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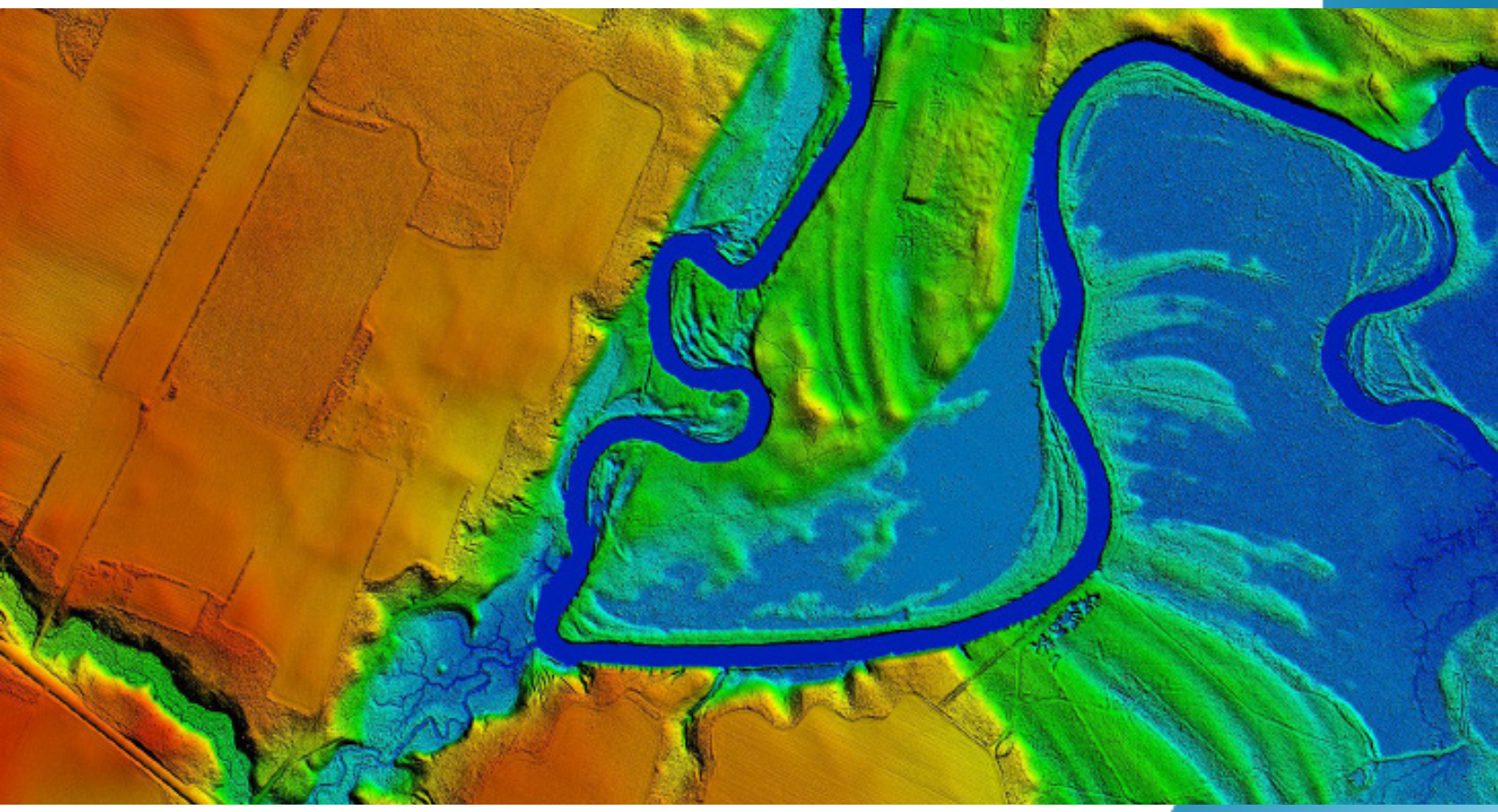

NC_HURRICANEFLORENCE_2020_D20 LIDAR PROJECT REPORT

Work Package ID: 186591

Work Unit ID: 217003

2020

Submitted: January 24, 2022

Prepared for:

USGS

science for a changing world

Prepared by:

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Contents

List of Figures

List of Tables

List of Appendices

1. Summary / Scope

1.1. Summary

This report contains a summary of the NC_HurricaneFlorence_2020_D20, Work Unit 217003 LiDAR acquisition task order, issued by USGS under their Contract G16PC00016 on December 10, 2019. The task order yielded a project area covering approximately 1834 square miles over North Carolina. 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
8 pts / m^2	1400 m	58.5°	20%	≤ 10 cm

1.3. Coverage

The project boundary covers 1834 square miles over North Carolina. 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 December 12, 2019 to January 8, 2020 in 11 total lifts. See "Section: 2.4. Time Period" for more details.

1.5. Issues

There were no major issues to report for this project.

NC_HurricaneFlorence_2020_D20 Work Unit 217003 Projected Coordinate System: UTM Zone 17N Horizontal Datum: NAD1983 (2011) Vertical Datum: NAVD88 (GEOID 18) Units: Meters	
Lidar Point Cloud	Classified Point Cloud in .LAS 1.4 format
Rasters	• 0.5 meter Hydro-flattened Bare Earth Digital Elevation Model (DEM) in GeoTIFF format • 0.5 meter Intensity images in GeoTIFF format
Vectors	Shapefiles (*.shp) • Deliverable Swath • LiDAR Tile Index Geodatabase (*.gdb) • Continuous Hydro-flattened Breaklines
Reports	Reports in PDF format • Focus on Delivery • Project Report
Metadata	XML Files (*.xml) • Breaklines • Classified Point Cloud • DEM • Intensity Imagery

