Airborne Topographic Lidar Report

Wisconsin WROC – 3DEP
Vernon County Lidar 2020

Prime Contractor: Ayres

Airborne Lidar Acquisition:
Quantum Spatial, an Nv5 Company

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1. Summary / Scope

1.1 Summary

This report contains a summary of the WROC 2020 Vernon County lidar acquisition task order, issued by Ayres Associates Inc. under Task Order 54 that was executed on January 21, 2020. The task order yielded a project area covering approximately 874 square miles over Vernon County in Wisconsin. 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
2 pts / m²	2300 m	58.5°	30%

1.3 Coverage

The project boundary covers approximately 874 square miles over Wisconsin. Project extents are shown in Figure 1.

1.4 Duration

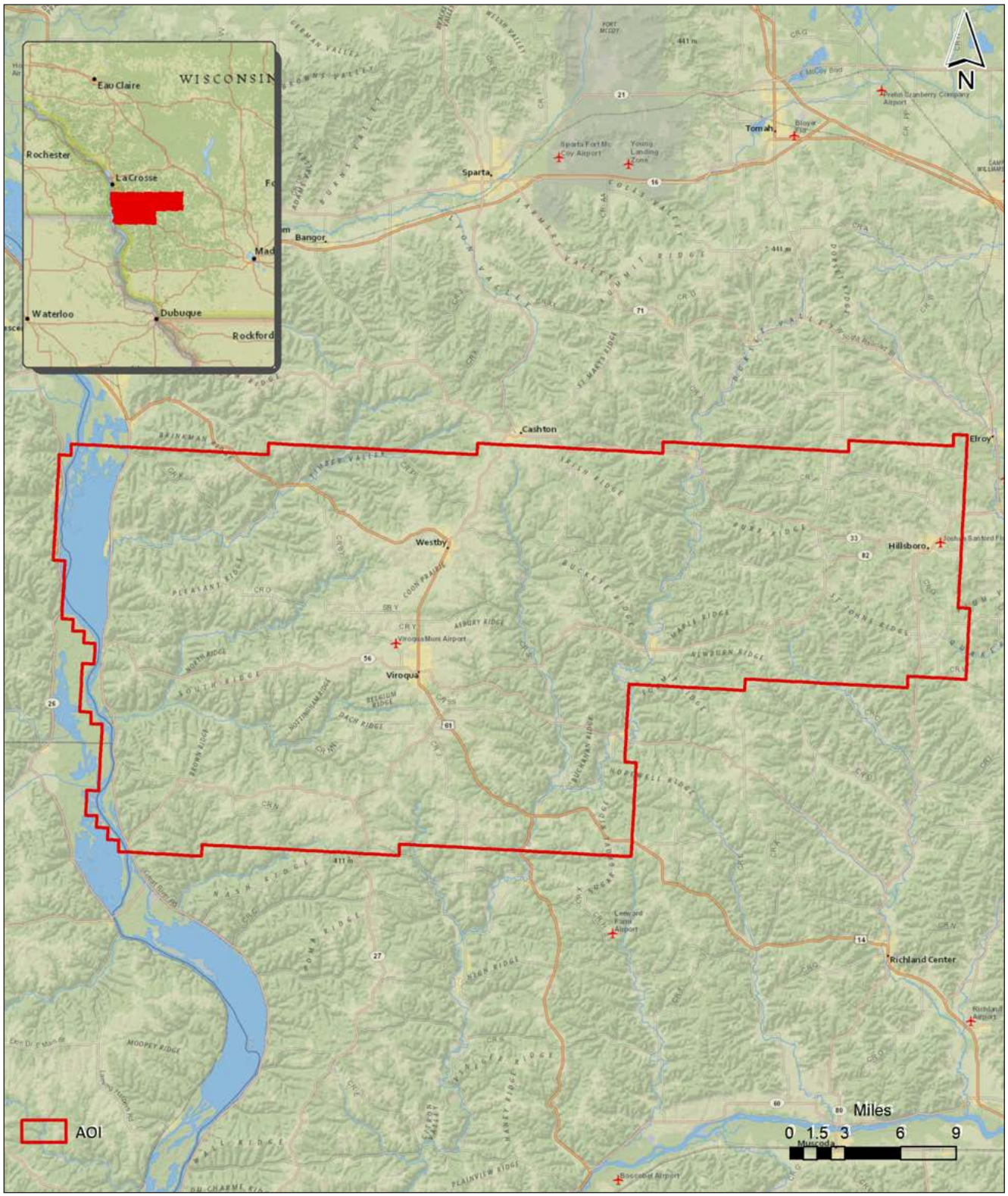
Lidar data was acquired from April 18, 2020, to April 21, 2020, in three lifts. See “Section: 2.4. Time Period” for more details.

