Airborne Topographic Lidar Report

Wisconsin WROC – 3DEP
Sauk County Lidar 2020

Prime Contractor: Ayres

Airborne Lidar Acquisition:
Quantum Spatial, an Nv5 Company

Ingenuity, Integrity, and Intelligence.

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Table of Contents

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List of Figures

List of Tables

1. Summary / Scope

1.1 Summary

This report contains a summary of the WROC 2020 Sauk 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 906 square miles over Sauk 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 906 square miles over Wisconsin. Project extents are shown in Figure 1.

1.4 Duration

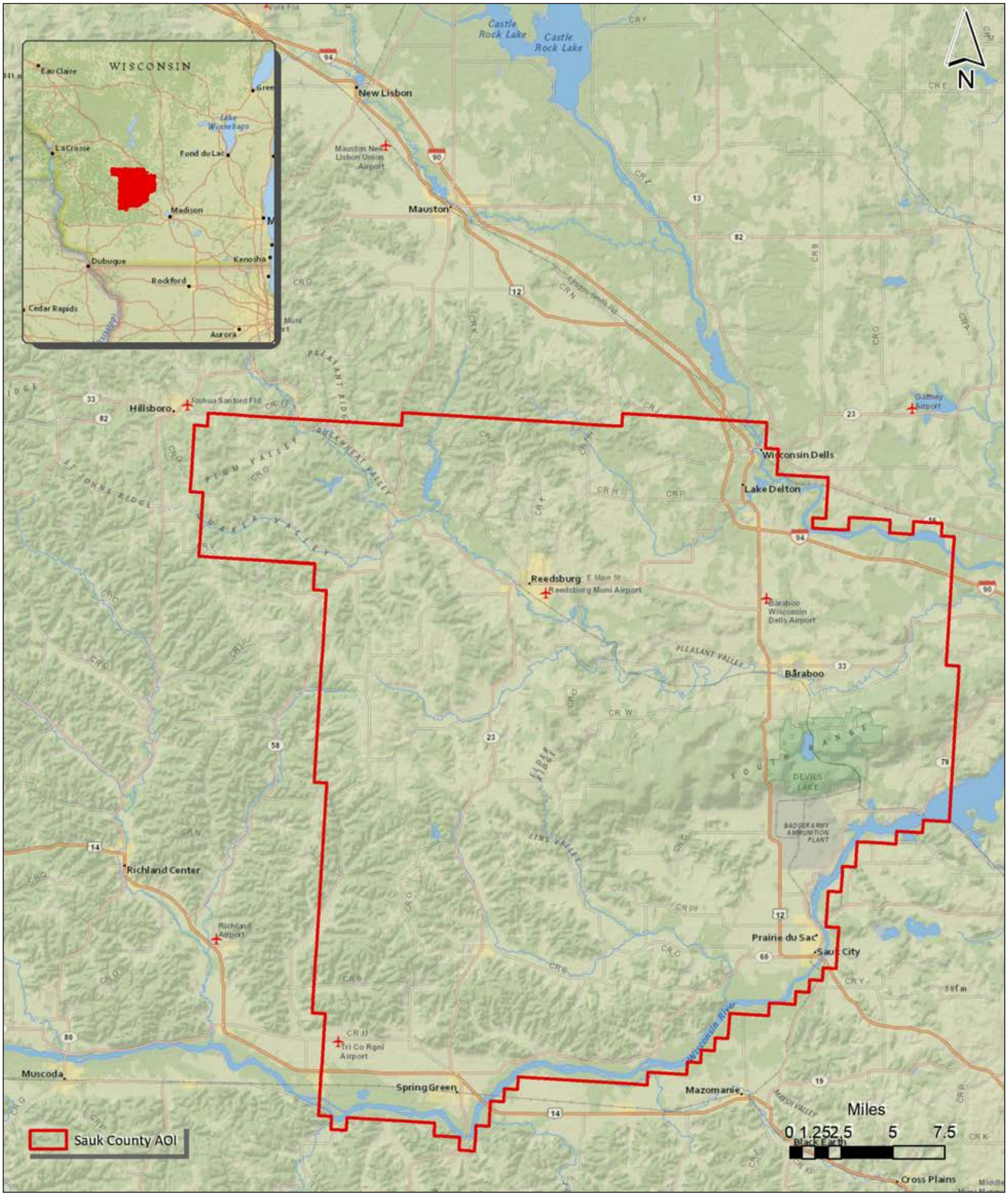
Lidar data was acquired from April 11, 2020, to April 21, 2020, in three lifts. See "Section: 2.4. Time Period" for more details.