NC_HurricaneFlorence_2020_D20
Work Unit 217003 Boundary

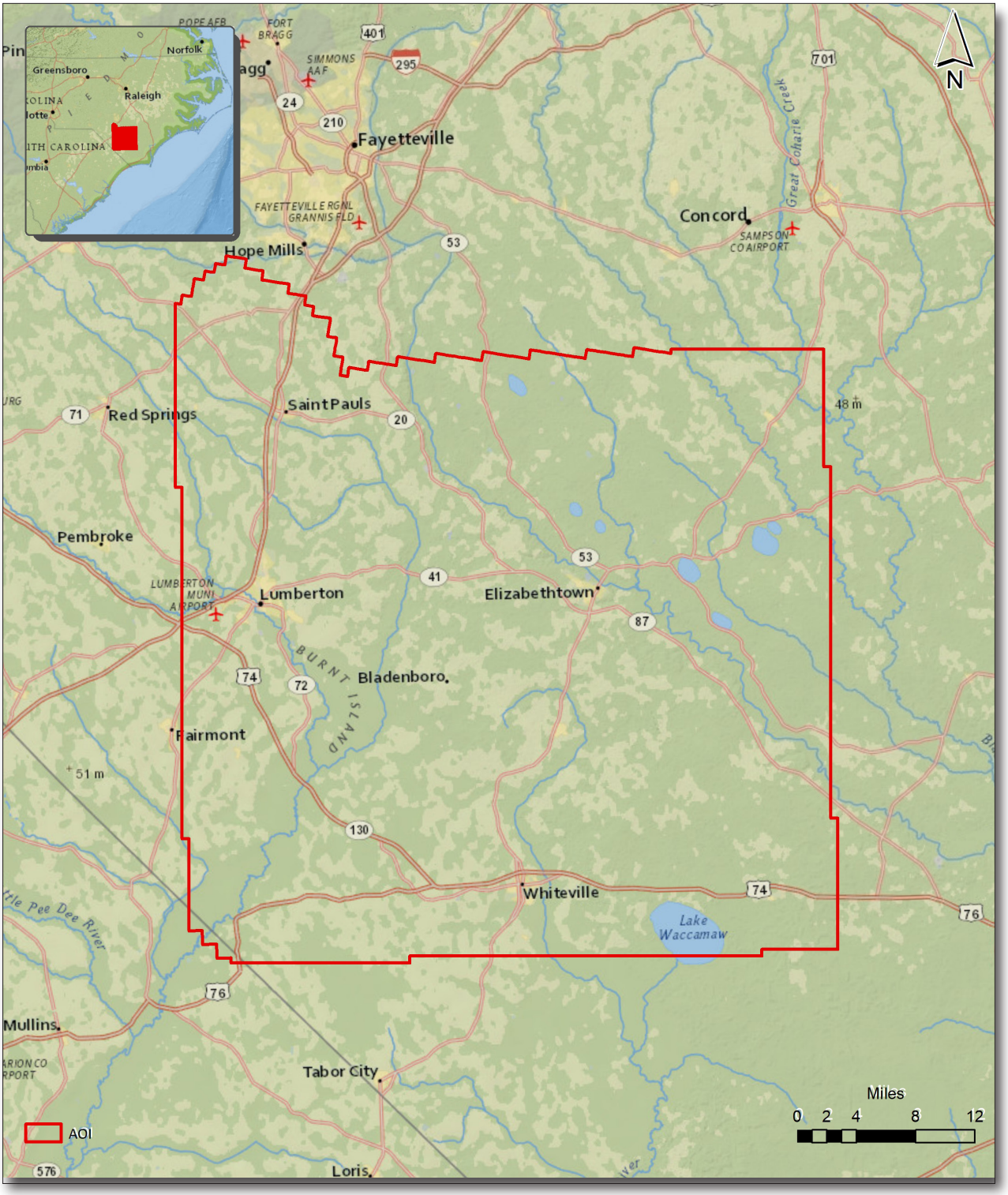

Figure 1. Work Unit Boundary

2. Planning / Equipment

2.1. Flight Planning

Flight planning was based on the unique project requirements and characteristics of the project site. The basis of planning included: required accuracies, type of development, amount / type of vegetation within project area, required data posting, and potential altitude restrictions for flights in project vicinity.

Detailed project flight planning calculations were performed for the project using RiPARAMETER planning software. Planned flight lines are shown in Figure 2.

2.2. LiDAR Sensor

Quantum Spatial utilized a Riegl VQ1560i lidar sensor (Figure 3), serial numbers 3061 and 3546 for lidar data acquisition.