1.5 Issues

There were no major issues to report for this project.

WROC 2020 VERNON COUNTY – DELIVERABLES PROJECTED COORDINATE SYSTEM: WISCRS VERNON COUNTY HORIZONTAL DATUM: NAD83 (2011) VERTICAL DATUM: NAVD88 (GEOID 12B) UNITS: U.S. SURVEY FEET
• One copy of lidar tiled point cloud data in LAS format on external hard drive
• All flight mission parameters appropriate for inclusion in FGDC/USGS compliant metadata

Figure 1. Vernon County Project 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 Leica MissionPro, RiPARAMETER, and TrackAir SnapPLAN planning software. The entire target area was comprised of 24 planned flight lines (Figure 2).

2.2 Lidar Sensor

Quantum Spatial used a Riegl VQ1560i lidar sensor (Figure 3), serial number 4040, for lidar collection.

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 uses 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.

Figure 2. Vernon County Planned Flight Lines

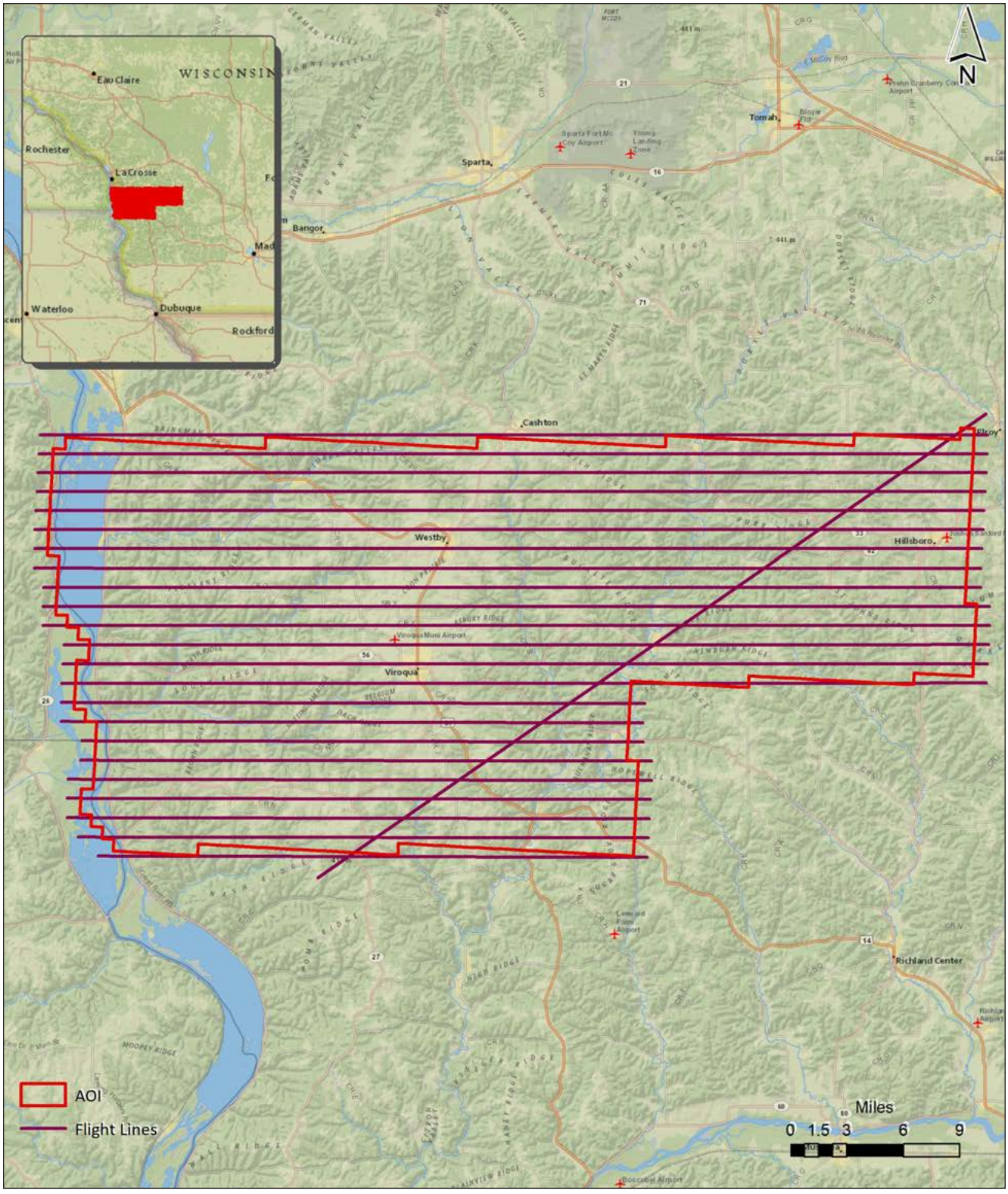


Table 2. Lidar System Specifications

		RIEGL VQ1560I
Terrain and Aircraft Scanner	Flying Height	2300 m
	Recommended Ground Speed	145 kts
Scanner	Field of View	58.5°
	Scan Rate Setting Used	2 x 160 lps
Laser	Laser Pulse Rate Used	2 x 350 kHz
	Multi Pulse in Air Mode	1
Coverage	Full Swath Width	2577 m
	Line Spacing	2219.68 m
Point Spacing and Density	Average Point Spacing	1.81 m
	Average Point Density	2 x 1.21 pts/m²

Figure 3. Riegl VQ1560i Lidar Sensor

2.3 Aircraft

All flights for the project were accomplished through the use of a customized plane. The plane type and tail number are listed below.

Lidar Collection Planes

- Piper Navajo (twin-piston), Tail Number: N22GE

This aircraft provided an ideal, stable aerial base for lidar acquisition. This aerial platform has 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 VQ1560i lidar system. Some of Quantum Spatial's operating aircraft can be seen in Figure 4 below.

Figure 4. Some of Quantum Spatial's Planes

2.4 Time Period

Project-specific flights were conducted in April of 2020. Three aircraft lifts were completed. The accomplished lifts are listed below.

- 04182020A (SN4040, N22GE)
- 04202020A (SN4040, N22GE)
- 04212020A (SN4040, N22GE)

