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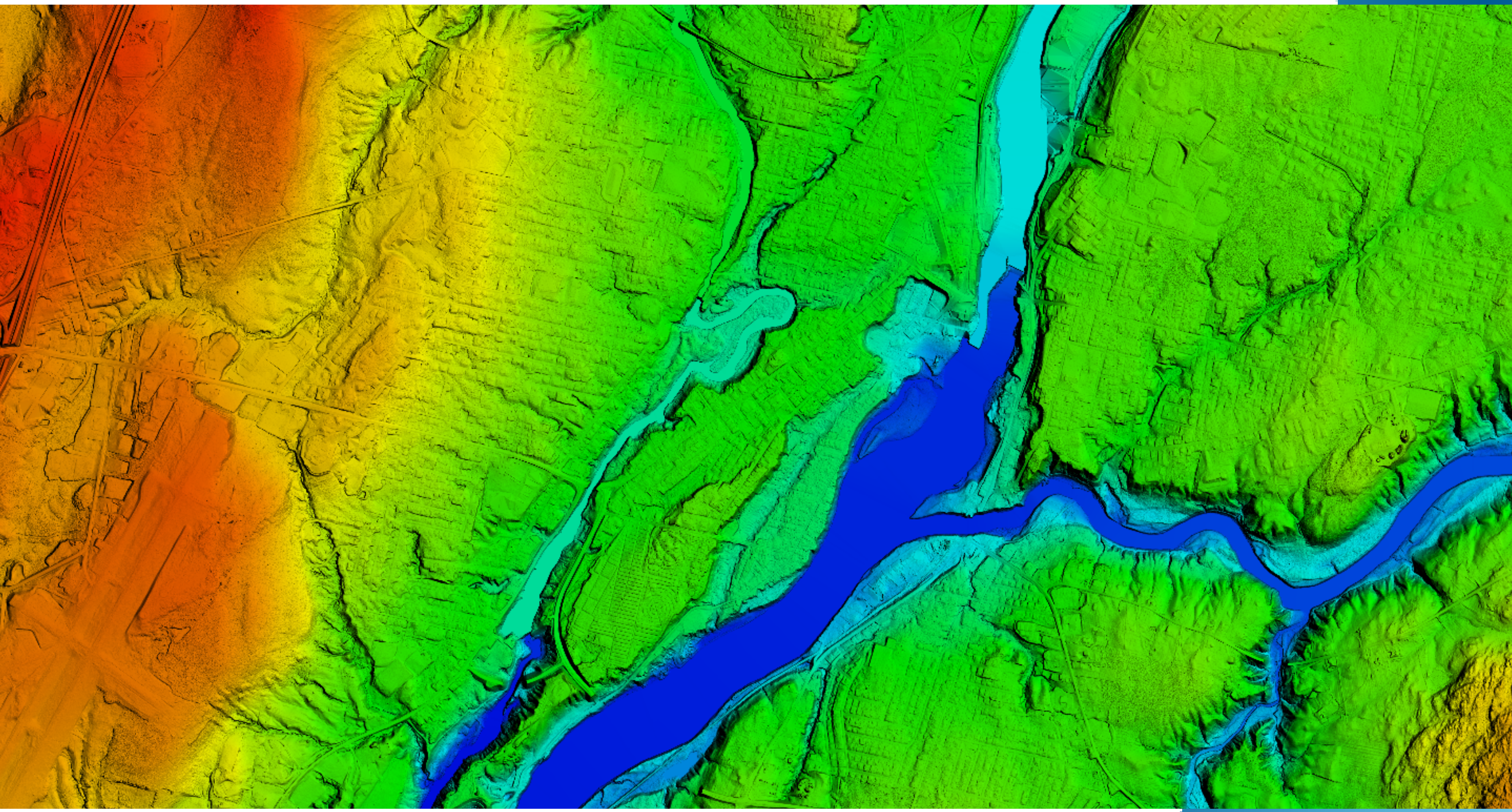

South Central Maine LIDAR PROCESSING REPORT

2023

Submitted: March 28, 2023

Project ID: 37735
Work Unit: 230147

Prepared:

USGS science for a changing world

Prepared by:

NV5 GEOSPATIAL

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1. Summary / Scope

1.1. Summary

This report contains a summary of the South Central Maine, Work Unit 230147 lidar acquisition task order, issued by USGS under their Contract 140G0221D0012 on 3/30/2022. The task order yielded a project area covering 2,505 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 ppsm	1350 m	60°	0%	≤ 10 cm

1.3. Coverage

The project boundary covers 2,505 square miles over Maine. Project extents are shown in Figure 1.

1.4. Duration

Lidar data was acquired from April 7, 2022 and April 21, 2022 in 13 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

This project was acquired with tidally impacted waters within +/- 120 minutes of predicted low tide of the corresponding tide station. NV5 Geospatial used 4 tidal stations: Salmon Falls River, ME, Cousins River, ME, Kennebec River, ME and Kennebec River Millstar/Lockwood Dam, ME.

South Central Maine Work Unit 230147 Projected Coordinate System: NAD_1983_2011_UTM_Zone_19N Horizontal Datum: NAD83 (2011) Vertical Datum: NAVD88 (GEOID GEOID18) 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
Vectors	Shapefiles (*.shp) • Project Boundary • Lidar Tile Index • Calibration and QC Checkpoints (NVA/VVA) • 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 • Contours

