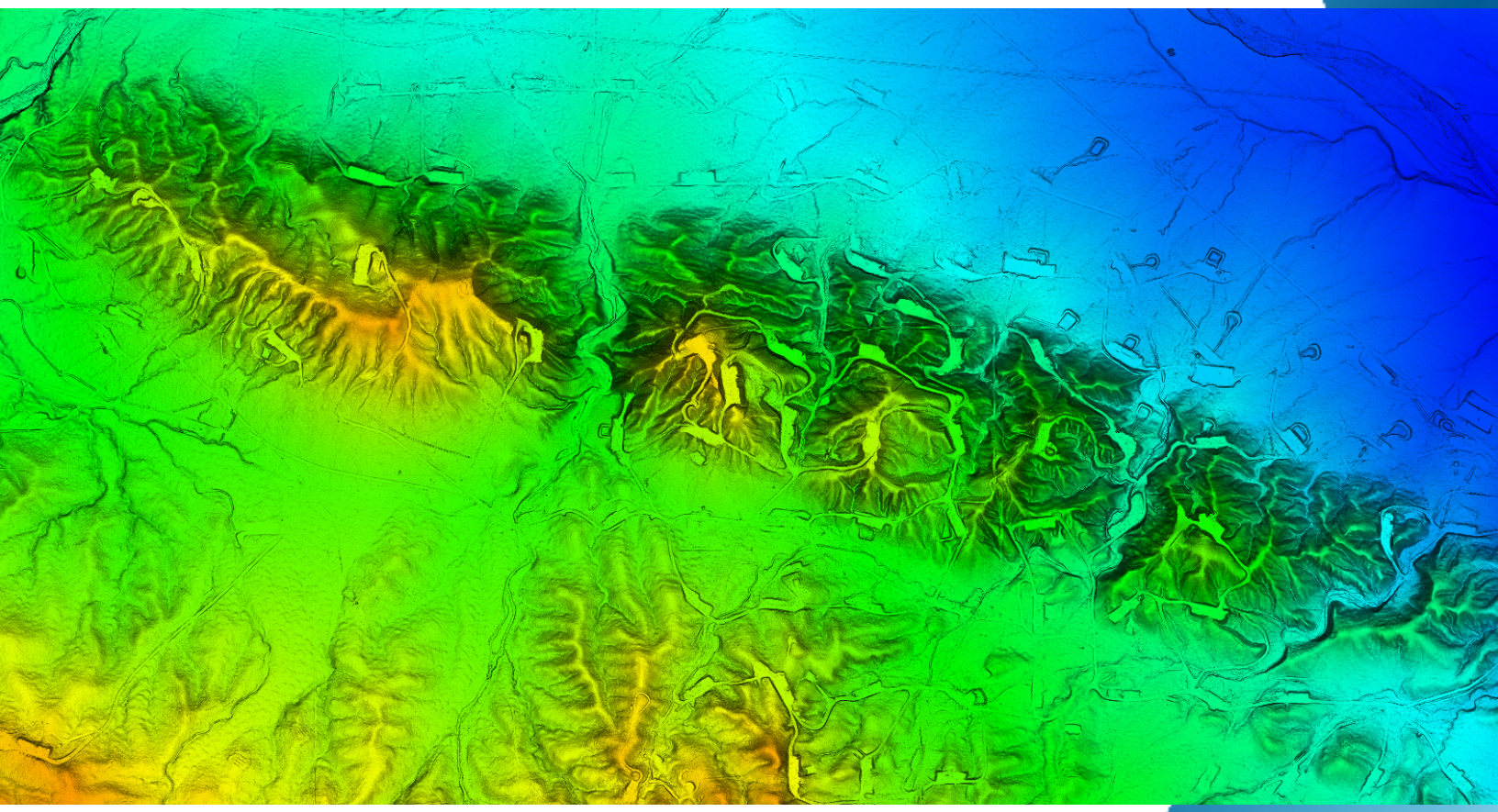
NV5 GEOSPATIAL



SAN JOAQUIN WU 300028 LIDAR PROCESSING REPORT

2022

Project ID: 217611
Work Unit: 300028

Submitted: October 19, 2022

Prepared for:

USGS
science for a changing world

tnm_help@usgs.gov

Prepared by:

NV5 GEOSPATIAL

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1. Summary / Scope

1.1. Summary

This report contains a summary of the San Joaquin, Work Unit 6 lidar acquisition task order, issued by USGS under their Cooperative Agreement number: G21AC10232-00. The task order yielded a project area covering 11,623 square miles over California. The intent of this document is only to provide specific validation information for the data acquisition/collection, processing, and production of deliverables completed as specified in the task order.

1.2. Scope

Aerial topographic lidar was acquired using state of the art technology along with the necessary surveyed ground control points (GCPs) and airborne GPS and inertial navigation systems. The aerial data collection was designed with the following specifications listed in Table 1 below.

Table 1. Originally Planned Lidar Specifications

Average Point Density	Flight Altitude (AGL)	Field of View	Minimum Side Overlap	RMSEz
10 pts / m2	1600 m	40°	30%	≤ 10 cm

1.3. Coverage

The work unit boundary covers 1,455 square miles over California. Work Unit extent are shown in Figure 1.

1.4. Duration

Lidar data was acquired from Febuary 21, 2021 to April 30, 2021 in 52 total lifts.

1.5. Issues

There were no issues to report.

San Joaquin Work Unit 300028 Projected Coordinate System: State Plane Horizontal Datum: NAD83 (2011) Vertical Datum: NAVD88 (GEOID 18) Units: US Survey Feet	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 1-foot Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 1-foot Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • Lidar Tile Index • Calibration and QC Checkpoints (NVA/VVA) • Flightline Swaths Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Focus on Accuracy • Survey Report • Processing Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery

San Joaquin Work Unit 30028 Boundary

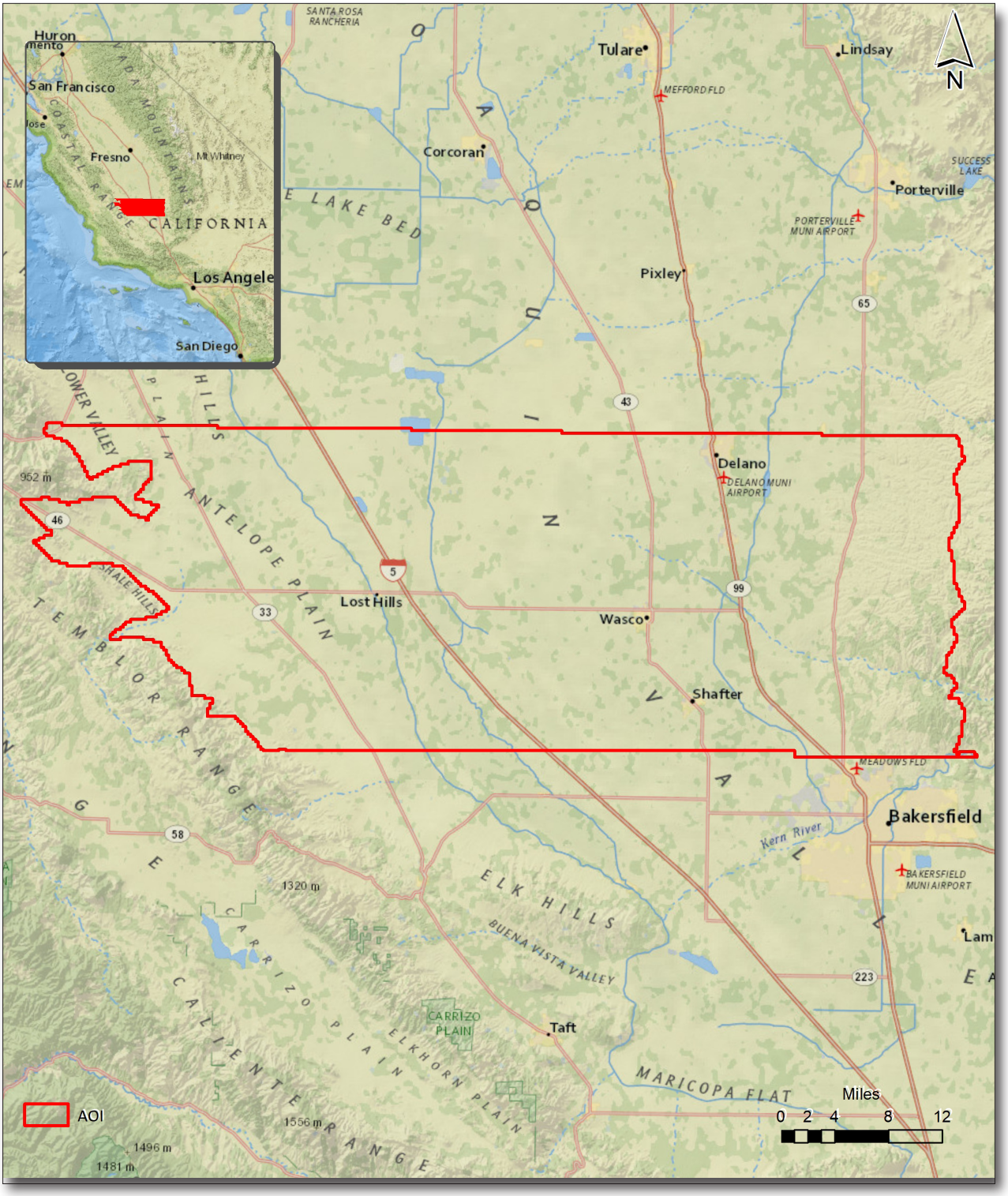


Figure 1. Work Unit Boundary

2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project by Towell Inc. using planning software.

2.2. Lidar Sensor

Towell Inc. utilized Optech Galaxy Prime lidar sensors (Figure 2), serial number(s) 5060411, for data acquisition.

These systems are capable of collecting data at a maximum frequency of 550 kHz. These systems utilize a Multi-Pulse in the Air option (MPIA). These sensors are also equipped with the ability to measure up to 8 returns per outgoing pulse

A brief summary of the aerial acquisition parameters for the project are shown in the lidar System Specifications in Table 2.

Table 2. Lidar System Specifications

		Optech Galaxy Prime
Terrain and Aircraft Scanner	Flying Height	1600 m
	Recommended Ground Speed	125 kts
Scanner	Field of View	40°
	Scan Rate Setting Used	100 Hz
Laser	Laser Pulse Rate Used	1000 kHz
Coverage	Full Swath Width	1165 m
	Line Spacing	815.29 m
Point Spacing and Density	Average Point Spacing	0.3 m
	Average Point Density	13.35 pts / m^2

Figure 2. Optech Galaxy Lidar Sensor

2.3. Aircraft

All flights for the project were accomplished through the use of Aspen Partenavia planes. Plane type and tail numbers are listed below.

Lidar Collection Planes

- Aspen Partenavia P-68, Tail Numbers: 300LF, N68VA

These aircraft provided an ideal, stable aerial base for lidar acquisition. These aerial platforms have relatively fast cruise speeds, which are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art Optech lidar system.

3. Processing Summary

3.1. Flight Logs

Flight logs were completed by Lidar sensor technicians for each mission during acquisition. These logs depict a variety of information, including:

- Job / Project #
- Flight Date / Lift Number
- FOV (Field of View)
- Scan Rate (HZ)
- Pulse Rate Frequency (Hz)
- Ground Speed
- Altitude
- Base Station
- PDOP avoidance times
- Flight Line #
- Flight Line Start and Stop Times
- Flight Line Altitude (AMSL)
- Heading
- Speed
- Returns
- Crab

Notes: (Visibility, winds, ride, weather, temperature, dew point, pressure, etc). Project specific flight logs for each sortie are available in Appendix A.

3.2. Lidar Processing

Applanix + POSPac software was used for post-processing of airborne GPS and inertial data (IMU), which is critical to the positioning and orientation of the lidar sensor during all flights. Applanix POSPac combines aircraft raw trajectory data with stationary GPS base station data yielding a “Smoothed Best Estimate Trajectory” (SBET) necessary for additional post processing software to develop the resulting geo-referenced point cloud from the lidar missions.

During the sensor trajectory processing (combining GPS & IMU datasets) certain statistical graphs and tables are generated within the Applanix POSPac processing environment which are commonly used as indicators of processing stability and accuracy. This data for analysis include: max horizontal / vertical GPS variance, separation plot, altitude plot, PDOP plot, base station baseline length, processing mode, number of satellite vehicles, and mission trajectory.

Point clouds were created using the Optech LMS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested and any bias is removed from the data. TerraScan and TerraModeler software packages are then used for automated data classification and manual cleanup. The data are manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler.

DEMs and Intensity Images are then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper is used as a final check of the bare earth dataset.

Finally, proprietary software is used to perform statistical analysis of the LAS files.

