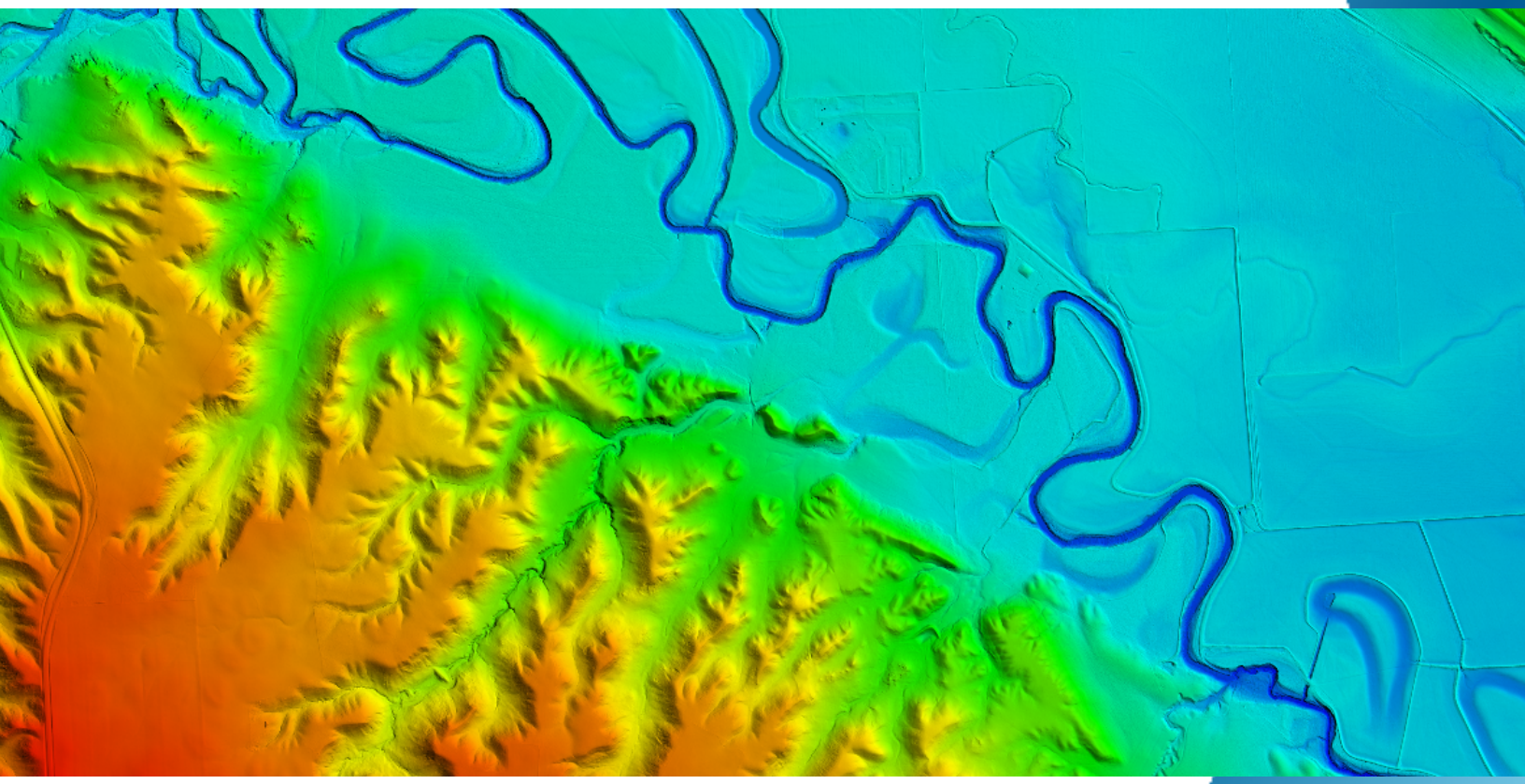
NV5 GEOSPATIAL



MT STATEWIDE PHASE2 2020 B20 LIDAR PROCESSING REPORT | 2023

Submitted: May 18, 2023

Project ID: 197114
Work Unit: 197111

Prepared for:

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science for a changing world

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NV5 GEOSPATIAL

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1. Summary / Scope

1.1. Summary

This report contains a summary of the MT_Statewide_Phase2_2020_B20, Work Unit 197111 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on 08/12/2020. The task order yielded a project area covering 2,388 square miles over Montana. 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
2 pts / m2	2500 m	58.5°	20%	≤ 10 cm

1.3. Coverage

The project boundary covers 2,388 square miles over Montana. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from October 8, 2020 to May, 11 2021 in 14 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

There were no issues to report.

MT_Statewide_Phase2_2020_B20 Work Unit 197111 Projected Coordinate System: Montana State Plane FIPS 2500 Horizontal Datum: NAD83(2011) Vertical Datum: NAVD88 (GEOID 18) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 1-meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 1-meter Intensity images in GeoTIFF format • 1-meter Maximum Surface Height Raster • 1-meter Swath Seperation Images
Vectors	Shapefiles (*.shp) • Project Boundary • Lidar Tile Index • Calibration and QC Checkpoints (NVA/VVA) Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines • Flightlines Swath
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

