Oshkosh 3 Rivers 2018 LiDAR Project Report

USGS Contract # G16PC00016
Task Order # 140G0219F0026

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1. Summary / Scope

1.1. Summary

This report contains a summary of the Oshkosh 3 Rivers 2018 LiDAR acquisition task order, issued by the USGS under their Contract G16PC00016 on 13 November 2018. The task order yielded a project area covering 5096 square miles over Wisconsin and Minnesota. 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
2.98 pts / m^2	2150 m	40°	30%	≤ 10 cm

1.3. Coverage

The project boundary covers 5096 square miles over Wisconsin and Minnesota. A buffer of 100 meters was created to meet task order specifications. Project extents are shown in Figure 1.

1.4. Duration

LiDAR data was acquired from 19 April 2019 to 21 May 2019 in 20 total lifts. See “Section: 2.4. Time Period” for more details.

1.5. Issues

There were no major issues to report for this project.

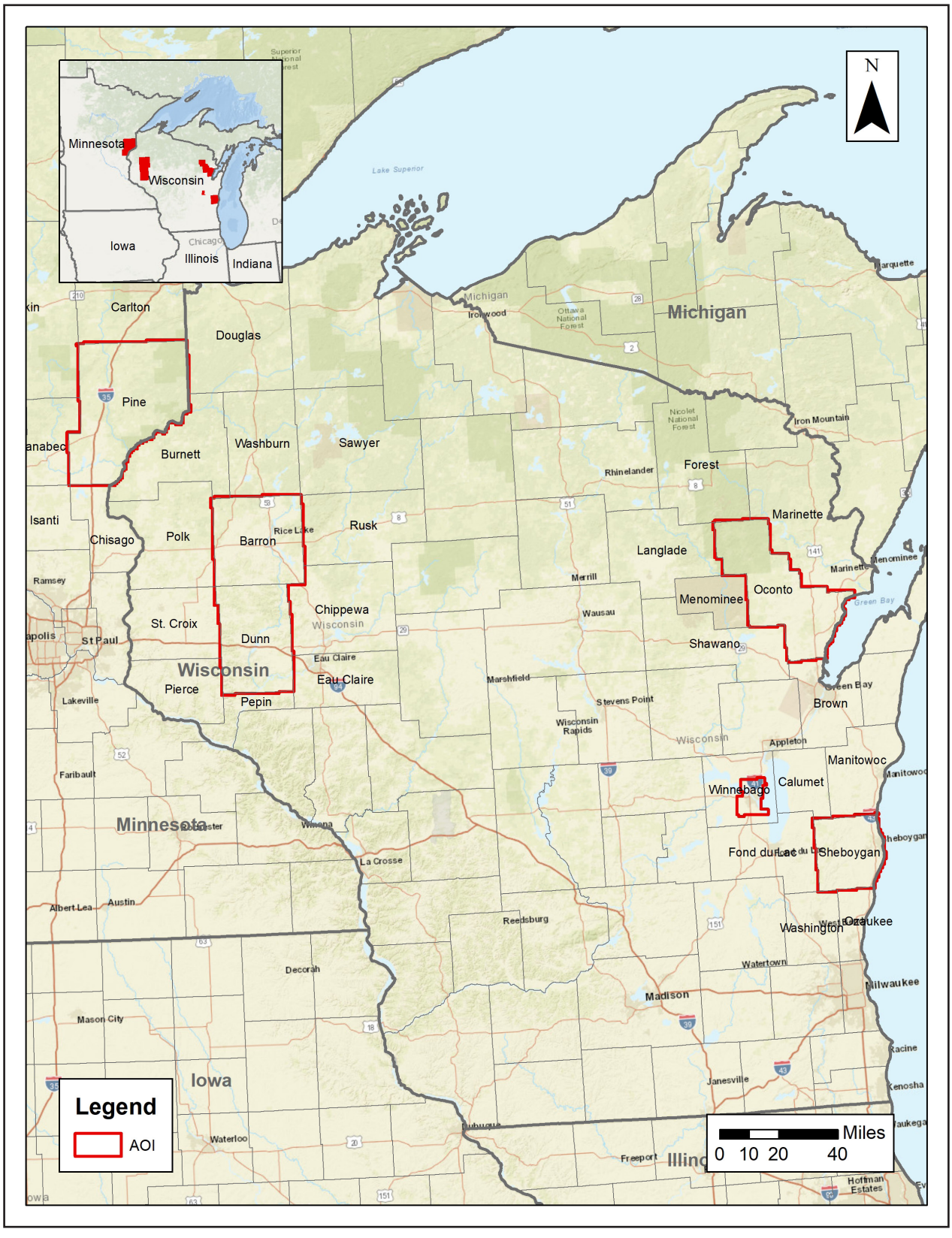
1.6. Deliverables

The following products were produced and delivered:

- Classified LiDAR point cloud data tiles in .LAS 1.4 format
- Continuous hydro-flattened breaklines in Esri file geodatabase format
- 1-meter hydro-flattened bare earth digital elevation model (DEM) tiles in ERDAS .IMG format
- 1-meter intensity imagery tiles in GeoTIFF format
- Flight logs in .PDF format
- Survey report in .PDF format
- FOCUS report in .PDF format
- FOCUS on Deliverables report in .PDF format
- FOCUS on Accuracy report in .PDF format
- Metadata in .XML format

All geospatial deliverables were produced with a horizontal datum/projection of NAD 1983 2011 UTM Zones 16N and 15N and Albers Equal Area and a vertical datum/projection of NAVD88 GEOID12B. All tiled deliverables were provided as 13,851 individual 1500 m x 1500 m UTM tiles and 14,269 individual 1000 m x 1000 m Albers tiles (Figure 5). Tile names are derived from the US National Grid.

Figure 1. 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 and RiPARAMETER planning software. The entire target area was comprised of 314 planned flight lines (Figure 2).

2.2. LiDAR Sensor

Quantum Spatial utilized Leica ALS80 and Riegl 1560i LiDAR sensors (Figure 3), serial numbers 8146, 3543, and 2738, during the project.

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.

The Leica ALS80 system is capable of collecting data at a maximum frequency of 1,000 kHz. The system utilizes a Multi-Pulse in the Air option (MPIA). The sensor also has the capacity for unlimited range returns from each outbound pulse. The intensity of the returns is also captured during aerial acquisition.

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

Figure 2. Planned Flight Lines - West (Top), East (Bottom)

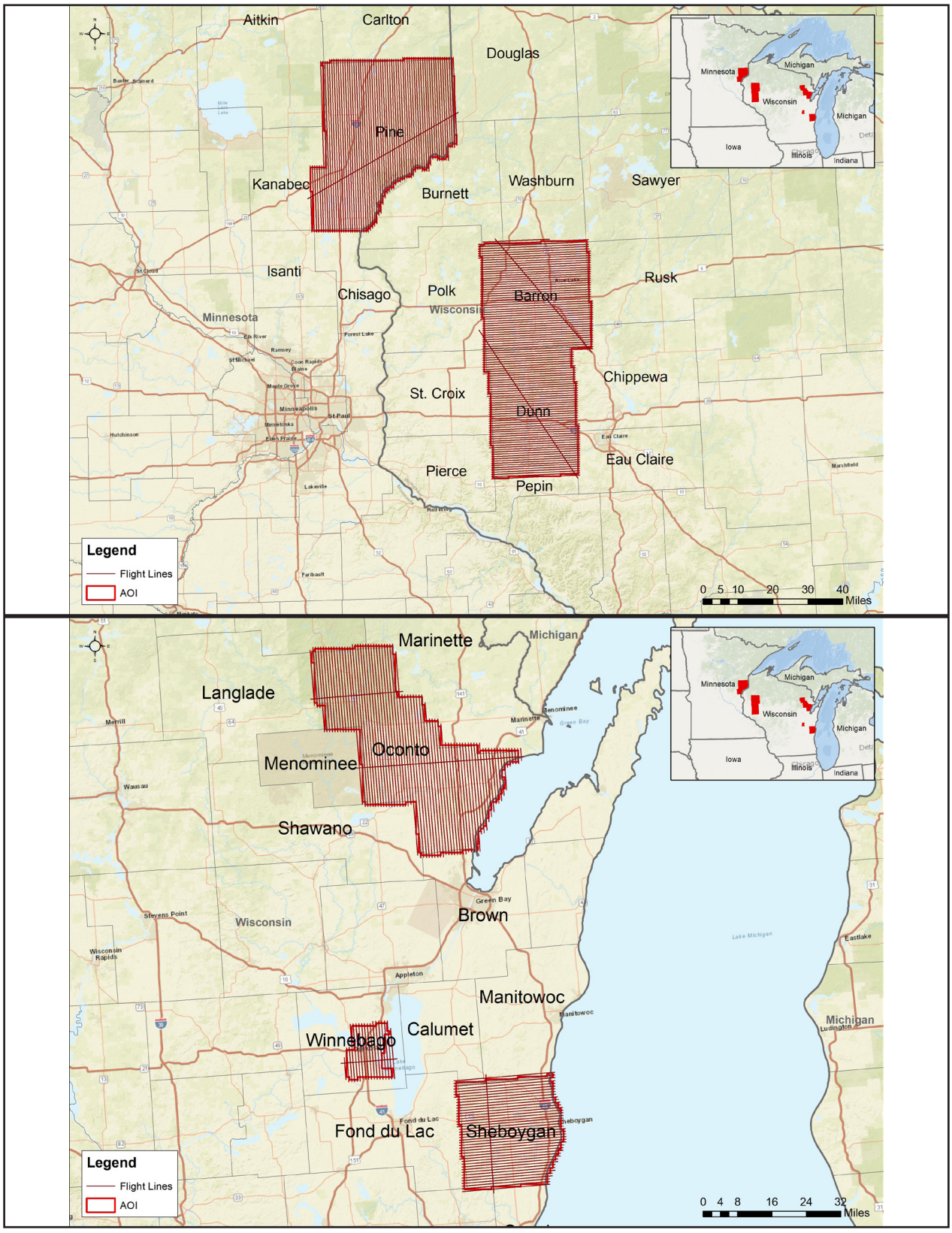
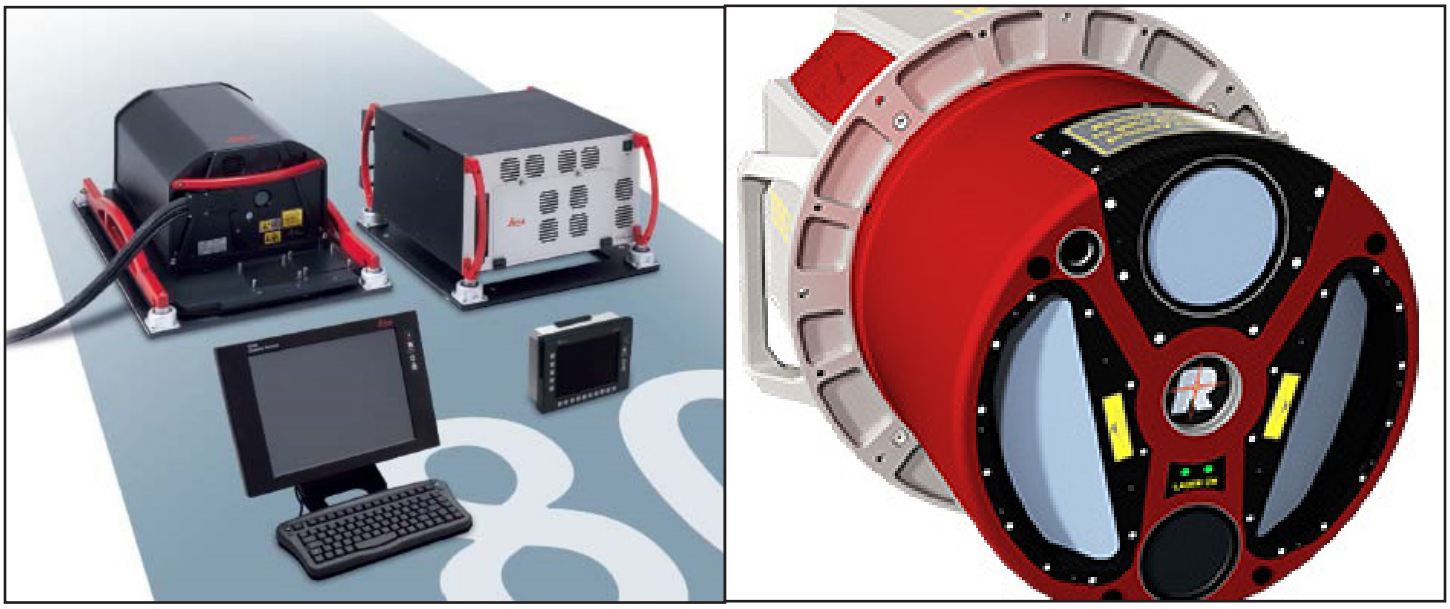


Table 2. LiDAR System Specifications

		ALS80	1560i
Terrain and Aircraft Scanner	Flying Height	2150 m	2000 m
	Recommended Ground Speed	160 kts	160 kts
Scanner	Field of View	40°	60°
	Scan Rate Setting Used	52 Hz	180 Hz
Laser	Laser Pulse Rate Used	381 kHz	700 kHz
	Multi Pulse in Air Mode	yes	yes
Coverage	Full Swath Width	1565 m	2309 m
	Line Spacing	1096 m	1616 m
Point Spacing and Density	Average Point Spacing	0.58 m	0.71 m
	Average Point Density	2.97 pts / m^2	1.99 pts / m^2

Figure 3. The Leica ALS80 and Riegl 1560i 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

- Twin-Piston Piper Navajo PA31, Tail Numbers: N6GR, C-FVZM, 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 state-of-the-art Leica ALS80 and Riegl 1560i LiDAR systems. 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 between 19 April 2019 and 21 May 2019. 19 aircraft lifts were completed. Accomplished lifts are listed below.