Software	Version
Optech LMS	4.4
Applanix + POSPac	8.6
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.016
TerraMatch	21.007

3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2020 Rev. A and are an industry standard for the classification of lidar point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

Table 3. LAS Classifications

	Classification Name	Description
1	Processed, but Unclassified	Laser returns that are not included in the ground class, or any other project classification
2	Bare earth	Laser returns that are determined to be ground using automated and manual cleaning algorithms
7	Low Noise	Laser returns that are often associated with scattering from reflective surfaces, or artificial points below the ground surface
8	Model Key Points	Educated thinned dataset of the Class 2 ground class used to create the contours
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.

3.4. Classified LAS Processing

The bare earth surface is then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface is finalized; it is then used to generate all hydro-breaklines through heads-up digitization.

All ground (ASPRS Class 2) lidar data inside of the Lake Pond and Double Line Drain hydro flattening breaklines were then classified to water (ASPRS Class 9) using proprietary tools. A buffer of 1.5 feet was also used around each hydro flattened feature to classify these ground (ASPRS Class 2) points to Ignored ground (ASPRS Class 20). All Lake Pond Island and Double Line Drain Island features were checked to ensure that the ground (ASPRS Class 2) points were reclassified to the correct classification after the automated classification was completed.

Any noise that was identified either through manual review or automated routines was classified to the appropriate class (ASPRS Class 7 and/or ASPRS Class 18) followed by flagging with the withheld bit.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper is used as a final check of the bare earth dataset. GeoCue was then used to create the deliverable industry-standard LAS files for all point cloud data. NV5 Geospatial's proprietary software was used to perform final statistical analysis of the classes in the LAS files, on a per tile level to verify final classification metrics and full LAS header information.

3.5. Hydro-Flattened Breakline Processing

Class 2 lidar was used to create a bare earth surface model. The surface model was then used to heads-up digitize 2D breaklines of Inland Streams and Rivers with a 100 foot nominal width and Inland Ponds and Lakes of 2 acres or greater surface area.

Elevation values were assigned to all Inland streams and rivers using NV5 Geospatial's proprietary software.

All ground (ASPRS Class 2) lidar data inside of the collected inland breaklines were then classified to water (ASPRS Class 9) using TerraScan macro functionality. A buffer of 1.5 feet was also used around each hydro-flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 20).

The breakline files were then translated to Esri file geodatabase format using Esri conversion tools.

Breaklines are reviewed against lidar intensity imagery to verify completeness of capture. All breaklines are then compared to TINs (triangular irregular networks) created from ground only points prior to water classification. The horizontal placement of breaklines is compared to terrain features and the breakline elevations are compared to lidar elevations to ensure all breaklines match the lidar within acceptable tolerances. Some deviation is expected between breakline and lidar elevations due to monotonicity, connectivity, and flattening rules that are enforced on the breaklines. Once completeness, horizontal placement, and vertical variance is reviewed, all breaklines are reviewed for topological consistency and data integrity using a combination of Esri Data Reviewer tools and proprietary tools.

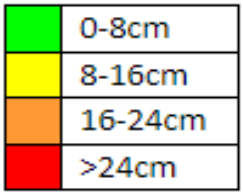
3.6. Hydro-Flattened Raster DEM Processing

Hydro-Flattened DEMs (topographic) represent a lidar-derived product illustrating the grounded terrain and associated breaklines (as described above) in raster form. NV5 Geospatial's proprietary software was used to take all input sources (bare earth lidar points, bridge and hydro breaklines, etc.) and create a Triangulated Irregular Network (TIN) on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper triangulation can occur. From the TIN, linear interpolation is used to calculate the cell values for the raster product. The raster product is then clipped back to the tile edge so that no overlapping cells remain across the project area. A 32-bit floating point GeoTIFF DEM was generated for each tile with a pixel size of value-units. NV5 Geospatial's proprietary software was used to write appropriate horizontal and vertical projection information as well as applicable header values into the file during product generation. Each DEM is reviewed in Global Mapper to check for any surface anomalies and to ensure a seamless dataset. NV5 Geospatial ensures there are no void or no-data values (-999999) in each derived DEM. This is achieved by

using propriety software checking all cell values that fall within the project boundary. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the DEMs against what is required before final delivery.

3.7. Swath Separation Raster Processing

Swath Separation Images are rasters that represent the interswath alignment between flight lines and provide a qualitative evaluation of the positional quality of the point cloud. NV5 Geospatial proprietary software generated 1-foot raster images in GeoTIFF format using last returns, excluding points flagged with the withheld bit, and using a point-in-cell algorithm. Images are generated with a 75% intensity opacity and (4) absolute 8-cm intervals, see below for interval coloring. Intensity images are linearly scaled to a value range specific to the project area to standardize the images and reduce differences between individual tiles. Appropriate horizontal projection information as well as applicable header values are written to the file during product generation. NV5 Geospatial uses a proprietary tool called FOCUS on Delivery to check all formatting requirements of the images against what is required before final delivery.



3.8. Top of Canopy DSM Processing

First-return highest hit lidar points from the vegetation class were used to create a 1 foot raster DSM. Using automated scripting routines within proprietary software, TIF files were created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.9. Raster DSM Processing

A normalized digital surface model was created by removing the DEM surface from the DSM surface. This allows for the visualization of all features (cars, trees, buildings, etc.) that are above the ground level. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