1.5 Issues

There were no major issues to report for this project.

WROC 2020 SAUK COUNTY – DELIVERABLES PROJECTED COORDINATE SYSTEM: WISCRS SAUK 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. Sauk 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 RiPARAMETER planning software. The entire target area was comprised of 67 planned flight lines (Figure 2).

2.2 Lidar Sensor

Quantum Spatial used a Riegl LMS-Q1560 lidar sensor (Figure 3), serial number 1264, for lidar collection.

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 uses MTA processing, echo digitization, and waveform analysis.

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

Figure 2. Sauk County Planned Flight Lines

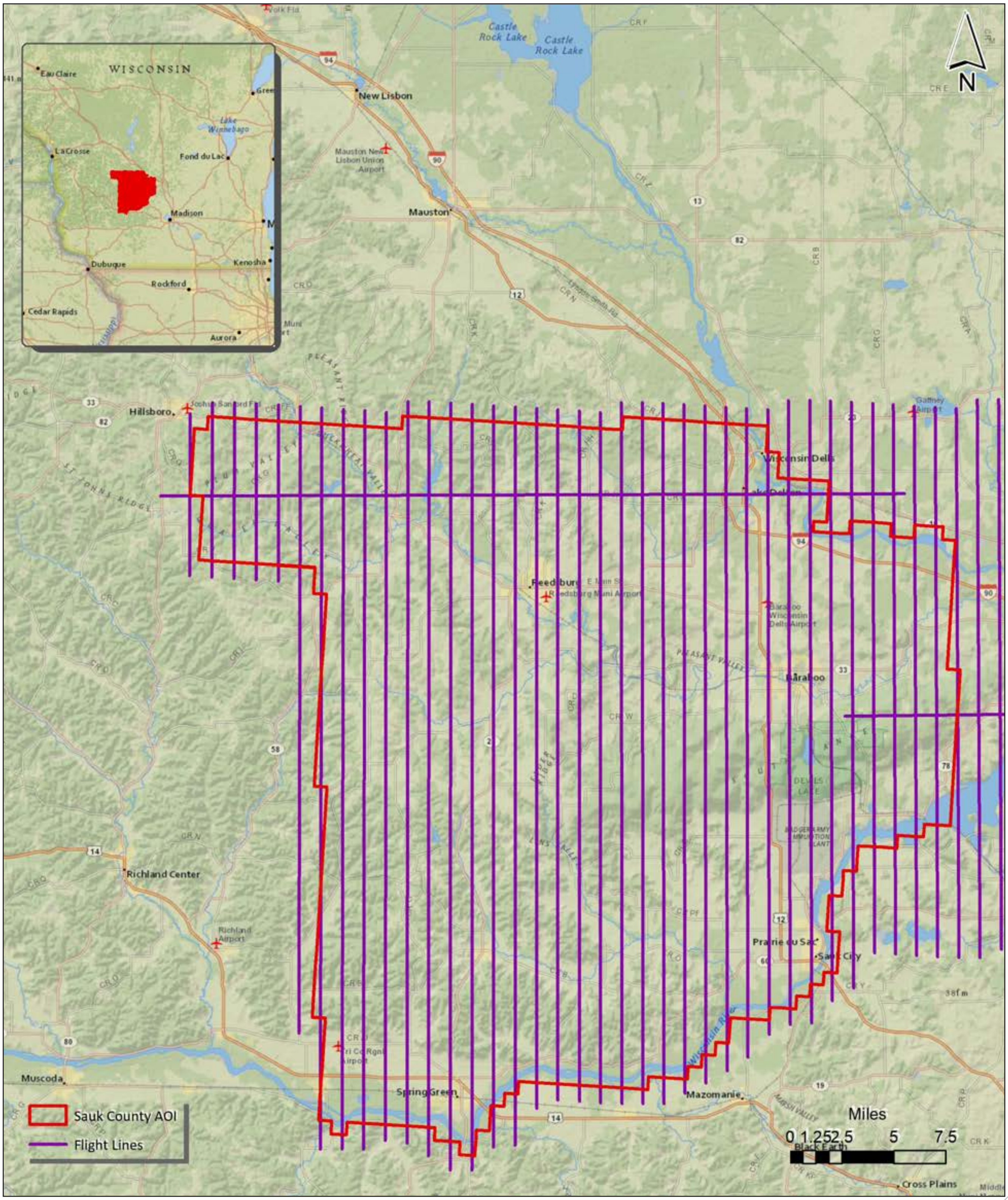


Table 2. Lidar System Specifications

		RIEGL LMS Q1560
Terrain and Aircraft Scanner	Flying Height	2300 m
	Recommended Ground Speed	150 kts
Scanner	Field of View	58.5°
	Scan Rate Setting Used	2 x 80 lps
Laser	Laser Pulse Rate Used	2 x 350 kHz
	Multi Pulse in Air Mode	1
Coverage	Full Swath Width	2576 m
	Line Spacing	2249.4 m
Point Spacing and Density	Average Point Spacing	0.710 m
	Average Point Density	2 x 2.43 pts/m²

Figure 3. Riegl LMS Q1560 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: C-FKMA

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 LMS-Q1560 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 2020. Four aircraft lifts were completed. The accomplished lifts are listed below.

- 04112020A (SN1264, C-FKMA)
- 04182020A (SN1264, C-FKMA)
- 04202020A (SN1264, C-FKMA)
- 04212020A (SN1264, C-FKMA)

