.120 m
Standard Deviation	0.360 ft / 0.110 m

Point ID	Easting	Northing	Known Z	DEM Z	dZ
3001	576285.557	4229651.826	8.860	10.250	1.390
3003	596702.880	4231230.787	12.090	12.290	0.200
3004	589578.129	4227232.633	8.220	8.450	0.230
3005	591570.262	4219689.364	6.020	6.430	0.410
3005 A	591592.826	4219715.124	6.580	5.920	0.660
3006	600145.922	4216406.797	33.540	33.870	0.330
3007	593069.857	4208078.422	180.950	180.760	0.190
3008	596566.454	4206959.554	145.970	146.650	0.680
3009	602277.704	4205233.746	132.180	132.350	0.170
3010	608664.470	4205050.520	225.760	225.950	0.190
3011	612270.734	4196243.084	139.540	139.610	0.070
3012	612788.683	4206450.231	13.880	14.160	0.280
3013	619157.841	4208328.848	-2.490	-2.530	0.040
3013 A	619233.838	4208322.106	-1.870	-1.150	0.720
3014	621088.233	4194209.340	12.300	13.250	0.950
3015	627384.013	4184198.813	44.490	44.570	0.080
3015 A	627419.523	4184168.603	44.920	44.860	0.060
3016	627932.455	4180094.035	110.460	109.610	0.850
3016 A	627931.331	4180147.291	108.690	108.890	0.200
3017	635242.509	4177404.118	52.940	53.010	0.070

Point ID	Easting	Northing	Known Z	DEM Z	dZ
3018	656262.492	4171869.395	32.720	32.940	0.220
3019	652789.278	4183155.976	20.760	21.000	0.240
3020	649250.513	4194368.720	12.380	12.850	0.470
3020 A	649249.059	4194411.967	12.500	12.590	0.090
3021	643404.438	4213321.965	7.770	8.440	0.670
3022	637506.436	4232154.530	11.230	11.390	0.160
3022 A	637504.845	4232130.706	13.690	13.800	0.110
3023	632334.469	4252280.802	27.080	27.140	0.060
3024	624362.862	4266135.426	11.790	12.340	0.550
3025	606990.550	4249508.279	28.210	28.220	0.010
3026	612589.247	4228516.237	22.390	22.620	0.230
3026 A	612589.272	4228561.654	23.040	23.250	0.210
3027	645939.741	4172007.731	73.290	73.350	0.060
3028	643166.898	4204779.478	6.940	7.530	0.590
3029	621663.177	4224253.858	-4.010	-3.470	0.540
3030	625201.611	4243810.899	11.850	11.980	0.130
3030 A	625229.160	4243841.844	10.970	11.190	0.220
3031	578399.749	4215516.630	13.870	14.100	0.230
3031 A	578442.380	4215516.263	5.950	6.730	0.780
3032	630491.628	4234286.640	21.130	21.360	0.230
3032 A	630486.852	4234332.870	23.000	23.470	0.470
3033	649377.500	4202316.632	11.200	11.340	0.140
3034	657359.239	4174732.485	34.110	34.940	0.830
3035	649722.928	4167754.251	104.260	104.460	0.200
3036	602861.127	4249105.519	42.910	43.160	0.250
3036 A	602864.714	4249139.057	43.030	43.130	0.100
3037	616995.638	4261818.129	19.250	19.130	0.120
3038	622999.424	4229366.643	-10.040	-9.820	0.220
3038 A	623025.701	4229161.266	-7.610	-7.320	0.290
3039	613755.384	4218201.137	1.940	2.470	0.530
3039 A	613532.460	4217704.652	3.460	4.570	1.110
3040	637621.315	4199605.622	5.660	5.810	0.150
3041	645091.558	4179557.147	26.140	26.210	0.070
3042	614955.294	4246643.040	9.400	9.950	0.550

Point ID	Easting	Northing	Known Z	DEM Z	dZ
3043	623740.329	4259227.631	28.900	28.960	0.060
3043 A	623715.456	4259195.799	18.240	18.530	0.290
3044	636454.834	4187011.525	24.330	25.320	0.990
3045	642146.002	4193388.285	21.950	22.400	0.450
3046	631819.678	4211783.380	-7.950	-6.610	1.340
3047	619306.463	4211765.264	-3.520	-3.220	0.300
3048	622326.716	4232919.845	12.480	13.180	0.700
3048 A	622319.231	4232974.719	14.320	15.990	1.670
3049	647678.561	4190412.810	11.700	11.770	0.070
3050	577916.889	4219835.345	95.310	95.900	0.590
3051	658089.457	4173429.916	35.430	36.380	0.950
3051 A	658055.152	4173381.225	46.230	46.550	0.320
3052	629663.631	4241335.140	26.950	27.030	0.080
3052 A	629684.718	4241320.183	26.290	26.590	0.300