South Central Maine
Work Unit 230147 Boundary

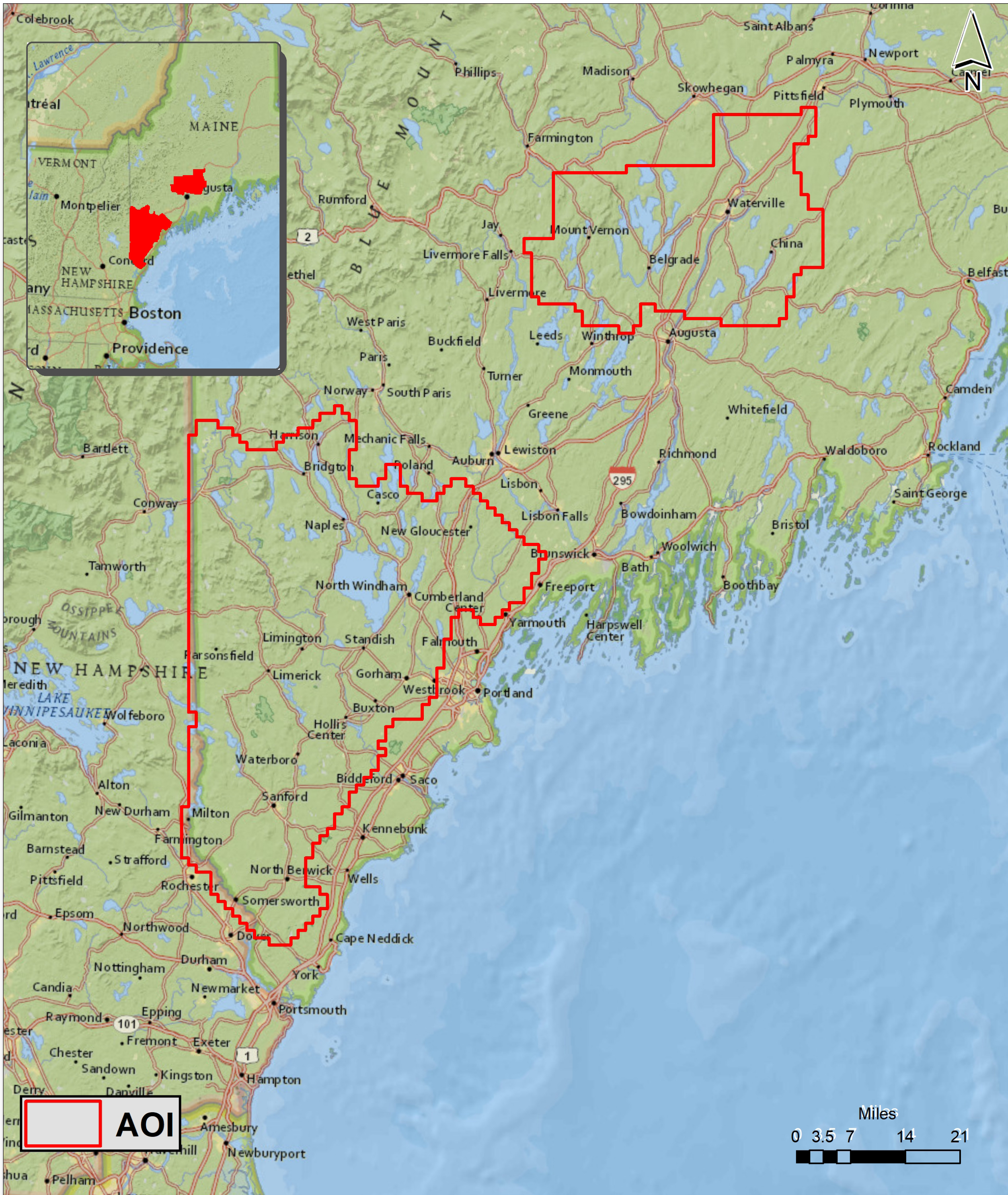


Figure 1. Work Unit Boundary

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 VQ-780i lidar sensors (Figure 2), serial number SN3368 for data acquisition.

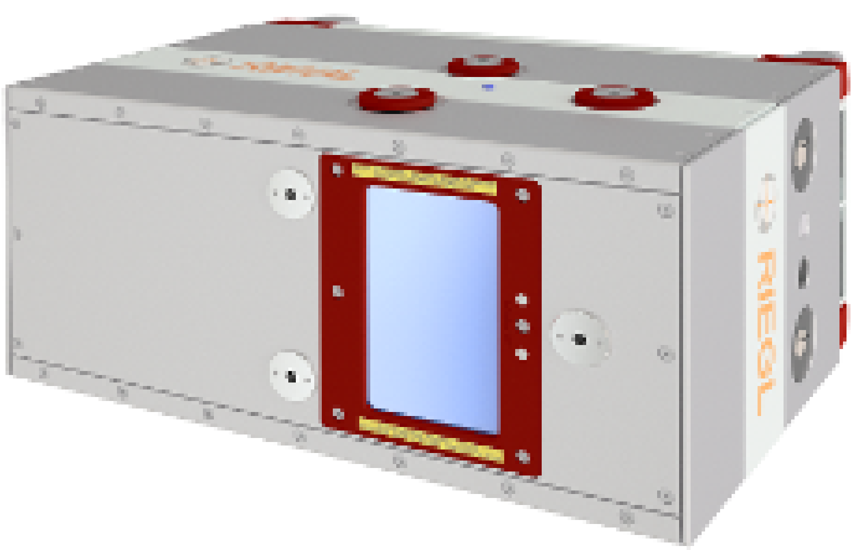
The Riegl VQ-780i system provides further increased performance and highest productivity based on a laser pulse repetition rate of up to 2 MHz, resulting in more than 1.33 million measurements/sec on the ground. The versatile scanner is designed for high efficient data acquisition at low, mid, and high altitudes, covering a variety of different airborne laser scanning applications from high density to wide area mapping.

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 VQ-780i
Terrain and Aircraft Scanner	Flying Height	1350 m
	Recommended Ground Speed	180 kts
Scanner	Field of View	60°
	Scan Rate Setting Used	199 Hz
Laser	Laser Pulse Rate Used	1000 kHz
	Multi Pulse in Air Mode	YES
Coverage	Full Swath Width	1599 m
	Line Spacing	0.463 m
Point Spacing and Density	Average Point Spacing	0.468 m
	Average Point Density	4.62 pts / m^2

Figure 2. Riegl VQ-780i Lidar Sensor



2.3. Aircraft

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

Lidar Collection Planes

- Piper PA-31 Navajo, Tail Number(s): C-GJDD

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

Figure 3. NV5 Geospatial's Aircraft

2.4. Time Period

Project specific flights were conducted between April 7, 2022 and April 21, 2022. Thirteen aircraft lifts were completed. Accomplished lifts are listed below.

