



# **Ross River 2019** LiDAR and Airphoto Data Capture and Processing

## **LiDAR and Air Photo Report**

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## 1. Introduction

McElhanney Ltd (MCSL) performed a LiDAR and aerial photography acquisition for Ross River, shown in Figure 1.

The site was flown on September 6<sup>th</sup>. This report describes the acquisition, post-processing and quality control methodology used to produce the final elevation models.

## 2. Mission Plan

**Project:** Ross RiverLiDAR and Aerial photo Project

**Date:** 2019-09-06

**Location:** Ross River

**Topography:** low relief



**Figure 1– LiDAR Survey Site**

### 3. Equipment

McElhanney utilized the Optech Galaxy system for LiDAR Capture (Figure 2).

For Product Specifications of Optech Galaxy please see

<http://www.teledyneoptech.com/index.php/product/optech-altm-galaxy/>

The Galaxy was mounted on Piper Navajo fixed wing Aircraft.



Figure 2 – Optech Galaxy components

On Board Camera Phase One iXU-RS1000 RGB simultaneous capture (Figure 3.)

### Phase One Industrial – Cameras iXU-RS1000 series



iXU-RS1000 series

Camera Type	iXU-RS1000
<b>Camera Specifications</b>	
Lens type	Rodenstock / Schneider-Kreuznach
Focal length F (mm)	RS lenses: 32, 40, 50, 70, 90, 110, 150 SK lenses: 28, 55, 80, 110, 150, 240
FOV (across line, deg)	86.5 (28mm) – 12.9 (240mm)
FOV (along flight line, deg)	70.3 (28mm) – 9.7 (240mm)
Aperture	f/5.6
Exposure principle	Leaf shutter
Exposure (sec)	1/2000 to 1/125
Image capture rate	1 frame every 0.6 sec
Light Sensitivity (ISO)	50-6400
Dynamic Range (db)	>84
Spectral characteristics	R,G,B
<b>Sensor Specifications</b>	
CMOS pixel size (µm)	4.6
CMOS array (pix)	11,608 x 8,708
Analog-to-digital-conversion (bit)	14
<b>Frame / Image Specifications</b>	
Frame geometry	Central projection
Image size (pixel)	11,608 x 8,708
Image volume (MP)	100
Color	RGB or NIR
Typical image size (MB)	300
Image format	Phase One RAW, TIFF, JPEG
<b>Operational Specifications</b>	
Power Consumption	< 10W
Dimensions (depends on lens)	97.4 x 93 x <218 mm
Weight (depends on lens)	< 2 kg

PHASE ONE  
Specialty Imaging Solutions

Figure 3 – Phase One Camera Series

#### 4. Flight Plan

**Table 1:** Flight Parameters- 2019-09-06

Strip ID	Start [s]	Stop [s]	PRF [kHz]	Scan Frequency [Hz]	Scan Swath [deg]	Speed Avg [m/s]	Height Avg [m]
1	502613.2	502730.4	117.2	550	66	50	77
2	502838.2	502964.7	126.5	550	66	50	77.1
3	503074.3	503214.8	140.5	550	66	50	75.4
4	503327.2	503468.7	141.5	550	66	50	75.8
5	503571.8	503711.4	139.6	550	66	50	76.7
6	503799.5	503924.2	124.7	550	66	50	79.1
7	503987.1	504116.4	129.3	550	66	50	78.6
8	504195.3	504320.8	125.6	550	66	50	76.8
9	504374.5	504513.1	138.6	550	66	50	75.1
10	504591	504721.2	130.3	550	66	50	77.3
11	504790.7	504924.7	134	550	66	50	72.5
12	504982.1	505106.7	124.7	550	66	50	76.4
13	505175.3	505300.9	125.6	550	66	50	75.5
14	505357.3	505484.7	127.4	550	66	50	74.2
15	505556.1	505678.9	122.8	550	66	50	77.8
16	505761.4	505867.4	106	550	66	50	71.8
17	505946.2	506027	80.8	550	66	50	74.6
18	506108.6	506199.7	91.1	550	66	50	76.3
19	506273.8	506333.1	59.3	550	66	50	73.6
20	506458.6	506600.1	141.5	550	66	50	77
21	507209.9	507221.7	11.7	450	66	50	77.9
22	507482.5	507615.5	133.1	450	66	50	80.4
23	507699.9	507859.1	159.2	450	66	50	71.6
24	507925.8	508067.3	141.4	450	66	50	78.6

Strip ID	Start [s]	Stop [s]	PRF [kHz]	Scan Frequency [Hz]	Scan Swath [deg]	Speed Avg [m/s]	Height Avg [m]
25	508138.6	508292.2	153.6	450	66	50	74.6
26	508354.2	508511.6	157.3	450	66	50	72.5
27	508594.1	508747.7	153.6	450	66	50	75.1
28	508804.1	508960.5	156.4	450	66	50	74
29	509037.4	509189.2	151.7	450	66	50	73.5
30	509280.1	509433.7	153.6	450	66	50	76.7
31	509575	509647.4	72.4	450	66	50	71.8
32	509760.8	509958.2	197.4	450	66	50	78
33	510134.1	510198.1	64	450	66	50	75.5
34	510321.7	510413.7	92	450	66	50	72.6
35	510489.7	510733.8	244.1	450	66	50	73.7
36	510822.9	511068	245	450	66	50	71.2
37	511143	511373.2	230.1	450	66	50	77.6
38	511493.1	511733.4	240.4	450	66	50	72.3
39	511844.9	512073.2	228.3	450	66	50	76.4
40	512162.3	512419.5	257.2	450	66	50	71.1
41	512510.4	512737.7	227.3	450	66	50	77.1
42	512836.1	513087.7	251.6	450	66	50	71.4
43	513204.8	513444.3	239.5	450	66	50	76.4
44	513572.5	513828.8	256.3	450	66	50	70.7
45	513893.6	513926.8	33.2	450	66	50	78.6
46	514030.8	514057.5	26.7	450	66	50	77
47	514146.6	514208.7	62.1	450	66	50	82.7
48	514463.9	514541.9	78	450	66	50	72.7
49	514613.2	514703.3	90.1	450	66	50	76.7
50	514782.2	514869.5	87.3	450	66	50	75.5
51	514948.3	515041.2	92.9	450	66	50	75.4

Strip ID	Start [s]	Stop [s]	PRF [kHz]	Scan Frequency [Hz]	Scan Swath [deg]	Speed Avg [m/s]	Height Avg [m]
52	515125.6	515226	100.4	450	66	50	72.4
53	515283.4	515367.9	84.5	450	66	50	80.1
54	515437.4	515536.8	99.5	450	66	50	73.1
55	515608.2	515701.1	92.9	450	66	50	76.8
56	515821.9	515911.1	89.2	450	66	50	74
57	515999.2	516038	38.8	450	66	50	82.3
58	516147.6	516224.7	77	450	66	50	71.9
59	516357.6	516507.5	149.8	350	66	50	74.2
60	516751.5	516823.9	72.4	450	66	50	76.7
61	516968.1	517038.6	70.5	450	66	50	72.6
62	517120.2	517230.8	110.7	450	66	50	79
63	517331.1	517480	148.9	450	66	50	73.7
64	517632.6	517780.6	148	450	66	50	77.9
65	517893	518058.7	165.7	450	66	50	71
66	518163.7	518329.4	165.7	450	66	50	72.9
67	518543.5	518638.3	94.8	450	66	50	74.2
68	518736.7	518886.6	149.8	450	66	50	79.1
69	518951.4	519118.1	166.6	450	66	50	73.4
70	519186.6	519340.2	153.6	450	66	50	80.2
71	519428.3	519594.1	165.7	450	66	50	74.8

## **5. Data Processing**

All GPS and IMU data was processed using PosPac MMS 8.4 software. The laser data was extracted using Teledyne Optech LMS software. The GPS antenna position in the airplane was calculated by post-processing the raw data at 1 second intervals for the entire flight.

We have used Precise Point Positioning (PPP) for the airborne GPS processing, and the coordinates were calculated in NAD83-CSRS.

The airborne positions were combined with the post-processed platform (aircraft) attitude information to generate a time tagged position and orientation solution.

The standard deviation of the airborne GPS solution for using KAR (Kinematics Ambiguity Resolution) was estimated to be 0.03, 0.04 and 0.05m in East, North and height directions, respectively.

The estimated values for the GPS antenna position were used with the laser ranges and platform angles to compute all the individual X, Y, and Z coordinates for each laser return in each flight line. The result is a processed point cloud containing all measured points.

## **6. Point Density**

Bare earth point density varies with canopy closure, understory density and topographic features. Mean density of the point cloud was measured at nominal 10.23 pts/m<sup>2</sup> and the Bare earth point density was measured at nominal 6.0 pts/m<sup>2</sup>.

## **7. Calibration**

**System: Optech ALTM Galaxy S/N 5060392**

**LiDAR Calibration flight:**



Calibration Date: June 14, 2019 Location: Whitehorse, Yukon

The LiDAR system calibration was flown over calibration site. The lever arms (offset between GPS antenna IMU and Laser Mirror), were measured as:

Lever Arms

GPS Lever arms in (m):

x: 0.28 y: -0.445 z: -1.196

IMU Lever arms in (m):

x: 0 y: 0 z: 0

There were a total number of 10 flight lines for calibration: 9 basic orthogonal lines for LMS software analysis and 1 redundant line for better accuracy. The lines were planned as follow:

Flight line direction: 3 lines north – south and 3 lines east – west and 1-line NW-SE  
All GPS with IMU data was processed using PosPac Applanix software v.8.3. and the laser data was extracted using LMS v.4.3 The GPS antenna position in the airplane was calculated by post-processing the raw data at 1 second intervals for the entire flight.

The calibration values used for this project are as follows:

imu\_ex: 0.049404867 arcsec

imu\_ey: -0.062994531 arcsec

imu\_ez: -0.131591982 arcsec

## **8. Quality Control**

The LiDAR data consistencies have been checked between the flight lines using Terrascan software.

### **Comparison of Bare Earth LiDAR data with Ground Survey Values**

According to ASPRS guidelines, the vertical accuracy of LiDAR is as follows:

$$RMSE_z = \text{Sqrt}[\sum (Z_{Lidar(i)} - Z_{check(i)})^2 / n] = 0.12 \text{ m}$$

Where the "Check" refers to the ground truth ( In this project, we used survey points which are at least three times more accurate than the individual LiDAR points) and  $n$  is the number of check points. LiDAR 2019 was checked vs road center line points from 2014 LiDAR dataset. A total of 11796 ground check points were used for this analysis.

Average dz	+0.003
Minimum dz	-0.200
Maximum dz	+0.530
Average magnitude	0.070
Root mean square	0.116
Std deviation	0.116

## 9. Deliverables

Final output data is provided in NAD83CSRS UTM N8 and the elevations are based on CGVD28 HT2 geoid model. The deliverables include:

- Bare Earth & Thinned model key points in las, xyz
- Non Bare Earth in las format
- Index map
- 15 cm Orthophoto
- Technical report