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

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

NC_HurricaneFlorence_2020_D20
Work Unit 217003 Planned Flight Lines

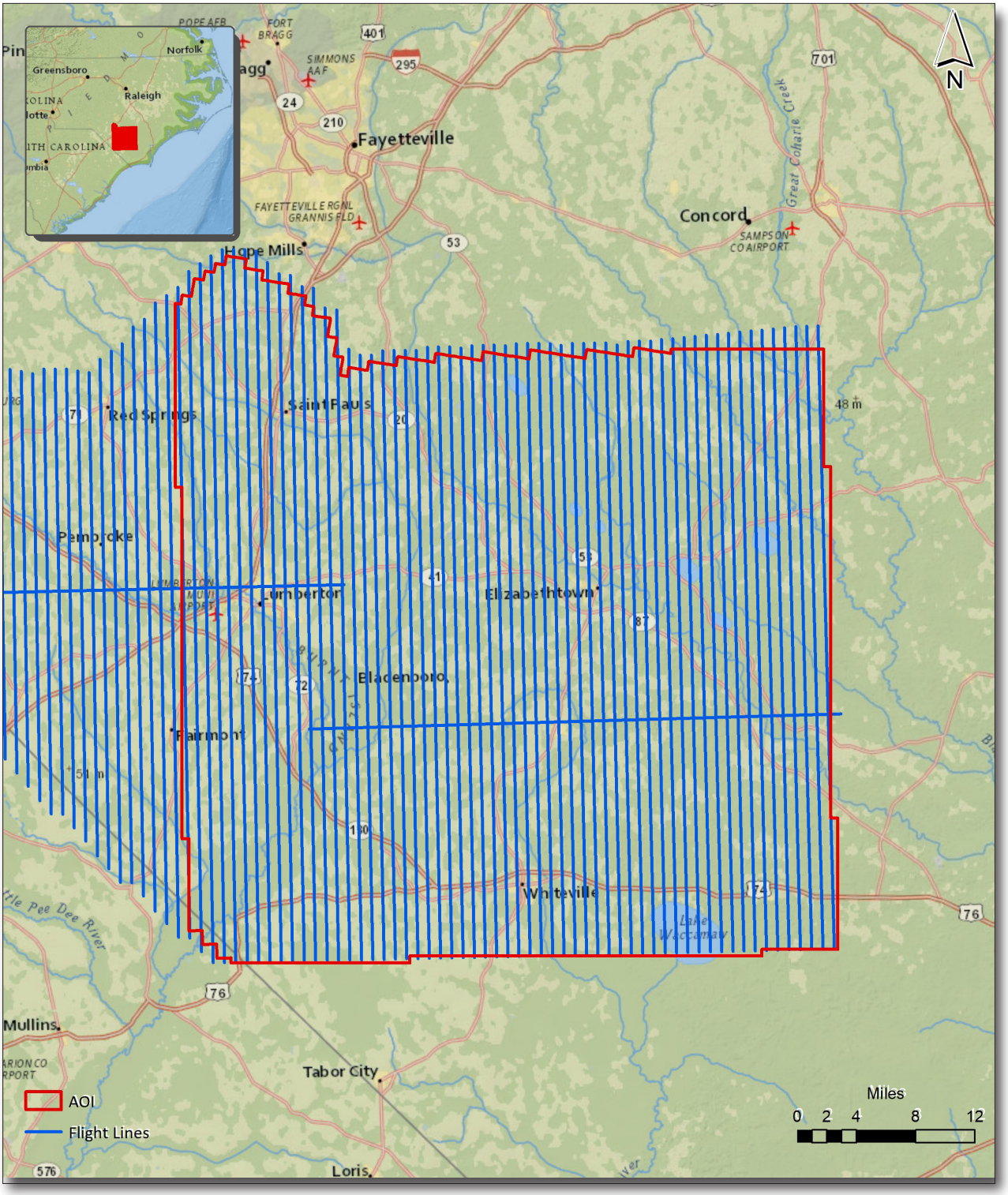

Figure 2. Planned Flight Lines

Table 2. LiDAR System Specifications

		Riegl VQ1560i (3061)	Riegl VQ1560i (3546)
Terrain and Aircraft Scanner	Flying Height	1400 m	1400 m
	Recommended Ground Speed	160 kts	160 kts
Scanner	Field of View	58.5°	58.5°
	Scan Rate Setting Used	180 Hz	160 Hz
Laser	Laser Pulse Rate Used	1000 kHz	2000 kHz
	Multi Pulse in Air Mode	yes	yes
Coverage	Full Swath Width	1568 m	1568 m
	Line Spacing	1254 m	1254 m
Point Spacing and Density	Average Point Spacing	.35 m	.35 m
	Average Point Density	8 pts / m^2	8 pts / m^2

Figure 3. Riegl VQ1560i LiDAR Sensor

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

- Cessna Caravan (single-turboprop), Tail Numbers: N704MD, N840JA
- Piper Navajo (twin-piston), Tail Numbers: N73TM

These aircraft provided an ideal, stable aerial base for LiDAR acquisition. These aerial platforms have relatively fast cruise speeds, which are beneficial for project mobilization / demobilization while maintaining relatively slow stall speeds, proving ideal for collection of high-density, consistent data posting using a state-of-the-art Riegl 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 between December 12, 2019 and January 8, 2020. Eleven aircraft lifts were completed. Accomplished lifts are listed below.

- 12122019A (SN3061,N840JA)
- 12312019A (SN3546,N704MD)
- 12312019B (SN3546,N704MD)
- 01012020A (SN3546,N704MD)
- 01022020A (SN3546,N704MD)
- 01052020A (SN3546,N704MD)
- 01052020B (SN3546,N704MD)
- 01062020A (SN3061,N73TM)
- 01062020A (SN3546,N704MD)
- 01082020A (SN3061,N73TM)
- 01082020A (SN3546,N704MD)

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).

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 RiPROCESS software. The generated point cloud is the mathematical three dimensional composite of all returns from all laser pulses as determined from the aerial mission. The point cloud is imported into GeoCue distributive processing software. Imported data is tiled and then calibrated using TerraMatch and proprietary software. Using TerraScan, the vertical accuracy of the surveyed ground control is tested and any bias is removed from the data. TerraScan and TerraModeler software packages are then used for automated data classification and manual cleanup. The data are manually reviewed and any remaining artifacts removed using functionality provided by TerraScan and TerraModeler.

DEMs and Intensity Images are then generated using proprietary software. In the bare earth surface model, above-ground features are excluded from the data set. Global Mapper is used as a final check of the bare earth dataset.

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

Software	Version
Applanix + POSPac	8.4
RiPROCESS	1.8.6
GeoCue	2017.1.14.1
Global Mapper	19.1;20.1
TerraModeler	20.004
TerraScan	20.011
TerraMatch	20.004

3.3. LAS Classification Scheme

The classification classes are determined by the USGS Version 2.1 specifications and are an industry standard for the classification of LIDAR point clouds. All data starts the process as Class 1 (Unclassified), and then through automated classification routines, the classifications are determined using TerraScan macro processing.

The classes used in the dataset are as follows and have the following descriptions:

Table 3. LAS Classifications

	Classification Name	Description
1	Processed, but Unclassified	Laser returns that are not included in the ground class, or any other project classification
2	Bare earth	Laser returns that are determined to be ground using automated and manual cleaning algorithms
7	Low Noise	Laser returns that are often associated with scattering from reflective surfaces, or artificial points below the ground surface
9	Water	Laser returns that are found inside of hydro features
17	Bridge Deck	Laser returns falling on bridge decks
18	High Noise	Laser returns that are often associated with birds or artificial points above the ground surface
20	Ignored Ground	Ground points that fall within the given threshold of a collected hydro feature.

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.

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. 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 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 1 meter was also used around each hydro flattened feature. These points were moved from ground (ASPRS Class 2) to Ignored Ground (ASPRS Class 20).

The breakline files were then translated to 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 0.5-meter Raster DEM. Using automated scripting routines within proprietary software, a GeoTIFF file was created for each tile. Each surface is reviewed using Global Mapper to check for any surface anomalies or incorrect elevations found within the surface.

3.7. Intensity Image Processing

GeoCue software was used to create the deliverable intensity images. All withheld points were ignored during this process. This helps to ensure a more aesthetically pleasing image. The GeoCue software was then used to verify full project coverage as well. GeoTIFF files with a cell size of 0.5-meter were then provided as the deliverable for this dataset requirement.

