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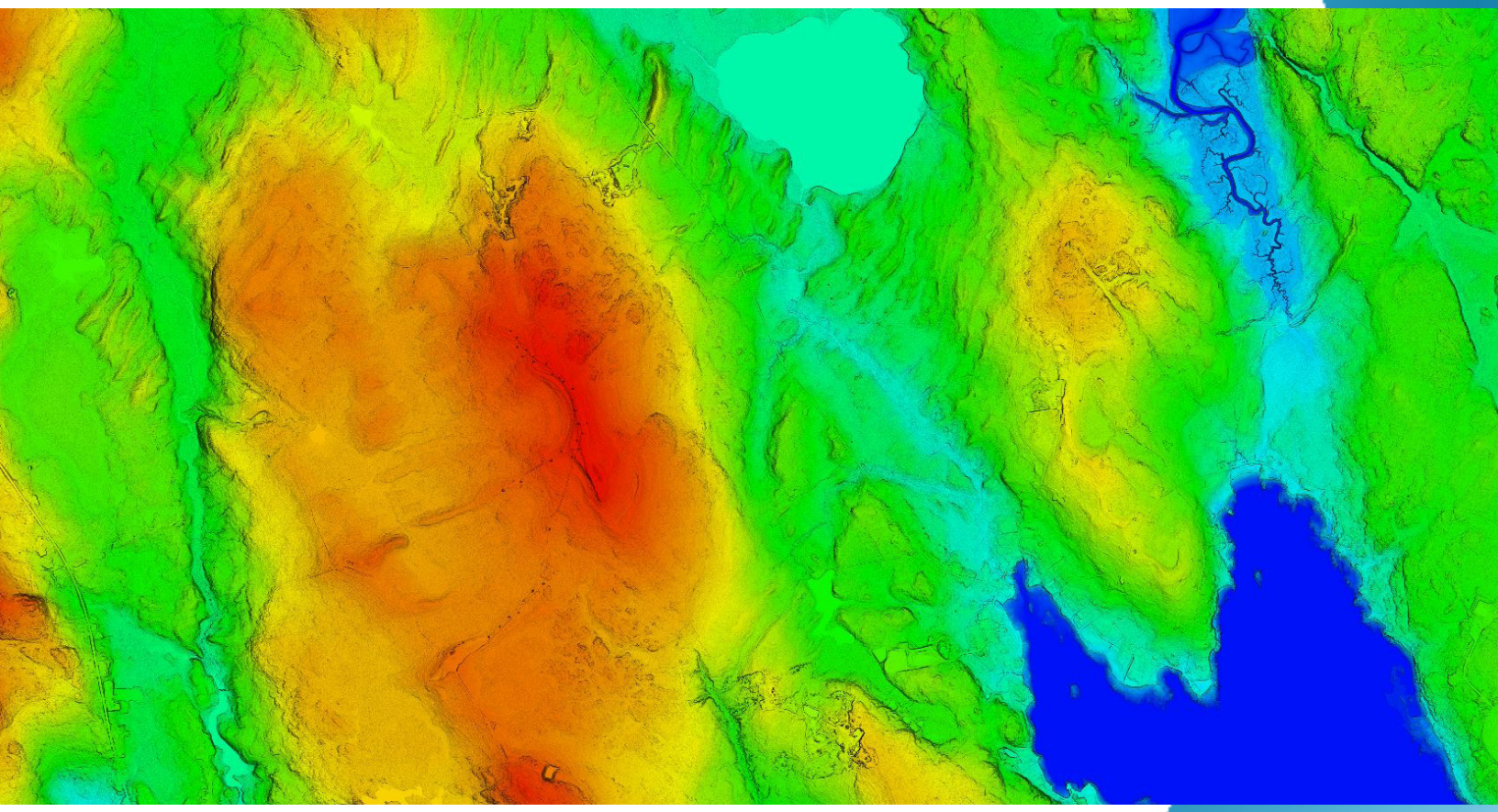

ME_MIDCOAST_2021_B21 LIDAR PROCESSING REPORT

2021

Work Package: 220048
Work Unit: 220045

Submitted: January 5, 2022

Prepared for:

USGS
science for a changing world

Prepared by:

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1. Summary / Scope

1.1. Summary

This report contains a summary of the ME_MidCoast_2021_B21, Work Unit 220045 lidar acquisition task order, issued by USGS under their Contract G16PC00016 on May 5, 2021. The task order yielded a project area covering approximately 1,387 square miles over Maine. 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	1900 m	58.5°	20%	≤ 10cm

1.3. Coverage

The project boundary covers approximately 1,387 square miles over Maine. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from May 9, 2021 to May 27, 2021 in nine total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

The following tiles are located over water and contain no deliverable points. Because of this, there are 8 fewer LAS and intensity deliverables than the 1,885 that appear in the tile index.