3. Processing Summary

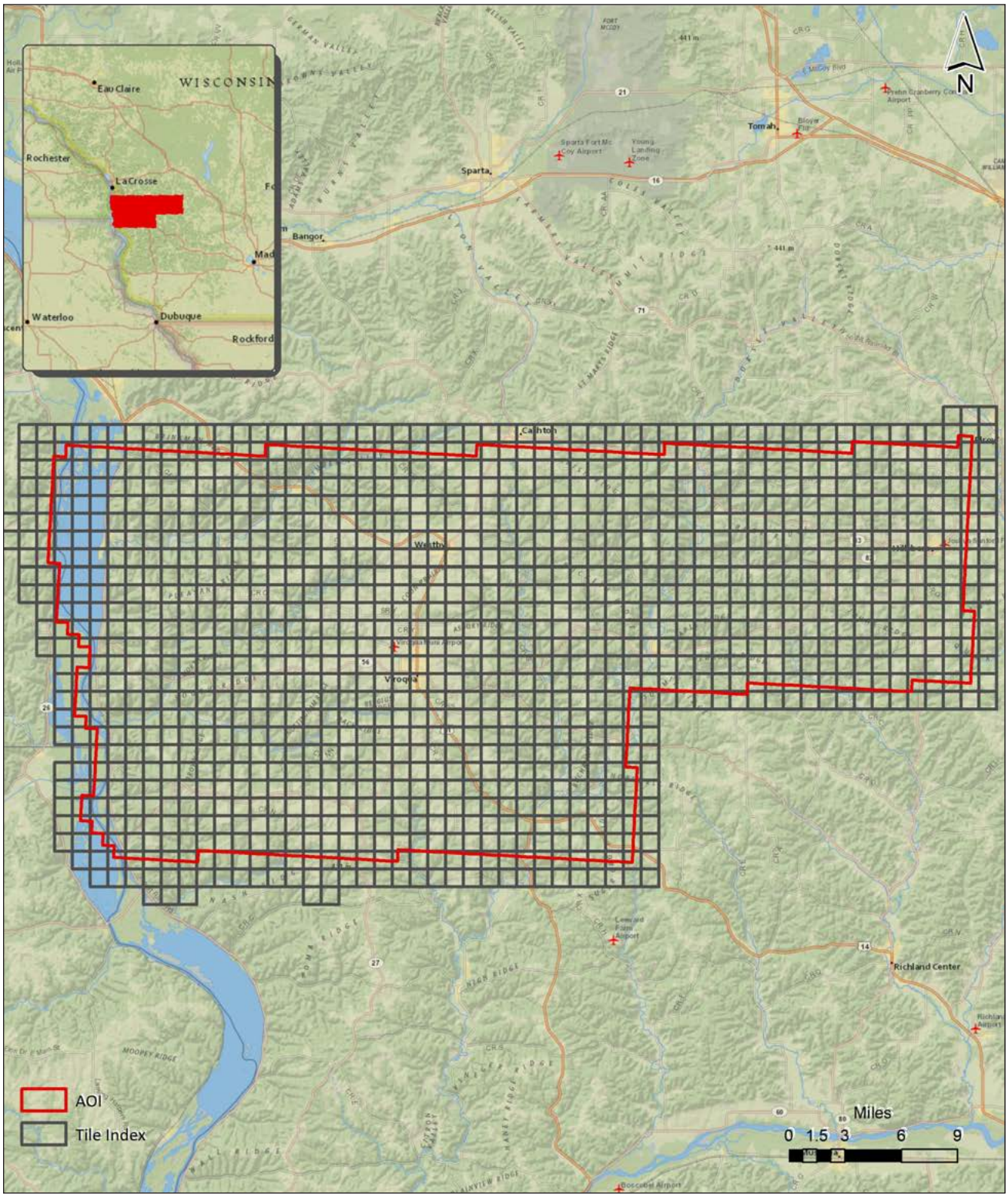
3.1 Lidar Processing

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.