NC_HurricaneFlorence_2020_D20
Work Unit 217003 Tile Layout

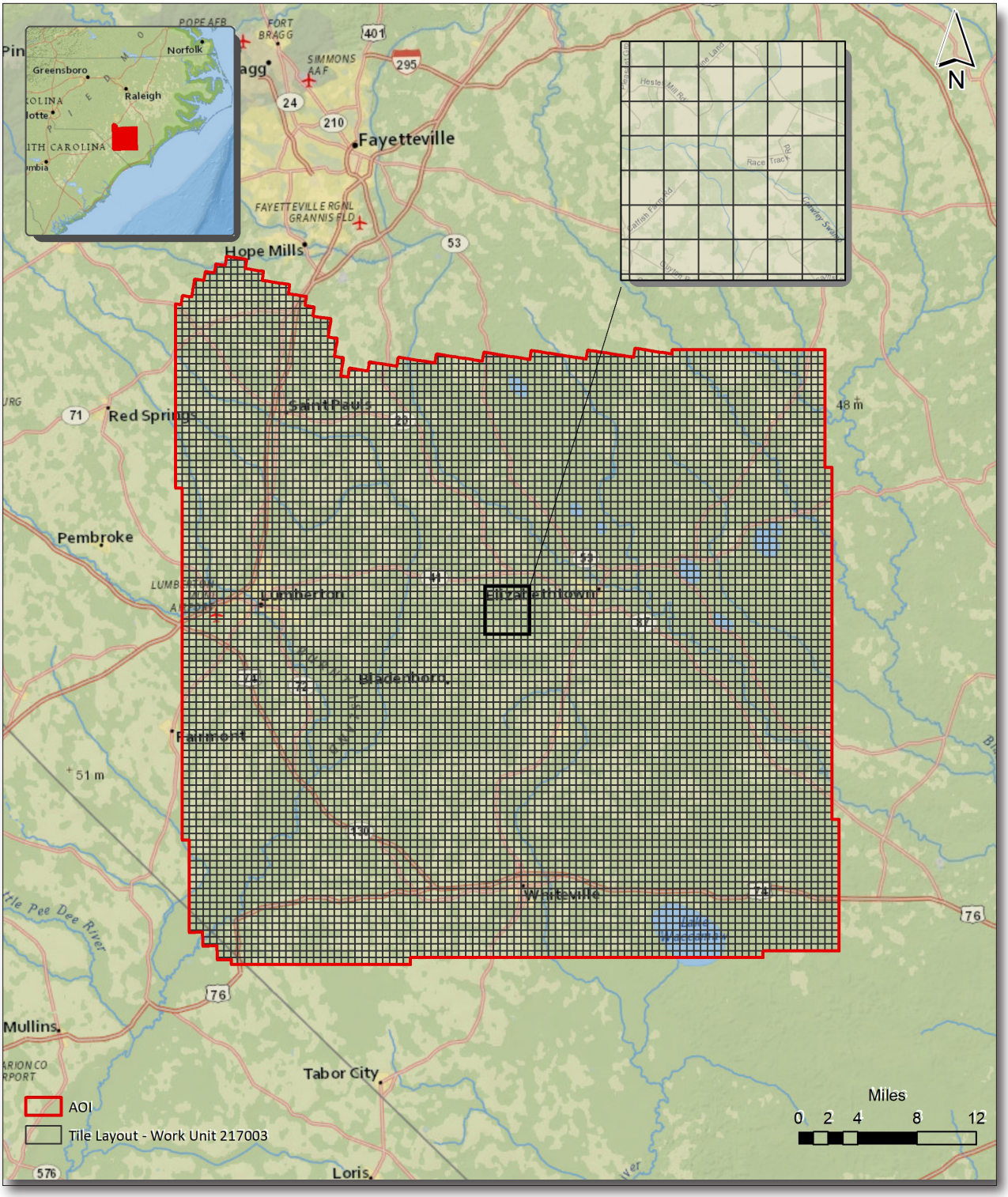

Figure 5. Lidar Tile Layout

4. Project Coverage Verification

Coverage verification was performed by comparing coverage of processed .LAS files captured during project collection to generate project shape files depicting boundaries of specified project areas. Please refer to Figure 6.