19TEJ558885.las 19TFK616921.las 19TFK625933.las 19TFK627933.las
19TFK640939.las 19TFK651948.las 19TFK660957.las 19TFK652930.las

ME_MidCoast_2021_B21 Work Unit 220045 Projected Coordinate System: UTM Zone 19N Horizontal Datum: NAD1983 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 Swath Separation images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Project Boundary • LiDAR Tile Index Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Survey Report • Processing Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery

ME_MidCoast_2021_B21
Work Unit 220045 Boundary

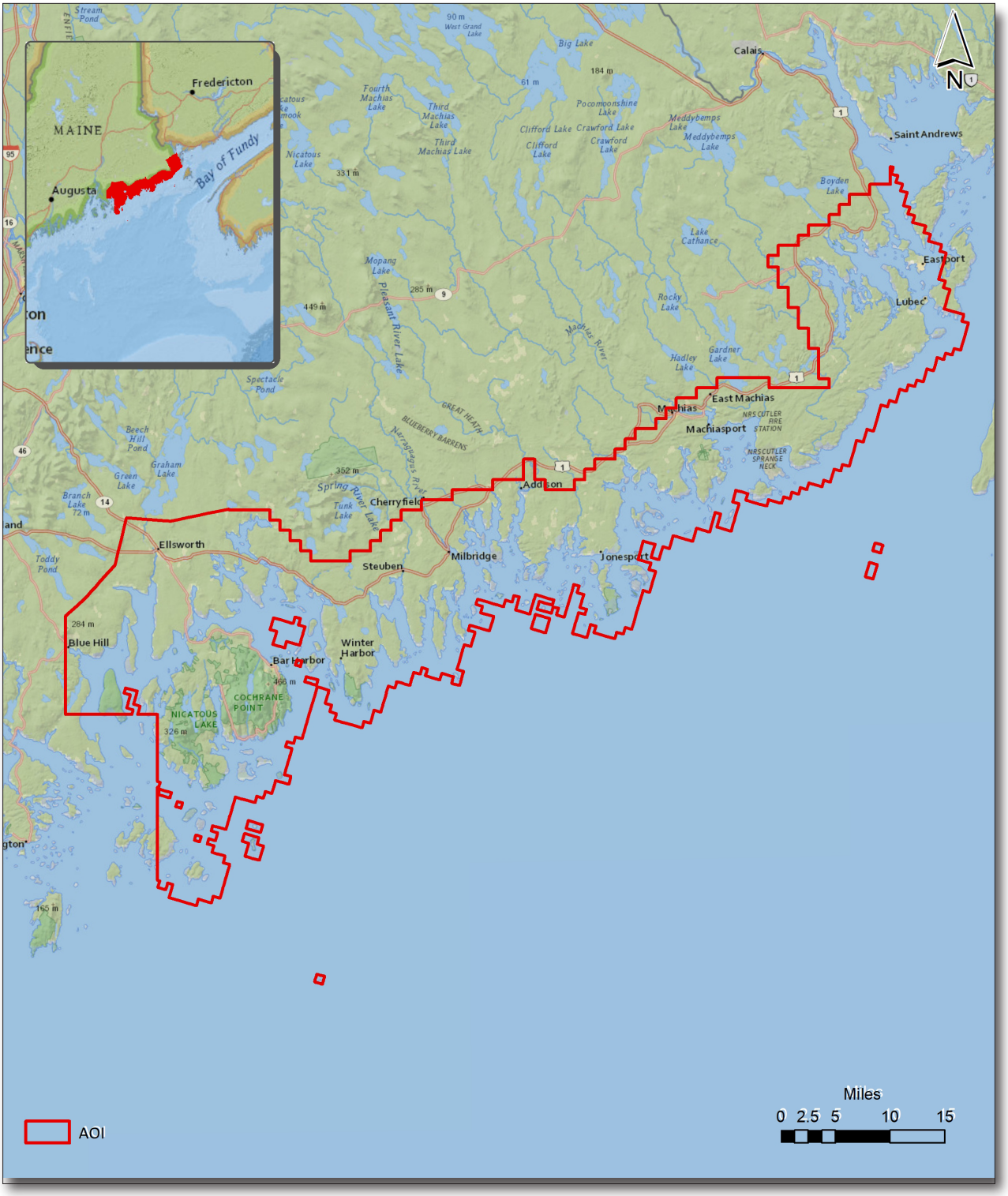


Figure 1. Work Unit Boundary

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. Planned flight lines are shown in Figure 2.

2.2. Lidar Sensor

NV5 Geospatial utilized a Rievl VQ1560i lidar sensors (Figure 3), serial number 3541 for data acquisition.

The Riegl 1560i system has a laser pulse repetition rate of up to 2 MHz resulting in more than 1.3 million measurements per second. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor is also equipped with the ability to measure up to an unlimited number of targets per pulse from the laser.