Lift	Start UTC	End UTC
04072022A (SN3368,C-GJDD)	4/07/2022 11:49:45 AM	4/07/2022 3:24:36 PM
04102022A (SN3368,C-GJDD)	4/10/2022 11:49:07 AM	4/10/2022 12:14:52 PM
04112022A (SN3368,C-GJDD)	4/11/2022 10:42:07 AM	4/11/2022 2:16:49 PM
04112022B (SN3368,C-GJDD)	4/11/2022 3:48:54 PM	4/11/2022 7:08:38 PM
04112022C (SN3368,C-GJDD)	4/11/2022 8:50:07 PM	4/12/2022 12:31:25 AM
04112022D (SN3368,C-GJDD)	4/12/2022 1:52:06 AM	4/12/2022 5:04:32 AM
04152022B (SN3368,C-JGDD)	4/15/2022 3:04:54 PM	4/15/2022 7:05:46 PM
04152022C (SN3368,C-JGDD)	4/15/2022 8:39:24 PM	4/15/2022 11:27:27 PM
04182022A (SN3368,C-JGDD)	4/18/2022 11:25:44 AM	4/18/2022 3:19:13 PM
04182022B (SN3368,C-JGDD)	4/18/2022 4:24:49 PM	4/18/2022 8:06:41 PM
04212022A1 (SN3368,C-JGDD)	4/21/2022 10:13:37 AM	4/21/2022 11:44:22 AM
04212022A2 (SN3368,C-JGDD)	4/21/2022 11:54:21 AM	4/21/2022 11:57:43 AM
04212022A3 (SN3368,C-JGDD)	4/21/2022 12:07:19 PM	4/21/2022 12:16:43 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 was imported into GeoCue distributive processing software. Imported data was tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control was tested and any bias was removed from the data. TerraScan and TerraModeler software packages were 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 were then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper was used as a final check of the bare earth dataset.

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

Software	Version
StripAlign	2.21
Applanix + POSPac	8.6
RiPROCESS	1.8.6
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 2021, Revision 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 bare earth class, or any other project classification
2	Bare earth	Laser returns that are determined to be bare earth 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 bare earth 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 bare earth surface
20	Ignored Ground	Bare earth points that fall within the given threshold of a collected hydro feature.
21	Snow	Bare Earth points that fall on snow, where identifiable
22	Temporal Exclusion	Points that are excluded due to differences in collection dates

3.4. Classified LAS Processing

The bare earth surface was then manually reviewed to ensure correct classification on the Class 2 (Ground) points. After the bare- earth surface was finalized; it was 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 3 feet/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

Using heads-up digitization, all Lake-Ponds, Double Line Drains, and Islands are manually collected that are within the project size specification. This includes Lake-Ponds greater than 2 acres in size, Double Line Drains with greater than a 100 foot nominal width, and Islands greater than 1 acre in size within a collected hydro feature. Lidar intensity imagery and bare-earth surface models are used to ensure appropriate and complete collection of these features.

Elevation values were assigned to all collected hydro features via NV5 Geospatial's proprietary software. This software sets Lake-Ponds to an appropriate, single elevation to allow for the generation of hydro-flattened digital elevation models (DEM). Double Line Drain elevations were assigned based on lidar elevations and surrounding terrain feature 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 variances are reviewed, all breaklines are evaluated for topological consistency and data integrity using a combination of proprietary tools and manual review of hydro-flattened DEMs.

Breaklines are combined into one seamless shapefile, clipped to the project boundary, and imported into an Esri file geodatabase for delivery.

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 1-meter. 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 was 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. 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.

(green)	0-8cm
(yellow)	8-16cm
(orange)	16-24cm
(red)	>24cm

3.9. Maximum Surface Height Raster Processing

Maximum Surface Height rasters (topographic) represent a lidar-derived product illustrating natural and built-up features. NV5 Geospatial's proprietary software was used to take all first-return classified lidar points, excluding those flagged with a withheld bit, and create a raster on a tile-by-tile basis. Data extending past the tile edge is incorporated in this process so that proper gridding can occur. 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 was generated for each tile with a pixel size of 1-meter. 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 maximum surface height raster is reviewed in Global Mapper to check for any anomalies and to ensure a seamless dataset. 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.

3.10. Contour Processing

Automated routines within TerraScan and TerraModeler generate an educated, thinned subset of bare earth points (ASPRS Class 8, Model Key). Model Key points and hydro-flattened breaklines were used to generate a terrain surface from which 2-foot contours could be generated. Using proprietary software, all tiled contour shapefiles were combined into one, continuous dataset within an Esri File Geodatabase. All lines have their elevations as their attributes and there are no spot elevations or depressions on separate layers.