NC_HurricaneFlorence_2020_D20
Work Unit 217003 Lidar Coverage

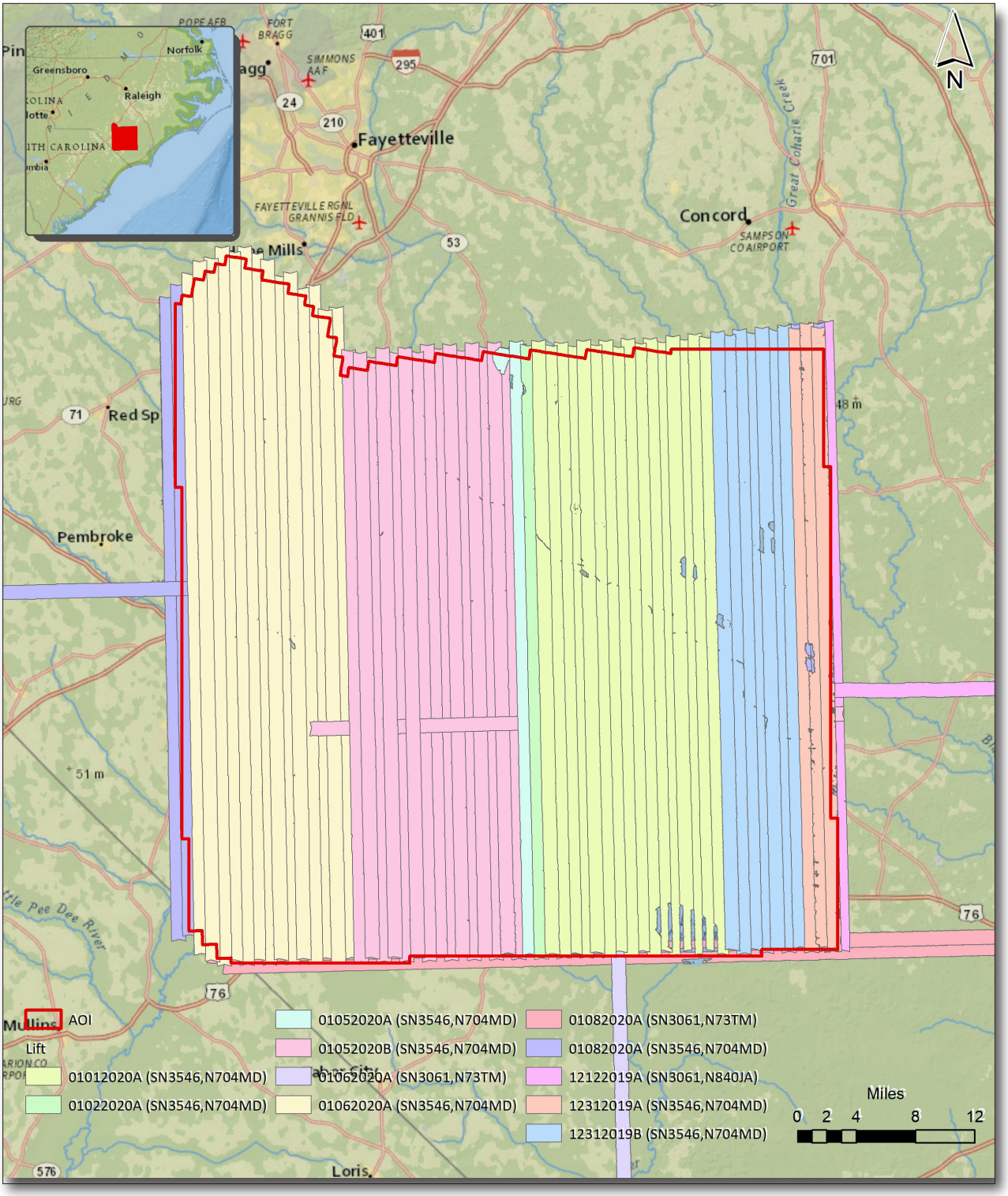

Figure 6. Lidar Coverage

Appendix A

Flight Logs

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

(email log daily to flight_Log_distribution_list@quantumspatial.com)

Date: 2019 12.31

Lift: A (B) C D E Pg 1 of 1

Project: 35630 NC LiDAR Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14183.4 End Hobbs: 14185.9 Total: 2.5 Pilot: LaRosa Co-Pilot: — Tech: E.Guillory

Dep Apt: Dep Time (Lcl): 1549 (Z): 2049 Arr Apt: Arr Time (Local): 1816 (Z): 2216 Tot Time Aloft: 2:25

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: 16 °c End: 10 °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL	3546	1400			160	Uniform
	FOV 58.52	Scan Freq 2x160	MpiA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Beg GB 97.17 Storage Media/# Set 2

End GB 191

Tot GB 94

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
85	348	210513	212100	150	1.9/14	4500	4	0	HAD to full reboot, then did not pick up any GLONASS sats.
84	194	212529	214005		1/14				on flight plan alt and line length are switched
83	348	214136	215610						giving POSTRACK ground level error.
82	194	215810	211830						
81	348	221342	222810						all lines high crab due to winds
80	194	223019	224300						
79	348	224544	230130		1.12/11				

Total Proj Lines: 14 Lines Flown: 7 Lines Remain: Online Time: 1:55 Mob Time: :23 Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 2019.12.31

Lift: (A) B C D E Pg 1 of 1

Project: 35630 NC LiDAR Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14182.1 End Hobbs: 14183.4 Total: 3.3 Pilot: C.LAROSA Co-Pilot: — Tech: E.Guillory

Dep Apt: Dep Time (Lcl): 948 (Z): 1448 Arr Apt: Arr Time (Local): 1105 (Z): 1605 Tot Time Aloft: 1:17

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: 8 °c End: 13 °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL	3546	1400			160	UNI
	FOV 58.52	Scan Freq 2x160	MpiA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Storage Name/# Set 2

Beg GB 67.85

End GB 97.17

Tot GB 29.32

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc
88	190	150227	151700	150	0.92/21	4502	Y	0	clear sky, conditions excellent
87	344	151917	153405	"	1.0/21	"	↓	0	
86	194	153527	155030	"	0.99/20	"	↓	0	
									all lines high crab due to wind

Total Proj Lines: Lines Flown: 3 Lines Remain: Online Time: :49 Mob Time: :30 Notes:

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

(email log daily to Flight_Log_distribution_list@quantumspatial.com)

Date: 2020.01.01 Life A B C D E Pg 1 of _

Project: NC LiDAR Proj #: 35630 Flight Mgmt File:

Aircraft: 704 MD Begin Hobbs: 14185.9 End Hobbs: Total: Pilot: LaRosa Co-Pilot: Tech: Guillory

Dep Apt: Dep Time (Lcl): 1410 (Z): 1910 Arr Apt: Arr Time (Local): (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: 14 °c End: °c OAT beg: °c End: °c Altimeter begin: 2992 end:

LiDAR	Type: Riegl 1560i	Serial #: 3546	Alt AGL: 1338 m	Alt AMSL	Avg Terr Ht	Max Gdspd: 160	Avg Pt Spacing
	FOV: 58.5	Scan Freq: 2 x 161	MpiA Y / N	Pulses In Air	Pulse Rate: 2000	Power: 100	PPSM

Beg GB: 191.65 Storage Name/s: 189.378 End GB: SET 2 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.
78	186	192115	193536	150	1.34/12	4600'	Y	0	conditions clear winds 010 no factor
77	353	193701	195120	150	1.24/13	4600'	Y	0	
76	190	195247	200656	"	1.2/13	1336 m	"	0	
75	353	200839	202311	"	1.19/13	"	"	0	
74	188	202443	203831	157	1.15/13	1339	Y	0	
73	353	204007	205434	150	1.11/15	1334	-	0	
72	188	205601	210953	158	1.1/13	1331	N	0	
71	354	211130	212538	151	1.1/13	1340	N		2 GLONASS online // ERROR 2646 : APD FOV_CTRL_
70	187	212705	214044	157	1.17/21	1341	N		7 GLONASS online ↓ LINE 70 PIC_COMM_ERROR
69	353	214934	220401	150	0.99/21	1335	N		
68	186	220528	221903	155	0.98/21	1328	N		
67	354	222050	223511	145	0.88/22	1339	N		
66	185	223619	225030	158	0.91/21	1335	N		
65	355	225208	230647	142	1.05/18	1345	N		
64	185	230823	2321	159	0.94/20	1347	N		
63	356	232352	233842	144	0.94/21	1342			