- 20190419A (SN8146, N6GR)
- 20190420A (SN8146, N6GR)
- 20190420B (SN8146, N6GR)
- 20190504A (SN8146, N6GR)
- 20190507A (SN8146, N6GR)
- 20190507B (SN8146, N6GR)
- 20190507A (SN2738, C-FVZM)
- 20190511A (SN2738, C-FVZM)
- 20190511A (SN8146, N6GR)
- 20190512A (SN8146, N6GR)
- 20190513A (SN8146, N6GR)
- 20190513A (SN2738, C-FVZM)
- 20190514A (SN2738, C-FVZM)
- 20190514A (SN8146, N6GR)
- 20190515A (SN2738, C-FVZM)
- 20190517A (SN3543, C-FFRY)
- 20190520A (SN3543, C-FFRY)
- 20190520B (SN2738, C-FVZM)
- 20190521A (SN2738, C-FVZM)

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

Inertial Explorer/Applanix + POSPac Mobile Mapping Suite 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. Inertial Explorer/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 Inertial Explorer/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.

The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. Laser point data are imported into TerraScan and a manual calibration is performed to assess the system offsets for pitch, roll, heading and scale. At this point this data is ready for analysis, classification, and filtering to generate a bare earth surface model in which the above-ground features are removed from the data set. Point clouds were created using the Leica CloudPro and RiPROCESS software. GeoCue distributive processing software was used in the creation of some files needed in downstream processing, as well as in the tiling of the dataset into more manageable file sizes. TerraScan and TerraModeler software packages were then used for the automated data classification, manual cleanup, and bare earth generation. Project specific macros were developed to classify the ground and remove side overlap between parallel flight lines.

All data was manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler. Global Mapper was used as a final check of the bare earth dataset. GeoCue was used to create the deliverable industry-standard LAS files for both the All Point Cloud Data and the Bare Earth. In-house software was then used to perform final statistical analysis of the classes in the LAS files.

3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 1.3 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:

- Class 1 – Processed, but Unclassified – These points would be the catch all for points that do not fit any of the other deliverable classes. This would cover features such as vegetation, cars, etc.
- Class 2 – Bare-Earth Ground – This is the bare earth surface
- Class 7 – Low Noise – Low points, manually identified below the surface that could be noise points in point cloud.
- Class 9 – Water – Points found inside of inland lake/ponds
- Class 17 – Bridge Decks – Points falling on bridge decks.
- Class 18 – High Noise – High points, manually identified above the surface that could be noise points in point cloud.
- Class 20 – Ignored Ground – Points found to be close to breakline features. Points are moved to this class from the Class 2 dataset. This class is ignored during the DEM creation process in order to provide smooth transition between the ground surface and hydro flattened surface.
- Class 21 – Snow – Where reliably identified
- Class 22 – Temporal Exclusion – Typically non-favored data in intertidal zones

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 TerraScan macro functionality. A buffer of 3 feet 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.

All overlap data was processed through automated functionality provided by TerraScan to classify the overlapping flight line data to approved classes by USGS. The overlap data was identified using the Overlap Flag, per LAS 1.4 specifications.

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. Quantum Spatial'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 Ponds and Lakes, Inland Pond and Lake Islands, Inland Streams and Rivers and Inland Stream and River Islands using TerraModeler functionality.

Elevation values were assigned to all Inland streams and rivers using Quantum Spatial'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

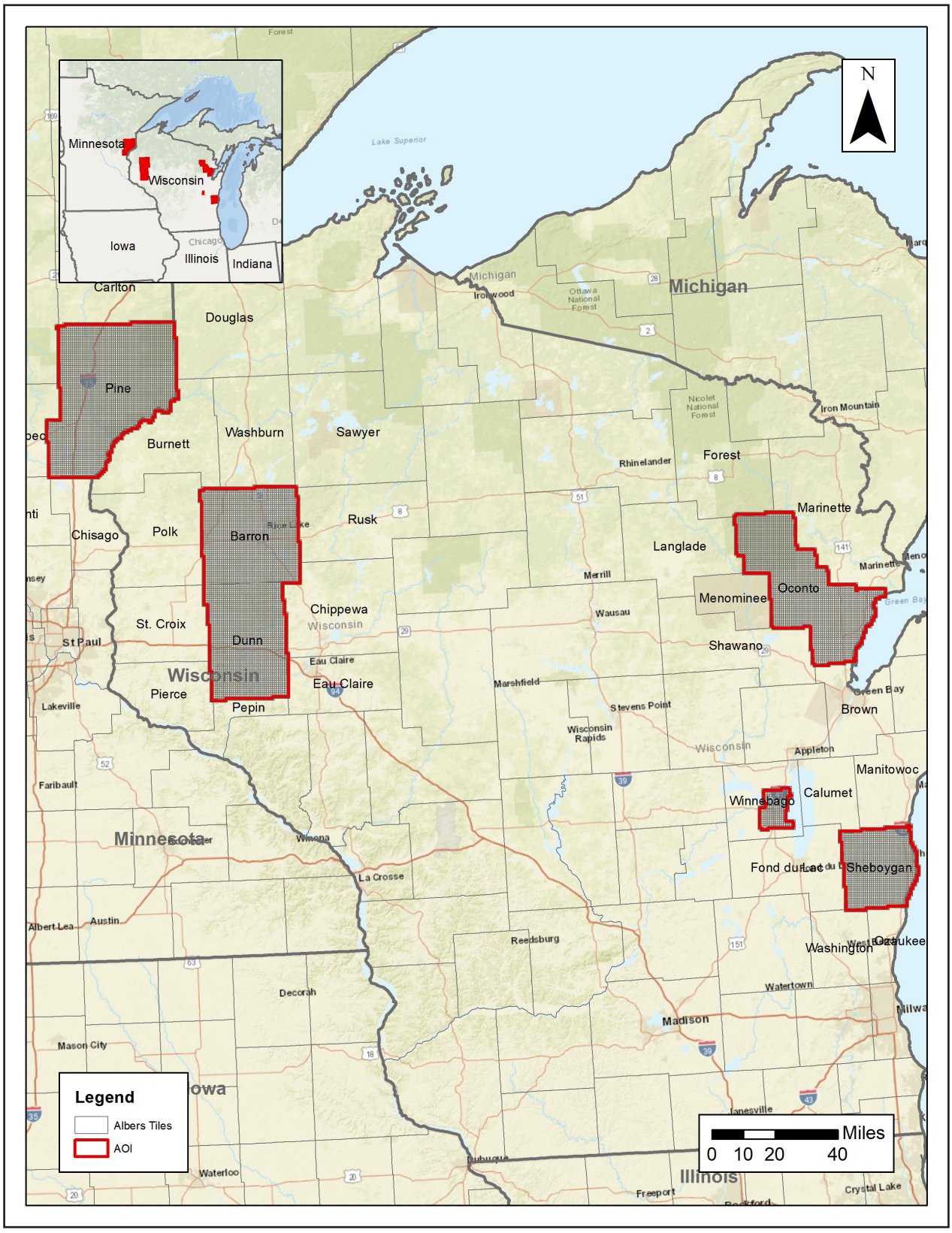
Class 2 LiDAR in conjunction with the hydro breaklines were used to create a 1 meter Raster DEM. Using automated scripting routines within ArcMap, an ERDAS Imagine .IMG file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations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

3.7. Intensity Image Processing

GeoCue software was used to create the deliverable intensity images. All overlap classes 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.

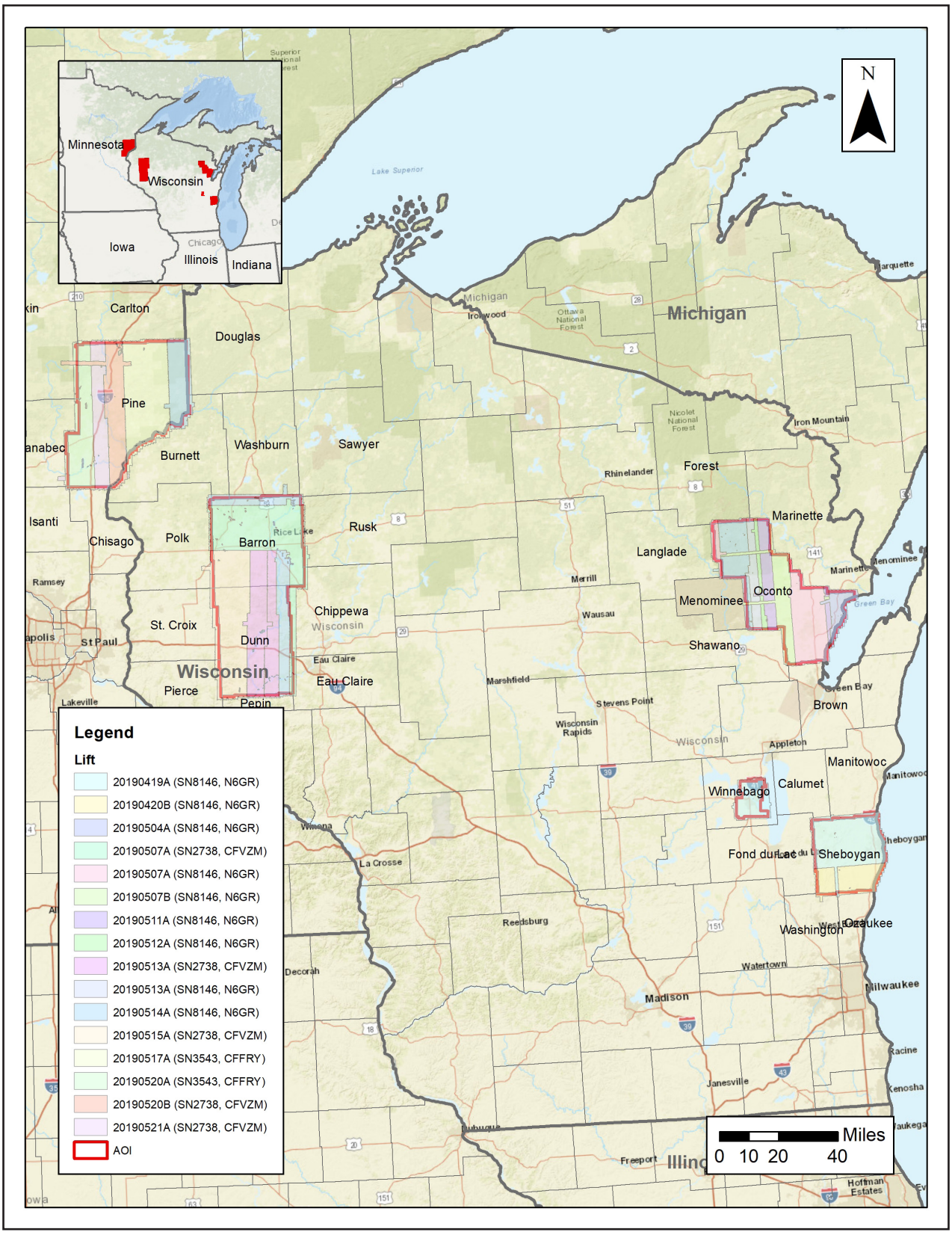
Figure 5. LiDAR Tile Layout



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 Flightline Coverage



5. Ground Control and Check Point Collection

Ayres Associates completed a field survey of 91 ground control (calibration) points along with 214 blind QA points in Non-Vegetated and Vegetated land cover classifications (total of 305 points) as an independent test of the accuracy of this project.

A combination of precise GPS surveying methods, including static and RTK observations were used to establish the 3D position of ground calibration points and QA points for the point classes above. GPS was not an appropriate methodology for surveying in the forested areas during the leaf-on conditions for the actual field survey (which was accomplished after the LiDAR acquisition). Therefore the 3D positions for the forested points were acquired using a GPS-derived offset point located out in the open near the forested area, and using precise offset surveying techniques to derive the 3D position of the forested point from the open control point. The explicit goal for these surveys was to develop 3D positions that were three times greater than the accuracy requirement for the elevation surface. In this case of the blind QA points the goal was a positional accuracy of 5 cm in terms of the RMSE.

For more information, see the Survey Reports in Appendix B.

The required accuracy testing was performed on the LiDAR dataset (both the LiDAR point cloud and derived DEM's) according to the USGS LiDAR Base Specification Version 1.3.

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.

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 123 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)/ASRPS 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 123 checkpoints located in bare earth and urban (non-vegetated) areas. See Figure 8.

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 91 checkpoints located in tall weeds/ crops and brushlands/low trees (vegetated) areas. The checkpoints were distributed throughout the project area and were surveyed using GPS techniques. See Figure 9.