3. Processing Summary

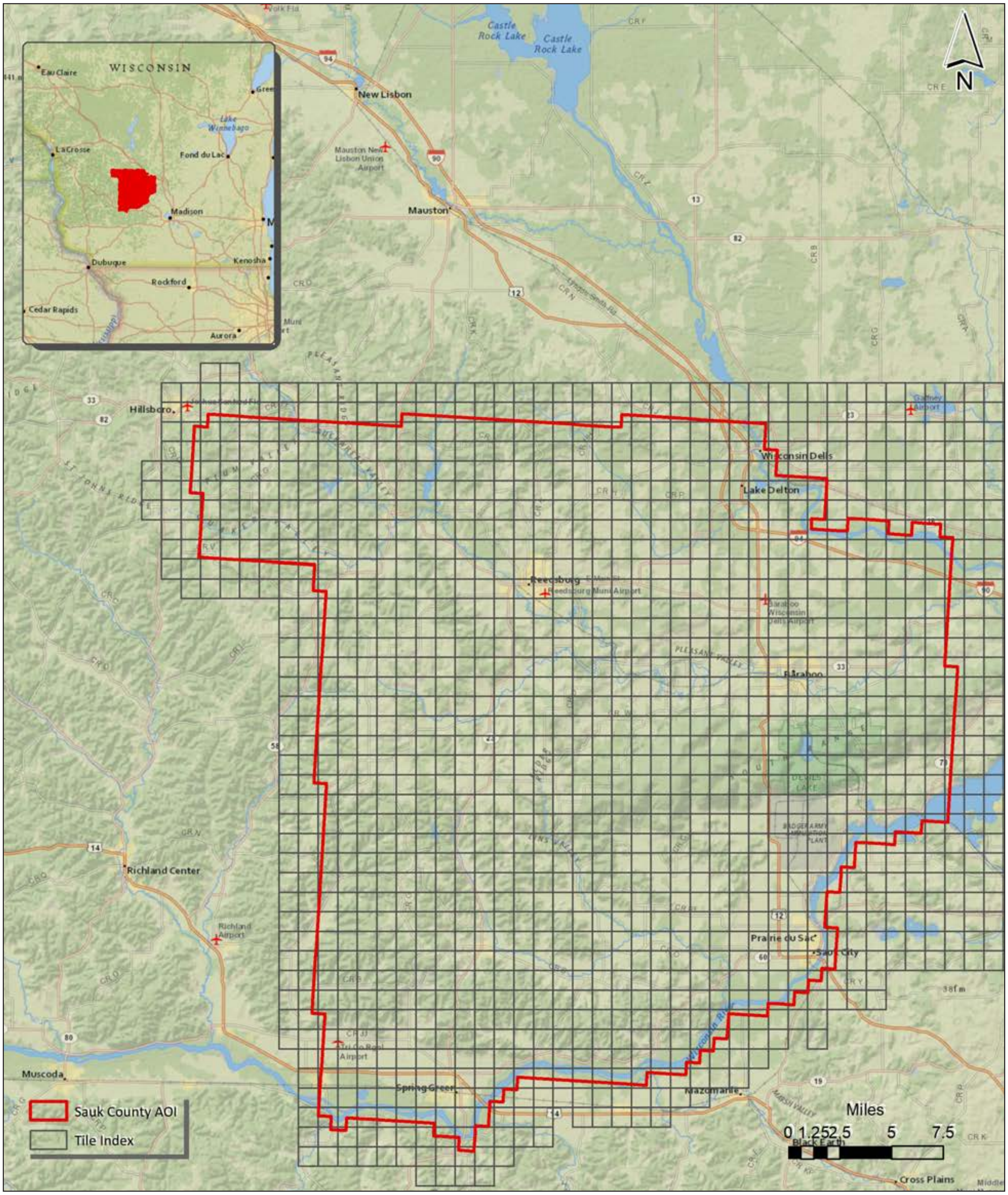
3.1 Lidar Processing

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.