Total Proj Lines: 90 Lines Flown: 16 Lines Remain: 64 Online Time: 4.63 Mob Time: 0.27 Notes:

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

(email log daily to flight_log_distribution list@quantumspatial.com)

Date: 2020.01.02

pg 1 of 2

Project: NC-LIDAR, Blk 5		Proj #: 35130		Flight Mgmt File			
Aircraft: 704MD	Begin Hobbs: 14190.6	End Hobbs: 14195.2	Total: 4.6	Pilot: C.LAROSA	Co-Pilot:	Tech: EBG	
Dep Apt:	Dep Time (Lcl): 848	(Z): 1348	Arr Apt:	Arr Time (Local): 1326	(Z): 1826	Tot Time Aloft: 4.63	
CORS: Y / (N)	Sta 1:	Sta 2:	Flyovers: Y / (N)	If Y, times: Sta 1)	Sta 2)		
GPS Unit: Y / N	Sta 1:	Sta 2:	Flyovers: Y / (N)	If Y, times: Sta 1)	Sta 2)		
Gd Temp beg: °c	End: °c	OAT beg: °c	End: °c	Altimeter begin: 2992	end:	56% / 73% / ToT 248.26	Beg 397.16 / GB 396.06 / End 521.84 / GB 519.64 / Tot 124.68 / GB 123.58 — Storage: SET 2
LiDAR	Type: RIEGL 1560i; FOV: 58.5	Serial #: 3546; Scan Freq: 2 x 161	Alt AGL: 4593' / 1400 m; MpIA Y / N	Alt AMSL; Pulses In Air	Avg Terr Ht; Pulse Rate: 2000	Max Gdspd; Power: 100	Avg Pt Spacing; PPSM

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
50 01	~~348~~	140815	140930	145	0.99/18		Y	0	WINDS
50 02	348	141108	141230	140	1.08/16	1375	Y	0	S-N
50 03	192	141455	141630	145	1.09/17	1386	|	|	
50 04	350	141839	142025	146	1.1/16	1379	|	|	S-N
50 05	190	142305	142515	145	1.1/16	1375	|	|	
50 06	351	142742	143055	150	1.1/16	1373	|	|	S-N
50 07	190	143356	143730	141	0.99/19	1379	|	|	misfire 143117
50 08	351	144000	1444	148	0.99/16	1363	|	|	S-N
50 09	190	144709	1452	147	0.99/17	1371	|	|	
50 10	351	145523	150059	148	0.99/17	1365	|	|	S-N
50 11	190	150504	151258	150	1.03/16	1373	|	|	
50 12	351	151450	152245	155	0.92/18	1375	|	|	light rain on line 4.1 nm to line end; move to EAST END; REFLY
50 13	190	153457	1542	142	1.02/18	1352	|	|	N-S REFLY ?

Total Proj Lines: 90 Lines Flown: 13 Lines Remain: 77 Online Time: 1:30 Mob Time: ~~1:00~~ 1.00 Notes:

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

(email log daily to flight_log_distribution_list@quantumspatial.com)

Date: 2020.01.07 Flt: A B C D E Pg 2 of 2

Project: NC LiDAR blk 3 Proj #: 35630 Flight Mgmt File:

Aircraft: 704 MD Begin Hobbs: 14190.6 End Hobbs: 14195.2 Total: 4.6 Pilot: LaRosa Co-Pilot: Tech: EBG

Dep Apt: Dep Time (Lcl): 948 (Z): 1348 Arr Apt: Arr Time (Local): 1326 (Z): 1826 Tot Time Aloft: 4.63

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: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL 1560i	3546	4593'			160	
	FOV	Scan Freq	MpiA Y / N	Pulses In Air	Pulse Rate	Power	PPSM
	58.52	160 x 2			2000	100	

Beg GB 397 Storage Name/# SET 2

End GB 520

Tot GB 24826

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc
3082	92	160555	162559	160	19/09	1346	N	0	
3081	269	162803	1647	138	17/1.14	1350	N	0	Wx @ line end moved N
~~3080~~									
3029	94	165831	171402	158	17/1.03	1350	N	0	
3028	267	171559	173402	136	18/0.99	1353	N	0	
3027	93	173527	175030	156	19/0.92	1346	N	0	

Total Proj Lines: 105 Lines Flown: 5 Lines Remain: 100 OnLine Time: 1:40 Mob Time: 1:00 Notes:

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

Date 2020 01 05

(email log daily to flight_log_distribution_list@quantumspatial.com)

Project: NC LiDAR block 5 Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 4197.6 End Hobbs: 4203.0 Total: Pilot: LaRosa Co-Pilot: Tech: EBG

Dep Apt: 1156 Dep Time (Lcl): ~~1356~~ (Z): 1656 Arr Apt: Arr Time (Local): 1718 (Z): 2218 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: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL 1560i	3546	4500			160	
	FOV 58.52	Scan Freq 2x160	MpIA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

400GB

Strip 40 41 Storage Numbers
Cls 40 8
End 241.86 SET 1
Cls 240.57
Tot ~~4200~~ Cls

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc
5060	185	170619	172014	156	.97/19	4500	N	0	REFLY
5059	357	17220	—	142	.97/19				REFLY @ GIMBAL stopped responding / REBOOT GSM only
5059	356	174551	180112	142	1.03/18	4480	N	0	Reboot GSM & reset valve. Happy now
5058	188	180322	181705	160	1.13/17	4500	N	0	
5057	355	181935	183507	144	0.94/19				
5056	188	183656	185100	153	0.97	1344m			N-S
5055	355	185317	190829	134-145	0.87/19	1345			134→145 kts
5054	187	191017	192412	160		1338			N-S
5053	355	192621	—	145	0.99/19				REFLY
5053	355	193335	194830	147	1.06/18	1345			
5052	186	195013	200359	157	1.03/19	1348			
5051	355	200617	202023	147	1/21	1343			
5050	189	202251	203632	163	088/22	1352			
5049	355	203819	205307	148	0.95/24	1355			
5048	187	205458	210840	157	1.12/21	1355			
5047	353	211033	212958	148	1.17/22	1353			S-N
5046	189	212637	214005	157	1.17/22	1359			
5089	88	214818	220011	160	0.91/21	1350			W-E