San Joaquin Work Unit 300028
Tile Layout

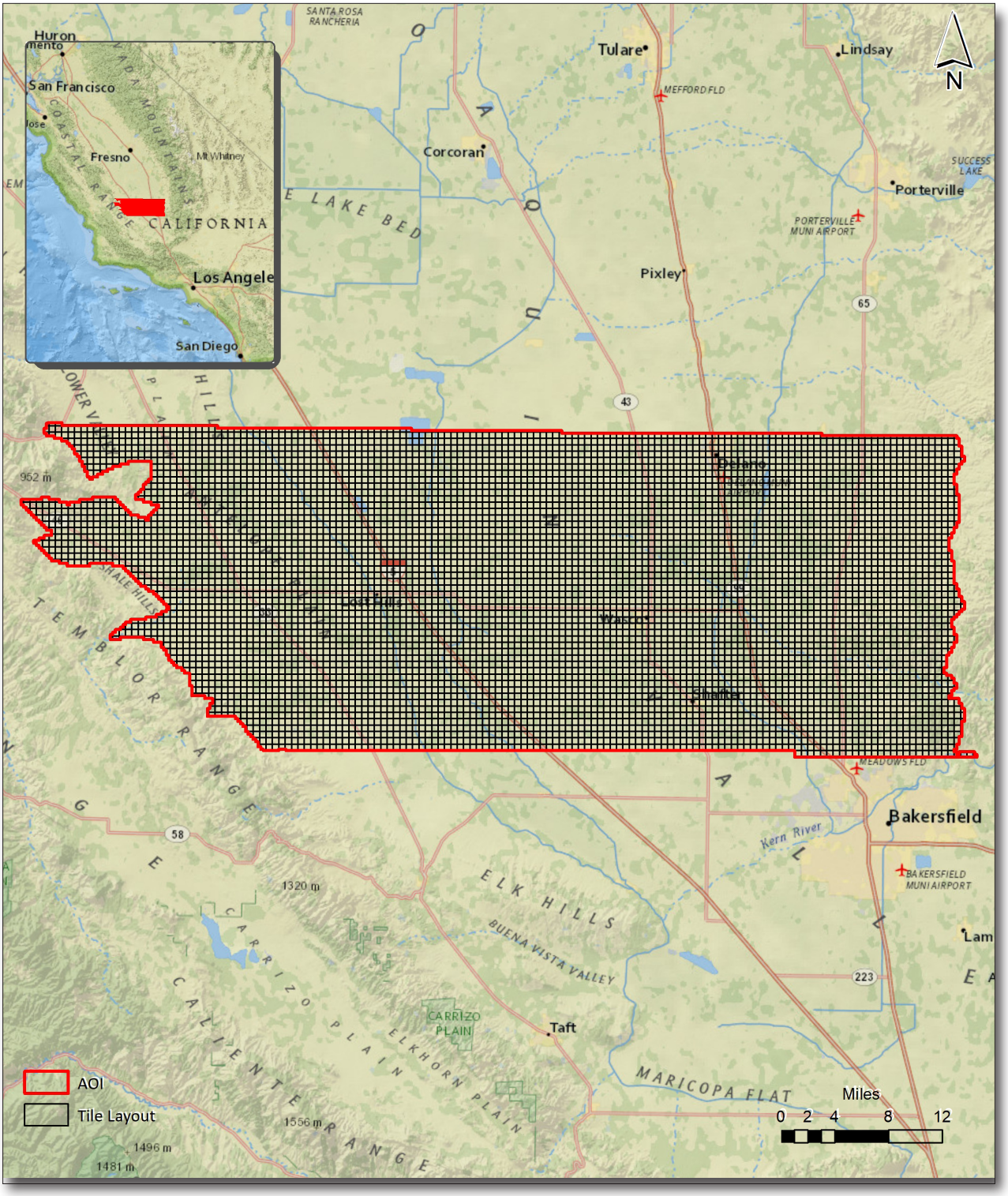


Figure 3. Lidar Tile Layout

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 4.