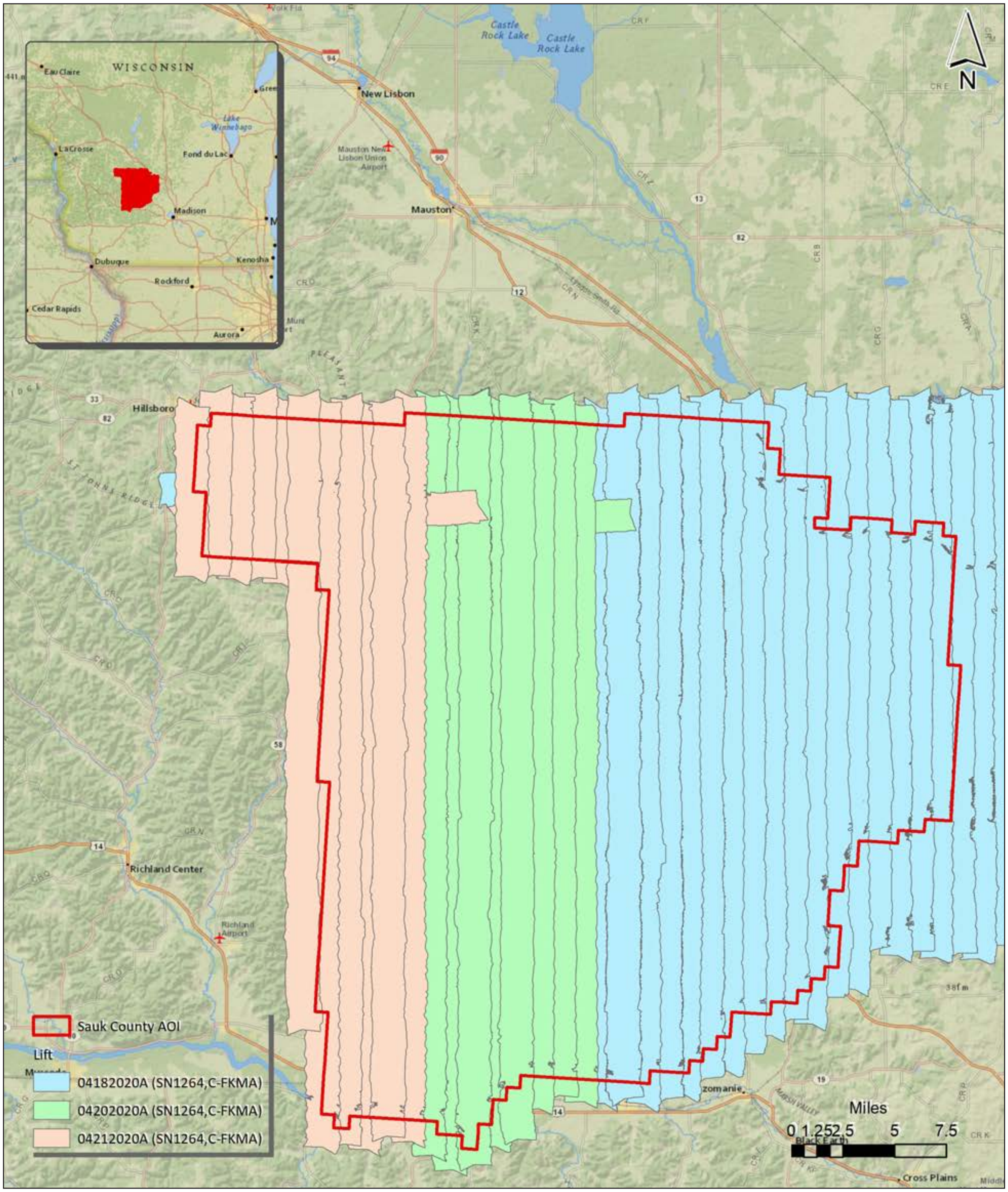
Figure 5. Lidar Tile Layout



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 22 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