Total Proj Lines: 90 Lines Flown: 16 Lines Remain: 33 Online Time: ~~5.8~~ 4.9 Mob Time: 0.7 Notes:

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Date 7/ /

Pg 1 of

Project NC_LiDAR_blk 5 Proj # 351630 Flight Mgmt File

Aircraft: 704MD Begin Hobbs: 14195.9 End Hobbs: 14197.6 Total: 1.7 Pilot: LAROSA Co-Pilot: Tech EBC

Dep Apt: Dep Time (Lcl): 904 (Z): 1405 Arr Apt: Arr Time (Local): 1046 (Z): 1546 Tot Time Aloft: 1:42

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: 3020 end:

LIDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL (560i	3546	4500			160	
	FOV 58.52	Scan Freq 2 x 160.0	MpIA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Beg GB 0 B 0 A Storage Number

End GB 40

Tot GB 40

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc. 327@26,
5062	187	144147	145535	162	0.92/21	4500	N	0	REFLY CLEAR SKY, SMOOTH High wind ~~FORGOT~~ N-S
5061	357	145735	151410	130	1.05/20			0	S-N
5060	185	151841		160				0	N-S 151625 bad monkey tail; ERROR 2646 again a1+2 GIMBAL off recycle power will not power on

Total Proj Lines: 90 Lines Flown: 2 Lines Remain: Online Time: 0.44 Mob Time: 1.03 Notes:

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

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Date: 2019.01.06

Lift: (A) B C D E Pg 1 of _

Project: NC LiDAR block 5 Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14203.0 End Hobbs: 14208.0 Total: 5.0 Pilot: CARosa Co-Pilot: Tech: EBG

Dep Apt: Dep Time (Lcl): 841 (Z): 1341 Arr Apt: Arr Time (Local): 1343 (Z): 1843 Tot Time Aloft: 5.03

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: 42.8F °c End: 65 °c OAT beg: °c End: °c Altimeter begin: 30.14 end:

LIDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL 1560i	3546	4500	1400 m	135'	160	
	FOV 58.52	Scan Freq 2x160	MpiA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Beg GB 241 (x2) Storage Name/#

End GB 433 (x2) SET

Tot GB 384 1

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
5045	354	140806	142255	157	.97/20	1360	010	0	beautiful, clear day in NC
5044	190	142455	144001	159	0.91/21	1377	-5°		S-N Avg 3-5° crab
5043	355	144139	145650	157	.87/21	1367			
5042	185	145829	151340	160		1368			S-N
5041	355	151535	153121	155	.99/21	1375			
5040	185	153259	154830	160	.99/19	1371			S-N
5039	355	155023	160620	153	.98/18	1370			
5038	185	160829	162421	157	1.0/18	1372			S-N
5037	355	162618	164200	154	1.0/19	1368			
5036	185	164426	170020	160	0.95/18	1376			N-S
5035	356	170200	171815	153	0.90/19	1363			
5034	183	171946	173534	159	0.91/19	1367			N-S
5033	357	173714	175310	154	0.92/19	1377			
5032	185	175443	180952	160	1.02/18	1376			N-S

Total Proj Lines: 90 Lines Flown: 14 Lines Remain: 24 OnLine Time: 4.03 Mob Time: 1.0 Notes:

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

Date: 1-7-24

Project: NC Supplemental LIDAR — Proj #: 35630 — Flight Mgmt File: 2024107A_35630

Aircraft: 727M — Begin Hobbs: 7976.5 — End Hobbs: 7980.7 — Total: 4.2 — Pilot: Steve — Co-Pilot: — Tech: [illegible]

Dep Apt: ILM — Dep Time (Local): 828 (Z) +5 EST — Arr Apt: ILM — Arr Time (Local): 1242 (Z) +5 EST — Tot Time Aloft: 4.2

CORS: Y / N — Sta 1: Mount off — 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: +6 °c — End: °c — Altimeter begin: 3008 — end:

Beg: 848 — End: 660

LIDAR — Type: 1560; — Serial #: 3061 — Alt AGL: 1400 — Alt AMSL: — Avg Terr Ht: — Max Gdspd: 160 kn — Avg Pt Spacing:

FOV: 58.5 — Scan Freq: 180 lps — MpiA Y / N — Pulses in Air: — Pulse Rate: 1000 kHz — Power: 100% — [illegible]: 8

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0-4)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
									Mount off
7019	279	1338	1359	125	0.9/30	4462		0/-	look for smoke East End/middle
7018	99	1402	1419	131	" "	4468		0	
7017	279	1422	1445	125	0.9/31	4478		0	
7016	99	1450	1506	160	" "	4475		0	*All lines Flown with
7015	279	1510	1534	160	0.8/34	4468		0	Mount off*
7014	99	1539	1555	160	0.9/31	4458		0	
7013	279	1600	1624	115	0.8/30	4462		0	
7012	99	1627	1646	159	0.9/28	4465		0	
7011	279	1650	1715	115	1/25	4462		-/+	light to Moderate turbulence and Q starting
Xtie	180	1719	1722	122	1/27	4470		+/-	

(A) Hobbs = 4.2
online = 3.8
mob = 0.4

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

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

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Date: 2020.01.08

Lift: (A) B C D E Pg 1 of _

Project: NC LiDAR block 5 Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14208.9 End Hobbs: 14213.6 Total: 5.6 Pilot: LAROSA Co-Pilot: Tech: EBG

Dep Apt: Dep Time (Lcl): 852 (Z): 1352 Arr Apt: Arr Time (Local): 1430 (Z): 1949 Tot Time Aloft: 5.6

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: 35°F End: °c OAT beg: °c End: °c Altimeter begin: 30.30 end:

LiDAR	Type: RIEGL 1560i	Serial #: SN 35546	Alt AGL: 4500	Alt AMSL:	Avg Terr Ht:	Max Gdspd: 160	Avg Pt Spacing:
	FOV: 58.52	Scan Freq: 2x160	MpiA Y / N	Pulses In Air:	Pulse Rate: 2000	Power: 100	PPSM