MT Statewide Phase2 2020 B20
Work Unit 197111 Boundary

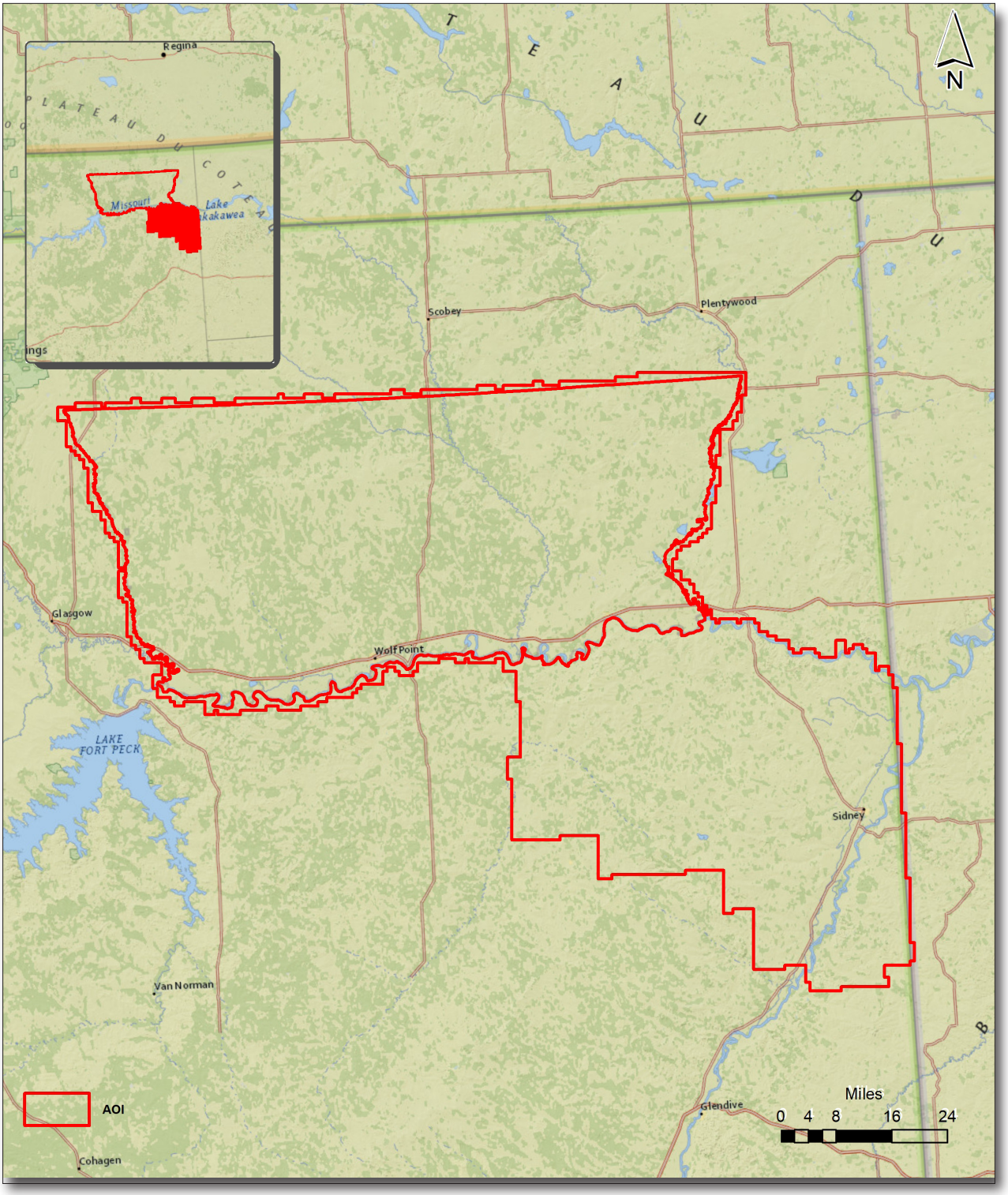


Figure 1. Work Unit Boundary

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 using RiPARAMETER planning software.

2.2. Lidar Sensor

NV5 Geospatial utilized Riegl LMS-Q1560 and VQ1560ii lidar sensors (Figure 2), serial number(s) 1264, 4051, and 3543, for data acquisition.

The Riegl LMS-Q1560 system has a laser pulse repetition rate of up to 800 kHz. This sensor has forward/backward looking capability and a wide field of view for ultra wide area mapping. There is a two channel scanner that utilizes MTA processing, echo digitization, and waveform analysis.

The Riegl 1560II system is a dual channel waveform processing airborne scanning system. It has a laser pulse repetition rate of up to 4 MHz resulting in up to 2.66 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA) and an integrated IMU/GNSS unit.

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

		Riegl LMS-Q1560 (1264)	Riegl VQ1560ii (4051)	Riegl VQ1560ii (3543)
Terrain and Aircraft Scanner	Flying Height	2,300 m	2,300 m	2,300 m
	Recommended Ground Speed	160 kts	160 kts	160 kts
Scanner	Field of View	60°	60°	60°
	Scan Rate Setting Used	89 lps	91 lps	102 lps
Laser	Laser Pulse Rate Used	400 kHz	400 kHz	500 kHz
	Multi Pulse in Air Mode	yes	yes	yes
Coverage	Full Swath Width	2,577 m	2,577 m	2,577 m
	Line Spacing	2,062 m	2,062 m	2,062 m
Point Spacing and Density	Average Point Spacing	0.63 m	0.63 m	0.58 m
	Average Point Density	2.5 pts / m^2	2.5 pts / m^2	3 pts / m^2

Figure 2. Riegl LMS-Q1560 and VQ1560ii Lidar Sensors

2.3. Aircraft

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

Lidar Collection Planes

- Piper PA-31-7400992, Tail Number(s): C-GJMT
- Piper PA-31-310, Tail Number(s): C-GKSX
- Piper PA-31-521, Tail Number(s): C-FFRY

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 Riegl lidar systems. NV5 Geospatial's operating aircraft can be seen in Figure 3 below.