San Joaquin Work Unit 300028
Lidar Coverage

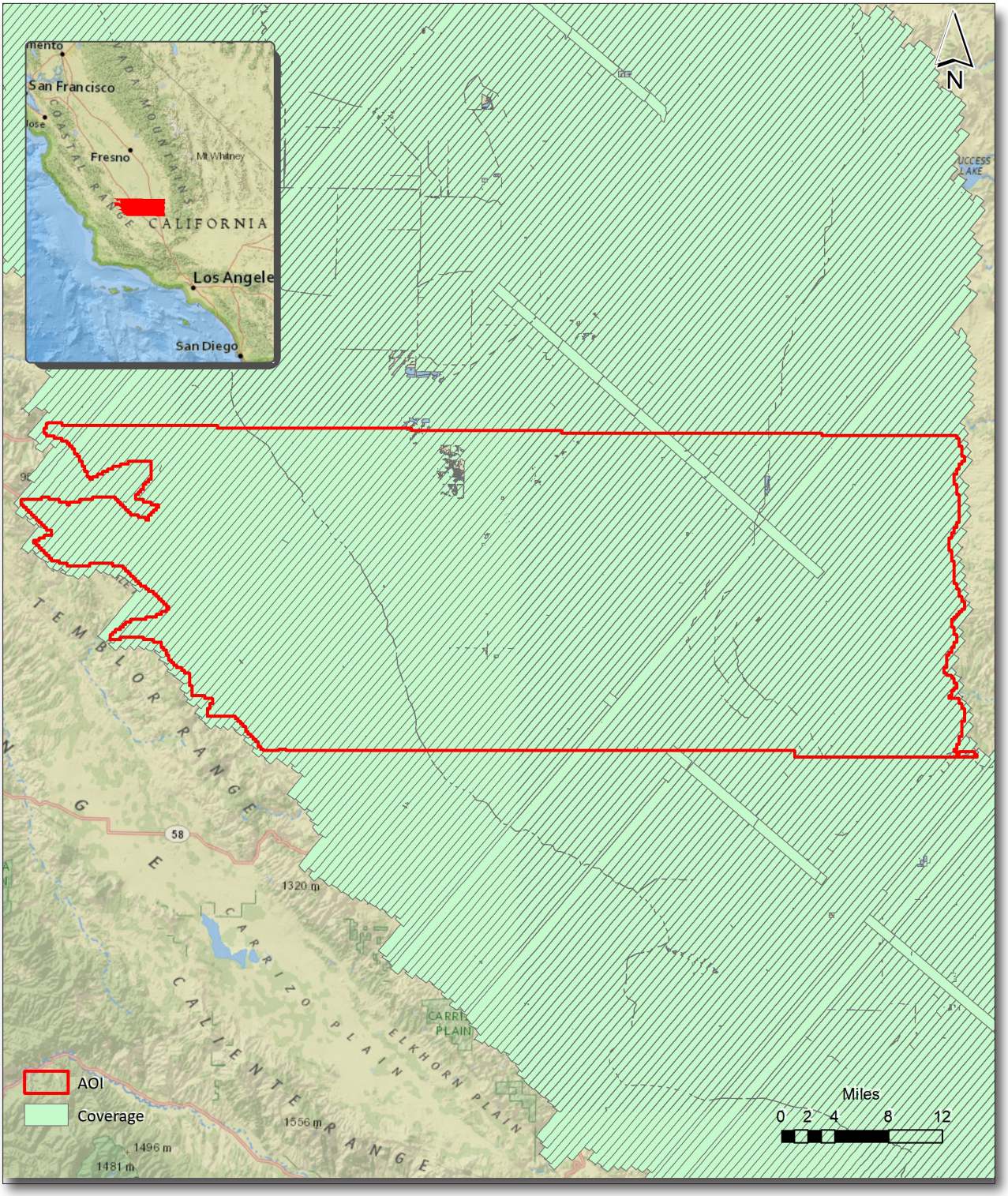


Figure 4. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

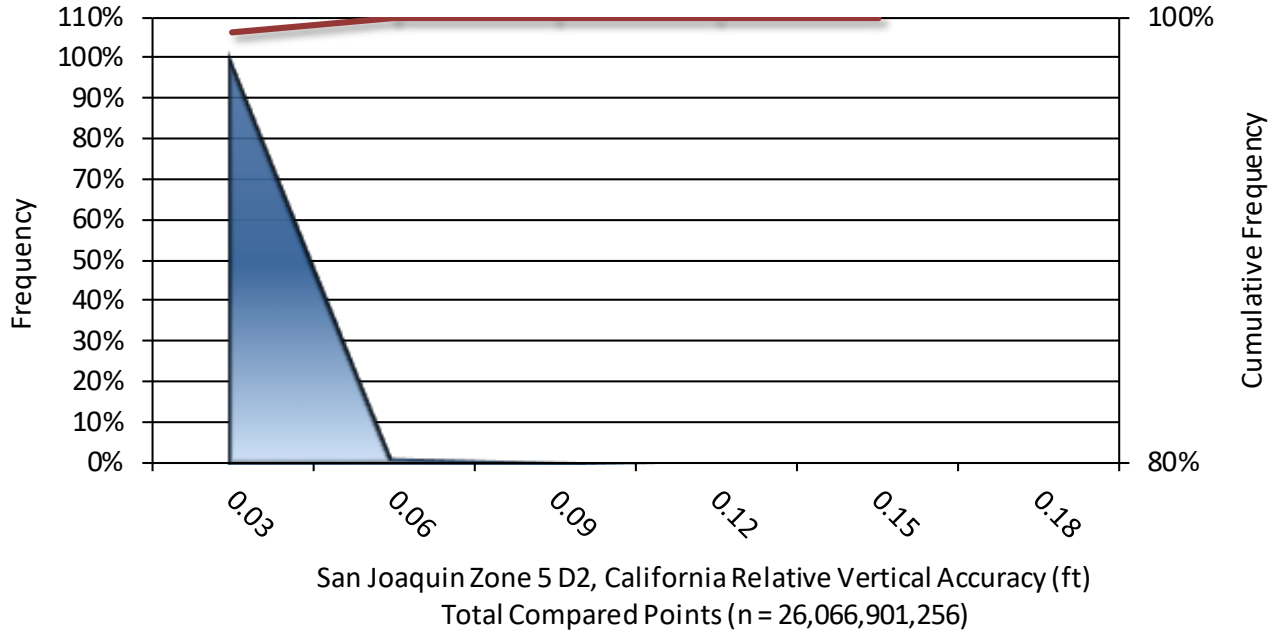
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial Data Accuracy (NSSDA) reporting standard where a theoretical point will fall within the obtained radius 95% of the time. Based on a flying altitude of 1,600 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.23 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.33 ft
	0.101 m
ACC_r	0.57 ft
	0.17 m

5.2. Relative Vertical Accuracy

Relative vertical accuracy refers to the internal consistency of the data set as a whole: the ability to place an object in the same location given multiple flight lines, GPS conditions, and aircraft attitudes. When the lidar system is well calibrated, the swath-to-swath vertical divergence is low (<0.10 meters). The relative vertical accuracy was computed by comparing the ground surface model of each individual flight line with its neighbors in overlapping regions. The average (mean) line to line relative vertical accuracy for the San Joaquin project was 0.022 feet (0.007 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	143 flight line surfaces
Average	0.022 ft
	0.007 m
Median	0.022 ft
	0.007 m
RMSE	0.022 ft
	0.007 m
Standard Deviation (1σ)	0.002 ft
	0.001 m
1.96σ	0.003 ft
	0.001 m



Project Report Appendices

The following section contains the appendices as listed in the San_Joaquin WU300028 Lidar Project Report.

Appendix A

Flight Logs

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-21-21
Mission(s): A

Survey Information 052A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: Aspen / 300LF	Receiver Type & SN: Trm 5700 / #7248
Airport Start/End: KBFL —	Antenna & Measurement Type: Zephyr
Time of T/O: 9:50AM Time of Landing: 3:10pm	Antenna Height – meters: 1.274
General Weather Conditions: CLEAR	Antenna Height – feet: 4.180 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): 052A - STARTED L50 - END L 37, HOBBS: 5.2

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

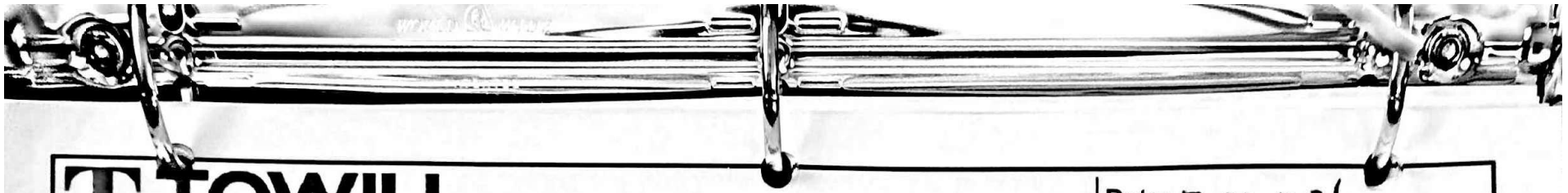
Date: 2-22-2024
Mission(s): A

Survey Information	053A	Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF		Receiver Type & SN: TRM 5700 / #7248	
Airport Start/End: KBFL – KBFL		Antenna & Measurement Type: Zephyr	
Time of T/O: 7:20AM	Time of Landing: 12:45pm	Antenna Height – meters: 1.365m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.480ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): 053A_L37-L$^{1}/_{2}$26, L$^{1}/_{2}$55-51
Very Rough moving over to the west for remainder of flight!

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020



TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-23-2021
Mission(s): A

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147 (054A)		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF / P-68		Receiver Type & SN: TRM5700 / # 7248	
Airport Start/End: KBFL - KBFL		Antenna & Measurement Type: Zephyr	
Time of T/O: 7:30am	Time of Landing: 12:35pm	Antenna Height – meters: 1.307m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.290ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L26 - L21)(L490-495)(L2041)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
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LIDAR FLIGHT LOG

Date: 2-24-2021
Mission(s): A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (055A)	Station Name: NA
Flight Vendor / Tail No: Aspen / N300LF / P-68	Receiver Type & SN: TRM 5700 / # 7248
Airport Start/End: KBFL – KBFL	Antenna & Measurement Type: Zephyr
Time of T/O: 11:45am Time of Landing: 3:30pm	Antenna Height – meters: 1.333m
General Weather Conditions: CLEAR	Antenna Height – feet: 4.375 ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): MX-50hour this morning. Posfile: 055AA
L½55 – L¼65