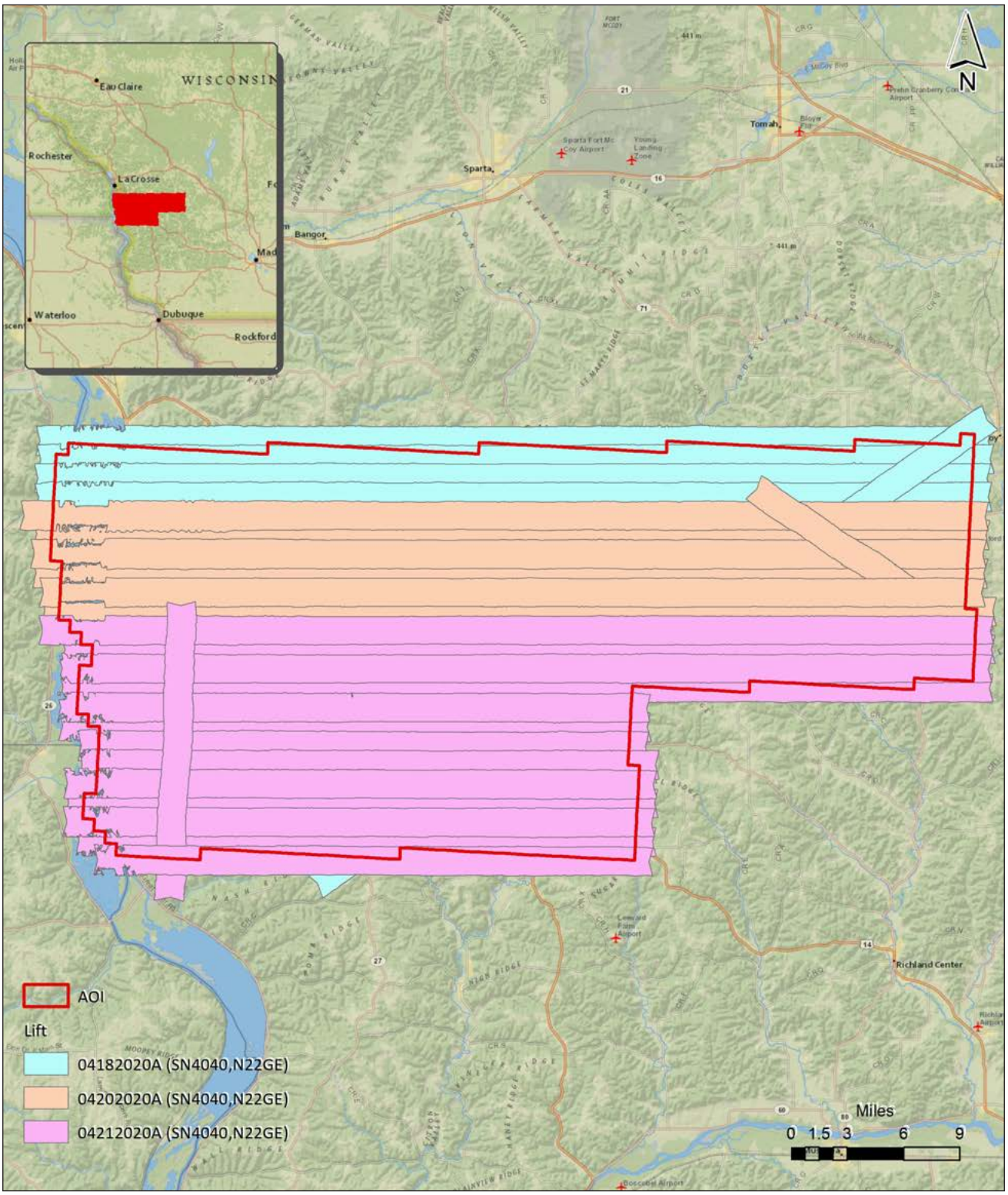
Figure 5. Lidar Tile Layout



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.

Figure 6. Lidar Flight Line Coverage



5. Ground Control and Check Point Collection

Quantum Spatial used 19 ground control (calibration) points collected by Ayres.

5.1 Calibration Control Point Testing

Figure 7 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.