Figure 3. NV5 Geospatial's Planes

2.4. Time Period

Project specific flights were conducted between October 8, 2020 to May, 11 2021. Fourteen aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
10082020A (SN4051,C-GKSX)	10/08/2020 3:53:45 PM	10/08/2020 4:29:12 PM
10092020A2 (SN4051,C-GKSX)	10/09/2020 6:43:40 PM	10/09/2020 10:12:01 PM
10102020A (SN3543,C-FFRY)	10/10/2020 6:00:50 PM	10/10/2020 10:19:59 PM
10102020A (SN4051,C-GKSX)	10/10/2020 5:10:06 PM	10/10/2020 9:21:13 PM
10132020A (SN3543,C-FFRY)	10/13/2020 5:04:40 PM	10/13/2020 9:20:24 PM
10132020A (SN4051,C-GKSX)	10/13/2020 5:05:46 PM	10/13/2020 9:17:17 PM
11042020A (SN3543,C-FFRY)	11/04/2020 7:07:51 PM	11/04/2020 10:15:15 PM
11052020B (SN3543,C-FFRY)	11/05/2020 6:25:48 PM	11/05/2020 10:13:44 PM
11062020A (SN3543,C-FFRY)	11/06/2020 4:11:16 PM	11/06/2020 8:48:35 PM
04302021A (SN1264,C-GJMT)	4/30/2021 4:08:30 PM	4/30/2021 7:32:40 PM
05012021A (SN1264,C-GJMT)	5/01/2021 3:35:09 PM	5/01/2021 7:23:27 PM
05072021A (SN1264,C-GJMT)	5/07/2021 3:51:05 PM	5/07/2021 8:26:56 PM
05102021A (SN1264,C-GJMT)	5/10/2021 2:07:38 PM	5/10/2021 4:47:58 PM
05112021A (SN1264,C-GJMT)	5/11/2021 2:13:21 PM	5/11/2021 3:12:27 PM

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 in flightline swath format were created using the RiPROCESS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Each flightline swath point cloud was calibrated using Strip Align software that corrects systematic geometric errors and improves the relative and absolute accuracy of the flightline swath point cloud. The calibrated point cloud swaths were imported into GeoCue distributive processing software and the imported data was then tiled so further processing could take place in TerraScan software. Using TerraScan, the vertical accuracy of the surveyed ground control was tested and any vertical bias was removed from the data. TerraScan and TerraModeler software packages were then used for automated data classification and manual cleanup. The data were 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.

Software	Version
Applanix + POSPac	8.6
RiPROCESS	1.8.6
Microstation Connect	10.16.02.34
GeoCue	2020.1.22.1
Global Mapper	19.1;20.1
TerraModeler	21.008
TerraScan	21.016
TerraMatch	21.007
StripAlign	2.21

3.3. LAS Classification Scheme

The classification classes are determined by Lidar Base Specifications 2.1 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
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 meter 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 3 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

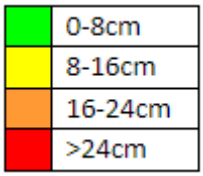
Class 2 lidar in conjunction with the hydro breaklines were used to create a 1-meter Raster DEM. Using automated scripting routines within proprietary software, a GeoTIFF file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Intensity Image Processing

Intensity images represent reflectivity values collected by the lidar sensor during acquisition. Proprietary software generates intensity images using first returns and excluding those flagged with a withheld bit. 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 during product generation.

3.8. 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-meter 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.