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-25-2021

Mission(s): A

Survey Information 056A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASTEN	Receiver Type & SN: Trm 5700 / #7248
Airport Start/End: KBFL – KBFL	Antenna & Measurement Type: Zephyr / Bottom Knotch
Time of T/O: 7:30AM Time of Landing: 12:30pm	Antenna Height – meters: 1.379m
General Weather Conditions: CLEAR	Antenna Height – feet: 4.525ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L65 – L277)

Sent map to: danielle.gorrell@faa.gov

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-26-2021
Mission(s): A

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147 (057A)		Station Name: NA	
Flight Vendor / Tail No: Aspen / N300LF / P-68		Receiver Type & SN: TRM 5700 / #7248	
Airport Start/End: KBFL - KBFL		Antenna & Measurement Type: Zephyr / Bottom Notch	
Time of T/O: 7:00am	Time of Landing: 1:00pm	Antenna Height – meters: 1.432m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.700ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L1277 – L1290) complete 6hrs

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-27-2021
Mission(s): A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM 5700 / #7248
Airport Start/End: 105 KBFL - KBFL	Antenna & Measurement Type: Zephyr / Bottom Notch
Time of T/O: 6:50 AM Time of Landing: 9:35am	Antenna Height – meters: 1.335m
General Weather Conditions: CLEAR	Antenna Height – feet: 4.380ft Checks?

058A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

058A (L 1/2 90 – 92) Moving northwest, clouds forming here!
(L 103 – 1/2 104) South half 104 complete!

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 2-28-2021
Mission(s): A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (059A)	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM 5700 / #7248
Airport Start/End: KBFL - KBFL	Antenna & Measurement Type: Zephyr / Bottom Notch
Time of T/O: 6:30am Time of Landing: 12:00pm	Antenna Height – meters: 1.250 m
General Weather Conditions: High clouds / CLEAR BELOW 12K	Antenna Height – feet: 4.100 ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L93 – L102) & North 1/2 L104

Pilot: BLAIS
LIDAR: PETERSEN

5.5 hrs

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
SURVEYING | MAPPING | GIS

LIDAR FLIGHT LOG

Date: 3-1-2021
Mission(s): A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 060A	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KBFL - KBFL	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:10am Time of Landing: 1:00pm	Antenna Height – meters: 1.295m
General Weather Conditions: CLEAR	Antenna Height – feet: 4.250ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L105 - L115/North Half)
Blais, Petersen
6.0hrs

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL
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LIDAR FLIGHT LOG

Date: 3-2-2021
Mission(s): A

Survey Information	061A	Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF / P-68		Receiver Type & SN: TRM 5700 / #7248	
Airport Start/End: KBFL - KBFL		Antenna & Measurement Type: Zephyr / BN	
Time of T/O: 1:20pm	Time of Landing: 4:00pm	Antenna Height – meters: 1.383m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.540ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L115-L119 North Half)

Pos File: 061AA

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-3-2021
Mission(s): A

Survey Information 062A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: Aspen / N300LF / P-68	Receiver Type & SN: TRM 5700 / #7248
Airport Start/End: KBFL - KBFL	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:10am Time of Landing: 1:10pm	Antenna Height – meters: 1.391m
General Weather Conditions: High Ovr. Cast.	Antenna Height – feet: 4.565ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds instrument anomolies, etc.): (L119 – L129 North Half)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-4-2021
Mission(s): A

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147 063A		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF / P-68		Receiver Type & SN: TRM 5700 / #7248	
Airport Start/End: KBFL - KBFL		Antenna & Measurement Type: Zephyr / BN	
Time of T/O: 5:05am	Time of Landing: 10:20 [redacted] am	Antenna Height – meters: 1.309m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.295ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (L129 - L138NH) ONLY 5.3 hrs, N300LF MX 100hr

Blais, Petersen

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/7/21
Mission(s): A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN – N300LF	Receiver Type & SN: 5700 / 7248
Airport Start/End: FRESNO – FAT	Antenna & Measurement Type: ZEPHYR – BW
Time of T/O: 9:00 AM Time of Landing: 2:20 pm	Antenna Height – meters: 1.478
General Weather Conditions: PARTLY CLOUDY	Antenna Height – feet: 4.849 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/8/21
Mission(s): 067A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: 5700 / 7248
Airport Start/End: FRESNO / FAT	Antenna & Measurement Type: ZEPHYR – BN
Time of T/O: 8:30 AM Time of Landing: 2:30 PM	Antenna Height – meters: 1.460
General Weather Conditions: PARTLY CLOUDY	Antenna Height – feet: 4.789 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/09/21
Mission(s): 068A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N800LF	Receiver Type & SN: 5700 / # 7248
Airport Start/End: FRESNO / KFAT	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 8:39 AM Time of Landing: 11:00 AM	Antenna Height – meters: 1.465
General Weather Conditions: OVERCAST	Antenna Height – feet: 4.807 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/13/21
Mission(s): 072

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: 5700 / # 7248
Airport Start/End: FRESNO / KFAT	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 9:00 AM Time of Landing: 12:00 PM	Antenna Height – meters: 1.476
General Weather Conditions: PTLY CLOUDY	Antenna Height – feet: 4.844 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

TOWILL LIDAR FLIGHT LOG Date: 3-4-2021 Mission(s): A

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LIDAR FLIGHT LOG

Date: 3/14/21
Mission(s): 073

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: 5700 / # 7248
Airport Start/End: FRESNO / KFAT	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 9:30 AM Time of Landing: 3:00 PM	Antenna Height – meters: 1.484
General Weather Conditions: PTLY CLOUDY	Antenna Height – feet: 4.869 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/17/21
Mission(s): 076A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: 5700 / # 7248
Airport Start/End: FRESNO / KFAT	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 9:00 Time of Landing: 2:30	Antenna Height – meters: 1.469
General Weather Conditions: CLEAR	Antenna Height – feet: 4.818 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3/18/21
Mission(s): 077A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: FRESNO
Flight Vendor / Tail No: ASPEN / N 300LF	Receiver Type & SN: 5700 / # 7248
Airport Start/End: FRESNO / KFAT	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 9:00AM Time of Landing: 3:00pm	Antenna Height – meters: 1.428
General Weather Conditions: CLEAR / HAZY	Antenna Height – feet: 4.682 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-21-2021

Mission(s):

Survey Information 080A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: Aspen / N300LF	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 8:30am Time of Landing: 11:50am	Antenna Height – meters: 1.515m
General Weather Conditions: Low Building Clouds No factor	Antenna Height – feet: 4.970ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): 080A START L182 - Complete (S)
L183 - Southwest Half (N)
L184 - Southwest Half (S)
L185 - Southwest Half (N)
L186 - Southwest Half (S)
L187 - Southwest Half (N) Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020
START (S) of tie line next mission