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

ME_MidCoast_2021_B21
Work Unit 220045 Planned Flight Lines

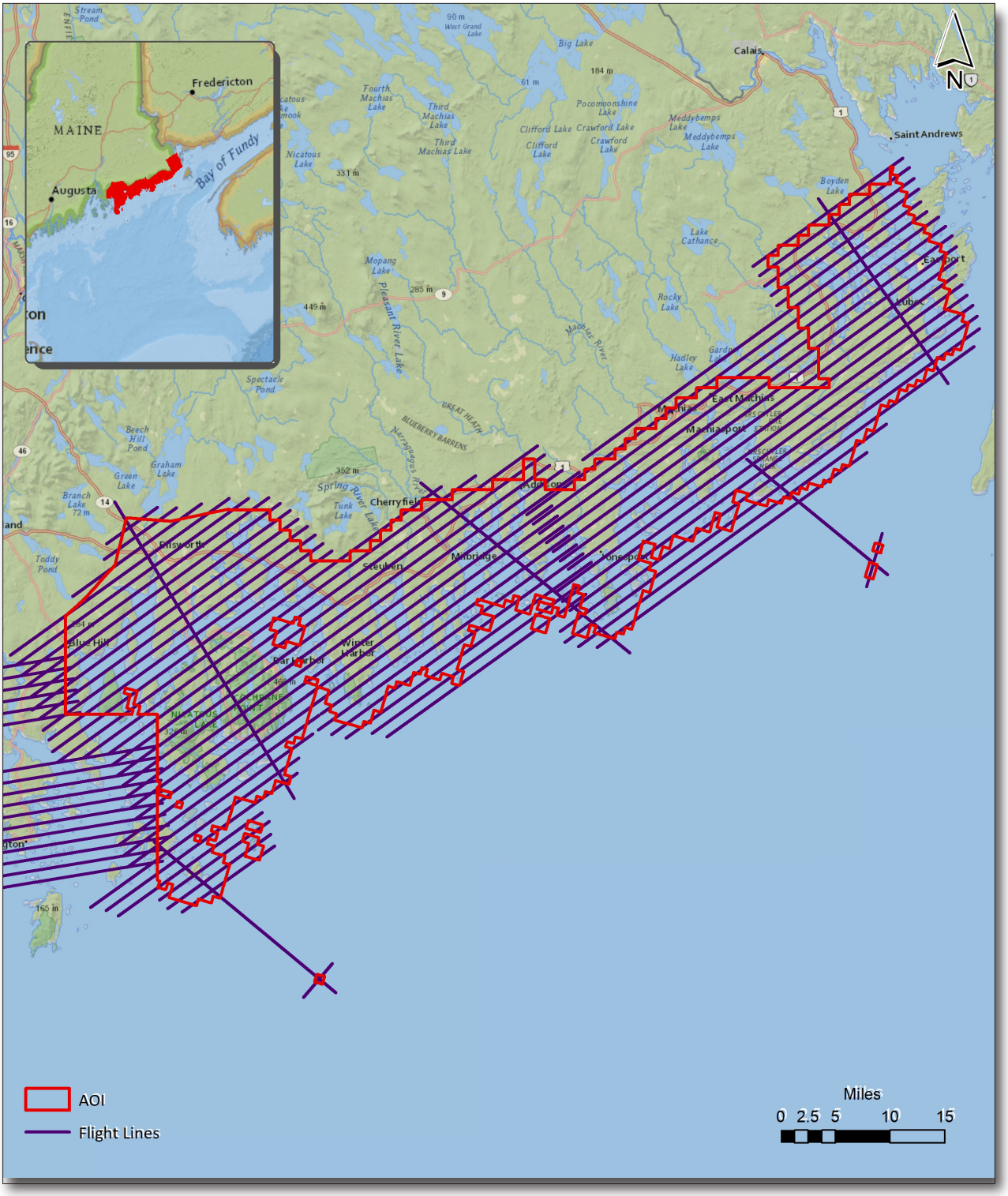


Figure 2. Planned Flight Lines

Table 2. Lidar System Specifications

		Riegl VQ1560i
Terrain and Aircraft Scanner	Flying Height	1900 m
	Recommended Ground Speed	140 kts
Scanner	Field of View	58°
	Scan Rate Setting Used	160 Hz
Laser	Laser Pulse Rate Used	350 kHz
	Multi Pulse in Air Mode	yes
Coverage	Full Swath Width	2110 m
	Line Spacing	1690 m
Point Spacing and Density	Average Point Spacing	0.58 m
	Average Point Density	3 pts / m^2

Figure 3. Riegl VQ1560i 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 Aztec (twin-piston), Tail Number(s): N62756

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 system. Some of NV5 Geospatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of NV5 Geospatial's Planes

2.4. Time Period

Project specific flights were conducted between May 9, 2021 and May 27, 2021. Nine aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
05092021A (SN3541,N62756)	5/09/2021 8:52:23 PM	5/09/2021 10:36:17 PM
05132021A (SN3541,N62756)	5/13/2021 9:48:07 PM	5/14/2021 1:11:58 AM
05142021A (SN3541,N62756)	5/14/2021 9:51:55 PM	5/15/2021 12:52:52 AM
05152021A (SN3541,N62756)	5/16/2021 12:05:14 AM	5/16/2021 1:47:46 AM
05172021A (SN3541,N62756)	5/17/2021 12:00:21 PM	5/17/2021 3:17:03 PM
05192021A (SN3541,N62756)	5/19/2021 3:47:17 PM	5/19/2021 5:06:20 PM
05202021A (SN3541,N62756)	5/20/2021 2:02:43 PM	5/20/2021 5:38:56 PM
05242021A (SN3541,N62756)	5/24/2021 5:48:22 PM	5/24/2021 7:54:56 PM
05272021A (SN3541,N62756)	5/27/2021 10:34:05 PM	5/27/2021 11:03:54 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 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. 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
RiPROCESS	1.8.6
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 the USGS Version 2.1 specifications 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.
22	Temporal Exclusion	Points that are excluded due to differences in collection dates

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 1 meter 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

GeoCue software was used to create the deliverable intensity images. All withheld points were

ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 1-meter were then provided as the deliverable for this dataset requirement.

3.8. Height 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. Proprietary software was used to create 1-meter raster images in GeoTIFF format.

ME_MidCoast_2021_B21
Work Unit 220045 Tile Layout

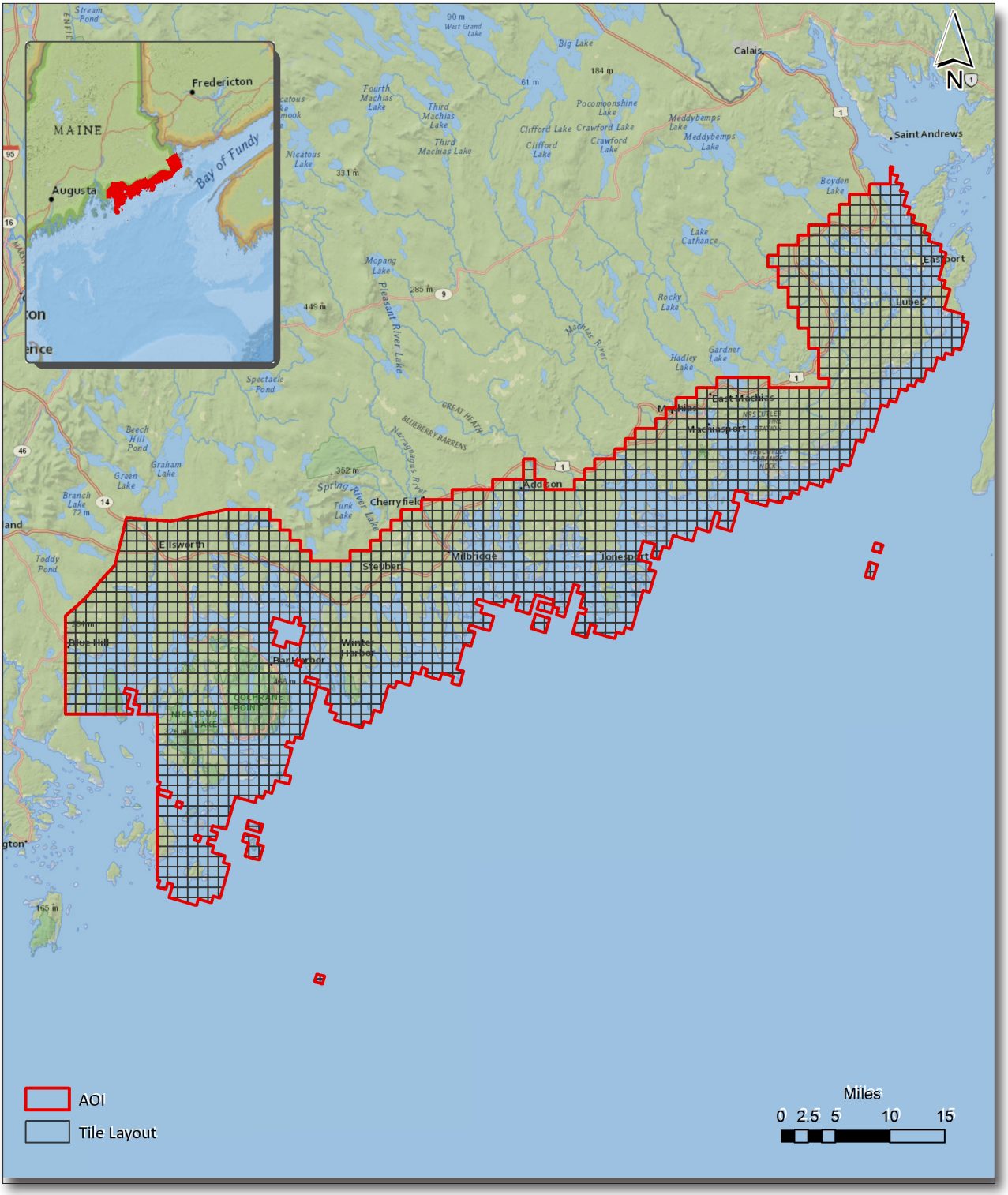


Figure 5. Lidar Tile Layout

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 6.

ME_MidCoast_2021_B21
Work Unit 220045 Lidar Coverage

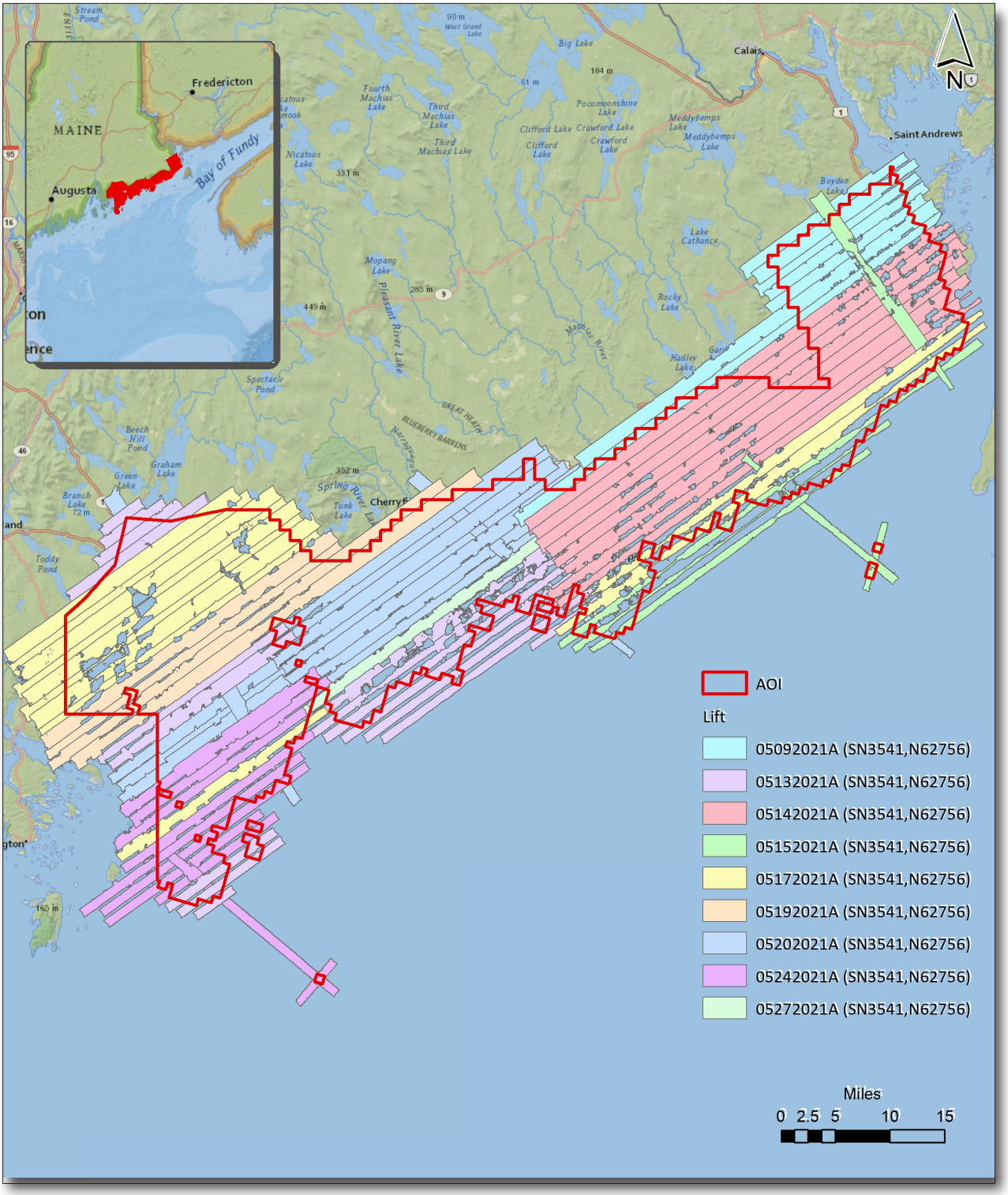


Figure 6. Lidar Coverage

5. Geometric Accuracy

5.1. Horizontal Accuracy

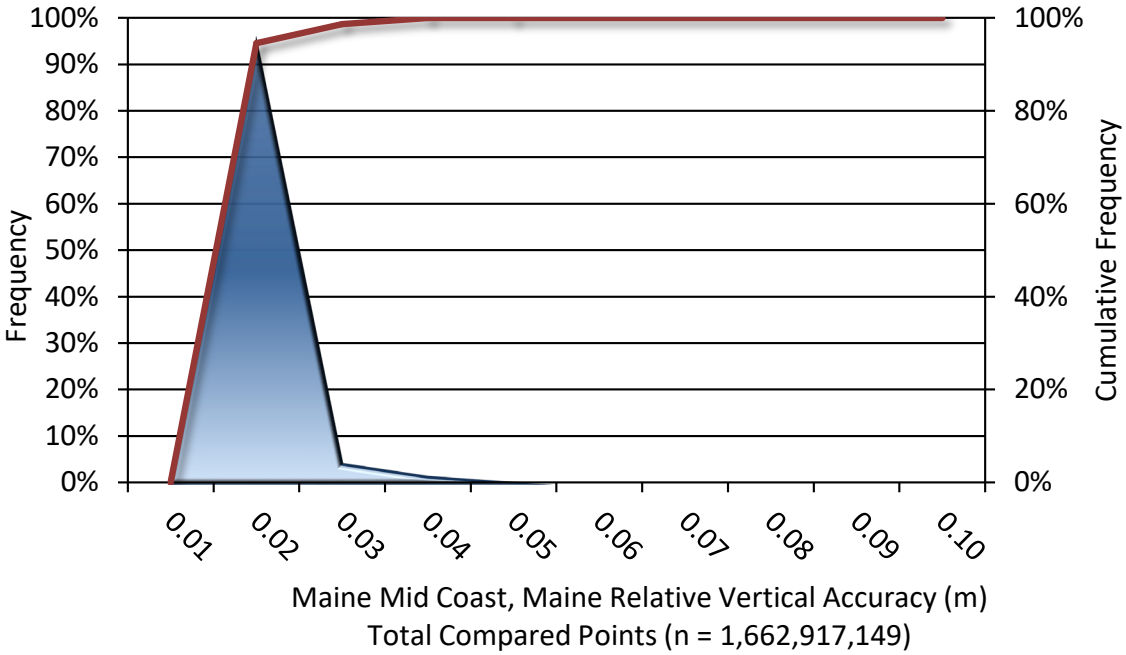
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 1900 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.019 meters, this project was compiled to meet 0.21 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.12 m
	0.39 ft
ACC_r	0.21 m
	0.68 ft

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 ME_MidCoast_2021_B21 project was 0.052 feet (0.016 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	73 flight line surfaces
Average	0.052 ft
	0.016 m
Median	0.053 ft
	0.016 m
RMSE	0.056 ft
	0.017 m
Standard Deviation (1σ)	0.009 ft
	0.003 m
1.96σ	0.017 ft
	0.005 m



Project Report Appendices

The following section contains the appendices as listed in the ME_MidCoast_B21_2021 Lidar Project Report.

Appendix A

Flight Logs

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_129_A
Date	9-May-21
Julian Day	129
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
20:21	23:20	4.6	2.98

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV01_1900m_140kn_350khz_2ppm_\	1	1970.652	159.5115104	2021-05-09 20:35:24	5/9/2021 20:36	test
R1_MENV01_1900m_140kn_350khz_2ppm_\	2	1969.86	132.6865184	2021-05-09 20:50:31	5/9/2021 20:50	test
R1_MENV01_1900m_140kn_350khz_2ppm_\	3000	1942.551	137.2428794	2021-05-09 20:52:21	5/9/2021 20:59	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3001	1943.256	115.2366667	2021-05-09 21:02:32	5/9/2021 21:10	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3002	1926.213	125.1794083	2021-05-09 21:13:42	5/9/2021 21:13	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3	1938.391	135.9288435	2021-05-09 21:17:56	5/9/2021 21:18	test
R1_MENV01_1900m_140kn_350khz_2ppm_\	3002	1936.269	136.7996838	2021-05-09 21:18:26	5/9/2021 21:25	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3003	1933.521	109.6053622	2021-05-09 21:28:49	5/9/2021 21:37	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3004	1923.268	138.9923354	2021-05-09 21:43:51	5/9/2021 21:50	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3005	1970.605	122.862351	2021-05-09 21:53:45	5/9/2021 22:12	
R1_MENV01_1900m_140kn_350khz_2ppm_\	3006	1943.528	130.334472	2021-05-09 22:18:14	5/9/2021 22:36	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_133_A
Date	13-May-21
Julian Day	133
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
20:33	0:20	5.7	3.78