South Central Maine
Work Unit 230147 Tile Layout

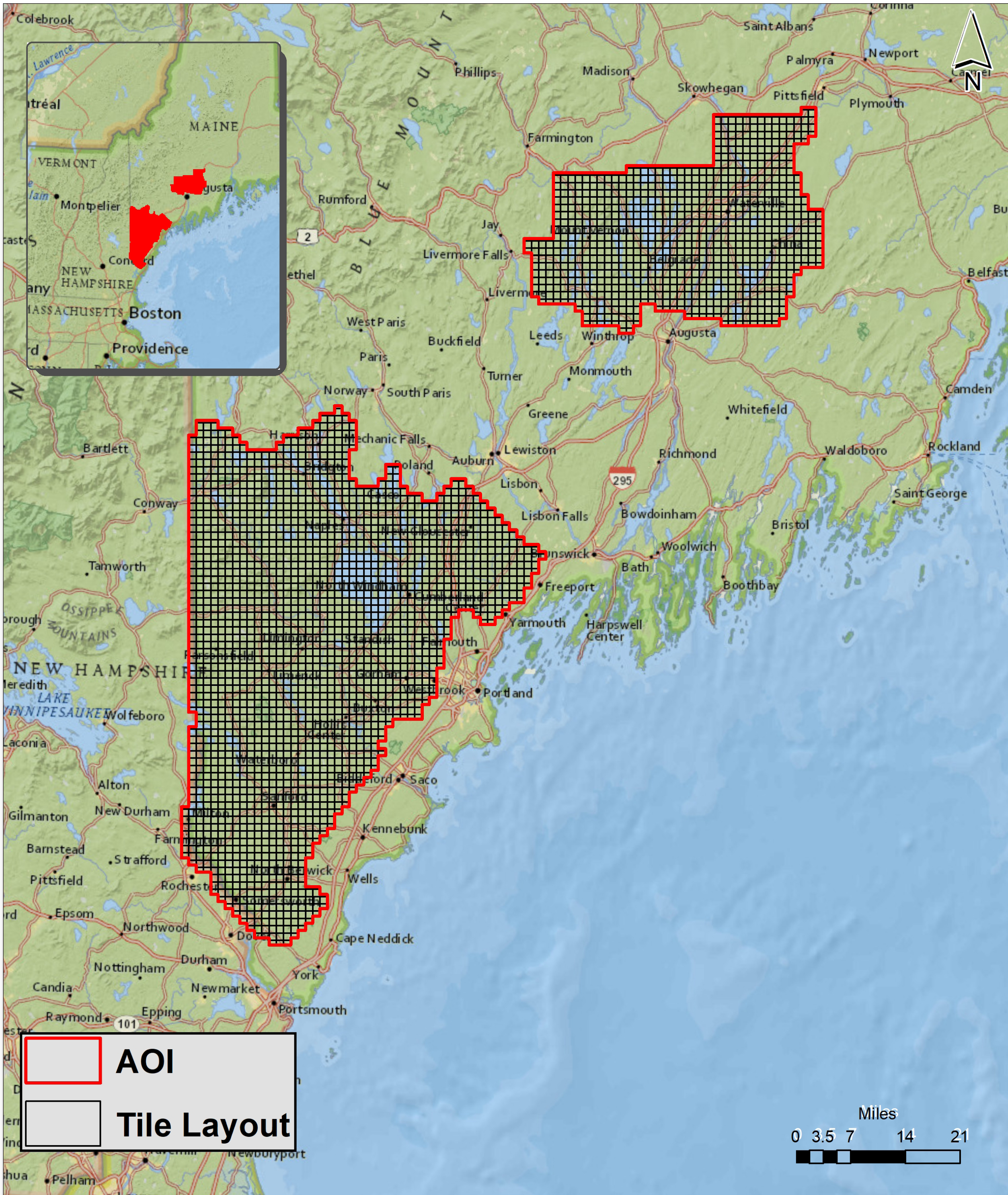


Figure 4. Lidar Tile Layout

4. Project Coverage Verification

A proprietary tool (FOCUS on Flight) produces grid-based polygons of each flightline, depicting exactly where lidar points exist. These swath polygons are reviewed against the project boundary to verify adequate project coverage. Please refer to Figure 5.

South Central Maine
Work Unit 230147 Lidar Coverage

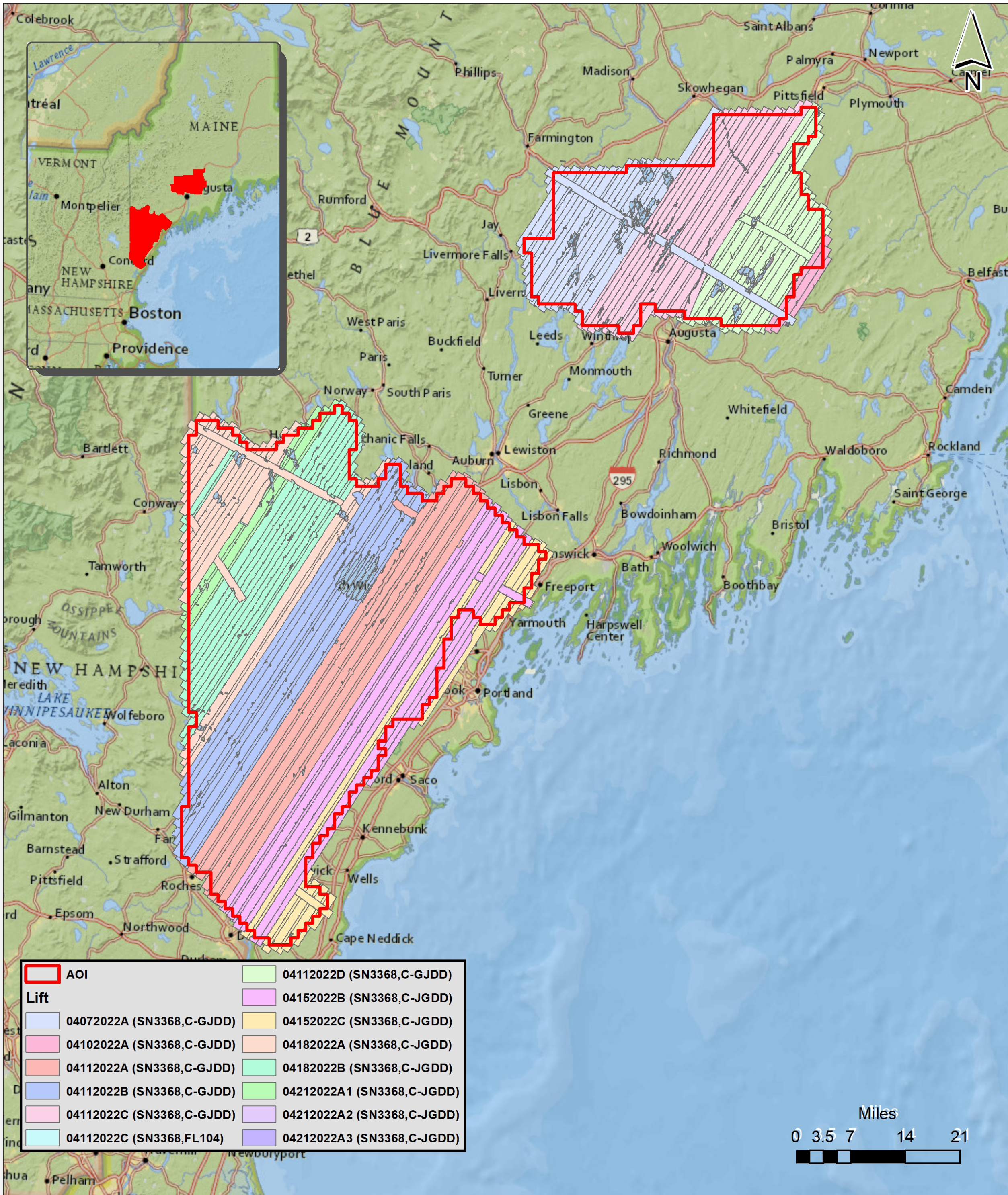


Figure 5. Lidar Coverage

5. Accuracy Testing

5.1. Calibration Control Point Testing

Figure 6 shows the location of each bare earth calibration point for the project area. TerraScan was used to perform a quality assurance check using the lidar bare earth calibration points. The results of the surface calibration are not an independent assessment of the accuracy of these project deliverables, but the statistical results do provide additional feedback as to the overall quality of the elevation surface.

5.2. Point Cloud Testing

The project specifications require that only Non-Vegetated Vertical Accuracy (NVA) be computed for raw lidar point cloud swath files. The required accuracy (ACCz) is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. The NVA was tested with 83 checkpoints located in bare earth and urban (non-vegetated) areas. These check points were not used in the calibration or post processing of the lidar point cloud data. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See survey report for additional survey methodologies.