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LIDAR FLIGHT LOG

Date: 3-22-2021
Mission(s):

Survey Information	08 1A	Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF		Receiver Type & SN: TRM5700 / #7248	
Airport Start/End: KFAT – KFAT		Antenna & Measurement Type: Zephyr / BN	
Time of T/O: 6:40am	Time of Landing: 1:30	Antenna Height – meters: 1.456m	
General Weather Conditions: CLEAR		Antenna Height – feet: 4.780ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):
08 1A - START L183 - L195
500GB
6.7 hrs

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-24-2021
Mission(s):

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (083A)	Station Name: [redacted] * No Flight Crew Base *
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: [redacted] USE Towill Surveyors
Airport Start/End: KOXR - KFAT	Antenna & Measurement Type: Base data for 083
Time of T/O: 9:40am Time of Landing: [redacted] 4:10 pm	Antenna Height – meters:
General Weather Conditions: SKY CLEAR	Antenna Height – feet: Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): START L196 - L204 / 083A

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-25-2021

Mission(s):

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (084A)	Station Name: NA
Flight Vendor / Tail No: ASPEN	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:40am Time of Landing: 10:50am	Antenna Height – meters: 1.280m
General Weather Conditions: HIGH OVC	Antenna Height – feet: 4.200ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds instrument anomolies, etc.): (084A Start L205 - L208 COMPLETE FULL LINES)

TRIED L209 But clouds and fires underneath the plane
↑
Incomplete!

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-26-2021

Mission(s):

Survey Information 085A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: 5700 TRM / # 7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:15am Time of Landing: 12:25pm	Antenna Height – meters: 1.441m
General Weather Conditions: CLEAR BUT REPORTING CLDS	Antenna Height – feet: 4.730ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: TRM5700 / # 7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 12:51pm Time of Landing: 3:25pm	Antenna Height – meters: 1.441m
General Weather Conditions: Scattered North East Half OF LINES	Antenna Height – feet: 4.730ft Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): PETERSEN ? PORTELLO

085B START
L219 (SW) Southwest half only
L220 (NE) Southwest half only
L221 (SW) Southwest half only
L222 (NE) Southwest half only
L223 (SW) Southwest half only
L224 (NE) Southwest half only

085A START L209 - L213 COMPLETE LINES
L214 (NE) Southwest half only
L215 (SW) Southwest half only
L216 (NE) Southwest half only
L217 (SW) Southwest half only
L218 (NE) Southwest half only

TURNED AROUND @ TIE LINE

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-27-2021

Mission(s):

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (086A)	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:32am Time of Landing: 1:30pm	Antenna Height – meters: 1.432m
General Weather Conditions: SKC	Antenna Height – feet: 4.700ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): 086A - START L255 - L266 South West half

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-28-2021

Mission(s):

Survey Information 087A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: [redacted] KFAT - KFAT 1:15pm	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:15am Time of Landing:	Antenna Height – meters: 1.524m
General Weather Conditions: SKC	Antenna Height – feet: 5.000ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): 087A - START (L266 NE Half - L280)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-29-2021
Mission(s):

Survey Information 088A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:22am Time of Landing: 1:05 pm	Antenna Height – meters: 1.454m
General Weather Conditions:	Antenna Height – feet: 4.770ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (088A START L214 - L228)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-30-2021
Mission(s): A+B

Survey Information 089A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM 5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:20am Time of Landing: 12:05pm	Antenna Height – meters: 1.530m
General Weather Conditions: SKC	Antenna Height – feet: 5.020ft Checks?

Survey Information 089B	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF	Receiver Type & SN: TRM 5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 12:55pm Time of Landing: 3:15pm	Antenna Height – meters: 1.530m
General Weather Conditions: SKC	Antenna Height – feet: 5.020ft Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

(START L229 – L236½) 089A

089B - START L236½ (NE) – L239½ (SW)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 3-31-2021

Mission(s):

Survey Information 090A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N300LF / P-68	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KFAT - KFAT	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 7:20am Time of Landing: 1:25pm	Antenna Height – meters: 1.460m
General Weather Conditions: SKC	Antenna Height – feet: 4.790ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): (090A - START - L239½ (SW) - L253 Full L254 Full)

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4-1-2021

Mission(s):

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147 091A		Station Name: NA	
Flight Vendor / Tail No: ASPEN / N300LF / P-68		Receiver Type & SN: TRM5700 / #7248	
Airport Start/End: KFAT - KFAT		Antenna & Measurement Type: Zephyr / BN	
Time of T/O: 8:18am	Time of Landing: 12:40pm	Antenna Height – meters: 1.463m	
General Weather Conditions: SKC		Antenna Height – feet: 4.800ft	Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): START L 240 ½ (NE) - 252 ALL COMPLETE

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/3/21
Mission(s): 093A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA -
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MADERA / KMAF	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11 AM Time of Landing: 4:30	Antenna Height – meters: 1.479
General Weather Conditions: CLEAR	Antenna Height – feet: 4.858 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/4/21
Mission(s): 094A, B

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MADERA / KMAE	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 2:00pm Time of Landing: 4:30	Antenna Height – meters: 1.478
General Weather Conditions: CLEAR	Antenna Height – feet: 4.849 - 1.478 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MADERA	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 4:50pm Time of Landing: 8:15	Antenna Height – meters: 1.478
General Weather Conditions: CLEAR	Antenna Height – feet: 4.849 - 1.478 ✓ Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/5/21
Mission(s): 095A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MADERA / KMAE	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 2:00 Time of Landing: 8:00pm	Antenna Height – meters: 1.481
General Weather Conditions: CLEAR	Antenna Height – feet: 4.851 – 1.481 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/6/21
Mission(s): 096A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MADERA / KMAE	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 3:00 Time of Landing: 8:30	Antenna Height – meters: 1.427
General Weather Conditions: CLEAR	Antenna Height – feet: 4.682 - 1.427 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/7/21
Mission(s): 097A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MADERA
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MADERA / KMAE	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 2:00 Time of Landing: 5:30	Antenna Height – meters: 1.520
General Weather Conditions: CLEAR	Antenna Height – feet: 4.985 — 1.519 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/9/21
Mission(s): 099A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 1:15 Time of Landing: 5:00	Antenna Height – meters: 1.463
General Weather Conditions: CLEAR	Antenna Height – feet: 4.801 – 1.463 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/10/21
Mission(s): 100A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:45 Time of Landing: 4:30	Antenna Height – meters: 1.497
General Weather Conditions: CLEAR	Antenna Height – feet: 4.910 – 1.497 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/11/21
Mission(s): 101A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #1 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:30 AM Time of Landing: 4:45 PM	Antenna Height – meters: 1.504
General Weather Conditions: CLEAR	Antenna Height – feet: 4.933 – 1.504 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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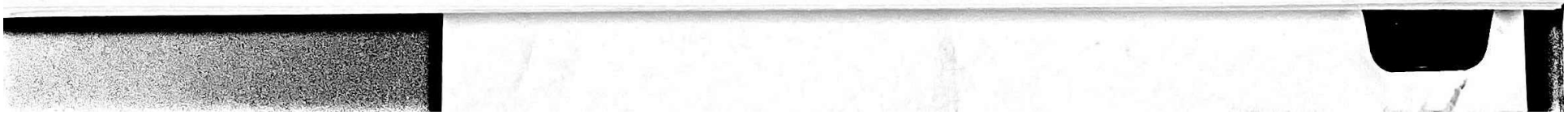
Last manufacturer service date: July 30, 2020



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LIDAR FLIGHT LOG

Date: 4/12/21
Mission(s): 102A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:20 AM Time of Landing: 5:00 PM	Antenna Height – meters: 1.527
General Weather Conditions: CLEAR	Antenna Height – feet: 5.009 – 1.527 ✓ Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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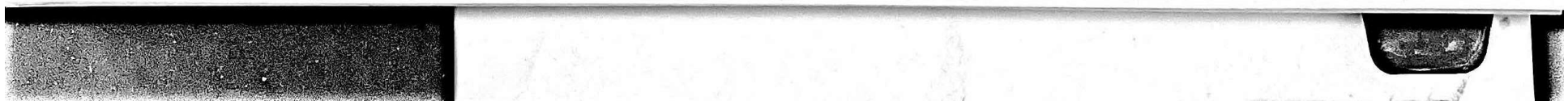
Last manufacturer service date: July 30, 2020



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LIDAR FLIGHT LOG

Date: 4/13/21
Mission(s): 103A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:15 AM Time of Landing: 5:00 PM	Antenna Height – meters: 1.499
General Weather Conditions: CLEAR	Antenna Height – feet: 4.918 — 1.499 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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LIDAR FLIGHT LOG

Date: 4/14/21
Mission(s): 104A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:15AM Time of Landing: 1:30 PM	Antenna Height – meters: 1.523
General Weather Conditions: CLOUDY / LOW CLOUDS	Antenna Height – feet: 4.995 — 1.523 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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LIDAR FLIGHT LOG

Date: 4/15/21
Mission(s): 105A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:20 AM Time of Landing: 5:15 PM	Antenna Height – meters: 1.484
General Weather Conditions: CLEAR	Antenna Height – feet: 4.870 – 1.484 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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LIDAR FLIGHT LOG

Date: 4/17/21
Mission(s): 107A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N686VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHR / BN
Time of T/O: 11:20 AM Time of Landing: 5:30 PM	Antenna Height – meters: 1.486
General Weather Conditions: CLEAR	Antenna Height – feet: 4.873 – 1.485 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/18/21
Mission(s): 108A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MERCED
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MERCED	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:20AM Time of Landing: 4:30	Antenna Height – meters: 1.537
General Weather Conditions: CLEAR	Antenna Height – feet: 5.040 – 1.536 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 109A
Mission(s): 4/19/21

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MODESTO
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / # 7248
Airport Start/End: MODESTO	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 12:30 Time of Landing: 4:00	Antenna Height – meters: 1.443
General Weather Conditions: CLEAR	Antenna Height – feet: 4.738 – 1.443 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4/21/21
Mission(s): 111A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: MODESTO
Flight Vendor / Tail No: ASPEN / N68VA	Receiver Type & SN: 5700 / #7248
Airport Start/End: MODESTO	Antenna & Measurement Type: ZEPHYR / BN
Time of T/O: 11:30 AM Time of Landing: 5:15PM	Antenna Height – meters: 1.469
General Weather Conditions: CLEAR	Antenna Height – feet: 4.819 – 1.469 Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

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Last manufacturer service date: July 30, 2020

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LIDAR FLIGHT LOG

Date: 4-28-2021
Mission(s): 118A

Survey Information 118A	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name: NA
Flight Vendor / Tail No: ASPEN / N68VA / P-68	Receiver Type & SN: TRM5700 / #7248
Airport Start/End: KMOD - KMOD	Antenna & Measurement Type: Zephyr / BN
Time of T/O: 10:00am Time of Landing: 3:45pm	Antenna Height – meters: 1.402m
General Weather Conditions: SKC	Antenna Height – feet: 4.600ft Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): START L443 - L461

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LIDAR FLIGHT LOG

Date: 4-29-2021
Mission(s): 119A

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147 (119A)	Station Name: NA
Flight Vendor / Tail No: ASPEN / N68VA / P-68	Receiver Type & SN: NA
Airport Start/End: KMOD - KMOD	Antenna & Measurement Type: NA
Time of T/O: 9:55am Time of Landing: 2:20pm	Antenna Height – meters: NA
General Weather Conditions: SKC	Antenna Height – feet: NA Checks?

Survey Information	Base Station Data
Project Name: DWR San Joaquin Valley 14750-147	Station Name:
Flight Vendor / Tail No:	Receiver Type & SN:
Airport Start/End:	Antenna & Measurement Type:
Time of T/O: Time of Landing:	Antenna Height – meters:
General Weather Conditions:	Antenna Height – feet: Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.): START L461 - L485

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LIDAR FLIGHT LOG

Date: 4-30-2021
Mission(s): 120A

Survey Information	120A	Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	NA
Flight Vendor / Tail No:	ASPEN / N68VA / P-68	Receiver Type & SN:	NA
Airport Start/End:	KMOD - KMOD	Antenna & Measurement Type:	NA
Time of T/O: 9:15am	Time of Landing: 12:20pm	Antenna Height – meters:	NA
General Weather Conditions:	SKC	Antenna Height – feet:	NA Checks?

Survey Information		Base Station Data	
Project Name: DWR San Joaquin Valley 14750-147		Station Name:	
Flight Vendor / Tail No:		Receiver Type & SN:	
Airport Start/End:		Antenna & Measurement Type:	
Time of T/O:	Time of Landing:	Antenna Height – meters:	
General Weather Conditions:		Antenna Height – feet:	Checks?

Comments (notable inflight disturbances, head/tail/crosswinds, instrument anomolies, etc.):

Optech Galaxy Prime s/n 5060411
Last manufacturer service date: July 30, 2020