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
Calibration	**N/A**	**N/A**	**91**
Raw NVA	**0.196 m**	**0.077 m**	**123**
NVA	**0.196 m**	**0.073 m**	**123**
VVA	**0.294 m**	**0.167 m**	**91**

Figure 7. Calibration Control Point Locations

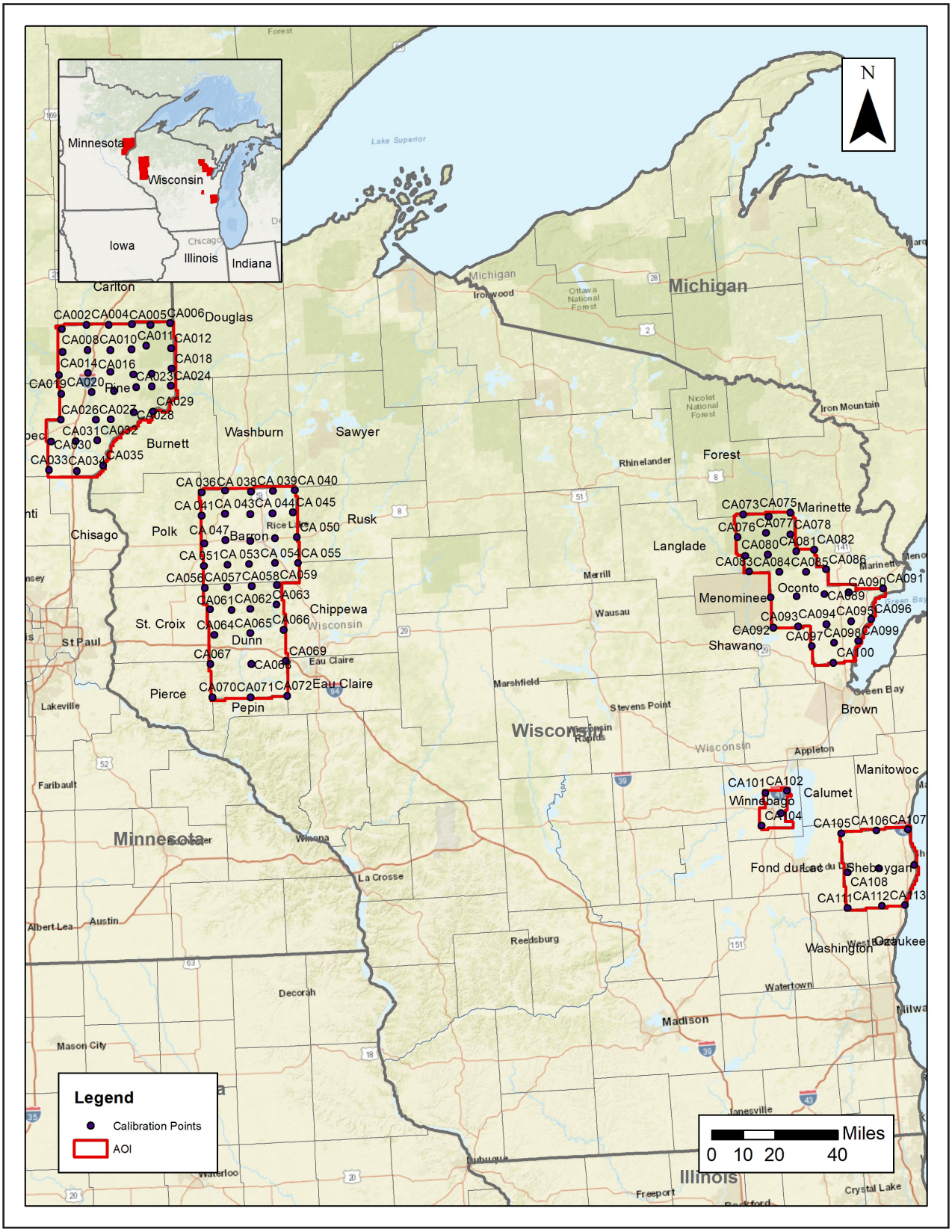


Figure 8. QC Checkpoint Locations - NVA

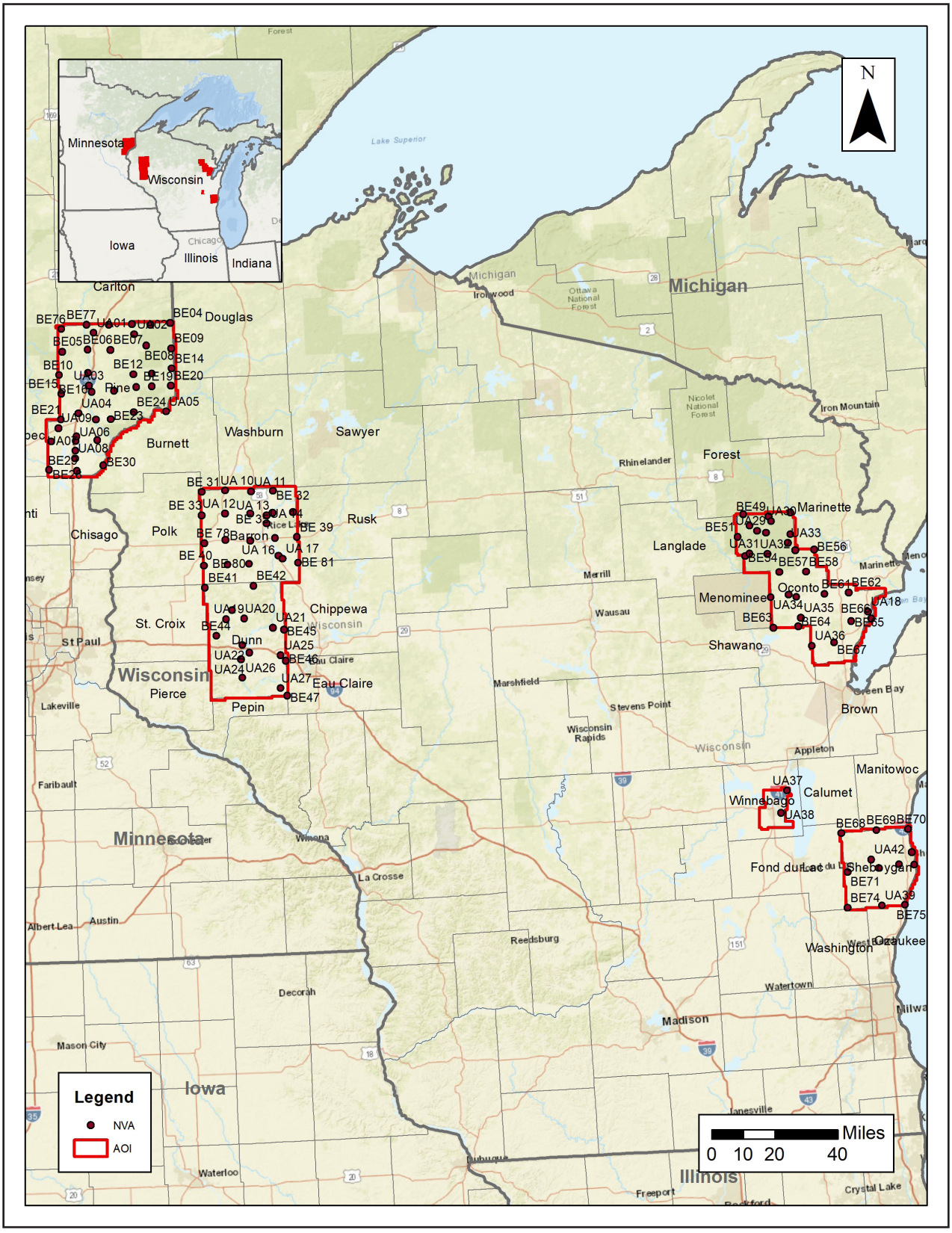
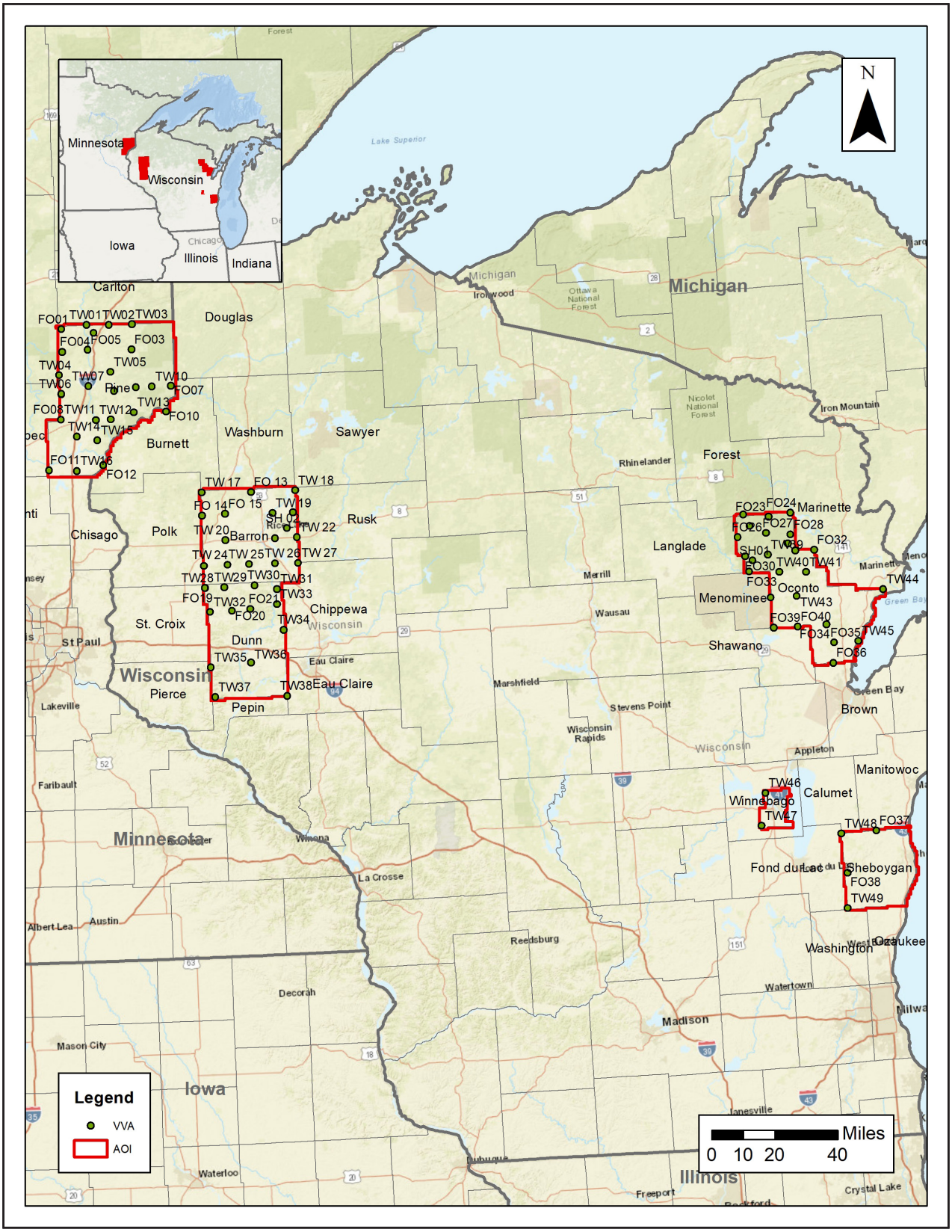


Figure 9. QC Checkpoint Locations - VVA



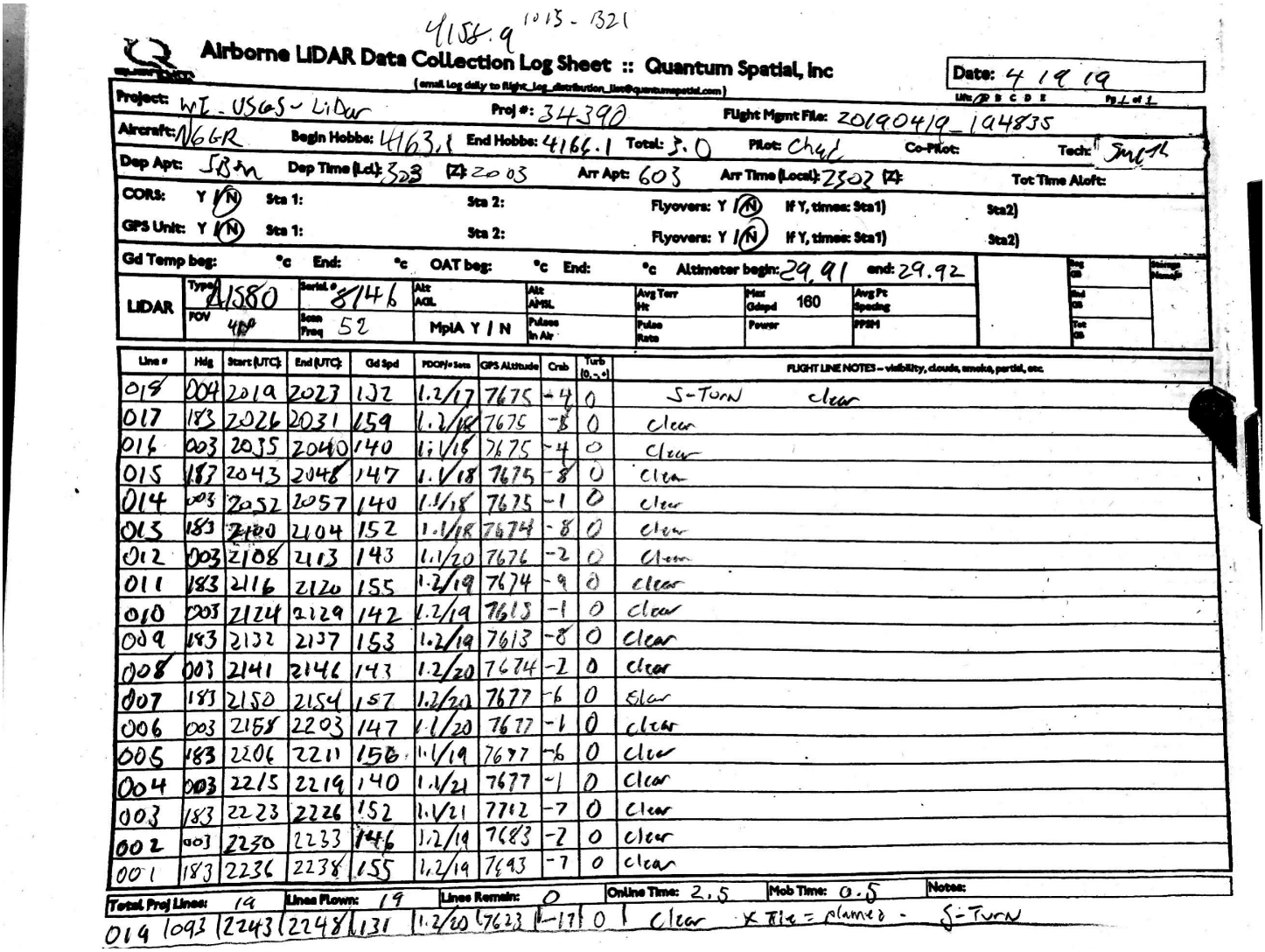
Project Report Appendices

The following section contains the appendices as listed in the Oshkosh 3 Rivers 2018 LiDAR Project Report.