Beg GB	427 433	Storage Name/#
End GB	622 628	SET 1
Tot GB	390	

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
5088	359	141006	142416	153	0.95/19	1330	6°	0	REFLOWN ✓ 20200108_M1
5087	180	142549	143953	156	0.89/20	1334	10°	0	REFLOWN ✓
5086	359	144133	145612	155	1.01/22	1334	7°	0	REFLOWN ✓
5060	180	152636	152017	159	1.13/21	1343	11°	0	REFLOWN ✓
5031	359	152955	154515	157		1366	10°	–	
5030	180	154735		159	.96/20	1379	12	+	ABORT / RESET GSM REFLY 160016/
5029	359	161703	163150	143	.89/20	1366	10°	–	
5028	180	163340	164645	158	0.89/20	1370	11°	–	
5027	0	164845	170225	146	0.85/21	1369	10°	–	
5026	180	170408	171605	159	0.9/21	1377	13°	–	
5025	359	171802	173050	147	0.88/20	1370	12°	0	
5024	179	173223	174342	162	0.95/19	1378	13°	0	
5023	0	17454	175710	147	1.07/19	1380	9°	0	
5022	179	175848	180919	159	0.94/20	1371	14°	–	
5021	0	181047		146	0.97/20	1371	11°	0	
5020	179	182313	183307	160	0.88/21	1376	13°	–	
5090	89	184323	185450	160	1.02/18	1361	6°	0	

Total Proj Lines: 90 Lines Flown: 17 Lines Remain: 0 Online Time: 4.77 Mob Time: 0.87 Notes:

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

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Date: 12/12/19

Lift: A B C D E Pg 1 of _

Project: North Carolina Block 6 Proj #: 35630 Flight Mgmt File: 20191212_NC_840JA_MI

Aircraft: 840 JA Begin Hobbs: 1822.1 End Hobbs: 1826.9 Total: Pilot: NS Co-Pilot: — Tech: JF

Dep Apt: OAJ Dep Time (Lcl): 0910 (Z): Arr Apt: OAJ Arr Time (Local): 1415 (Z): Tot Time Aloft: 4.8

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: end:

LiDAR									Beg GB	Storage Name/#
	Type 1560.	Serial # 3061	Alt AGL	Alt AMSL 1400	Avg Terr Ht	Max Gdspd 160	Avg Pt Spacing		End GB	
	FOV 38.52	Scan Freq 1000 × 2	MpiA Y / N	Pulses In Air	Pulse Rate 320	Power 100 %	PPSM 8		Tot GB	

Line #	Hdg	Start (UTC)	End (UTC)	Gd Spd	POON/+Secs	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
6001	189.2	144155	145617	158	.92	4478			
6002	009.1	14 58 01	151702	155	.93	4478			
6003	189.2	151355	152809	151	1.01	4478			
6004	009.1	153002	154442	158	1.01	4478			
6005	189.2	154559	160051	152	1	4475			
6006	009.2	160207	161639	158	.9	4475			
6007	189.3	161744	163255	147	.96	4461			
6008	009.2	163411	164823	162	.93	4462			
6009	189.3	164953	170455	145	.93	4465			
6010	009.2	170626	172045	158	1.09	4475			
6011	189.3	172212	173708	145	1.06	4472			
6012	009.2	173901	175255	157	1.02	4472			
6013	189.3	175457	180949	147	.98	4461			
6014	009.2	181133	182540	157	.97	4462			
~~6015~~	~~189.3~~	~~182724~~		~~143~~	~~.87~~	~~4465~~			Cloud bank moved in / will Refly

Total Proj Lines: Lines Flown: 14 Lines Remain: Online Time: 4.4 Mob Time: .4 Notes:

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

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Date: 2019 12.31

Lift: A (B) C D E Pg 1 of 1

Project: 35630 NC LiDAR Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14183.4 End Hobbs: 14185.9 Total: 2.5 Pilot: LaRosa Co-Pilot: — Tech: E.Guillory

Dep Apt: Dep Time (Lcl): 1549 (Z): 2049 Arr Apt: Arr Time (Local): 1816 (Z): 2216 Tot Time Aloft: 2:25

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: 16 °c End: 10 °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL	3546	1400			160	Uniform
	FOV 58.52	Scan Freq 2x160	MpiA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Beg GB 97.17 Storage Media/# Set 2

End GB 191

Tot GB 94

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/# Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc.
85	348	210513	212100	150	1.9/14	4500	4	0	HAD to full reboot, then did not pick up any GLONASS sats.
84	194	212529	214005		1/14				on flight plan alt and line length are switched
83	348	214136	215610						giving POSTRACK ground level error.
82	194	215810	211830						
81	348	221342	222810						all lines high crab due to winds
80	194	223019	224300						
79	348	224544	230130		1.12/11				

Total Proj Lines: 14 Lines Flown: 7 Lines Remain: Online Time: 1:55 Mob Time: :23 Notes:

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

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Date: 2019.12.31

Lift: (A) B C D E Pg 1 of 1

Project: 35630 NC LiDAR Proj #: 35630 Flight Mgmt File:

Aircraft: 704MD Begin Hobbs: 14182.1 End Hobbs: 14183.4 Total: 3.3 Pilot: C.LAROSA Co-Pilot: — Tech: E.Guillory

Dep Apt: Dep Time (Lcl): 948 (Z): 1448 Arr Apt: Arr Time (Local): 1105 (Z): 1605 Tot Time Aloft: 1:17

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: 8 °c End: 13 °c OAT beg: °c End: °c Altimeter begin: end:

LiDAR	Type	Serial #	Alt AGL	Alt AMSL	Avg Terr Ht	Max Gdspd	Avg Pt Spacing
	RIEGL	3546	1400			160	UNI
	FOV 58.52	Scan Freq 2x160	MpiA Y / N	Pulses In Air	Pulse Rate 2000	Power 100	PPSM

Storage Name/# Set 2

Beg GB 67.85

End GB 97.17

Tot GB 29.32

Line #	Hdg	Start (UTC):	End (UTC):	Gd Spd	PDOP/#Sats	GPS Altitude	Crab	Turb (0, -, +)	FLIGHT LINE NOTES – visibility, clouds, smoke, partial, etc
88	190	150227	151700	150	0.92/21	4502	Y	0	clear sky, conditions excellent
87	344	151917	153405	"	1.0/21	"	↓	0	
86	194	153527	155030	"	0.99/20	"	↓	0	
									all lines high crab due to wind

Total Proj Lines: Lines Flown: 3 Lines Remain: Online Time: :49 Mob Time: :30 Notes: