LiDAR Data Report

WOLF HEAD DISCOVERY & MINING – YUKON SITE

Data collected and prepared for:

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EML Project 18-015

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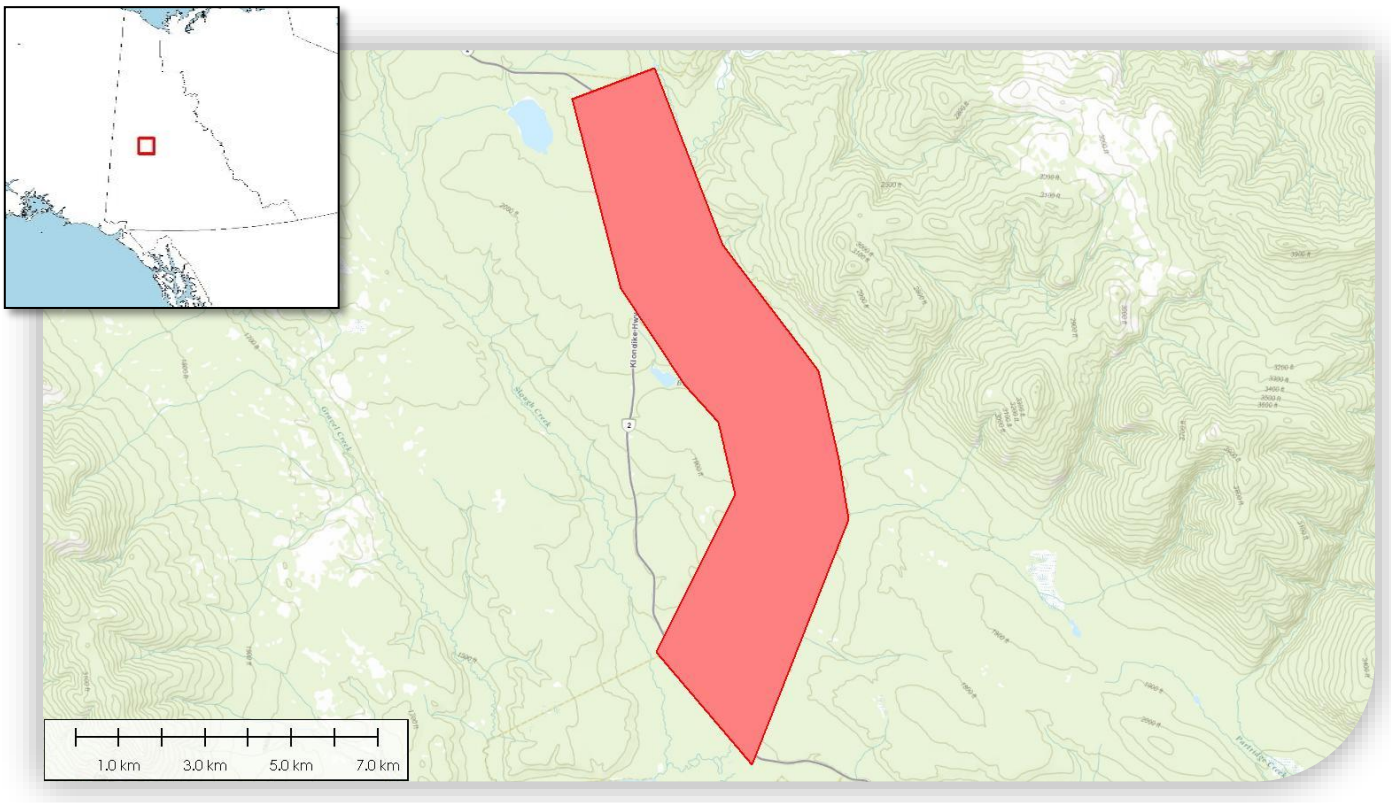
1. Project Overview

1.1 Area of Interest

Eagle Mapping Ltd. collected aerial LiDAR for Wolf Head Discovery and Mining of their Yukon Site located 85 km west of Mayo, YT. The Area of Interest (AOI) for this project covers a total of 41 sq. km. A significant buffer was collected surrounding the project AOI in order to guarantee accuracy and density within the boundary.



1.2 Acquisition Conditions

Collection occurred on July 4, 2018 and was completed in a single mission from Whitehorse's Erik Nielsen International airport. Weather conditions were favorable with moderate winds and a scattered layer of clouds at 9000ft, well above the planned flight line altitudes.

1.3 File Formats, Units, and Projection

Project deliverables include the following:

Lidar Point Cloud – 4 ppm

- Calibrated and classified LiDAR data in LAS v1.2 file format
- Delivered as one file per project tile
- Point classification scheme shown below

'Bare Earth' Digital Elevation Model – 1m Grid

- ArcASCII grid format (.asc); delivered as one file per project tile
- LAS v1.2 file format; delivered as one file

'Highest Hit' Digital Surface Model – 1m Grid

- ArcASCII grid format (.asc); delivered as one file per project tile
- LAS v1.2 file format; delivered as one file

Project Files

- Project boundary
- Delivered in ESRI Shapefile format (.shp)

LiDAR Data Report

- Overview of project specifications, methodology and accuracies achieved
- PDF format

Map Projection Information	
Projection	UTM zone 8N
Horizontal Datum	NAD83 (CSRS)
Vertical Datum	CGVD2013
Geoid	CGG2013
Units	Meters
EPSG Code	3155

LiDAR Point Classification	
Class	Description
1	Unclassified
2	Ground

2. Acquisition & Calibration

2.1 Airborne LiDAR Collection

A Riegl Q1560 dual-channel LiDAR system was used for acquisition of the LiDAR data. This system was installed in a Piper PA31 Panther Navajo, owned by Peregrine Aerial Surveys. This Aircraft is based in Abbotsford, BC. In total, 7 lines were required to cover the AOI. Nominal flying height was 1450m above ground level (AGL) and flying speed was approximately 140kts. The scan field of view for the Riegl Q1560 is 29° either side of nadir, for a total scan field of view of 58°. The scan rate used for this project was 800 kHz. However, due to the nature of the 4-sided rotating mirror in Riegl scanners only 2/3 of pulses are recorded (533 kHz useable). This yields an average pulse density of 2 pulses per channel per swath (4 pulses per dual-channel flight line). The project was flown with a minimum of 25% side overlap. The per-line densities mentioned above can thus be an estimate of true pulse density on the surface. Note, each pulse may result in one or more returned points as the pulse filters through vegetation, etc. Water or highly absorbent material may result in very few or no LiDAR returns as these materials poorly reflect the laser pulse or may absorb it entirely.

LiDAR Acquisition Specifications	
Flight Altitude	1450m AGL
Flying Speed	140kts nominal
Scan Rate	800khz (533khz usable)
Scan Field of View	58°
Line Spacing	1130m
Minimum Overlap	30%

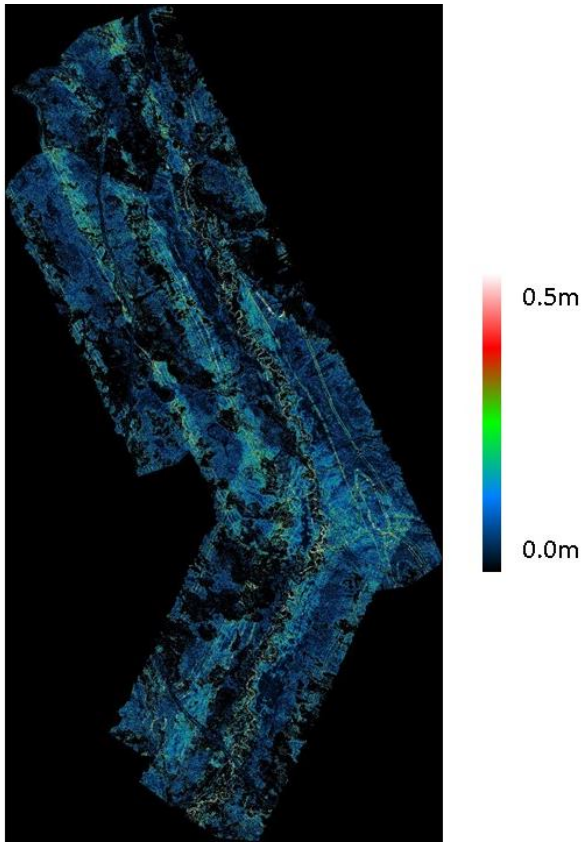
2.2 Aircraft GNSS Trajectory Processing

GNSS post-processing determines the position and attitude of the aircraft at 200Hz along the entire flight path. This data is logged on the Q1560 via an Applanix POS AV510. Trimble RTX correction services was used for post-processing. This service provides real-time corrections for GNSS solutions and is extremely helpful for remote locations where base station coverage is limited.

Processing is done with Applanix PosPAC v8.2 software. Here the aircraft GNSS / IMU data is combined to provide adjusted positions for the aircraft in latitude, longitude, and height, roll, pitch, and yaw / heading. The final trajectory is then smoothed, and exported in .pos format for use in RiProcess for LiDAR processing. The resulting flight path is commonly referred to as a Smoothed Best Estimate of Trajectory (SBET).

Trajectory Processing Results	
Min. # of Satellites	12
Max. # of Satellites	17
Minimum PDOP	1.2
Maximum PDOP	2.0
RMSE	3.5 cm

2.3 LiDAR Calibration



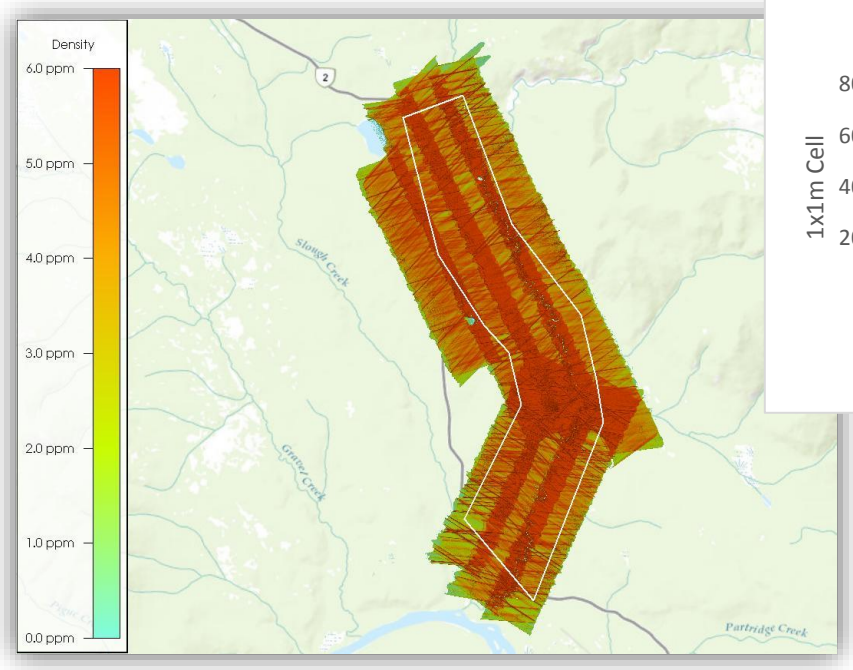
LiDAR data was calibrated using BayesStripAlign 2.0 software. This software registers overlapping LiDAR swaths and corrects both relative and absolute geometric errors. It uses a rigorous time–dependent approach to reduce discrepancies between strips due to IMU attitude and positional errors. Once aligned, manual cross section checks are performed to verify the automatic results. When deemed properly calibrated, the LAS data is exported along with individual 'trajectories' for each scan line. All data is projected into UTM and adjusted to the proper geoid (CGG2013) at this time.

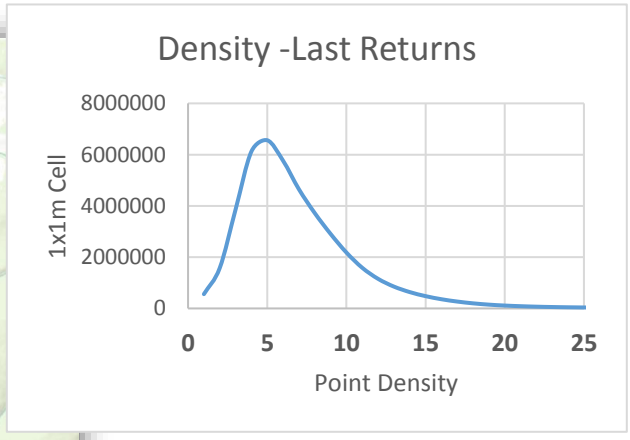
Left: Image shows vertical discrepancies after calibration

3. Results and Conclusions

3.1 Point Density

The delivered LiDAR data is positioned with an average density of 6+ points / sq. meter for all returns, and 4+ points / sq. meter counting only first-returns. Density is much greater for all returns vs first-returns due to the full waveform analysis performed by the Q1560 laser. By analyzing the full LiDAR waveform, the Q1560 is able to extract many additional points in vegetation, or other terrain where the laser pulse is 'filtered' through many objects in close proximity to each other.





3.2 Accuracy

Due to the statistically sound SBET trajectory and robust calibration processing it is Eagle Mapping's conclusion that the delivered LiDAR data is accurate to ± 30cm Horizontally and ± 15cm vertically.