Appendix A

Flight Logs

20190419A (SN8146, N6GR)



4158.9 1013 - 1321

Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email Log daily to flight_log_distribution_list@quantumspatial.com)

Date: 4 19 19 — Lifts: A B C D E — Pg 1 of 1

Project: WI - USGS - LiDar — Proj #: 34390 — Flight Mgmt File: 20190419_194835

Aircraft: N66R — Begin Hobbs: 4163.1 — End Hobbs: 4166.1 — Total: 3.0 — Pilot: Chad — Co-Pilot: — Tech: Jake

Dep Apt: 58M — Dep Time (Lcl): 1323 (Z): 2003 — Arr Apt: 6D3 — Arr Time (Local): 2302 (Z): — Tot Time Aloft:

CORS: Y / (N) — Sta 1: — Sta 2: — Flyovers: Y / (N) — If Y, times: Sta1) — Sta2)

GPS Unit: Y / (N) — Sta 1: — Sta 2: — Flyovers: Y / (N) — If Y, times: Sta1) — Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: 29.91 end: 29.92

LiDAR	Type: Al580	Serial #: 8146	Alt AGL	Alt ASL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing	Beg GS	Mid GS	Swings Numb
	FOV 40°	Scan Freq 52	MpIA Y / N	Pulses In Air	Pulse Rate	Power	PPSM	End GS	Tot GS	

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0,-,+)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
018	004	2019	2027	132	1.2/17	7675	-4	0	S-Turn clear
017	183	2026	2031	159	1.2/18	7675	-8	0	clear
016	003	2035	2040	140	1.1/18	7675	-4	0	clear
015	183	2043	2048	147	1.1/18	7675	-8	0	clear
014	003	2052	2057	140	1.1/18	7675	-1	0	clear
013	183	2100	2104	152	1.1/18	7674	-8	0	clear
012	003	2108	2113	143	1.1/20	7676	-2	0	clear
011	183	2116	2120	155	1.2/19	7674	-9	0	clear
010	003	2124	2129	142	1.2/19	7613	-1	0	clear
009	183	2132	2137	153	1.2/19	7613	-8	0	clear
008	003	2141	2146	143	1.2/20	7674	-2	0	clear
007	183	2150	2154	157	1.2/20	7677	-6	0	clear
006	003	2158	2203	147	1.1/20	7677	-1	0	clear
005	183	2206	2211	156	1.1/19	7677	-6	0	clear
004	003	2215	2219	140	1.1/21	7677	-1	0	clear
003	183	2223	2226	152	1.1/21	7712	-7	0	clear
002	003	2230	2233	146	1.2/19	7683	-2	0	clear
001	183	2236	2238	155	1.2/19	7693	-7	0	clear

Total Proj Lines: 19 — Lines Flown: 19 — Lines Remain: 0 — Online Time: 2.5 — Mob Time: 0.5 — Notes:

014 093 2243 2248 131 1.2/20 7623 -17 0 clear * Tie = planned - S-Turn

Scanned with CamScanner

20190420A (SN8146, N6GR)

Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 04/20/2019 Lift: (A) B C D E Pg 2 of 2

Project: SHEBOYGAN Co. Proj #: 34390 Flight Mgmt File:

Aircraft: N6GR Begin Hobbs: 4166.1 End Hobbs: 4172.1 Total: 6.0 Pilot: UNANGST Co-Pilot: Tech: SWINFORD

Dep Apt: KSBM Dep Time (Lcl): 7:55 (Z): 12:55 Arr Apt: KSBM Arr Time (Local): 6:35 (Z): 23:39 Tot Time Aloft: 6.0

CORS: Y / (N) Sta 1: PPP Sta 2: Flyovers: Y / (N) If Y, times: Sta1) Sta2)

GPS Unit: Y / (N) Sta 1: Sta 2: Flyovers: Y / (N) If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR									
Type ALS 80	Serial # 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		Beg GB 465	Storage Name/#
FOV 40	Scan Freq 52	MpiA Y / N	Pulses In Air	Pulse Rate 381	Power 100%	PPSM		End GB 336	2
								Tot GB 129	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
24	94	16:46	16:56	153	1.5/19	7500	-16		
23	274	16:59	17:07	158	1.1/20	7500	+5		
22	94	17:10	17:19	154	1.1/21	7500	-16		
21	274	17:22	17:30	154	1.2/21	7500	+5		
20	94	17:33	17:42	150	1.2/20	7500	-19		
19	274	17:45	17:54	155	1.2/19	7500	+5		
18	94	17:57	18:06	144	1.1/21	7500	-19		
17	274	18:09	18:18	150	1.0/22	7500	+5		
16	94	18:20	18:29	144	1.2/21	7500	-19		
43	05	18:39	18:49	129	1.2/21	7700	-10		

Total Proj Lines: Lines Flown: Lines Remain: Online Time: 5.5 Mob Time: .5 Notes:

20190420B (SN8146, N6GR)

Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email Log daily to flight_log_distribution_list@quantumspatial.com)

Date: 04/20/2019 — Lift: A (B) C D E — Pg 1 of 1

Project:	SHEBOYGAN Co.		**Proj #:**	34390		**Flight Mgmt File:**			
Aircraft:	N6GR	**Begin Hobbs:**	4172.1	**End Hobbs:**	4175.3	**Total:**	3.2	**Pilot:**	UNANGST	**Co-Pilot:**		**Tech:**	SWINFORD
Dep Apt:	KSBM	**Dep Time (Lcl):**	3:05	**(Z):**	20:05	**Arr Apt:**	KSBM	**Arr Time (Local):**	6:35	**(Z):**	23:35	**Tot Time Aloft:**	3.2
CORS:	Y / (N)	**Sta 1:**	PPP	**Sta 2:**		**Flyovers:**	Y / (N)	**If Y, times: Sta1)**		**Sta2)**			
GPS Unit:	Y / (N)	**Sta 1:**		**Sta 2:**		**Flyovers:**	Y / (N)	**If Y, times: Sta1)**		**Sta2)**			
Gd Temp beg:	°c	**End:**	°c	**OAT beg:**	°c	**End:**	°c	**Altimeter begin:**		**end:**			

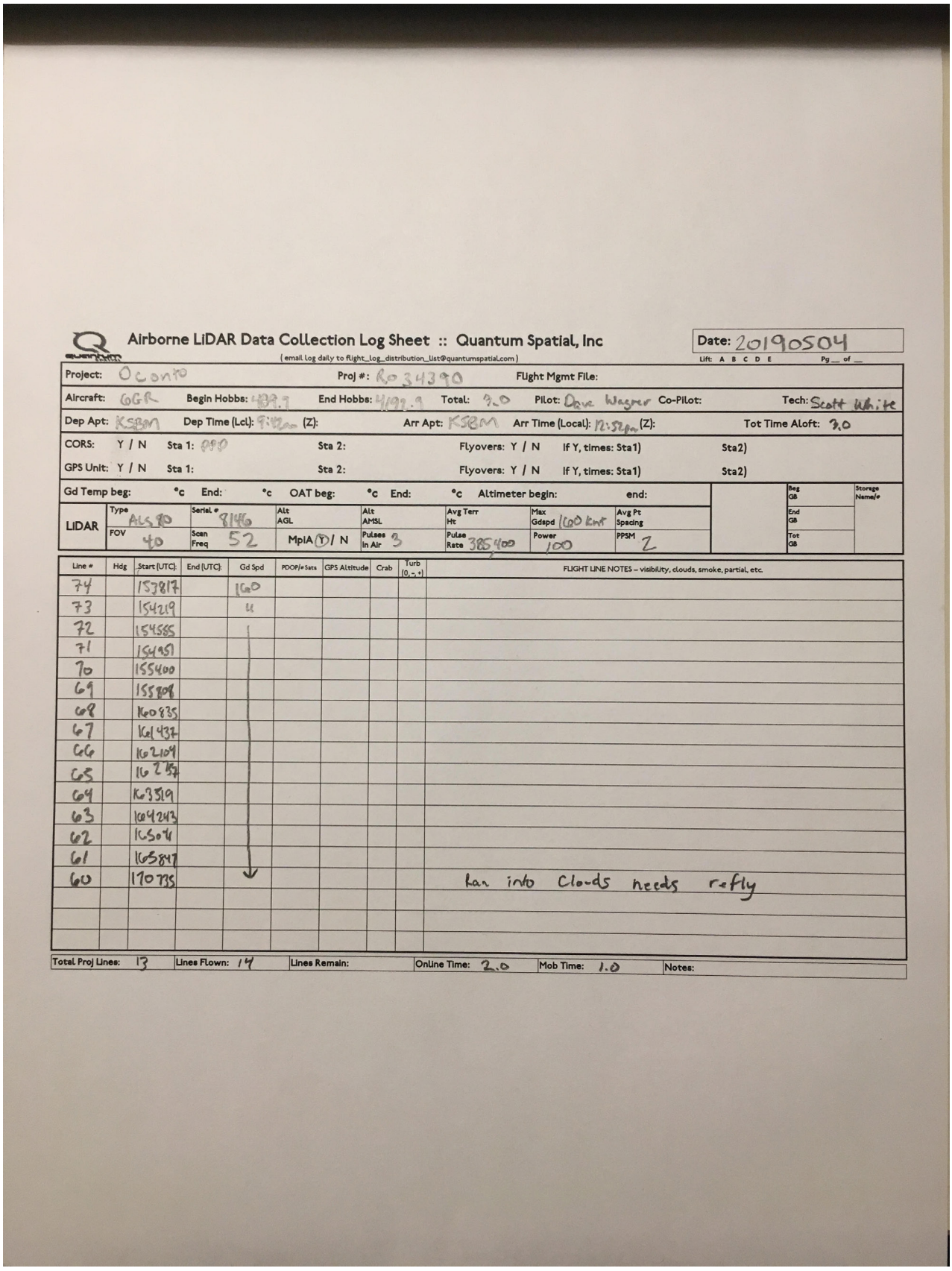
LiDAR	Type: ALS80	Serial #: 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd: 160	Avg Pt Spacing	Beg GB: 336	Storage Name/#	2
	FOV: 40	Scan Freq: 52	MpiA Y / N	Pulses in Air	Pulse Rate: 381	Power: 100%	PPSM	End GB		
								Tot GB		

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
15	274	20:24	20:32	146	1.0/22	7500	+6		S TURN
14	94	20:35	20:43	152	1.1/21	7500	-18		
13	274	20:46	20:54	155	1.1/22	7500	+6		
12	94	20:58	21:06	154	1.3/21	7500	-18		
11	274	21:09	21:17	157	1.1/21	7500	+6		
10	94	21:20	21:30	152	1.1/21	7500	-18		
9	274	21:32	21:41	157	1.2/20	7500	+6		
8	94	21:43	21:51	150	1.2/19	7500	-18		
7	274	21:54	22:02	152	1.1/19	7500	+6		
6	94	22:05	22:12	153	1.2/20	7500	-18		
5	274	22:15	22:22	155	1.1/20	7500	+6		
4	94	22:25	22:33	155	1.3/20	7500	-18		
3	274	22:36	22:43	156	1.2/22	7500	+6		
2	94	22:46	22:54	150	1.2/22	7500	-18		
1	274	22:57	23:04	155	1.2/21	7500	+6		
X-TIE	06	23:07	23:12	127	1.2/21	7500	-10		UNPLANNED CROSS FLIGHT
									5.50

Total Proj Lines:	Lines Flown:	Lines Remain:	Online Time: 2.75	Mob Time: .5	Notes:

8.25

20190504A (SN8146, N6GR)



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(email Log daily to flight_log_distribution_list@quantumspatial.com)

Date: 20190504 Lift: A B C D E Pg __ of __

Project: Oconto Proj #: R034390 Flight Mgmt File:

Aircraft: GGR Begin Hobbs: 4189.1 End Hobbs: 4192.1 Total: 3.0 Pilot: Dave Wagner Co-Pilot: Tech: Scott White

Dep Apt: KSBM Dep Time (Lcl): 9:12am (Z): Arr Apt: KSBM Arr Time (Local): 12:52pm (Z): Tot Time Aloft: 3.0

CORS: Y / N Sta 1: 880 Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

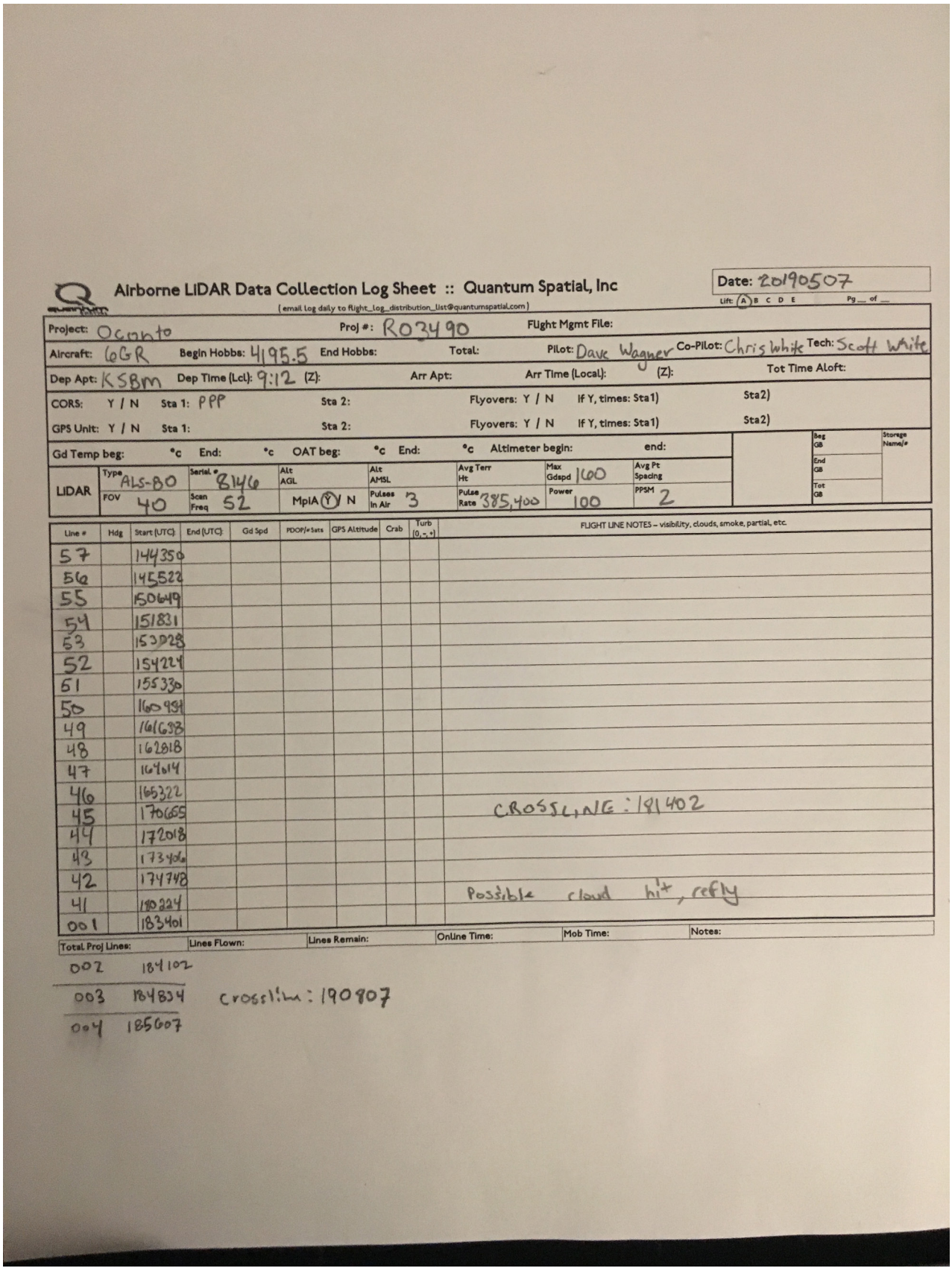
LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	ALS 50	8146				160 kmt	
	FOV	Scan Freq	MpIA (Y) / N	Pulses in Air	Pulse Rate	Power	PPSM
	40	52		3	385400	100	2

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0,-,+)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
74		153817		160					
73		154219		"					
72		154585							
71		154951							
70		155400							
69		155804							
68		160835							
67		161437							
66		162109							
65		162757							
64		163519							
63		164243							
62		165014							
61		165847							
60		170735		↓					Ran into Clouds needs refly

Total Proj Lines: 13 Lines Flown: 14 Lines Remain: Online Time: 2.0 Mob Time: 1.0 Notes:

20190507A (SN8146, N6GR)



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Date: 20190507

Lift: A B C D E Pg __ of __

Project: Ocanto Proj #: R03490 Flight Mgmt File:

Aircraft: 6GR Begin Hobbs: 4195.5 End Hobbs: Total: Pilot: Dave Wagner Co-Pilot: Chris White Tech: Scott White

Dep Apt: KSBM Dep Time (Lcl): 9:12 (Z): Arr Apt: Arr Time (Local): (Z): Tot Time Aloft:

CORS: Y / N Sta 1: PPP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

LIDAR	Type ALS-80	Serial # 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing
	FOV 40	Scan Freq 52	MpiA (Y) N	Pulses In Air 3	Pulse Rate 385,400	Power 100	PPSM 2

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
57		144350							
56		145522							
55		150649							
54		151831							
53		153028							
52		154224							
51		155330							
50		160499							
49		161638							
48		162818							
47		164014							
46		165322							
45		170655							CROSSLINE: 181402
44		172018							
43		173406							
42		174748							
41		180224							Possible cloud hit, refly
001		183401							

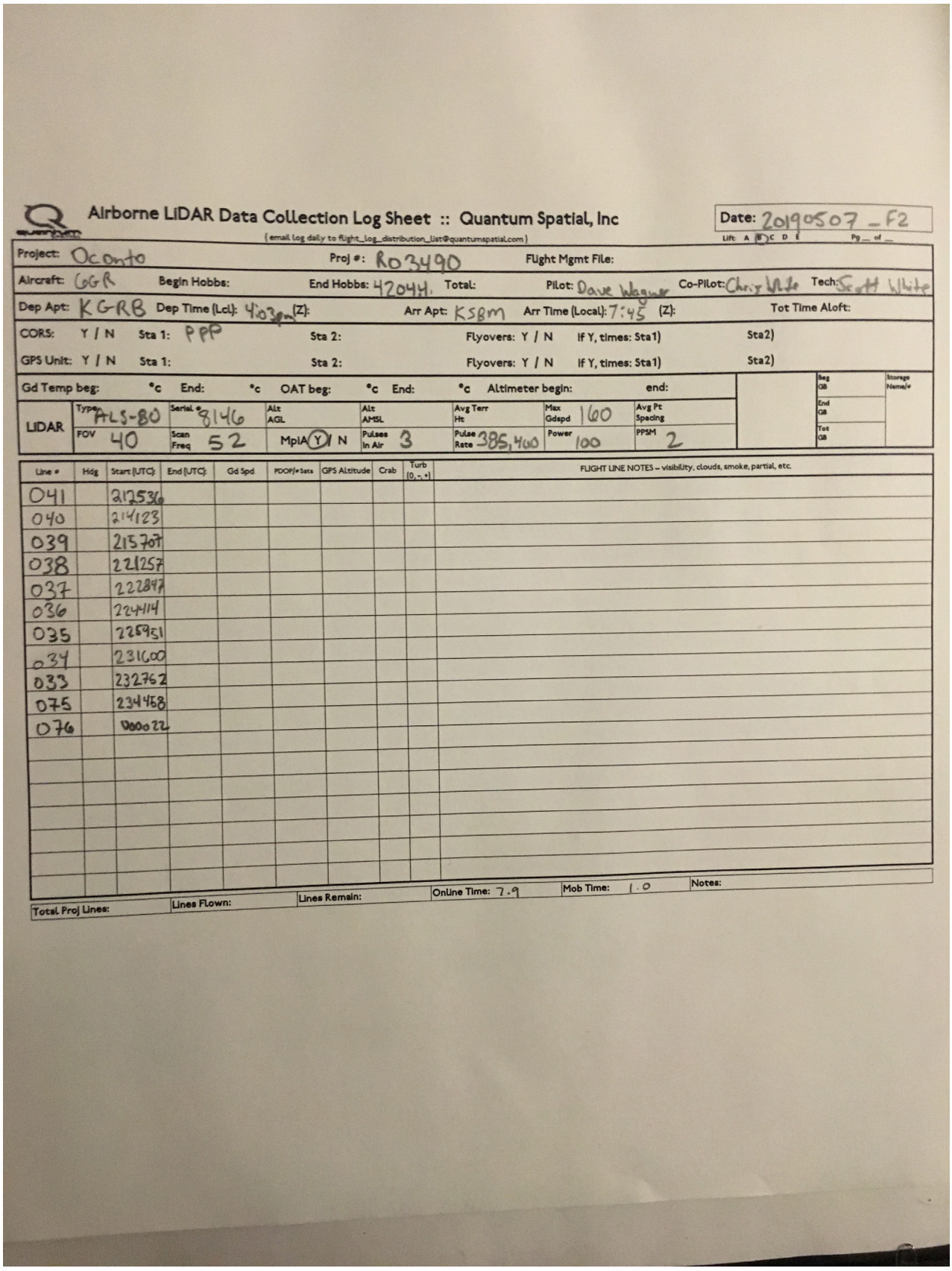
Total Proj Lines:	Lines Flown:	Lines Remain:	Online Time:	Mob Time:	Notes:

002 184102

003 184834 Crossline: 190807

004 185607

20190507B (SN8146, N6GR)



Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

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Date: 20190507 _F2

Lift: A (B) C D E Pg__ of __

Project: Oconto Proj #: R03490 Flight Mgmt File:

Aircraft: 66R Begin Hobbs: End Hobbs: 42044. Total: Pilot: Dave Wagner Co-Pilot: Chris White Tech: Scott White

Dep Apt: KGRB Dep Time (Lcl): 4:03pm (Z): Arr Apt: K58M Arr Time (Local): 7:45 (Z): Tot Time Aloft:

CORS: Y / N Sta 1: PPP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

LIDAR	Type: ALS-80	Serial #: 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd: 160	Avg Pt Spacing
	FOV: 40	Scan Freq: 52	MpIA (Y) / N	Pulses In Air: 3	Pulse Rate: 385,400	Power: 100	PPSM: 2

Beg GB | End GB | Tot GB | Storage Name/#

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
041		212536							
040		214123							
039		215707							
038		221257							
037		222847							
036		224414							
035		225951							
034		231600							
033		232762							
075		234458							
076		000022							

Total Proj Lines: Lines Flown: Lines Remain: OnLine Time: 7.9 Mob Time: 1.0 Notes:

20190507A (SN2738, C-FVZM)

Julian Day 127	Flt A

LIDAR Flight Log

AIRBORNE IMAGING

Date	MAY 7/19	Aircraft	C-FVZM
Project	3179_QSI_MN-WI_WEST	Pilot	MATHIESON
Location	EAU CLAIRE KEAU	Operator	TARR
Mission Objective			

System	RIEGL 1560I
Unit	38
IMU	Applanix AP50
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes
TEMP: -3°C 7500' @ 17:00Z

Aircraft Block Time		
Engine On 15:20	Ramp Out 15:46	Takeoff 15:51
Engine Off 22:15	Ramp In 22:05	Landing 22:04
Total 6.9 hrs	Total 6.3 hrs	Total 6.2 hrs

Mission Plan			
AGL Height	2000 m	Pulse Rep Rate	700 kHz
Ground Speed	160 kts	Scan Rate	181 Hz
Laser Current	100 %	FOV	60 Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	15:29	15:34
Post Mission	22:07	22:12

Flight Line	LiDAR File Name	Flight Direction	GPS Time Start	GPS Time End	Ln Aborted Time	Date Stamp	ALS Time Stamp	Comments
00		00	1606	1613		190507	162002	
036		184	1620	1624		190507	162302	
035		4	1628	1633		190507	162852	
034		184	1637	1642			163744	
033		4	1646	1650			164635	
032		184	1655	1713			165550	* CLOUDS FORMING ON SOUTH
031		4	1716	1733			171626	ENDS OF LINES SO MOVE NORTH *
X-TIELNS30-36		94	1737	1739			173709	X-TIE W-E
103		274	1743	1754			174321	
102		94	1758	1809			175819	
101		274	1812	1823			181256	
100		94	1827	1838			182737	
99		274	1842	1853			184246	
98		94	1857	1908			185733	
97		274	1912	1922		190507	191205	

Pg 1 of 2

Julian Day 127	Flt A

LIDAR Flight Log

AIRBORNE IMAGING

Date MAY 7/19	Aircraft C-FVZM
Project 3179-QSI_MN.WI_WEST	Pilot MATHIESON
Location EAU CLAIRE KEAU	Operator TARR
Mission Objective	

System RIEGL 1560I	
Unit 38	
IMU Applanix AP50	
GPS Rx Trimble	
Scanner 1 Drive 1	
Scanner 2 Drive 2	

Additional Notes
TEMP -2°C 7500' @ 19:00Z

Aircraft Block Time		
Engine On 15:20	Ramp Out 15:46	Takeoff 15:51
Engine Off 22:15	Ramp In 2205	Landing 2204
Total 6.9 hrs	Total 6.3 hrs	Total 6.2 hrs

Mission Plan			
AGL Height 2000	m	Pulse Rep Rate 700	kHz
Ground Speed 160	kts	Scan Rate 181	Hz
Laser Current 100	%	FOV 60	Deg's

Static Alignment	GPS Time	
	Start	End
Pre Mission	15:29	15:34
Post Mission	22:07	22:12

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Ln Aborted	Date Stamp	ALS Time Stamp	Comments
			Start	End	Time			
96		94	1926	1937		190507	192632	
95		274	1940	1951			194053	
94		94	1955	2006			195512	
93		274	2010	2021			201006	
92		94	2024	2035			202435	
91		274	2039	2050			203940	
90		94	2054	2105			205415	
89		274	2108	2119			210837	
88		94	2122	2134			212253	
X-TIE LINE 88-103		184	2137	2143			213744	
∞		∞	2144	2150			—	

Pg 2 of 2

20190511A (SN2738, C-FVZM)

Julian Day	131	Flight	A

LIDAR Flight Log

Date May 11/2019	**Aircraft** C-FVZM
Project 3179_QSI_MN_WI_WEST	**Pilot** J. Mathieson
Location EAU CLAIRE, WI KEAU	**Operator** D. Tarr
Mission Objective	

System	Riegl 1560i
Unit	S2222738
IMU	Applanix AP 60
GPS Rx	Trimble R8
Scanner 1 Drive	3
Scanner 2 Drive	4

Additional Notes

Temp -3C @7600' @ 1400z

Time to next maintenance: 40.5 ☐ 50 hr ☑ 100 hr

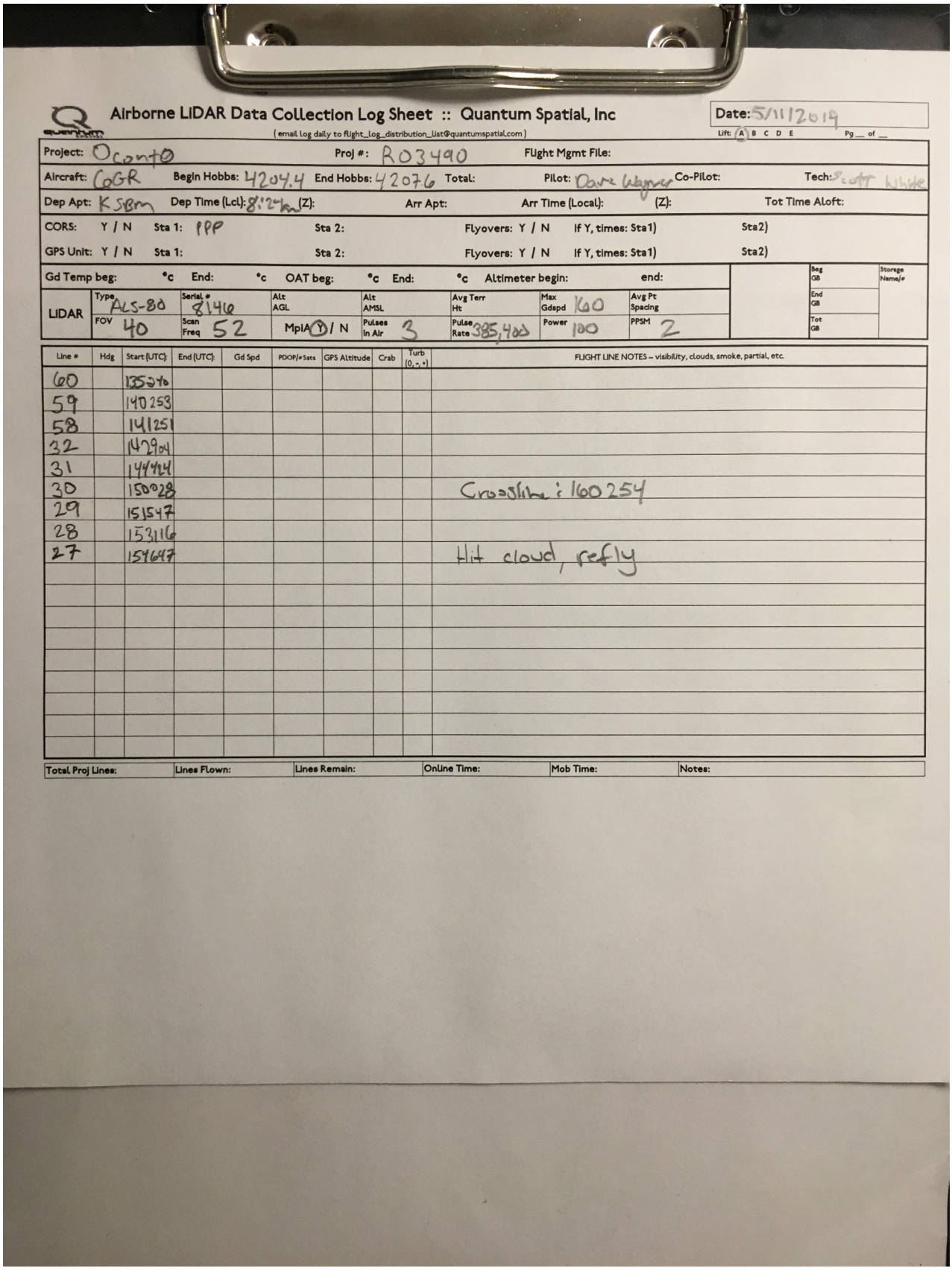
Aircraft Block Time		
Engine On 12:32	**Takeoff**	12:52
Engine Off 19:20	**Landing**	19:09
Total 6.80 hrs	**Total** hrs	6.30

Mission Plan			
AGL Height	2000 m	**Pulse Rate**	700
Target Speed	160 kts	**Scan Rate**	181
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time Start	GPS Time End
Pre Mission	12:37	12:42
Post Mission	19:12	19:17

Flight Line	LiDAR File Name	Flight Direction	GPS Time Start	GPS Time End	Line Aborted Time	Line Aborted nmi to End	Mission ID Time Stamp 190511	Comments
8		8	1310	1317				Figure 8
087		274	1320	1331			132039	
086		94	1335	1347			133526	
085		274	1350	1401			135057	
084		94	1405	1416			140540	Cenrtral Block Complete.
X-TIE		184	1421	1424			142115	X-TIE LNS# 84-90
030		184	1428	1445			142823	
029		4	1449	1506			144935	
028		184	1510	1527			151037	
027		4	1531	1548			153132	
026		184	1553	1601	1601	25n	155302	Clouds forming. Try north block.
X-TIE		94	1609	1612			160925	X-TIE LNS# 25-32
083		0	1632	1640			163212	
082		180	1644	1654			164449	
081		0	1658	1708			165836	

20190511A (SN8146, N6GR)



Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email Log daily to flight_log_distribution_list@quantumspatial.com)

Date: 5/11/2019

Lift: (A) B C D E Pg __ of __

Project: Ocanto Proj #: R03490 Flight Mgmt File:

Aircraft: C6GR Begin Hobbs: 4204.4 End Hobbs: 4207.6 Total: Pilot: Dave Wagner Co-Pilot: Tech: Scott White

Dep Apt: KSBM Dep Time (Lcl): 8:12am (Z): Arr Apt: Arr Time (Local): (Z): Tot Time Aloft:

CORS: Y / N Sta 1: PPP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

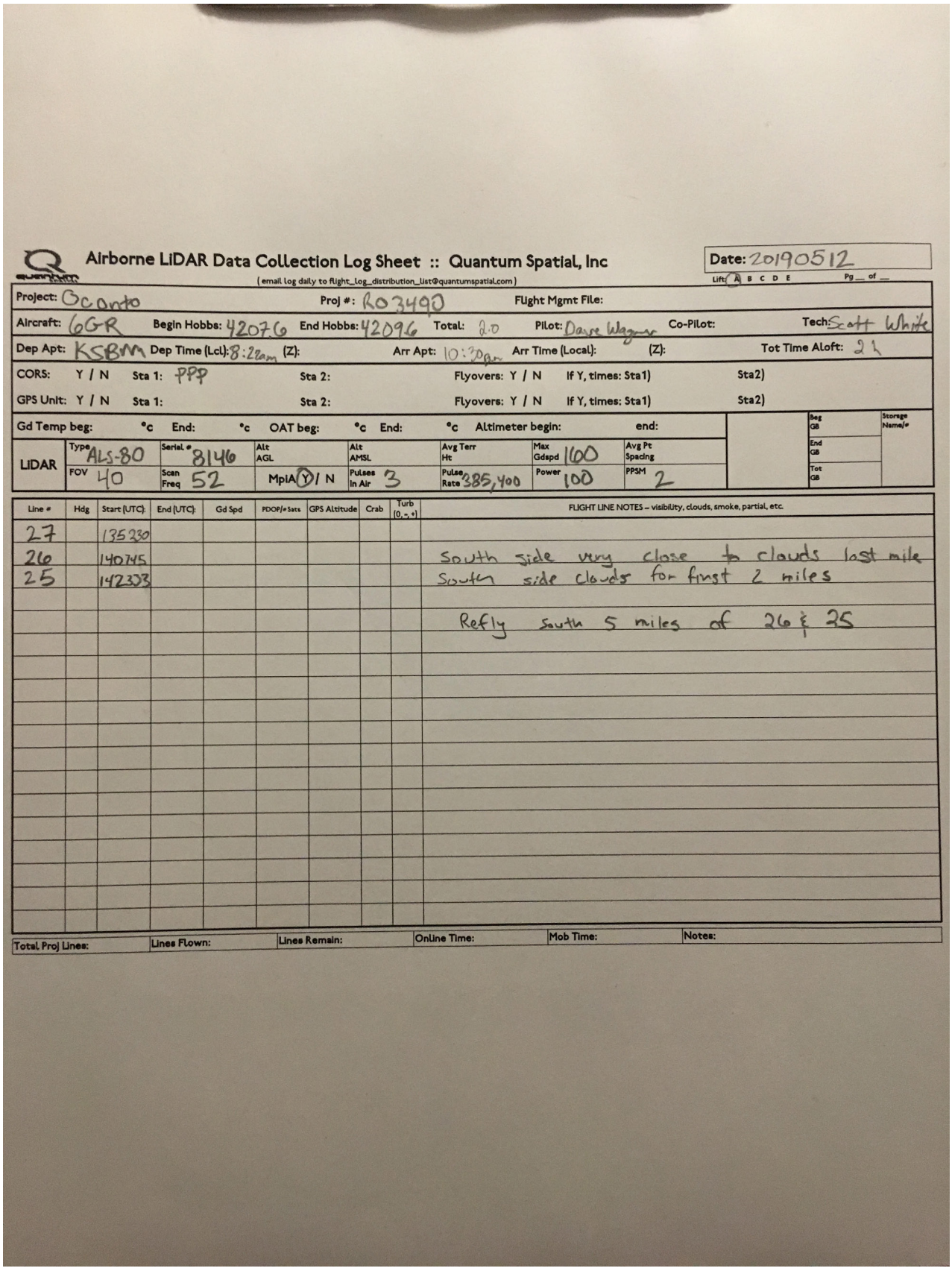
LiDAR	Type: ALS-80	Serial #: 81416	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd: 160	Avg Pt Spacing
	FOV: 40	Scan Freq: 52	MpiA (Y) / N	Pulses In Air: 3	Pulse Rate: 385,400	Power: 100	PPSM: 2

Beg GB | End GB | Tot GB | Storage Name/#

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
60		135246							
59		140253							
58		141251							
32		142904							
31		144424							
30		150028							Crossline: 160254
29		151547							
28		153116							
27		154647							Hit cloud, refly

Total Proj Lines: Lines Flown: Lines Remain: Online Time: Mob Time: Notes:

20190512A (SN8146, N6GR)



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Date: 20190512 Lift: A B C D E Pg __ of __

Project: Oconto Proj #: R03490 Flight Mgmt File:

Aircraft: 6GR Begin Hobbs: 42076 End Hobbs: 42096 Total: 2.0 Pilot: Dave Wagner Co-Pilot: Tech: Scott White

Dep Apt: KSBM Dep Time (Lcl): 8:22am (Z): Arr Apt: 10:30pm Arr Time (Local): (Z): Tot Time Aloft: 2.1

CORS: Y / N Sta 1: PPP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

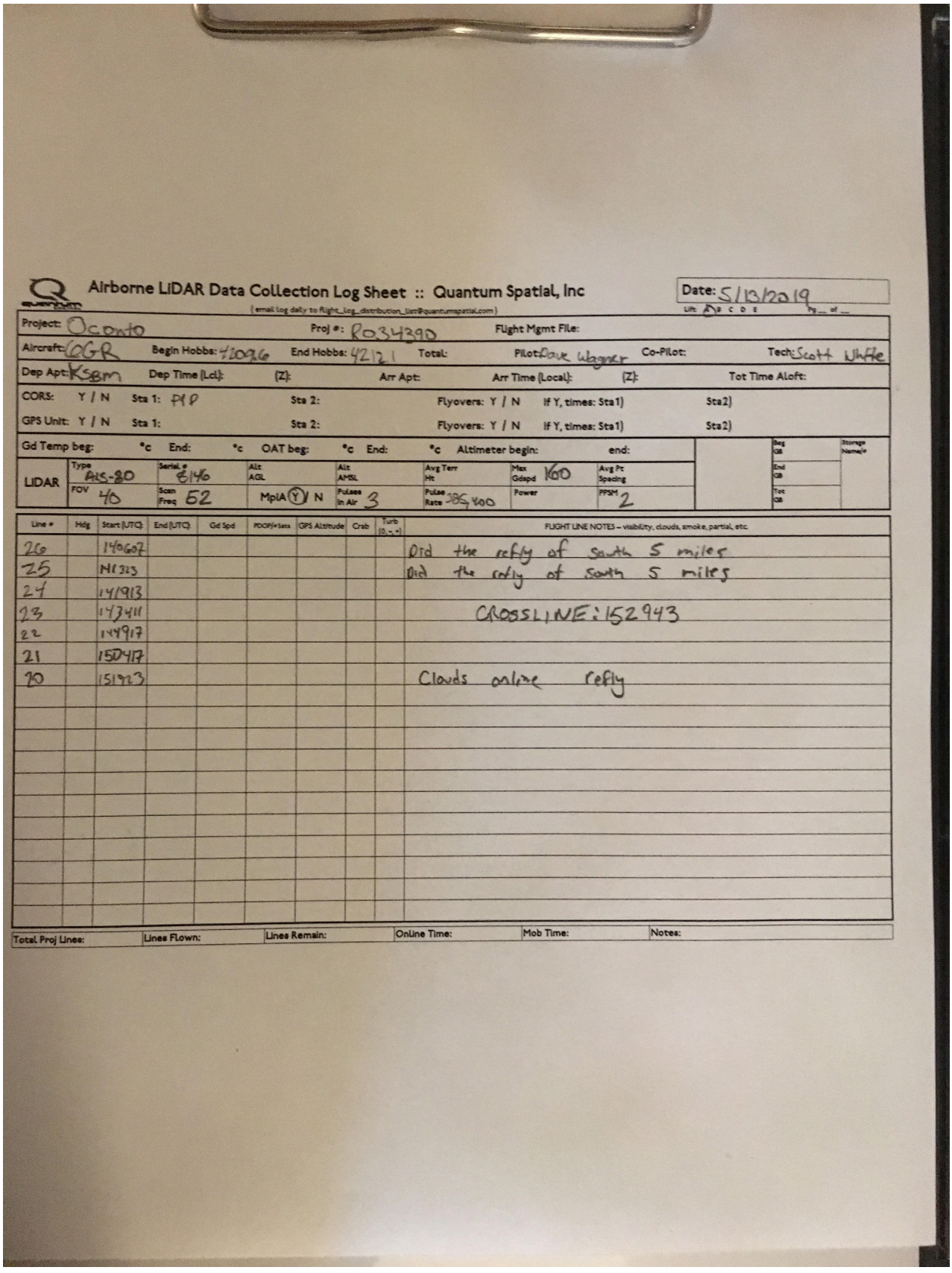
LiDAR	Type ALS-80	Serial # 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd 100	Avg Pt Spacing
	FOV 40	Scan Freq 52	MpiA (Y) / N	Pulses In Air 3	Pulse Rate 385,400	Power 100	PPSM 2

Beg GB	Storage Name/#
End GB	
Tot GB	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
27		135230							
26		140745							South side very close to clouds last mile
25		142333							South side clouds for first 2 miles
									Refly south 5 miles of 26 & 25

Total Proj Lines: Lines Flown: Lines Remain: Online Time: Mob Time: Notes:

20190513A (SN8146, N6GR)



Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email log daily to Flight_Log_distribution_List@quantumspatial.com)

Date: 5/13/2019

Lift: A B C D E Pg __ of __

Project: Oconto Proj #: R034390 Flight Mgmt File:

Aircraft: CGR Begin Hobbs: 420926 End Hobbs: 421211 Total: Pilot: Dave Wagner Co-Pilot: Tech: Scott Whitte

Dep Apt: KSBM Dep Time (Lcl): (Z): Arr Apt: Arr Time (Local): (Z): Tot Time Aloft:

CORS: Y / N Sta 1: PIP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type: ALS-80	Serial #: 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd: 100	Avg Pt Spacing
	FOV: 40	Scan Freq: 52	MpiA: (Y) N	Pulses in Air: 3	Pulse Rate: 385,400	Power	PPSM: 2

Beg GB | End GB | Tot GB | Storage Name/#

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/#sats	GPS Altitude	Crab	Turb (0,-,+)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
26		140607							Did the refly of South 5 miles
25		140323							Did the refly of South 5 miles
24		141913							
23		147411							CROSSLINE: 152943
22		144917							
21		150417							
20		151923							Clouds online refly

Total Proj Lines: | Lines Flown: | Lines Remain: | OnLine Time: | Mob Time: | Notes:

20190513A (SN2738, C-FVZM)

Julian Day	133	Flight	A

LIDAR Flight Log

Date MAY13/2019	**Aircraft** C-FVZM
Project 3179_QSI_MN_WI_WEST	**Pilot** J. Mathieson
Location EAU CLAIRE, WI	**Operator** D. Tarr
Mission Objective	

System	Riegl 1560i
Unit	S2222738
IMU	Applanix AP 60
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

TEMP -4C @7200' @1400z.

Time to next maintenance: _____ ☐ 50 hr ☑ 100 hr

Aircraft Block Time		
Engine On 12:33	**Takeoff**	12:51
Engine Off 16:30	**Landing**	16:18
Total 3.95 hrs	**Total** hrs	3.50hrs

Mission Plan			
AGL Height	2000 m	**Pulse Rate**	700
Target Speed	160 kts	**Scan Rate**	181
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1238	1243
Post Mission	1621	1626

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190513	Comments
			Start	End	Time	nmi to End		
8		8	1308	1314				Figure 8
026		184	1317	1334			131731	Redo complete line from 131A.
025		4	1338	1356			133841	
024		184	1359	1417			135950	
023		4	1421	1439			142132	
022		184	1442	1459			144232	
021		4	1503	1510	1510	26nau	150320	Clouds@5000' try north block.
X-TIE		94	1604	1607			160425	X-TIE LNS#18-28 @6600'.
8		8	1608	1614				Figure 8.
								North Block clouds to low.

Page 1 of 1

20190514A (SN2738, C-FVZM)

Julian Day 134	Flight A

LIDAR Flight Log

Date MAY 14/2019	**Aircraft** C-FVZM
Project 3179_QSI_MN_WI_WEST	**Pilot** J. Mathieson
Location EAU CLAIRE, WI	**Operator** D. Tarr
Mission Objective	

System Riegl 1560i	
Unit S2222738	
IMU Applanix AP 60	
GPS Rx Trimble	
Scanner 1 Drive 3	
Scanner 2 Drive 4	

Additional Notes

Temp 0C @7200' @15:00z

Time to next maintenance: _____ ☐ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 12:33	**Takeoff**	12:52
Engine Off 16:34	**Landing**	16:22
Total 4.02 hrs	**Total** hrs	3.50HRS

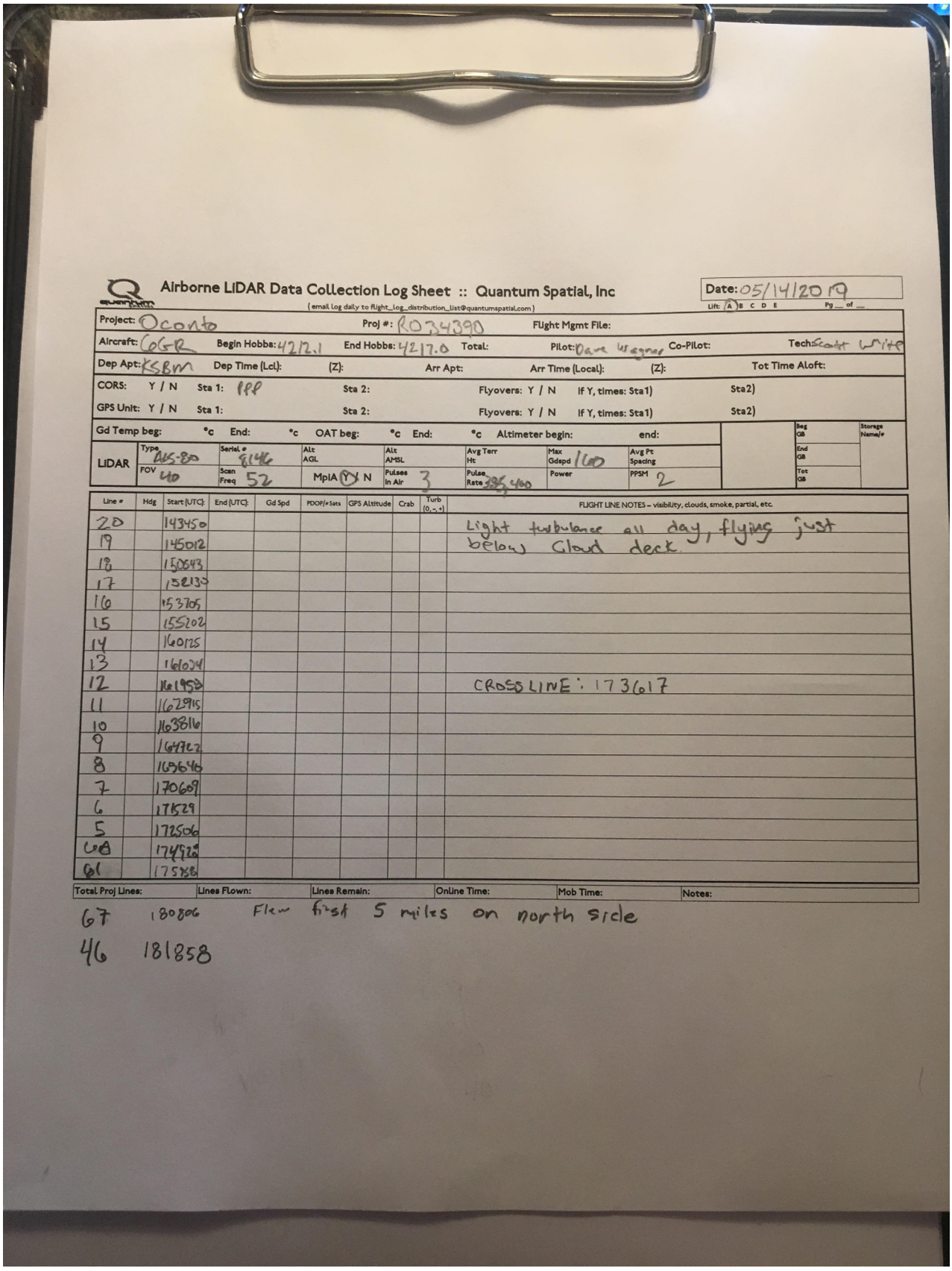
Mission Plan			
AGL Height 2000	m	**Pulse Rate** 700	
Target Speed 160	kts	**Scan Rate** 181	
Laser Current 100	%	**FOV** 60	degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1238	1243
Post Mission	1625	1630

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190514	Comments
			Start	End	Time	nmi to End		
8		8	1300	1310				Figure 8.
021		4	1317	1328			131703	Did north 29 nau. 3nau overlap.
020		184	1332	1350			133240	
019		4	1412	1429			141248	Snapshot troubles reseat wires.
018		184	1434	1451			143402	
017		4	1455	1512			145540	
016		184	1516	1534			151659	
015		4	1538	1547	1547	20 nau	153807	Clouds forming north 20nau left.
X-TIE		94	1551	1554			155101	X-TIE LNS# 13-23
8		8	1604	1611				Figure 8.

Page 1 **of** 1

20190514A (SN8146, N6GR)



Airborne LiDAR Data Collection Log Sheet :: Quantum Spatial, Inc

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 05/14/2019 Lift: A B C D E Pg __ of __

Project: Oconto Proj #: R034390 Flight Mgmt File:

Aircraft: C6SR Begin Hobbs: 4212.1 End Hobbs: 4217.0 Total: Pilot: Dave Wagner Co-Pilot: Tech: Scott White

Dep Apt: KSBM Dep Time (Lcl): (Z): Arr Apt: Arr Time (Local): (Z): Tot Time Aloft:

CORS: Y / N Sta 1: PPP Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

GPS Unit: Y / N Sta 1: Sta 2: Flyovers: Y / N If Y, times: Sta1) Sta2)

Gd Temp beg: °c End: °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type: ALS-80	Serial #: 8146	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd: 160	Avg Pt Spacing	Beg GB	End GB	Tot GB	Storage Name/#
	FOV: 40	Scan Freq: 52	MpIA (Y) N	Pulses In Air: 3	Pulse Rate: 335,400	Power	PPSM: 2				

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
20		143450							Light turbulence all day, flying just
19		145012							below cloud deck
18		150543							
17		152130							
16		153705							
15		155202							
14		160725							
13		161924							
12		161958							CROSS LINE: 173617
11		162915							
10		163816							
9		164742							
8		165646							
7		170609							
6		171529							
5		172506							
6A		174520							
61		175438							

Total Proj Lines:	Lines Flown:	Lines Remain:	Online Time:	Mob Time:	Notes:
67	180806				Flew first 5 miles on north side
46	181858				

20190515A (SN2738, C-FVZM)

Julian Day	135	Flight	A

LIDAR Flight Log

Date	MAY15/2019	**Aircraft**	C-FVZM
Project	3179_QSI_MN_WI_WEST	**Pilot**	J. Mathieson
Location	EAU CLAIRE, WI	**Operator**	D. Tarr
Mission Objective			

System	Riegl 1560i
Unit	S2222738
IMU	Applanix AP 60
GPS Rx	Trimble
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

TEMP 5C @7200 @1500z

Time to next maintenance: _____ ☐ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 13:53	**Takeoff**	14:12
Engine Off 21:00	**Landing**	20:48
Total 7.12 hrs	**Total** hrs	6.6hrs

Mission Plan			
AGL Height	2000 m	**Pulse Rate**	700
Target Speed	160 kts	**Scan Rate**	181
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1358	1403
Post Mission	2050	2055

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190515	Comments
			Start	End	Time	nmi to End		
8		8	1422	1430				Figure 8.
015		4	1431	1443			143116	North 20nau.
014		184	1447	1504			144712	
013		4	1508	1528			150848	
012		184	1531	1548			153134	
011		4	1553	1611			155309	
010		184	1615	1628	1628	11nau	161510	4 mins 11 nau to south Clouds.
009		4	1633	1647			163318	South 11 nau to do Clouds.
008		184	1651	1705	1705	9nau	165138	3 mins 10 nau to south Clouds.
007		4	1709	1724			170943	South 10 nau to do Clouds.
006		184	1727	1744			172751	2 mins 10 nau to south Clouds.
005		4	1749	1805			174921	South 10 nau to do Clouds.
004		184	1809	1827			180938	
003		4	1833	1847			183309	
002		184	1850	1900			185059	

20190517A (SN3543, C-FFRY)

Julian Day 137	Flight a

LIDAR Flight Log

Date May 17th 2019	**Aircraft** C-FFRY
Project 3179_QSI_MN_WI_West_QL2	**Pilot** Nick Hattie
Location Eau Claire, WI	**Operator** R. Canelon
Mission Objective	

System	VQ-1560i
Unit	S2223543
IMU	
GPS Rx	Trimble
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

AIRBORNE IMAGING
A Clean Harbors Company

Time to next maintenance: 5.0 ☑ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 13:30	**Takeoff** 13:52	
Engine Off 20:11	**Landing** 20:03	
Total 6.7 hrs	**Total** 6.2 hrs	

Mission Plan			
AGL Height 2000	m	**Pulse Rate** 700	
Target Speed 160	kts	**Scan Rate** 180	
Laser Current 100	%	**FOV** 60	degs

Static Alignment	GPS Time Start	GPS Time End
Pre Mission	13:35:00	13:40:00
Post Mission	20:05:30	20:10:30

Flight Line	LiDAR File Name	Flight Direction	GPS Time Start	GPS Time End	Line Aborted Time	Line Aborted nmi to End	Mission ID Time Stamp 190517	Comments
test strip		N/A	14:02:44	14:03:00			140244	
Figure 8		----------	14:18:00	14:26:30			----------	
75		N	14:35:34	14:46:05			143534	
74		S	14:50:32	15:01:10			145032	
73		N	15:06:52	15:18:30			150652	
72		S	15:22:49	15:33:50			152249	
71		N	15:38:29	15:50:00			153829	
70		S	15:53:22	16:04:50			155322	
69		N	16:09:54	16:22:00			160954	
68		S	16:25:20	16:37:50			162520	
67		N	16:41:58	16:54:35			164158	
66		S	16:57:43	17:09:50			165743	
65		N	17:14:47	17:26:45			171447	
64		S	17:30:30	17:43:05			173030	
63		N	17:46:43	17:59:40			174643	

Julian Day 137	Flight a

LIDAR Flight Log

Date May 17th 2019	**Aircraft** C-FFRY
Project 3179_QSI_MN_WI_West_QL2	**Pilot** Nick Hattie
Location Eau Claire, WI	**Operator** R. Canelon
Mission Objective	

System	VQ-1560i
Unit	S2223543
IMU	
GPS Rx	Trimble
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

AIRBORNE IMAGING
A Clean Harbors Company

Time to next maintenance: 5.0 ☑ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 13:30	**Takeoff** 13:52	
Engine Off 20:11	**Landing** 20:03	
Total 6.7 hrs	**Total** 6.2 hrs	

Mission Plan			
AGL Height 2000	m	**Pulse Rate** 700	
Target Speed 160	kts	**Scan Rate** 180	
Laser Current 100	%	**FOV** 60	degs

Static Alignment	GPS Time Start	GPS Time End
Pre Mission	13:35:00	13:40:00
Post Mission	20:05:30	20:10:30

Flight Line	LiDAR File Name	Flight Direction	GPS Time Start	GPS Time End	Line Aborted Time	Line Aborted nmi to End	Mission ID Time Stamp 190517	Comments
62		S	18:02:52	18:16:05			180252	
61		N	18:20:24	18:33:50			182024	
60		S	18:37:20	18:51:20			183720	
59		N	18:54:37	19:09:40			185437	
X-Tie		E	19:13:54	19:19:20			191354	
Figure 8		----------	19:19:30	19:25:20			----------	

20190520A (SN3543, C-FFRY)

Julian Day	140	Flight	A

LIDAR Flight Log

Date May 20/2019	**Aircraft** C-FFRY
Project 3179 QSI MN WI QL2	**Pilot** N. Hattie
Location Eau Claire, WI	**Operator** R. Canelon
Mission Objective	

System VQ-1560i	
Unit S2223543	
IMU	
GPS Rx Trimble	
Scanner 1 Drive	
Scanner 2 Drive	

Additional Notes

AIRBORNE IMAGING
A Clean Harbors Company

Time to next maintenance: _____ ☐ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 12:54	**Takeoff** 13:39	
Engine Off 18:17	**Landing** 18:06	
Total 5.4 hrs	**Total** 4.5 hrs	

Mission Plan			
AGL Height	2000 m	**Pulse Rate**	700
Target Speed	160 kts	**Scan Rate**	180
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	13:32:35	13:37:35
Post Mission	18:10:00	18:15:00

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190520	Comments
			Start	End	Time	nmi to End		
Figure 8		----------	14:14::35	14:20:30			----------	
x-tie		W	14:24:14	14:26:50			142414	
45		N	14:33:36	14:51:20			143336	
44		S	14:54:32	15:11:00			145432	
43		N	15:15:22	15:33:20			15522	
46		S	15:36:41	15:53:15			153641	
41		N	15:57:36	16:14:30			155736	flew over 1 cloud @18.0nmi from N end
42		S	16:17:46	16:34:00			161746	cloud @30nmi and 7 nmi from S end
39		N	16:37:38	16:44:20			163738	flew over 1 cloud @10.0nmi from N end
38		S	16:47:43	16:5430			164743	flew over 1 cloud @5nmi from S end
37		N	16:58:37	17:06:00			165837	Big cloud starting @13.5 to 11.2 from N end
40		S	17:09:08	17:15:30			170908	clouds 0.5nmi from start and last 3.5nmi
x-tie2		E	17:23:09	17:24:35			172309	
Figure 8		---------	17:25:00				----------	

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20190520B (SN2738, C-FVZM)

Julian Day	140	Flight	B

LIDAR Flight Log

Date	May 20/2019	Aircraft	C-FVZM
Project	3179_QSI_MN_WI_WEST	Pilot	J.Mathieson
Location	Duluth,MN KDLH	Operator	D.Tarr
Mission Objective			

System	VQ-1560i
Unit	S2222738
IMU	Appanlix
GPS Rx	Trimble R8
Scanner 1 Drive	1
Scanner 2 Drive	2

Additional Notes

Time to next maintenance: _____ ☐ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 13:20	Takeoff	13:39
Engine Off 17:30	Landing	17:15
Total 4.17 hrs	Total hrs	3.6hrs

Mission Plan			
AGL Height	2000 m	Pulse Rate	700
Target Speed	160 kts	Scan Rate	182
Laser Current	100 %	FOV	60 degs

Static Alignment	GPS Time	
	Start	End
Pre Mission	1325	1330
Post Mission	1720	1725

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190520	Comments
			Start	End	Time	nmi to End		
8		8	1401	1408				Figure 8
X-TIE		94	1409	1417			140940	X-TIE LNS# 41-60
058		180	1424	1440			142456	
057		0	1445	1446			144509	ABORT SNAPSHOT FROZE.
057		0	1452	1509			145200	
056		180	1513	1529			151304	
055		0	1533	1551			153341	
054		180	1555	1612			155511	
053		0	1616	1630	1630	10nau to go.	161610	Abort clouds 10nau to go.
052		180	1634	1639	1639	21nau to go.	163411	North 10nau to do Clouds.
053		0	1647	1653			164740	Hit more clouds Refly.
								Abort mission Clouds forming.
8		8	1654	1700				Figure 8.

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20190521A (SN2738, C-FVZM)

Julian Day	141	Flight	A

LIDAR Flight Log

Date MAY21/2019	**Aircraft** C-FVZM
Project 3179_QSI_MN_WI_WEST	**Pilot** J. Mathieson
Location EAU CLAIRE, WI	**Operator** D. Tarr
Mission Objective	

System	Riegl 1560i
Unit	S2222738
IMU	Applanix AP 60
GPS Rx	Trimble R8
Scanner 1 Drive	3
Scanner 2 Drive	4

Additional Notes

AIRBORNE IMAGING
A Clean Harbors Company

Time to next maintenance: _____ ☐ 50 hr ☐ 100 hr

Aircraft Block Time		
Engine On 13:02	**Takeoff**	13:23
Engine Off 18:47	**Landing**	18:34
Total 5.75 hrs	**Total** hrs	5.2hrs

Mission Plan			
AGL Height	2000 m	**Pulse Rate**	700
Target Speed	160 kts	**Scan Rate**	181
Laser Current	100 %	**FOV**	60 degs

Static Alignment	GPS Time	
	Start	**End**
Pre Mission	1308	1313
Post Mission	1837	1842

Flight Line	LiDAR File Name	Flight Direction	GPS Time		Line Aborted		Mission ID Time Stamp 190521	Comments
			Start	End	Time	nmi to End		
8		8	1338	1344			-	Figure 8.
053		180	1346	1403			134633	Refly.
052		0	1408	1414			140822	Snapshot froze.
052		0	1420	1432			142040	
051		180	1436	1454			143636	
050		0	1458	1514			145807	
049		180	1518	1536			151848	
048		0	1540	1557			154048	
047		180	1601	1618			160141	
042		0	1622	1638			162224	Refly.
041		180	1643	1700			164335	Refly.
040		0	1704	1711			170435	Refly.
039		180	1715	1722			171536	Refly.
038		0	1726	1732			172611	Refly.
037		180	1736	1743			173650	Refly.

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Appendix B

Survey Reports

Survey Report
QSI FEMA GCP Barron Co
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	
Crew Chief:	Ken Clark
Additional Field Crew:	
Project Start Date:	04/23/2019
Report Date:	05/17/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 15 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	AB8463, AH8940, AH8951, AH8953, DL4458, DN5152, DN7257, DN7266, QN0609
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	WISCORS Network through VRS connection was the origination of the control used with checks and calibration as discussed. GPS methods were used where VRS connection and obstructions permitted. Other areas used control set by VRS RTK methods and robotic total station methods were used.
Equipment Used:	GPS Trimble R8-3 GNSS S/N 5239497193– (Ayres #72.22) Total station Trimble S6 S/N 93410052 – (Ayres #75.41) Data Collector Trimble TSC3 S/N RS17C22010 (Ayres #75.41)

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Recorded appropriate: NVA (Bare Earth & Urban) and VVA (Forested,Tall Weed/Crop). Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip. Points CA038, UA11, and FO13 were moved approximately 3700’ due to access restrictions at Camp Phillips.

Survey Methods (continued)

All work was performed in and referenced to NAD83 (2011), NAVD 88(2012), Geoid 12B, Universal Transverse Mercator, Zone 15 North in meters.

Established horizontal and vertical coordinate values on the points by a minimum of two – 180 epoch observations with separate initializations using RTK GPS and the WISCORS network. The resultant coordinates and elevations provided in the deliverables are an average of the two observations.

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment as described herein and meet the ±3 centimeter vertical accuracy requirement at the 95% confidence level.

Points not able to be directly occupied by GPS means were measured using Total Station methods from control point pairs set utilizing GPS methods outlined above.

Traffic Observations

N/A

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected

None

Survey Report
QSI FEMA GCP Dunn Co
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	
Crew Chief:	Doug D'Jock
Additional Field Crew:	
Project Start Date:	04/24/2019
Report Date:	05/15/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 15 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	AI3119, DJ4316, DK5299, DL4114, DL4247, DN7014, DN7073, DN7102, DN7304
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	WISCORS Network through VRS connection was the origination of the control used with checks and calibration as discussed. GPS methods were used where VRS connection and obstructions permitted. Other areas used control set by VRS RTK methods and robotic total station methods were used.
Equipment Used:	GPS Trimble R10 GNSS S/N 5736470271– (Ayres #70.58) GPS Trimble R8-3 GNSS S/N 5239496998– (Ayres #72.22) Total station Trimble S6 S/N 93410505 – (Ayres #75.53) Data Collector Trimble TSC3 S/N RS17C22013 (Ayres #75.37)

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Recorded appropriate: NVA (Bare Earth & Urban) and VVA (Forested,Tall Weed/Crop). Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip.

Survey Methods (continued)

All work was performed in and referenced to NAD83 (2011), NAVD 88(2012), Geoid 12B, Universal Transverse Mercator, Zone 15 North in meters.

Established horizontal and vertical coordinate values on the points by a minimum of two – 180 epoch observations with separate initializations using RTK GPS and the WISCORS network. The resultant coordinates and elevations provided in the deliverables are an average of the two observations.

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment as described herein and meet the ±3 centimeter vertical accuracy requirement at the 95% confidence level.

Points not able to be directly occupied by GPS means were measured using Total Station methods from control point pairs set utilizing GPS methods outlined above.

Traffic Observations

N/A

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected

None

Survey Report
QSI FEMA GCP Oconto Co
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	James Cappeart
Crew Chief:	Ryan Klarner
Additional Field Crew:	
Project Start Date:	5/1/2019
Report Date:	5/7/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 16 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	5L72 Suring GPS Coleman GPS Silver Cliff GPS Mountain GPS
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	WISCORS Network through VRS connection was the origination of the control. GPS methods were used where VRS connection and obstructions permitted. Other areas used control set by VRS RTK methods and robotic total station methods were used.
Equipment Used:	Trimble R8 GPS - S/N 5220487439 Trimble SX10 Robotic Total Station – S/N 30411230

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip.

Survey Methods (continued)

Established horizontal and vertical coordinate values on the points by two 3-minute RTK observation

For FO points two control points set by two 3 minute RTK observations and robotic total station used to establish horizontal and vertical coordinate values

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment

OPUS solutions were required at 2 points because of lack of cell phone reception.

Traffic Observations

Varied by Site.

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected

Survey Report
QSI FEMA GCP Oshkosh Block
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	James Cappeart
Crew Chief:	Travis Gardebrecht
Additional Field Crew:	
Project Start Date:	4/19/2019
Report Date:	4/22/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 16 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	DE7435 – 4W19 DF6034 – OSHKOSH S GPS AI9529 – UTICA E GPS
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	RTK GPS observations were used for direct observations
Equipment Used:	Trimble R10 GPS - S/N 5731470616

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Recorded appropriate: NVA (Bare Earth & Urban) and VVA (Forested, Swamp/Wetland, Tall Weed/Crop). Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip.

Survey Methods (continued)

Established horizontal and vertical coordinate values on the points by two 3 minute RTK observation

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment

Traffic Observations

Varied by Site.

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected

Survey Report
QSI FEMA GCP Pine County
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	James Cappeart
Crew Chief:	John Gilbertson
Additional Field Crew:	
Project Start Date:	04/29/2019
Report Date:	05/15/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 15 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	AC4961 AC4962 AC4976 AC4977 AE9354 DF5962 DH4955 DL4724 DL4738 DM2727 DM4932 QO0360 RN0611
Summary of control checks and calibration (if applicable):	See Field Notes for control checks on NGS monuments. A one point vertical calibration was performed using NGS monument AC4977. This was based on an average of all NGS data collected throughout the job.
Survey Methods Used:	MnCORS Network through VRS connection was the origination of the control used with checks and calibration as discussed. Other areas used control set by VRS RTK methods and robotic total station methods were used.
Equipment Used:	GPS Trimble R10 GNSS S/N 5736470271– (Ayres #70.58) GPS Trimble R8-3 GNSS S/N 5239496998– (Ayres #72.22) Total station Trimble S6 S/N 93410071 – (Ayres #74.11) Data Collector Trimble TSC3 S/N RS17C22036 (Ayres #75.38)

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Recorded all: NVA (Bare Earth & Urban), VVA (Forested,Tall Weed/Crop), and CA (Calibration) points. Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip. Also recorded numerous NGS monuments and photo documented each.

Survey Methods (continued)

All work was performed in and referenced to NAD83 (2011), NAVD 88(2012), Geoid 12B, Universal Transverse Mercator, Zone 15 North in meters.

Established horizontal and vertical coordinate values on the points by a minimum of two – 180 epoch observations with separate initializations using RTK GPS and the MnCORS network. The resultant coordinates and elevations provided in the deliverables are an average of the two observations.

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment as described herein and meet the ±3 centimeter vertical accuracy requirement at the 95% confidence level.

Points not able to be directly occupied by GPS means were measured using Total Station methods from control point pairs set utilizing GPS methods outlined above.

Traffic Observations

N/A

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected

None

Survey Report
QSI FEMA GCP Sheboygan Co
Ayres Project No. 72-0227.12

Client:	Quantum Spatial
Type of Survey:	LIDAR Control Survey (USGS Specs)
Project Manager:	Zach Nienow
Survey Project Manager:	James Cappeart
RLS of Record:	James Cappeart
Crew Chief:	Derek Fonder
Additional Field Crew:	
Project Start Date:	5/1/2019
Report Date:	5/6/2019

Control Summary

Horizontal Datum:	NAD83 (2011)
Vertical Datum:	NAVD88, GEOID12B
Rectangular Coordinate System:	UTM Zone 16 North, Meters
Used NGS Control?	☒ Yes ☐ No
List any NGS control points used:	DF5987 – Centerville S GPS DE7783 – Holland S GPS AI5987– New Fane GPS DF5995– Plymouth N GPS DF6106– St Anna GPS
Summary of control checks and calibration (if applicable):	(See Field Notes for control checks on NGS monuments – No calibration was needed)
Survey Methods Used:	WISCORS Network through VRS connection was the origination of the control used with checks and calibration as discussed. GPS methods were used where VRS connection and obstructions permitted. Other areas used control set by VRS RTK methods and robotic total station methods were used.
Equipment Used:	Trimble R10 GPS - S/N 5731470616 Trimble S6 Robotic Total Station – S/N 93410493

Utilities

Diggers Hotline Ticket #:	N/A
Locator Contact Info:	N/A
General Notes:	

Crew Chief Notes

Recorded appropriate: NVA (Bare Earth & Urban) and VVA (Forested,Tall Weed/Crop). Took 5 pictures of each point – one from each cardinal direction, and one of the rod tip.

Survey Methods (continued)

Established horizontal and vertical coordinate values on the points by two 1.5 minute RTK observation

For FO points two control points set by two 1.5 minute RTK observations and robotic total station used to establish horizontal and vertical coordinate values

Check shots were taken on numerous NGS control points (see field notes) to verify that the values obtained are consistent with the datum/adjustment

Traffic Observations

Varied by Site.

Summary of RLS Decisions (Right of Way, Property Lines)

N/A

Survey Data Not Collected