MT Statewide Phase2 2020 B20
Work Unit 197111 Tile Layout

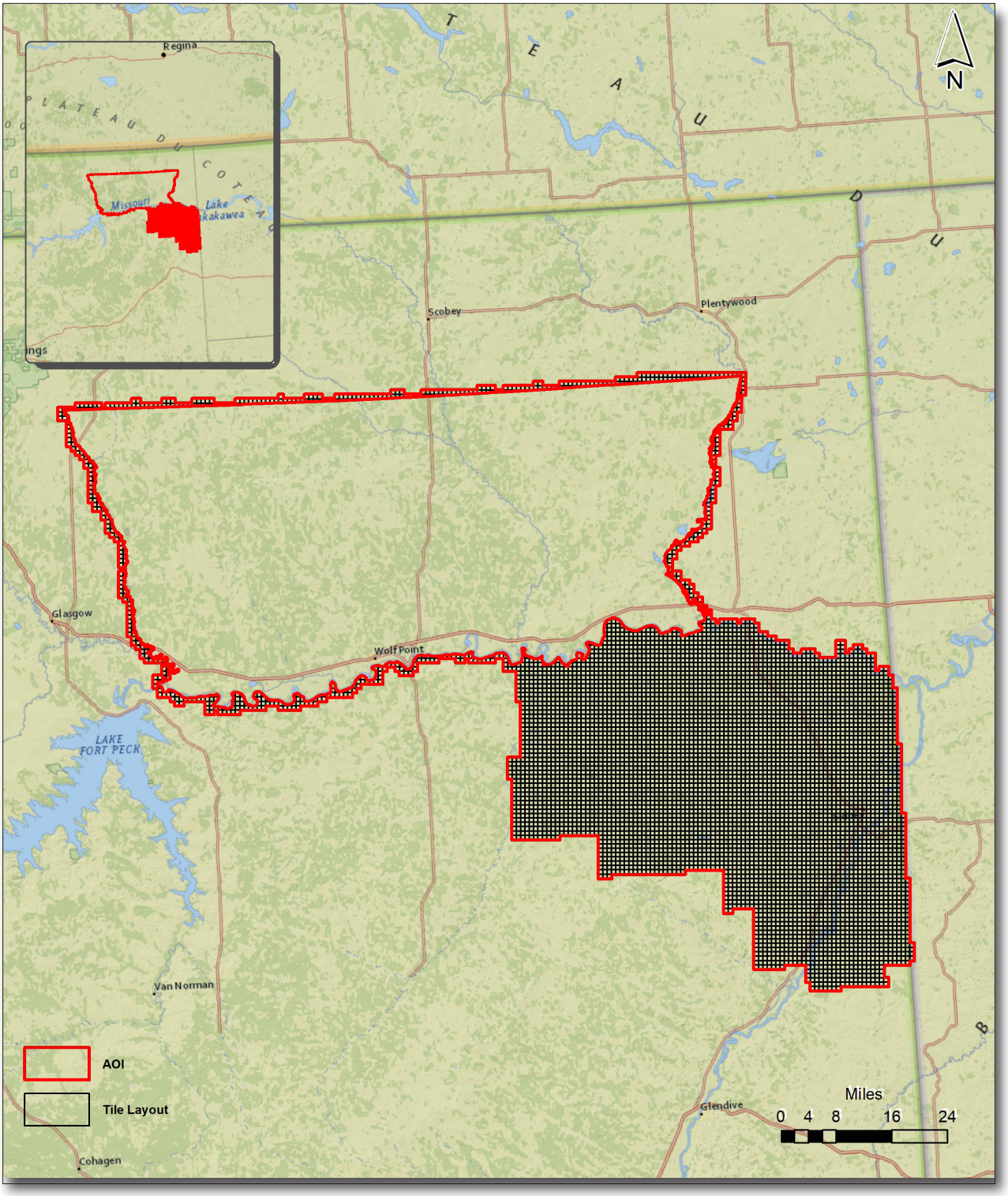


Figure 4. Lidar Tile Layout

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 5.

MT Statewide Phase2 2020 B20
Work Unit 197111 Lidar Coverage

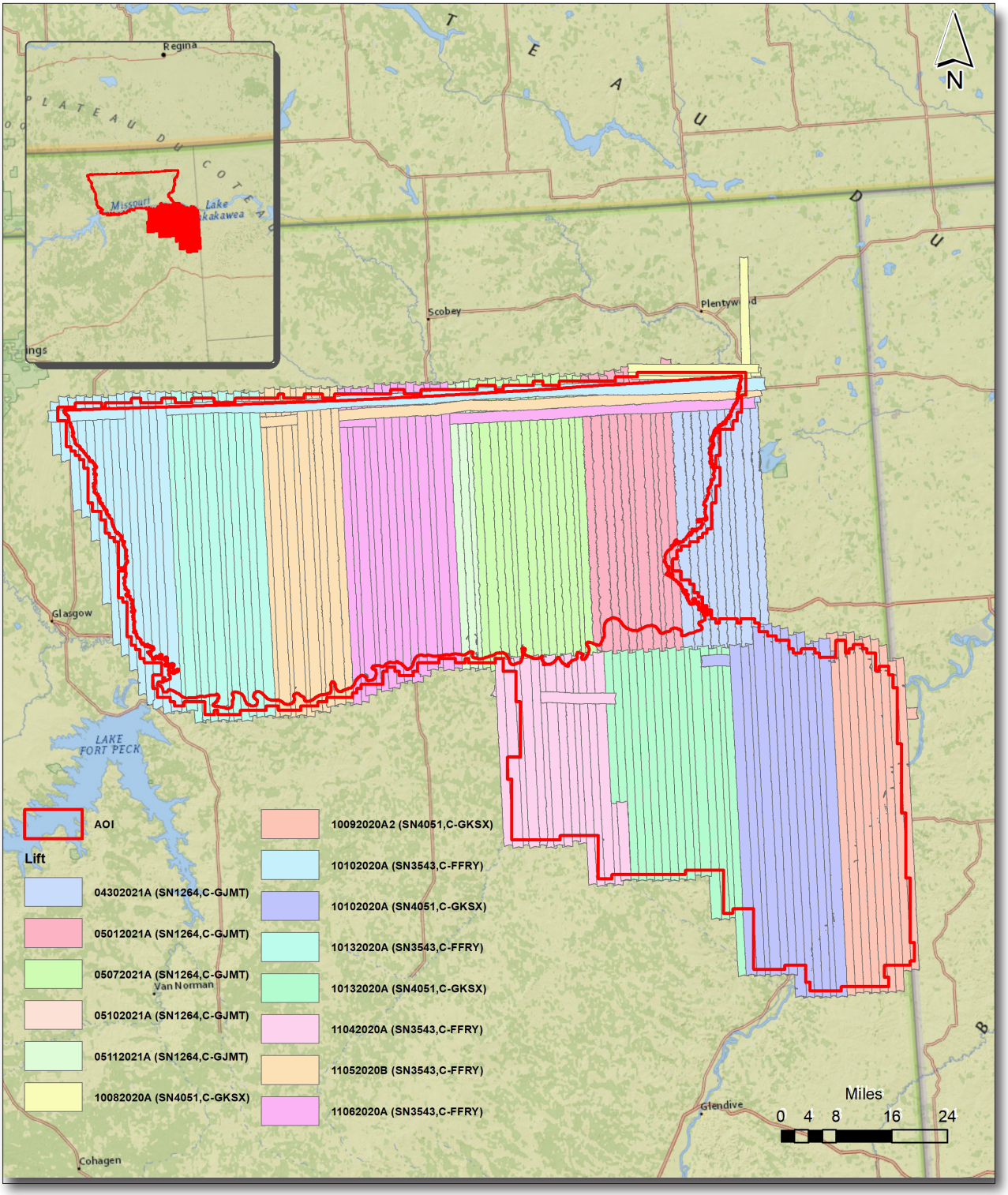


Figure 5. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

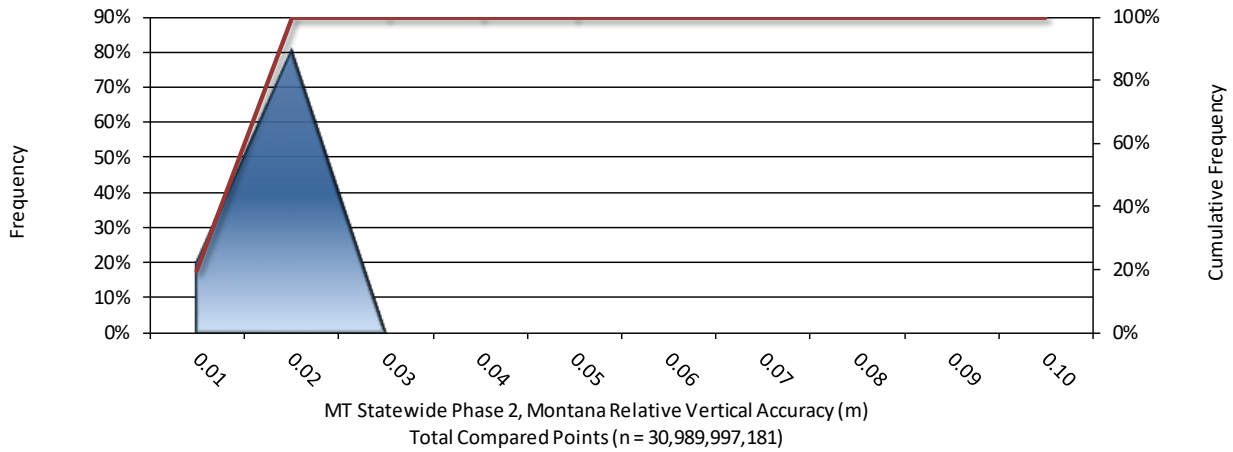
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 2,300 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.015 meters, this project was compiled to meet 0.25 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.47 ft
	0.14 m
ACC_r	0.82 ft
	0.25 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 MT_Statewide_Phase2_2020_B20 project was 0.034 feet (0.010 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	173 flight line surfaces
Average	0.034 ft
	0.010 m
Median	0.037 ft
	0.011 m
RMSE	0.036 ft
	0.011 m
Standard Deviation (1σ)	0.004 ft
	0.002 m
1.96σ	0.008 ft
	0.002 m



Project Report Appendices

The following section contains the appendices as listed in the MT Statewide Phase2 2020 B20 Lidar Project Report.

Appendix A

Flight Logs

Julian Day 284	Flight A

LIDAR Flight Log

Date	October 10, 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	N. Emson
Location	Estevan Airport CYEN	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-61%
hpa-1008
AMLS-580m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	17:00	**Takeoff**	17:17	
Engine Off	23:20	**Landing**	23:11	
Total	6.3 hrs	**Total**	5.9 hrs	

Mission Plan			
AGL Height	2300 m	**Pulse Rate**	400 (x2) kHz
Target Speed	160 kts	**Scan Rate**	89 lps
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1709	1714
Post Mission	2315	2320

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
F8		-	1754	1759			-	
X-tie	432028401	-	1800	1840			180049	
Figure 8			1840	1845			-	
1001	432028402	170	1849	1852			184919	
1002	432028403	350	1844	1859			185442	
1003	432028404	170	1900	1908			190049	
1004	432028405	350	1913	1920			191320	
1005	432028406	170	1923	1932			192321	
1006	432028407	350	1936	1948			193638	
1007	432028408	170	1952	2006	`		195210	
1008	432028409	350	2009	2023			200917	
1009	432028410	170	2025	2041			202553	
1010	432028411	350	2044	2101			204443	
1011	432028412	170	2103	2121			210320	
1012	432028413	350	2122	2140			212244	

Julian Day 284	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 10, 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	N. Emson
Location	Estevan Airport CYEN	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-61%
hpa-1008
AMLS-580m

Time to next maintenance: _____ ○ 50 hr ◉ 100 hr

Aircraft Block Time				
Engine On	17:00	**Takeoff**	17:17	
Engine Off	23:20	**Landing**	23:11	
Total	6.3 hrs	**Total**	5.9 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	400 (x2)	kHz
Target Speed	160	kts	**Scan Rate**	89	lps
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1709	1714
Post Mission	2315	2320

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
1013	432028414	170	2143	2200			214308	
1014	432028415	350	2203	2221			220322	
F8		-	2221	2227				
		-						
		-						

Julian Day 287	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 13 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	N. Emson
Location	Estevan Sask Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-5C
H-60%
hpa-1013
AMLS-580m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:44	**Takeoff**	16:02	
Engine Off	22:26	**Landing**	22:16	
Total	6.7 hrs	**Total**	6.2 hrs	

Mission Plan			
AGL Height	2300 m	**Pulse Rate**	400 (x2) kHz
Target Speed	160 kts	**Scan Rate**	267Hz
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1552	1557
Post Mission	2219	2224

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
F8		-	1659	1704				
X-tie	432028701	-	1704	1720			170439	
1015	432028702	170	1728	1745			172837	
1016	432028703	350	1747	1805			174709	
1017	432028704	170	1807	1824			180720	
1018	432028705	350	1826	1843			182621	
1019	432028706	170	1846	1903			184625	
1020	432028707	350	1906	1923			190618	
1021	432028708	170	1926	1944			192627	
1022	432028709	350	1946	2003			194622	
1023	432028710	170	2006	2023			200603	
1024	432028711	350	2026	2041			202615	
1025	432028712	170	2044	2102			204450	
1026	432028713	350	2104	2120			210443	
F8		-	2121	2126				

Julian Day 309	Flight A

LIDAR Flight Log

Date	November 04 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-12C
H-44%
hpa-1008
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	17:30	**Takeoff**	18:05	
Engine Off	23:20	**Landing**	23:05	
Total	5.8 hrs	**Total**	5.0 hrs	

Mission Plan			
AGL Height	2300 m	**Pulse Rate**	500(x2) kHz
Target Speed	160 kts	**Scan Rate**	267Hz
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1756	1801
Post Mission	2307	2312

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
F8		-	1859	1904				
1103	432030901	352	1907	1913			190751	9nm South End
1102	432030902	172	1915	1921			191545	9nm South End
1101	432030903	352	1922	1936			192257	
1100	432030904	172	1937	1950			193726	
1099	432030905	352	1952	2004			195219	
1098	432030906	172	2007	2019			200732	
1097	432030907	352	2020	2030			202023	
1096	432030907	172	2032	2044			203256	
1095	432030908	352	2045	2056			204520	
1094	432030909	172	2057	2109			205750	
1093	432030910	352	2110	2121			211018	
1092	432030911	172	2122	2133			212229	
1091	432030912	352	2134	2145			213457	
1090	432030913	172	2146	2157			214645	

Julian Day 309	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	November 04 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-12C
H-44%
hpa-1008
AMLS-581m

Time to next maintenance: _____ ○ 50 hr ◉ 100 hr

Aircraft Block Time				
Engine On	17:30	**Takeoff**	18:05	
Engine Off	23:20	**Landing**	23:05	
Total	5.8 hrs	**Total**	5.0 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1756	1801
Post Mission	2307	2312

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
1089	432030914	352	2158	2209			215840	
X-tie	432030915	-	2210	2217			221040	
F8		-	2217	2222				
		-						
		-						

Julian Day 310	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	November 05 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-71%
hpa-1012
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:13	**Takeoff**	15:34	
Engine Off	15:55	**Landing**	15:48	
Total	0.7 hrs	**Total**	0.2 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1521	1526
Post Mission		

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
F8		-						Aborted Aircraft power drop to 8.2Vlts

Julian Day 310	Flight A

LIDAR Flight Log

Date	November 05 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-71%
hpa-1012
AMLS-581m

Time to next maintenance: _____ ○ 50 hr ◉ 100 hr

Aircraft Block Time				
Engine On	15:13	**Takeoff**	15:34	
Engine Off	15:55	**Landing**	15:48	
Total	0.7 hrs	**Total**	0.2 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1521	1526
Post Mission		

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
X-tie								
x-tie		-						
F8		-						

Julian Day 310	Flight A

LIDAR Flight Log

Date	November 05 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-71%
hpa-1012
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:13	**Takeoff**	15:34	
Engine Off	15:55	**Landing**	15:48	
Total	0.7 hrs	**Total**	0.2 hrs	

Mission Plan			
AGL Height	2300 m	**Pulse Rate**	500(x2) kHz
Target Speed	160 kts	**Scan Rate**	267Hz
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1521	1526
Post Mission		

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
		-					-	

Julian Day 310	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	November 05 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-71%
hpa-1012
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:13	**Takeoff**	15:34	
Engine Off	15:55	**Landing**	15:48	
Total	0.7 hrs	**Total**	0.2 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1521	1526
Post Mission		

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	

Julian Day 310	Flight A

LIDAR Flight Log

Date	November 05 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-8C
H-71%
hpa-1012
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:13	**Takeoff**	15:34	
Engine Off	15:55	**Landing**	15:48	
Total	0.7 hrs	**Total**	0.2 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1521	1526
Post Mission		

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp _____	Comments
			Start	End	Time	nmi to End		

Julian Day 311	Flight A

LIDAR Flight Log

Date	November 06 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-4C
H-81%
hpa-1009
AMLS-581m

Time to next maintenance: _____ ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:15	**Takeoff**	15:31	
Engine Off	21:45	**Landing**	21:36	
Total	6.5 hrs	**Total**	6.1 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1523	1528
Post Mission	2137	2142

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
F8		-	1603	1608				
X-Tie	432031101	-	1611	1634			161115	
1037	432031102	171	1638	1657			163847	
1038	432031103	351	1659	1716			165927	
1039	432031104	171	1717	1734			171736	
1040	432031105	351	1735	1752			173536	
1041	432031106	171	1753	1810			175355	
1042	432031107	351	1812	1828			181215	
1043	432031108	171	1830	1847			183039	
1044	432031109	351	1848	1904			184851	
1045	432031110	171	1906	1923			190659	
1046	432031111	351	1924	1940			192451	
1047	432031112	171	1942	1958			194236	
1048	432031113	351	2000	2015			200003	
1049	432031114	171	2017	2033			201720	

Julian Day 311	Flight A

LIDAR Flight Log

Date	November 06 , 2020	**Aircraft**	C-FFRY
Project	3202_QSI_Montana_Phase1	**Pilot**	Mac. McQuarrie
Location	Estevan Airport	**Operator**	Dan Arteaga
Mission Objective			

System	Riegl VQ-1560ii GSM
Unit	S2223543
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	43
Scanner 2 Drive	

Additional Notes

T-4C
H-81%
hpa-1009
AMLS-581m

Time to next maintenance: _____ ○ 50 hr ◉ 100 hr

Aircraft Block Time				
Engine On	15:15	**Takeoff**	15:31	
Engine Off	21:45	**Landing**	21:36	
Total	6.5 hrs	**Total**	6.1 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	500(x2)	kHz
Target Speed	160	kts	**Scan Rate**	267	Hz
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1523	1528
Post Mission	2137	2142

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID	Comments
			Start	End	Time	nmi to End	Time Stamp _____	
1050	432031115	351	2035	2050			203501	
F8		-	2052	2057				

Julian Day 282	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 8, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel

Mission Objective

QL1 first priority. Will not finish, but will get close.
1001-1003 next flight, along with QL 2.

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	A1
Scanner 2 Drive	A1

Additional Notes

Pressed to finish, but pilot concerned about fuel, with high winds at CYEN. Possible extra time for circuits/re routing. Better safe than sorry.

Time to next maintenance: 45.2+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	14:54	**Takeoff**	15:18	
Engine Off	21:08	**Landing**	20:59	
Total	6.2 hrs	**Total**	5.7 hrs	

Mission Plan			
AGL Height	1800 m	**Pulse Rate**	700 KHz
Target Speed	160 kts	**Scan Rate**	134(136 plane)
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	15:06	15:11
Post Mission	21:02	21:07

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201008	Comments
			Start	End	Time	nmi to End		
							201008_150610	
Test-Strip		245.0+/-	15:31	15:31			201008_153111	8700 ft
Figure 8		8	15:46	15:51				8100 ft
X-Tie	512028201	174.0+/-	15:53	15:59			155345	8200 ft
1031	512028202	266.5	16:03	16:09			160325	7800 ft
1030	512028203	086.0	16:13	16:19			161308	7800 ft
1029	512028204	266.4	16:22	16:29			162238	7800 ft
1028	512028205	085.9	16:32	16:38			163229	7800 ft
1027	512028206	266.5	16:42	16:48			164207	7800 ft
1026	512028207	086.0	16:51	16:58			165153	7800 ft
1025	512028208	266.4	17:01	17:08			170131	7800 ft
1024	512028209	086.0	17:11	17:17			171124	7800 ft
1023	512028210	266.5	17:21	17:27			172100	7800 ft
1022	512028211	086.0	17:30	17:36			173047	7800 ft
1021	512028212	266.5	17:40	17:46			174014	7800 ft

Julian Day 282	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 8, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel

Mission Objective

QL1 first priority. Will not finish, but will get close.
1001-1003 next flight, along with QL 2.

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	A1
Scanner 2 Drive	A1

Additional Notes

Pressed to finish, but pilot concerned about fuel, with high winds at CYEN. Possible extra time for circuits/re routing. Better safe than sorry.

Time to next maintenance: 45.2+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time					
Engine On	14:54	**Takeoff**	15:18		
Engine Off	21:08	**Landing**	20:59		
Total	6.2 hrs	**Total**	5.7 hrs		

Mission Plan					
AGL Height	1800	m	**Pulse Rate**	700 KHz	
Target Speed	160	kts	**Scan Rate**	134(136 plane)	
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	15:06	15:11
Post Mission	21:02	21:07

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201008	Comments
			Start	End	Time	nmi to End		
1020	512028213	086.0	17:49	17:55			201008_174951	7800 ft
1019	512028214	266.5	17:59	18:05			175908	7800 ft
1018	512028215	086.0	18:08	18:14			180847	7800 ft
1017	512028216	266.4	18:18	18:24			181817	7800 ft
1016	512028217	086.0	18:27	18:33			182750	7800 ft
1015	512028218	266.4	18:37	18:44			183726	7800 ft
1014	512028219	086.0	18:47	18:53			184716	7800 ft
1013	512028220	266.4	18:56	19:03			185659	7800 ft
1012	512028221	085.8	19:06	19:12			190643	7800 ft
1011	512028222	266.5	19:16	19:22			191616	7900 ft
1010	512028223	085.8	19:25	19:32			192557	7900 ft
1009	512028224	266.5	19:35	19:42			193532	7900 ft
1008	512028225	086.0	19:45	19:51			194540	7900 ft
1007	512028226	266.5	19:55	20:02			195515	7900 ft
1006	512028227	085.8	20:05	20:11			200505	8000 ft

Julian Day 282	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 8, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel

Mission Objective

QL1 first priority. Will not finish, but will get close.
1001-1003 next flight, along with QL 2.

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	A1
Scanner 2 Drive	A1

Additional Notes

Pressed to finish, but pilot concerned about fuel, with high winds at CYEN. Possible extra time for circuits/re routing. Better safe than sorry.

Time to next maintenance: 45.2+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	14:54	**Takeoff**	15:18	
Engine Off	21:08	**Landing**	20:59	
Total	6.2 hrs	**Total**	5.7 hrs	

Mission Plan			
AGL Height	1800 m	**Pulse Rate**	700 KHz
Target Speed	160 kts	**Scan Rate**	134(136 plane)
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	15:06	15:11
Post Mission	21:02	21:07

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201008	Comments
			Start	End	Time	nmi to End		
1005	512028228	266.4	20:14	20:21			201008_201442	8000 ft
1004	512028229	086.0	20:24	20:30			202434	8000 ft
Figure 8		8	20:31	20:34				8100 ft

v 20200520

Julian Day 283	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 9, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel
Mission Objective			

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	B1
Scanner 2 Drive	B1

Additional Notes

Cloud to the west, head east after 3 lines on CL1.

Time to next maintenance: 39.5+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	16:53	**Takeoff**	17:09	
Engine Off	22:57	**Landing**	22:49	
Total	6.1 hrs	**Total**	5.7 hrs	

Mission Plan					
AGL Height	1800	m	**Pulse Rate**	700 KHz	
Target Speed	160	kts	**Scan Rate**	134(136 plane)	
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	17:00	17:05
Post Mission	22:51	22:56

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201009	Comments
			Start	End	Time	nmi to End		
							201009_170027	
Figure 8		8	17:35	17:40				8100 ft
X-Tie_1	512028301	177.0+/-	17:42	17:43			201009_174209	8200 ft
1003	512028302	266.4	17:47	17:54			174739	8000 ft
1002	512028303	085.9	17:57	18:03			175720	8000 ft
1001	512028304	266.5	18:06	18:13			180646	8100 ft
Figure 8		8	18:13	18:17				8100 ft
								SWITCH TO HIGH PLAN QL2

Julian Day	284	Flight	A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 10, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel
Mission Objective			

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	A1
Scanner 2 Drive	A1

Additional Notes

Time to next maintenance: 33.8+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:56	**Takeoff**	16:16	
Engine Off	22:06	**Landing**	21:57	
Total	6.2 hrs	**Total**	5.7 hrs	

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	400 KHz	
Target Speed	160	kts	**Scan Rate**	89 (91 plane)	
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	16:04	16:09
Post Mission	22:00	22:05

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201010	Comments
			Start	End	Time	nmi to End		
							201010_160402	
Figure 8		8	17:00	17:05				9500 ft
X-Tie	512027421	083.1+/-	17:10	17:16			201010_171006	9500 ft
1129	512027422	173.5	17:21	17:38			172104	9400 ft
1128	512027423	353.5	17:41	17:58			174141	9400 ft
1127	512027424	173.5	18:01	18:19			180152	9400 ft
1126	512027425	353.5	18:22	18:40			182220	9400 ft
1125	512027426	173.4	18:43	19:01			184304	9400 ft
1124	512027427	353.4	19:04	19:21			190408	9400 ft
1123	512027428	173.4	19:25	19:42			192510	9400 ft
1122	512027429	353.3	19:45	20:02			194542	9400 ft
1121	512027430	173.3	20:05	20:23			200543	9400 ft
1120	512027431	353.3	20:26	20:42			202633	9500 ft
1119	512027432	173.2	20:45	21:02			204529	9500 ft
1118	512027433	353.2	21:05	21:21			210513	9500 ft

Julian Day 284	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 10, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel
Mission Objective			

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	A1
Scanner 2 Drive	A1

Additional Notes

Time to next maintenance: 33.8+/- ◉ 50 hr ○ 100 hr

Aircraft Block Time				
Engine On	15:56	**Takeoff**	16:16	
Engine Off	22:06	**Landing**	21:57	
Total	6.2 hrs	**Total**	5.7 hrs	

Mission Plan			
AGL Height	2300 m	**Pulse Rate**	400 KHz
Target Speed	160 kts	**Scan Rate**	89 (91 plane)
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	16:04	16:09
Post Mission	22:00	22:05

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201010	Comments
			Start	End	Time	nmi to End		
							201010_160402	
Figure 8		8	21:21	21:26				9500 ft

Julian Day 287	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 13, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana_QL2	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel

Mission Objective

1104-1117, more if possible.

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	B1
Scanner 2 Drive	B1

Additional Notes

*Fair bit of yaw, due to high winds.

Hit low ceilings south 5NM of 1102 &1103, refly 7NM to include in X-Tie

Time to next maintenance: 28.1 ◉ 50 hr ○ 100 hr

Aircraft Block Time					
Engine On	15:54	**Takeoff**	16:11		
Engine Off	22:03	**Landing**	21:55		
Total	6.2 hrs	**Total**	5.7 hrs		

Mission Plan					
AGL Height	2300	m	**Pulse Rate**	400 KHz	
Target Speed	160	kts	**Scan Rate**	89 (91 plane)	
Laser Current	100	%	**FOV**	60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	16:02	16:07
Post Mission	21:57	22:02

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201013	Comments
			Start	End	Time	nmi to End		
							201013_160259	
Figure 8		8	17:00	17:05				9400 ft
X-Tie	532028721	081.0+/-	17:05	17:11			201013_170545	9400-9500 ft
1117	532028722	173.2	17:16	17:32			171656	9400 ft
1116	532028723	353.1	17:37	17:50			173714	9400 ft
1115	532028724	173.1	17:53	18:06			175336	9500 ft * some cloud popping up
1114	532028725	353.1	18:10	18:23			181015	9500 ft
1113	532028726	173.0	18:26	18:37			182635	9500 ft
1112	532028727	353.0	18:40	18:51			184044	9600 ft
1111	532028728	173.0	18:54	19:05			185443	9600 ft
1110	532028729	352.9	19:09	19:20			190935	9500 ft
1109	532028730	172.9	19:24	19:35			192400	9500 ft
1108	532028731	352.8	19:38	19:50			193837	9500 ft
1107	532028732	172.8	19:52	20:04			195258	9500 ft
1106	532028733	352.8	20:07	20:18			200732	9500 ft

Julian Day 287	Flight A

LIDAR Flight Log

AIRBORNE IMAGING
A Clean Harbors Company

Date	October 13, 2020	**Aircraft**	C-GKSX
Project	3202_QSI_Montana_QL2	**Pilot**	Y. Kadota
Location	CYEN	**Operator**	R. Gemmel

Mission Objective

1104-1117, more if possible.

System	VQ-1560ii
Unit	51
IMU	Applanix AP60
GPS Rx	Trimble GNSS17
Scanner 1 Drive	B1
Scanner 2 Drive	B1

Additional Notes

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Hit low ceilings south 5NM of 1102 &1103, refly 7NM to include in X-Tie

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Mission Plan			
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Target Speed	160 kts	**Scan Rate**	89 (91 plane)
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	16:02	16:07
Post Mission	21:57	22:02

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 201013	Comments
			Start	End	Time	nmi to End		
1105	532028734	172.7	20:22	20:33			201013_202211	9500 ft
1104	532028735	352.7	20:36	20:48			203659	9500 ft
1103	532028736	172.7	20:51	21:03			205143	9500 ft, possible moisture, refly S. 7NM
1102	532028737	352.6	21:06	21:17			210603	9500 ft, possible moisture, refly S. 7NM
Figure 8		8	21:17	21:21				9500 ft