Figure 7. Calibration Control Point Locations

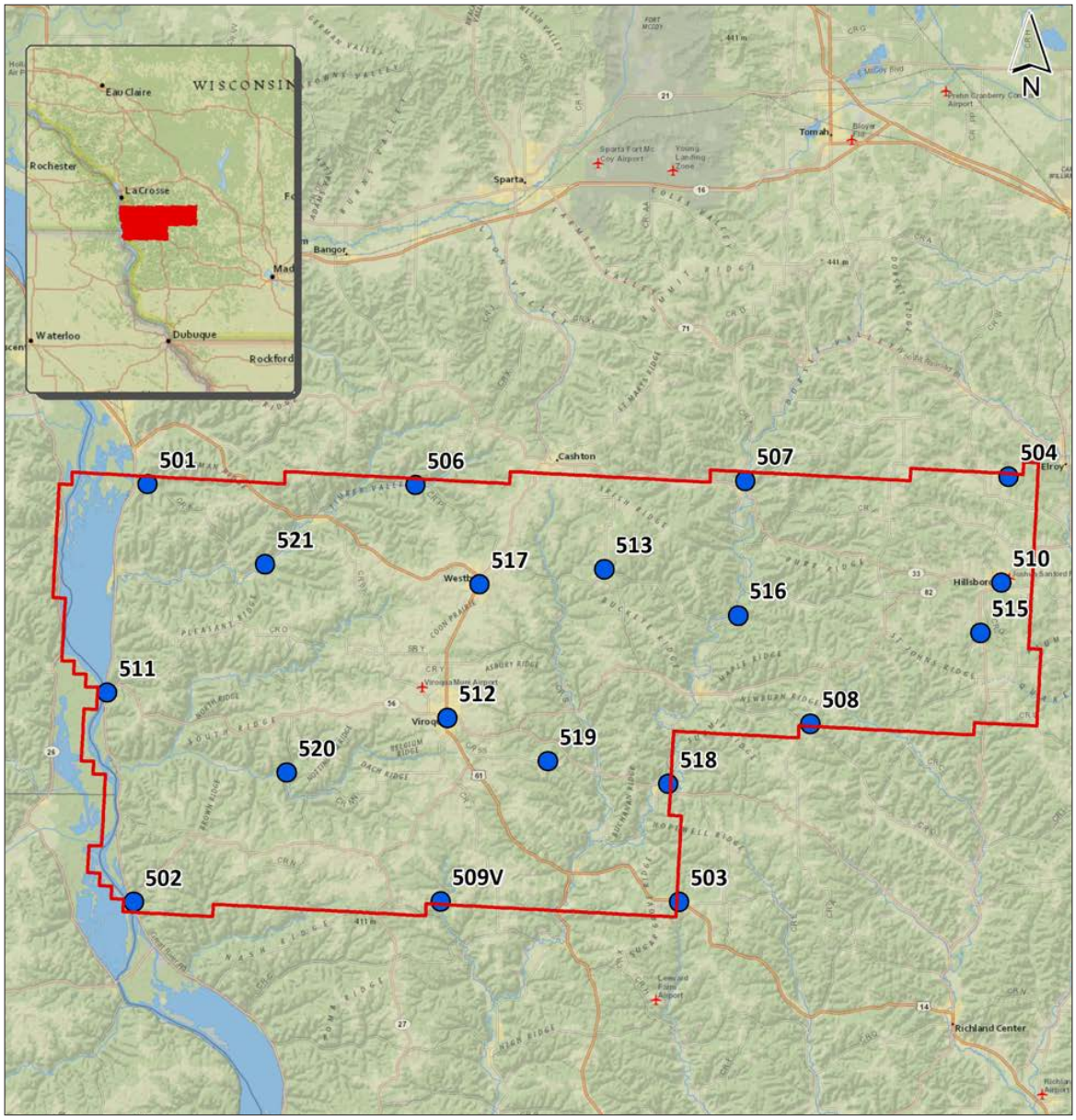


Table 3. Calibration Control Point Report
Units = U.S. survey feet

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
501	623136.746	211020.171	727.526	727.51	-0.016
502	619402.349	100851.43	640.048	640.21	0.162
503	763345.733	100946.646	1249.127	1249.17	0.043
504	850282.779	213056.883	1035.185	1035.11	-0.075
506	693828.679	210747.332	823.896	823.97	0.074
507	780788.197	211898.087	910.262	910.17	-0.092
508	797938.984	147939.76	1284.65	1284.68	0.03
509V	700486.01	101013.041	853.455	853.49	0.035
510	848321.858	184979.131	951.191	951.05	-0.141
511	612465.84	156107.921	639.706	639.81	0.104
512	702205.542	149421.36	1262.747	1262.8	0.053
513	743539.123	188602.642	1218.014	1217.94	-0.074
515	842783.365	171867.802	1009.369	1009.41	0.041
516	778847.66	176482.256	873.898	873.78	-0.118
517	710719.726	184594.784	1306.465	1306.5	0.035
518	760464.151	132015.575	770.08	770.08	0
519	728712.106	137986.23	1187.489	1187.41	-0.079
520	659831.784	134982.209	702.709	702.82	0.111
521	654142.965	189873.887	697.446	697.42	-0.026

Average Dz	0.004
Minimum Dz	-0.141
Maximum Dz	0.162
Average Magnitude	0.069
Root Mean Square	0.081
Std Deviation	0.083