Elevations from the unclassified lidar surface were measured for the x,y location of each check point. Elevations interpolated from the lidar surface were then compared to the elevation values of the surveyed control points. AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASPRS Guidelines.

5.3. Digital Elevation Model (DEM) Testing

The project specifications require the accuracy (ACCz) of the derived DEM be calculated and reported in two ways:

1. The required NVA is: 19.6 cm at a 95% confidence level, derived according to NSSDA, i.e., based on RMSE of 10 cm in the "bare earth" and "urban" land cover classes. This is a required accuracy. The NVA was tested with 83 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 7.
2. Vegetated Vertical Accuracy (VVA): VVA shall be reported for "brushlands/low trees" and "tall weeds/crops" land cover classes. The target VVA is: 29.4 cm at the 95th percentile, derived according to ASPRS Guidelines, Vertical Accuracy Reporting for lidar Data, i.e., based on the 95th percentile error in all vegetated land cover classes combined. This is a target accuracy. The VVA was tested with 64 checkpoints located in tall weeds/crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area. See Figure 8.

AccuracyZ has been tested to meet 19.6 cm or better Non-Vegetated Vertical Accuracy at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standards for Spatial Data Accuracy (NSSDA); assessed and reported using National Digital Elevation Program (NDEP)/ASRPS Guidelines.

A brief summary of results are listed below.

	Target	Measured	Point Count
Raw NVA	0.196 m	0.0647 m	83
NVA	0.196 m	0.0625 m	83
VVA	0.294 m	0.1579 m	64

South Central Maine
Calibration Points

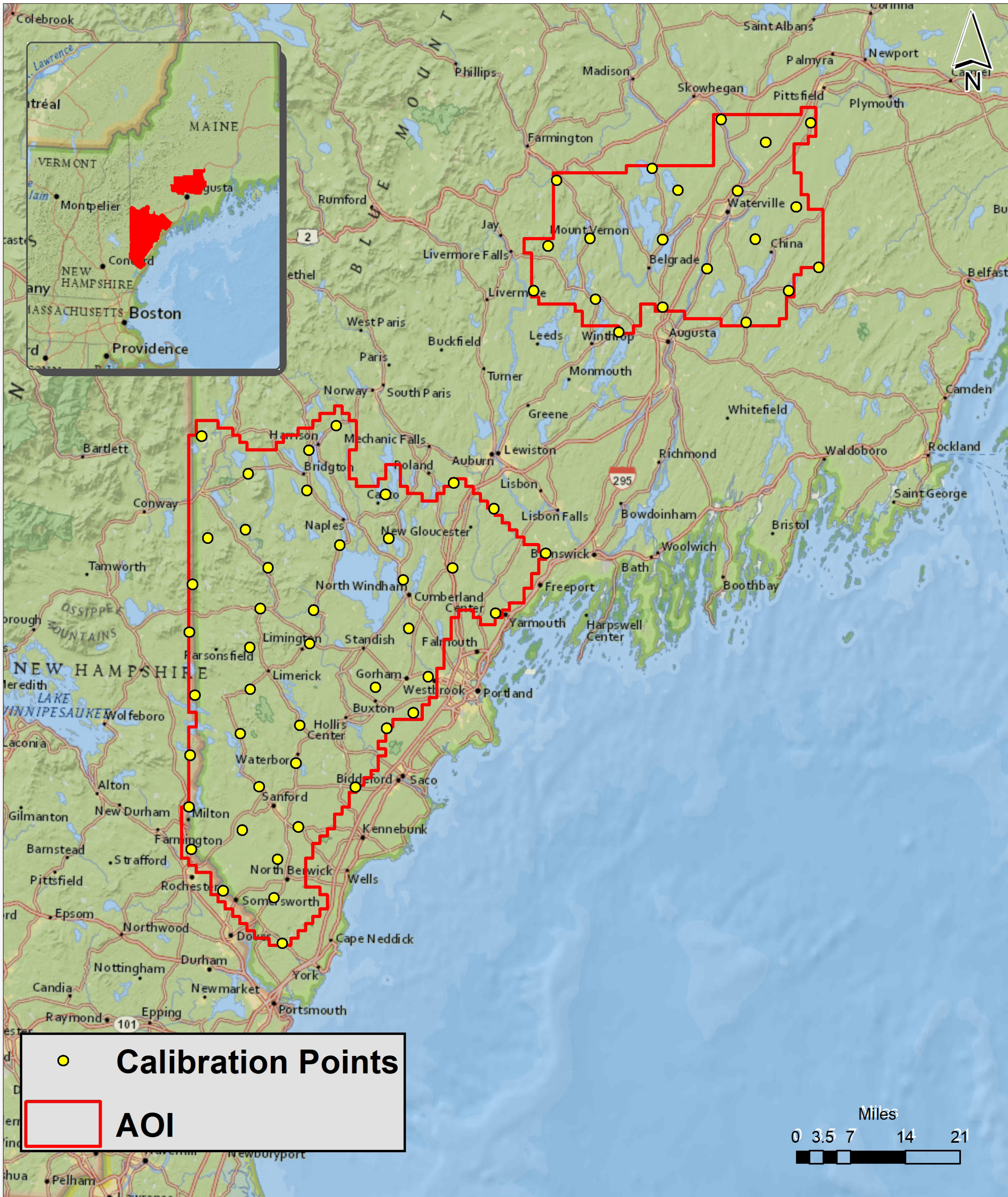


Figure 6. Calibration Control Point Locations

South Central Maine
NVA Points

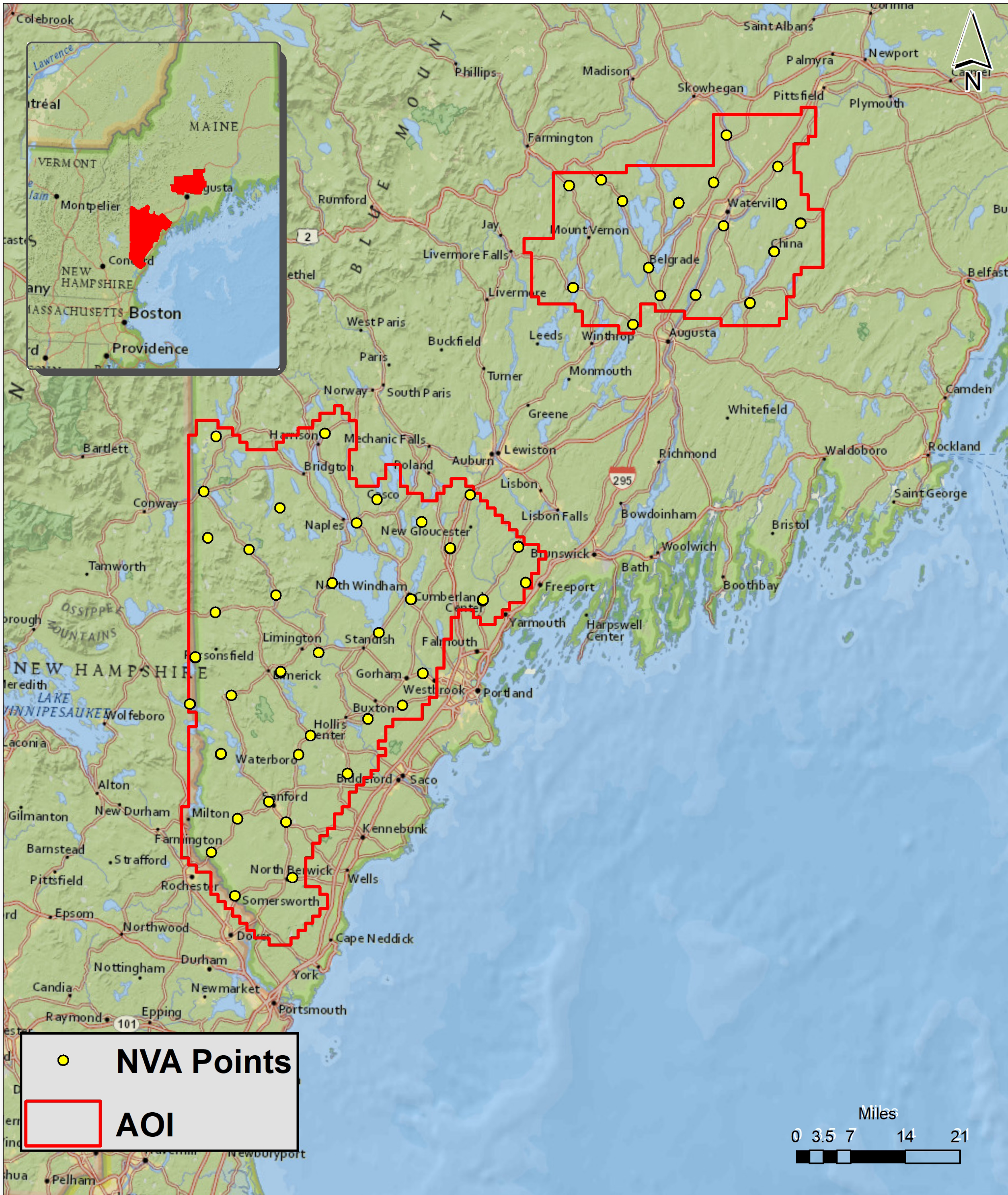


Figure 7. QC Checkpoint Locations - NVA

South Central Maine
VVA Points

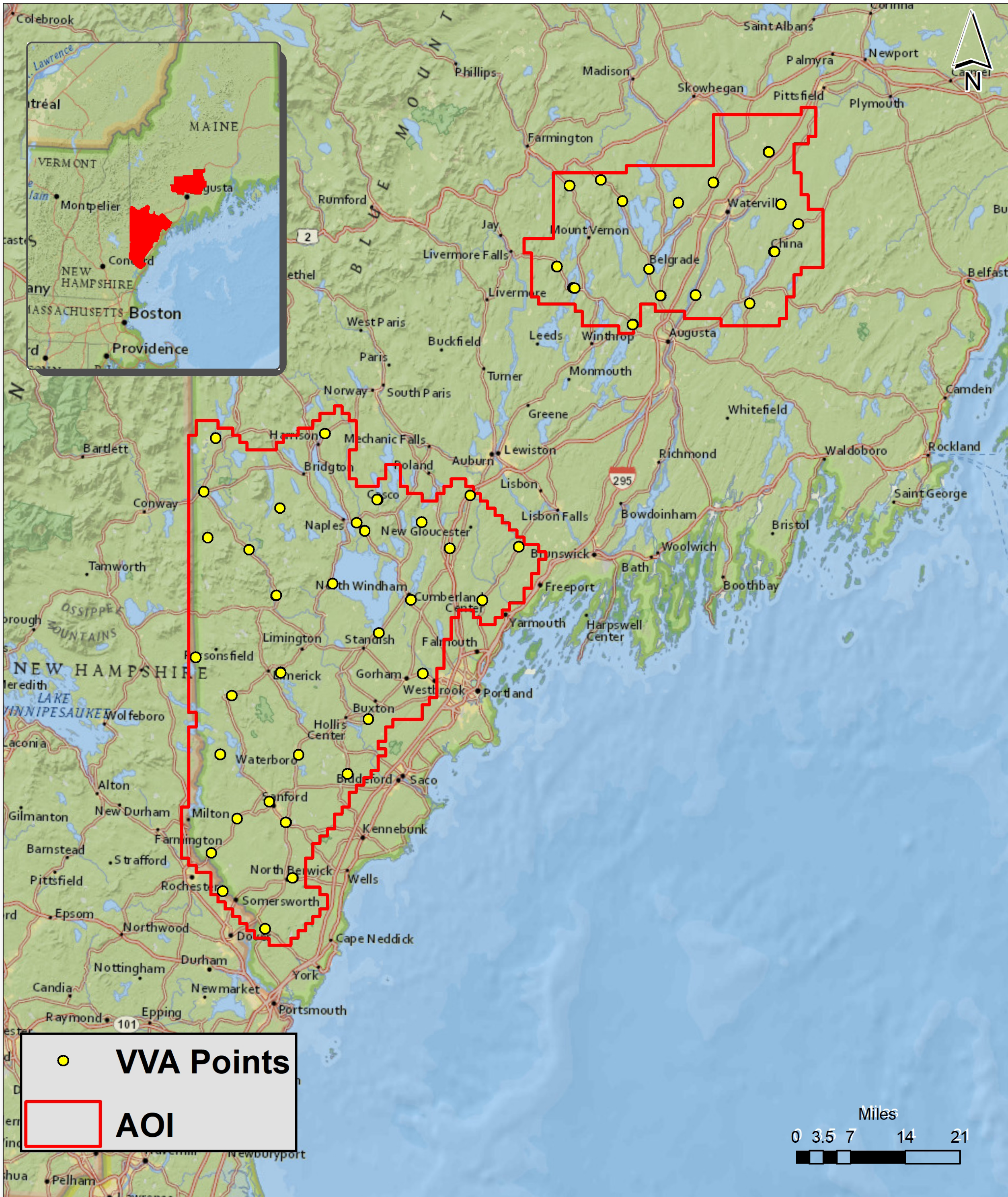


Figure 8. QC Checkpoint Locations - VVA

6. Geometric Accuracy

6.1. Horizontal Accuracy

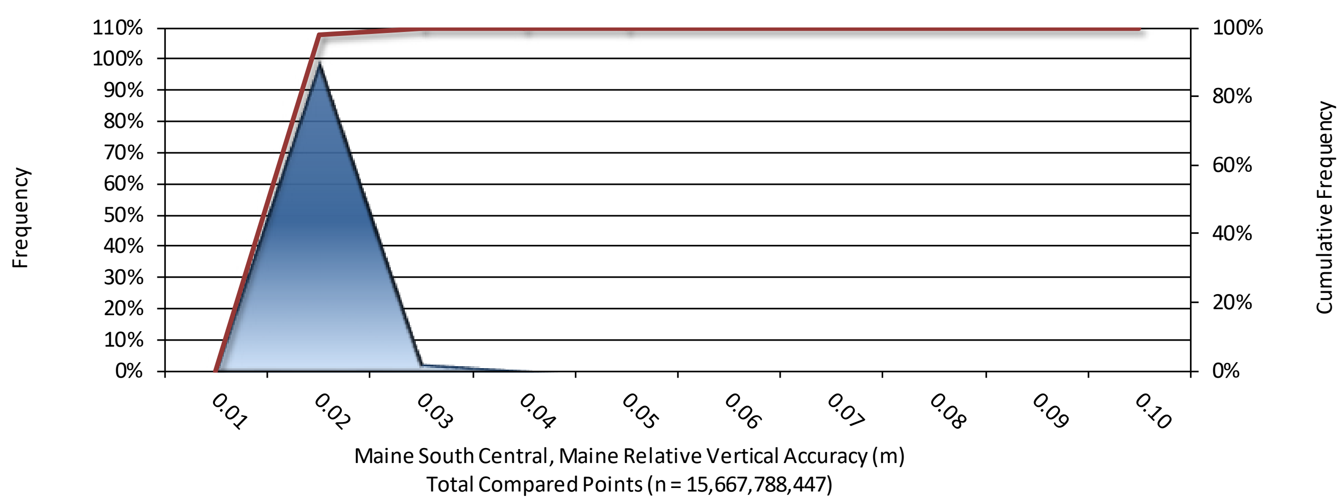
Lidar horizontal accuracy is a function of Global Navigation Satellite System (GNSS) derived positional error, flying altitude, and INS derived attitude error. The obtained $RMSE_r$ value is multiplied by a conversion factor of 1.7308 to yield the horizontal component of the National Standards for Spatial 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 1,350 meters, an IMU error of 0.002 decimal degrees, and a GNSS positional error of 0.027 meters, this project was compiled to meet 0.5 meter horizontal accuracy at the 95% confidence level. A summary is shown below.

Horizontal Accuracy	
$RMSE_r$	0.29 ft
	0.09 m
ACC_r	0.50 ft
	0.15 m

6.2. 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 Maine South Central project was 0.060 feet (0.018 meters). A summary is shown below.

Relative Vertical Accuracy	
Sample	141 flight line surfaces
Average	0.060 ft
	0.018 m
Median	0.062 ft
	0.062 m
RMSE	0.019 ft
	0.019 m
Standard Deviation (1σ)	0.003 ft
	0.001 m
1.96σ	0.006 ft
	0.002 m



Project Report Appendices

The following section contains the appendices as listed in the Maine South Central Lidar Project Report.

Appendix A

Flight Logs

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

		Mission Notes
Mission Name	Partner_20220407_F1	
Mission Date	4/7/2022	Flight
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	NV5 Geospatial	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00117	SW	12:00:00	12:30:00		
00118	SW	12:00:00	12:30:00		
00119	SW	12:00:00	12:30:00		
00120	SW	12:00:00	12:30:00		
00121	SW	12:00:00	12:30:00		
00122	SW	12:00:00	12:30:00		
00123	SW	12:00:00	12:30:00		
00124	SW	12:00:00	12:30:00		
00125	SW	12:00:00	12:30:00		
00126	SW	12:00:00	12:30:00		PDOP above 3.5 requirement
00127	SW	12:00:00	12:30:00		
00128	SW	12:00:00	12:30:00		
00129	SW	12:00:00	12:30:00		
00130	SW	12:00:00	12:30:00		
00131	SW	12:00:00	12:30:00		
00132	SW	12:00:00	12:30:00		
00133	SW	12:00:00	12:30:00		
00134	SW	12:00:00	12:30:00		
00135	SW	12:00:00	12:30:00		
00136	SW	12:00:00	12:30:00		
00137	SW	12:00:00	12:30:00		
00140	SE	12:00:00	12:30:00		

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220410_F1	**Mission Notes**
Mission Date	4/10/2022	FLight
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	NV5 Geospatial	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00085	SW	12:00:00	12:30:00		
00086	SW	12:00:00	12:30:00		
00087	SW	12:00:00	12:30:00		

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220411_F1	**Mission Notes**
Mission Date	4/11/2022	Flight
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	NV5 Geospatial	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00025	SW	12:00:00	12:30:00		
00026	SW	12:00:00	12:30:00		
00027	SW	12:00:00	12:30:00		
00028	SW	12:00:00	12:30:00		
00029	SW	12:00:00	12:30:00		
00030	SW	12:00:00	12:30:00		
00031	SW	12:00:00	12:30:00		
00032	SW	12:00:00	12:30:00		
00033	SW	12:00:00	12:30:00		
00034	SW	12:00:00	12:30:00		
00035	SW	12:00:00	12:30:00		
00036	SW	12:00:00	12:30:00		
00037	SW	12:00:00	12:30:00		
00038	SW	12:00:00	12:30:00		
00039	SW	12:00:00	12:30:00		
00040	SW	12:00:00	12:30:00		
00041	SW	12:00:00	12:30:00		
00042	SW	12:00:00	12:30:00		
00043	SW	12:00:00	12:30:00		

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220411_F2	**Mission Notes**
Mission Date	4/11/2022	Flight
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	NV5 Geospatial	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00088	SW	12:00:00	12:30:00		
00089	SW	12:00:00	12:30:00		
00090	SW	12:00:00	12:30:00		
00091	SW	12:00:00	12:30:00		
00092	SW	12:00:00	12:30:00		
00093	SW	12:00:00	12:30:00		
00094	SW	12:00:00	12:30:00		
00095	SW	12:00:00	12:30:00		
00096	SW	12:00:00	12:30:00		
00097	SW	12:00:00	12:30:00		
00098	SW	12:00:00	12:30:00		
00099	SW	12:00:00	12:30:00		
00100	SW	12:00:00	12:30:00		
00101	SW	12:00:00	12:30:00		
00102	SW	12:00:00	12:30:00		
00103	SW	12:00:00	12:30:00		
00104	SW	12:00:00	12:30:00		Refly 6-9 statute miles FNE due to hole in coverage from possible turbulence (screenshots attached)
00105	SW	12:00:00	12:30:00		
00106	SW	12:00:00	12:30:00		
00107	SW	12:00:00	12:30:00		
00108	SW	12:00:00	12:30:00		
00109	SW	12:00:00	12:30:00		
00110	SW	12:00:00	12:30:00		
00111	SW	12:00:00	12:30:00		
00112	SW	12:00:00	12:30:00		
00113	SW	12:00:00	12:30:00		
00114	SW	12:00:00	12:30:00		
00115	SW	12:00:00	12:30:00		
00116	SW	12:00:00	12:30:00		
00117	SW	12:00:00	12:30:00		
00138	S	12:00:00	12:30:00		
00139	S	12:00:00	12:30:00		
00140	SE	12:00:00	12:30:00		

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220415_F1	**Mission Notes**
Mission Date	4/15/2022	additional acq completed
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	N/A	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00001	SW	12:00:00	12:30:00		
00002	SW	12:00:00	12:30:00		
00003	SW	12:00:00	12:30:00		
00004	SW	12:00:00	12:30:00		
00005	SW	12:00:00	12:30:00		
00006	SW	12:00:00	12:30:00		
00007	SW	12:00:00	12:30:00		
00008	SW	12:00:00	12:30:00		
00009	SW	12:00:00	12:30:00		
00010	SW	12:00:00	12:30:00		
00011	SW	12:00:00	12:30:00		
00012	SW	12:00:00	12:30:00		flown 2x
00013	SW	12:00:00	12:30:00		
00014	SW	12:00:00	12:30:00		
00015	SW	12:00:00	12:30:00		
00016	SW	12:00:00	12:30:00		
00017	SW	12:00:00	12:30:00		
00018	SW	12:00:00	12:30:00		
00019	SW	12:00:00	12:30:00		
00020	SW	12:00:00	12:30:00		
00021	SW	12:00:00	12:30:00		
00022	SW	12:00:00	12:30:00		
00023	SW	12:00:00	12:30:00		
00024	SW	12:00:00	12:30:00		flown 2x

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220418_F1	**Mission Notes**
Mission Date	4/18/2022	Flown under good conditions
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	N/A	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00036	SW	12:00:00	12:30:00		reflown but previously accepted
00044	SW	12:00:00	12:30:00		
00045	SW	12:00:00	12:30:00		
00046	SW	12:00:00	12:30:00		
00062	SW	12:00:00	12:30:00		
00063	SW	12:00:00	12:30:00		
00064	SW	12:00:00	12:30:00		
00065	SW	12:00:00	12:30:00		
00066	SW	12:00:00	12:30:00		
00067	SW	12:00:00	12:30:00		
00068	SW	12:00:00	12:30:00		
00069	SW	12:00:00	12:30:00		
00070	SW	12:00:00	12:30:00		
00071	SW	12:00:00	12:30:00		
00072	SW	12:00:00	12:30:00		
00073	SW	12:00:00	12:30:00		
00074	SW	12:00:00	12:30:00		
00075	SW	12:00:00	12:30:00		
00076	SW	12:00:00	12:30:00		
00077	SW	12:00:00	12:30:00		
00078	SW	12:00:00	12:30:00		
00080	SE	12:00:00	12:30:00		
00081	SE	12:00:00	12:30:00		
00082	SW	12:00:00	12:30:00		
00083	SW	12:00:00	12:30:00		reflown: all per log due to traffic
00084	SE	12:00:00	12:30:00		4/18_1 (51-end) then 4/18_2 (95-remain) noted useless data

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220418_F2	**Mission Notes**
Mission Date	4/18/2022	Flown as wx allows
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	N/A	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00047	SW	12:00:00	12:30:00		
00048	SW	12:00:00	12:30:00		
00049	SW	12:00:00	12:30:00		
00050	SW	12:00:00	12:30:00		
00051	SW	12:00:00	12:30:00		traffic 43-26wpt, appears an attempt was made 4/18_3 but system error prevented completion
00052	SW	12:00:00	12:30:00		
00053	SW	12:00:00	12:30:00		
00054	SW	12:00:00	12:30:00		
00055	SW	12:00:00	12:30:00		
00056	SW	12:00:00	12:30:00		
00057	SW	12:00:00	12:30:00		

Project	947122-R037735.00	South Central Maine
Flightplan	37735_ME_780i_2ppsm_Xeos	

Mission Name	Partner_20220421_F1	**Mission Notes**
Mission Date	4/21/2022	Completed Remaining Collection
Aircraft	CGJPD	
Pilot	(Subcontractor)	
Co-Pilot		
Operator	(Subcontractor)	
Co-Operator		
Vendor	Xeos	
Base Airport	N/A	
Departure (Local Time)		
Arrival (Local Time)		

Line	Heading	Start Time (UTC)	Stop Time (UTC)	Speed (kt)	Notes
00051	SW	12:00:00	12:30:00		reflight
00058	SW	12:00:00	12:30:00		
00059	SW	12:00:00	12:30:00		
00060	SW	12:00:00	12:30:00		
00061	SW	12:00:00	12:30:00		
00084	SE	12:00:00	12:30:00		
00104	SW	12:00:00	12:30:00		reflight
00126	SW	12:00:00	12:30:00		reflight