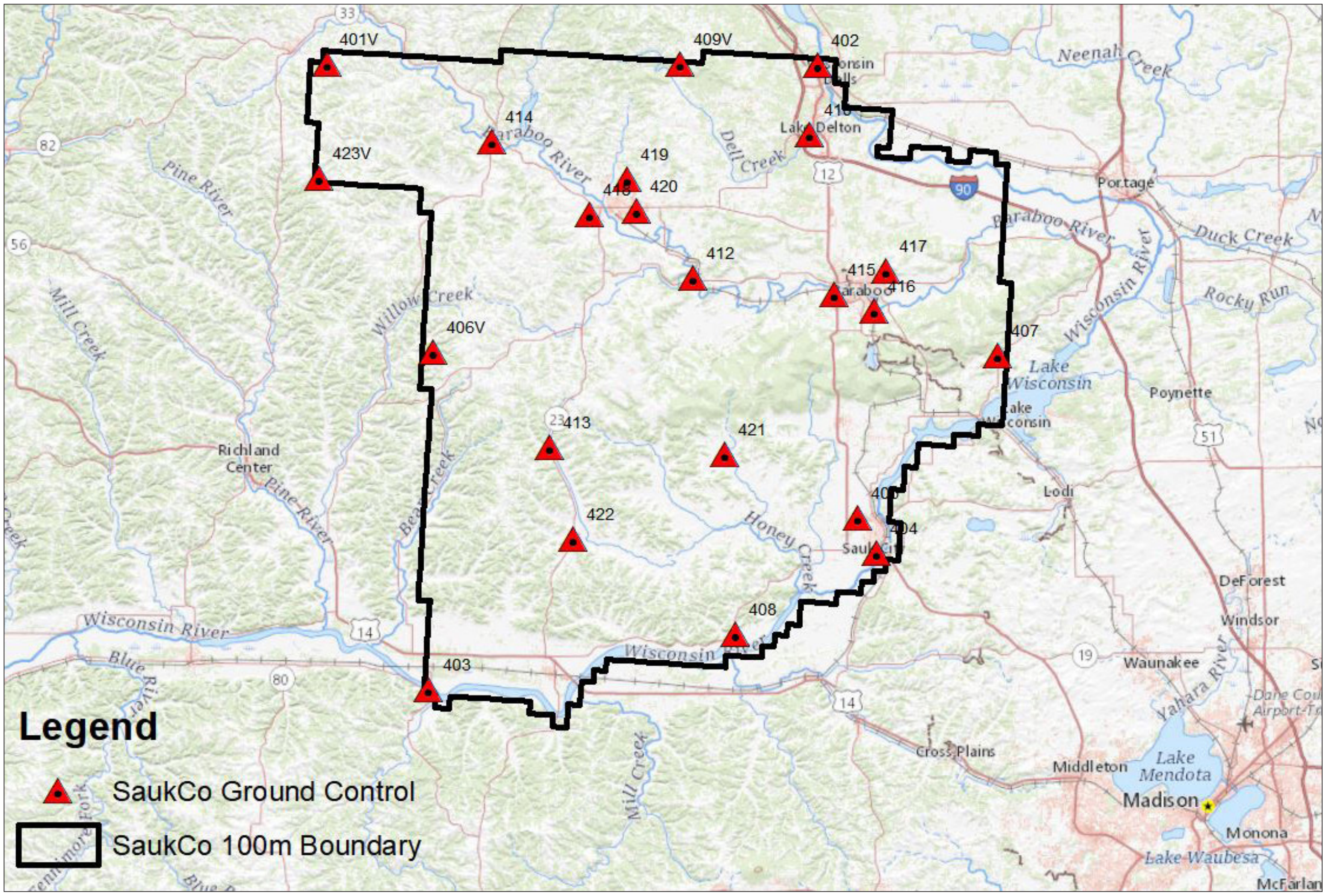


Table 3. Calibration Control Point Report
Units = U.S. survey feet

NUMBER	EASTING	NORTHING	KNOWN Z	LASER Z	DZ
402	2024415.23	598005.95	902.81	902.77	-0.04
403	1916664.66	424112.21	717.49	717.56	0.07
404	2041133.23	462186.00	752.19	752.19	0.00
405	2035794.84	472068.24	813.96	813.99	0.02
407	2074527.34	517238.88	908.86	908.92	0.05
408	2001854.89	439857.29	736.80	736.87	0.06
410	2022381.21	578649.78	894.28	894.21	-0.07
412	1989919.26	538614.77	882.64	882.71	0.07
413	1950163.88	491482.89	868.57	868.52	-0.06
414	1934112.06	576739.66	893.20	893.22	0.02
415	2029020.00	534312.20	943.60	943.60	-0.01
416	2040334.96	529639.42	876.82	876.84	0.02
417	2043572.76	540729.53	939.26	939.21	-0.05
418	1961154.76	556265.35	907.24	907.25	0.01
419	1971617.46	566175.18	975.44	975.43	-0.02
420	1974249.08	557199.20	900.43	900.42	-0.01
421	1998891.00	489854.67	802.87	802.83	-0.04
422	1956799.08	466119.88	801.16	801.03	-0.14
401V	1888054.71	598265.93	1029.40	1029.31	-0.10
406V	1917862.16	518053.69	916.74	916.68	-0.06
409V	1986344.50	598071.34	935.29	935.27	-0.02
423V	1886036.08	566547.91	1303.47	1303.43	-0.05

Average Dz	0.03
Minimum Dz	-0.002
Maximum Dz	0.070
Root Mean Square	0.043
Std Deviation	0.028