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV02_1900m_140kn_350khz_2ppm_\	1	1800.539	125.1444192	2021-05-13 21:41:26	5/13/2021 21:41	test
R1_MENV02_1900m_140kn_350khz_2ppm_\	2	1980.732	129.3100683	2021-05-13 21:46:55	5/13/2021 21:47	test
R1_MENV02_1900m_140kn_350khz_2ppm_\	2000	1980.133	131.3452688	2021-05-13 21:48:04	5/13/2021 21:49	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2001	2024.777	123.4999306	2021-05-13 21:53:26	5/13/2021 21:56	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2002	2012.235	133.2891088	2021-05-13 21:59:30	5/13/2021 22:03	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2003	1982.113	127.7763786	2021-05-13 22:06:11	5/13/2021 22:07	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2031	2073.782	128.5344762	2021-05-13 22:18:40	5/13/2021 22:27	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2032	2078.302	124.3474448	2021-05-13 22:30:12	5/13/2021 22:38	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2047	1861.952	133.9947227	2021-05-13 22:48:13	5/13/2021 22:49	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2046	1856.722	127.7822101	2021-05-13 22:55:20	5/13/2021 23:00	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2045	1913.952	131.2305822	2021-05-13 23:03:37	5/13/2021 23:08	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2026	1900.086	131.003153	2021-05-13 23:12:26	5/13/2021 23:23	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2027	1894.782	119.194325	2021-05-13 23:27:09	5/13/2021 23:40	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2028	1875.222	136.6655589	2021-05-13 23:43:54	5/13/2021 23:53	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2029	1868.95	123.6515501	2021-05-13 23:56:45	5/14/2021 0:07	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2025	1986.962	141.8653309	2021-05-14 00:12:33	5/14/2021 0:24	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2030	1867.801	116.8053456	2021-05-14 00:27:24	5/14/2021 0:30	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2024	1977.288	114.1228464	2021-05-14 00:39:47	5/14/2021 0:52	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2003	1981.662	118.1543706	2021-05-14 01:05:10	5/14/2021 1:11	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_134_A
Date	14-May-21
Julian Day	134
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
20:20	00:31:00	5.5	4.18

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV03_1900m_140kn_350khz_2ppm_V	3007	1932.621	131.7729136	5/14/2021 21:51	5/14/2021 22:11	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3008	1972.102	128.8182768	5/14/2021 22:15	5/14/2021 22:35	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3009	1946.745	127.3934421	5/14/2021 22:38	5/14/2021 22:58	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3010	1954.927	122.3958294	5/14/2021 23:01	5/14/2021 23:21	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3011	1944.817	131.8681618	5/14/2021 23:24	5/14/2021 23:43	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3012	1933.593	125.9375059	5/14/2021 23:47	5/15/2021 0:06	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3013	1934.489	127.0727085	5/15/2021 0:09	5/15/2021 0:29	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3014	1930.608	127.3370707	5/15/2021 0:32	5/15/2021 0:52	
R1_MENV03_1900m_140kn_350khz_2ppm_V	3020	1861.179	126.2679587	2021-05-15 00:56:04	5/15/2021 0:58	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_135_A
Date	15-May-21
Julian Day	135
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
22:47	00:20:00	3.2	2.55

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV03_1900m_140kn_350khz_2ppm_\	3019	1863.514	136.0532493	5/16/2021 0:05	5/16/2021 0:17	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3021	1869.669	119.0096602	5/16/2021 0:20	5/16/2021 0:23	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3023	1911.244	113.5241437	5/16/2021 0:26	5/16/2021 0:35	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3018	1877.397	136.4614557	5/16/2021 0:48	5/16/2021 1:01	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3022	1941.307	112.6610787	5/16/2021 1:05	5/16/2021 1:15	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3017	1919.518	112.1070843	5/16/2021 1:25	5/16/2021 1:47	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_137_A
Date	17-May-21
Julian Day	137
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
10:24	14:39:00	5	4.25

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV02_1900m_140kn_350khz_2ppm_\	1	888.436	115.0733842	5/17/2021 11:28	5/17/2021 11:29	Test Shot
R1_MENV02_1900m_140kn_350khz_2ppm_\	2004	2041.078	125.6400984	5/17/2021 12:00	5/17/2021 12:11	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2005	2144.554	130.0681659	5/17/2021 12:14	5/17/2021 12:26	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2006	2060.286	126.1765982	5/17/2021 12:29	5/17/2021 12:41	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2007	1974.291	130.0662221	5/17/2021 12:45	5/17/2021 12:57	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2008	2025.593	125.6051093	5/17/2021 13:01	5/17/2021 13:14	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2009	2080.064	127.9940886	5/17/2021 13:18	5/17/2021 13:30	Refly
R1_MENV02_1900m_140kn_350khz_2ppm_\	2010	2178.489	122.9051155	5/17/2021 13:34	5/17/2021 13:48	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2011	1992.912	131.6971038	5/17/2021 13:51	5/17/2021 14:04	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3015	1932.573	129.3917096	5/17/2021 14:14	5/17/2021 14:32	
R1_MENV03_1900m_140kn_350khz_2ppm_\	3016	1934.22	125.7139643	5/17/2021 14:36	5/17/2021 14:56	
R1_MENV02_1900m_140kn_350khz_2ppm_\	2039	1914.646	126.6664459	5/17/2021 15:07	5/17/2021 15:17	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_139_A
Date	19-May-21
Julian Day	139
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
14:23:00	16:30:00	3.4	2.12

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV02_1900m_140kn_350khz_2ppm_V	1	1012.219	114.2511398	2021-05-19 15:28:53	5/19/2021 15:29	test shot
R1_MENV02_1900m_140kn_350khz_2ppm_V	2012	1977.051	146.0892952	2021-05-19 15:47:14	5/19/2021 15:59	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2014	1997.334	106.2872274	2021-05-19 16:02:26	5/19/2021 16:23	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2013	1977.785	136.9027074	2021-05-19 16:28:37	5/19/2021 16:40	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2015	2031.471	105.6166026	2021-05-19 16:43:58	5/19/2021 17:06	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_140_A
Date	20-May-21
Julian Day	139
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
12:50:00	17:03:00	4.9	4.22

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV02_1900m_140kn_350khz_2ppm_V	1	1140.341	109.5062264	2021-05-20 13:54:47	5/20/2021 13:55	Test Fire
R1_MENV02_1900m_140kn_350khz_2ppm_V	2049	2297.22	131.2791782	2021-05-20 14:02:42	5/20/2021 14:15	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2033	2247.745	104.2928475	2021-05-20 14:24:50	5/20/2021 14:35	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2034	2310.605	134.1113531	2021-05-20 14:37:56	5/20/2021 14:46	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2035	2319.327	101.0855115	2021-05-20 14:49:59	5/20/2021 15:00	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2016	1935.913	106.5477019	2021-05-20 15:05:06	5/20/2021 15:20	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2017	1945.543	133.1685907	2021-05-20 15:23:44	5/20/2021 15:35	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2018	1945.074	107.7645458	2021-05-20 15:39:15	5/20/2021 15:54	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2019	1954.055	135.6294922	2021-05-20 15:57:24	5/20/2021 16:09	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2021	1948.792	110.4451011	2021-05-20 16:12:49	5/20/2021 16:27	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2022	1963.36	136.2437456	2021-05-20 16:30:06	5/20/2021 16:41	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2020	1939.958	109.5703731	2021-05-20 16:44:01	5/20/2021 17:00	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2048	1947.191	122.304469	2021-05-20 17:08:54	5/20/2021 17:19	
R1_MENV02_1900m_140kn_350khz_2ppm_V	2023	1965.582	135.3942875	2021-05-20 17:27:50	5/20/2021 17:38	

Project	2021-2383-4859-NV5_Maine-LiDAR
Mission ID	756_21_144_A
Date	24-May-21
Julian Day	139
Aircraft	Aztec - N62756
Sensor	VQ-1560i - S2223541
Pilot(s)	Peter Durudogan
Operator	Greg Ring
Planned AGL	1900 m
Planned Speed	140 knots

Time

Up (UTC)	Down (UTC)	Hobbs (Hours)	Air (Hours)
13:30:00	15:30:00	2.7	2

Lines

Plan ID	Run	Altitude (m)	Speed (knots)	Start	Stop	Note
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1579	1	1301.659	106.5924102	2021-05-24 17:32:30	5/24/2021 17:32	test fire
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1580	2050	1922.46	135.1065992	2021-05-24 17:48:13	5/24/2021 17:56	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1581	2051	1870.057	118.7627925	2021-05-24 18:02:52	5/24/2021 18:05	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1582	2036	2188.456	122.3122443	2021-05-24 18:19:21	5/24/2021 18:28	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1583	2037	2016.96	123.0645104	2021-05-24 18:31:53	5/24/2021 18:41	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1584	2038	1953.121	124.7031675	2021-05-24 18:45:05	5/24/2021 18:55	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1585	2040	1926.343	121.1595472	2021-05-24 18:58:27	5/24/2021 19:07	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1586	2041	1931.379	123.0198021	2021-05-24 19:12:27	5/24/2021 19:23	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1587	2042	1888.646	126.8705491	2021-05-24 19:26:19	5/24/2021 19:35	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1588	2043	1926.097	123.202523	2021-05-24 19:39:06	5/24/2021 19:46	
R1_MENV02_1900m_140kn_350khz_2ppm_VQ1589	2044	1931.216	124.6545715	2021-05-24 19:49:10	5/24/2021 19:54	