Watson Lake – 2024 LiDAR & Orthophoto

September 15, 2025

Submitted to: Government of Yukon
Prepared by McElhanney

Contact
Azadeh Koohzare, Ph.D., P.Eng
Division Manager
+1 604-424-4784
akoohzare@mcelhanney.com

Address
200 – 858 Beatty Street, Vancouver BC Canada, V6B 1C1

Prepared by
Morteza Esfandiari, M.Sc., P.Eng

Reviewed by
Azadeh Koohzare, Ph.D., P.Eng

Our file: 2611-20549-01

Contents

Project Summary

McElhanney Ltd. performed a LiDAR and aerial photography acquisition for Watson Lake site, YT as shown in Figure 1. The site was flown on August 2nd, and 8th, 2024. This report describes the acquisition, post-processing and quality control methodology used to produce the final elevation models.

1. Mission Plan

Project: Watson Lake, Yukon Government

Date: 2024-08-02; 2024-08-08

Location: Watson Lake, YT

Topography: low relief valley

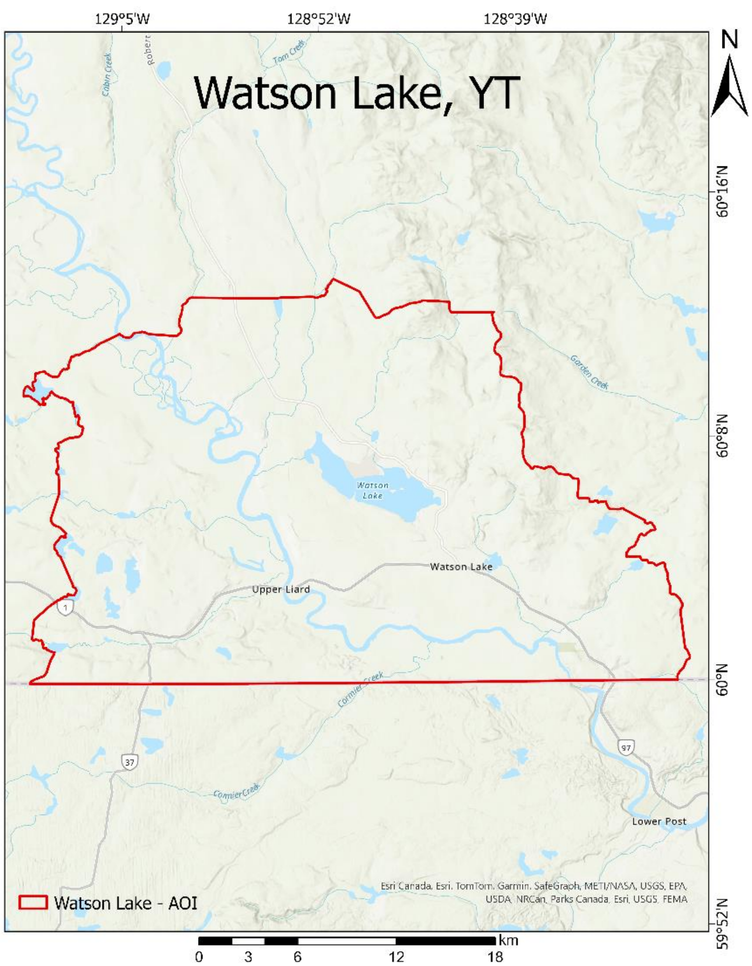

Figure 1 - LiDAR Survey Site

2. Equipment

McElhanney utilized the Leica TerrainMapper-2 (TM2), Hyperion2+ system for LiDAR Capture (Figure 2). For Product Specifications please see

https://leica-geosystems.com/products/airborne-systems/topographic-lidar-sensors/leica-terrainmapper-2

The LiDAR system is mounted on Piper Navajo fixed wing aircraft. On-board camera is Leica MFC150 / Leica MFC150-NIR Camera Head - simultaneous capture.

Figure 2 - Leica TerrainMapper-2 system components

3. Data Processing

All GPS and IMU data was processed using Inertial Explorer v8.9 software. The laser data was extracted using Leica HxMap 4.5 software. The GPS antenna position in the airplane was calculated by post-processing the raw data at one (1) second intervals for the entire flight. We have used Precise Point Positioning (PPP) to process the trajectories, and the coordinates were calculated in NAD83(CSRS).

4. Point Density

Bare earth point density varies with canopy closure, understory density and topographic features. The mean density of the point cloud for both sites was measured and is reported in Table 1.

Table 1 - LiDAR Point Densities

	Point-Cloud Density (points/m^2)	Bare-Earth Density (points/m^2)	Bare-Earth Point Spacing (m)
Klondike Valley	33.90	9.89	0.32

5. Calibration

System: Leica TM-2

LiDAR Calibration flight:

Calibration Date: April 11, 2024, Location: Red Deer, AB

Base station used for calibration (in NAD83(CSRS) UTM Zone 12N Epoch 2010):

- ABRE E307796.528m N5794942.885m Ellipsoid Elevation 848.617m

The LiDAR system calibration was flown over calibration site. The lever arms (offset between GPS antenna IMU and Laser Mirror), were calibrated based on 31 ground survey points.

Lever Arms

GPS Lever arms in (m):

X = -0.220 m Y = -0.217 m Z = 1.299 m

IMU Lever arms in (m):

x: 0 y: 0 z: 0

6. Quality Control

The LiDAR data consistencies have been checked between the flight lines using Leica-Hxmap software during GNSS post-processing and using TerraScan software during classification and QC.

6.1 Comparison of Bare Earth LiDAR Data with Control Data – Vertical Accuracy

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

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

Where the "Check" refers to the ground truth (in this project, we used existing LiDAR ground points) and *n* is the number of check points. A total of 677 check points were used for this analysis.

2020 - LiDAR bare-earth check points – Group 01	
Number of points:	491
Average dz	+0.002 m
Minimum dz	-0.087 m
Maximum dz	+0.121 m
Average magnitude	0.047 m
Root mean square	0.054 m
Std deviation	0.054 m
2020 - LiDAR bare-earth check points – Group 02	
Number of points:	186
Average dz	+0.040 m
Minimum dz	-0.026 m
Maximum dz	+0.130 m
Average magnitude	0.044 m
Root mean square	0.057 m
Std deviation	0.040 m

6.2 LiDAR Horizontal Accuracy

Establishing LiDAR horizontal accuracy involves a visual assessment relying on the ability to locate features in the LiDAR point cloud. When a feature is identified, its location is then compared to the location of control points measured at the feature in the field. The ability to locate features in LiDAR data is strongly linked to the point-cloud density, and thus, mean point-spacing achieved over the assessment area. Figures Figure 3 and Figure 4 demonstrate the horizontal accuracy of the collected LiDAR dataset.

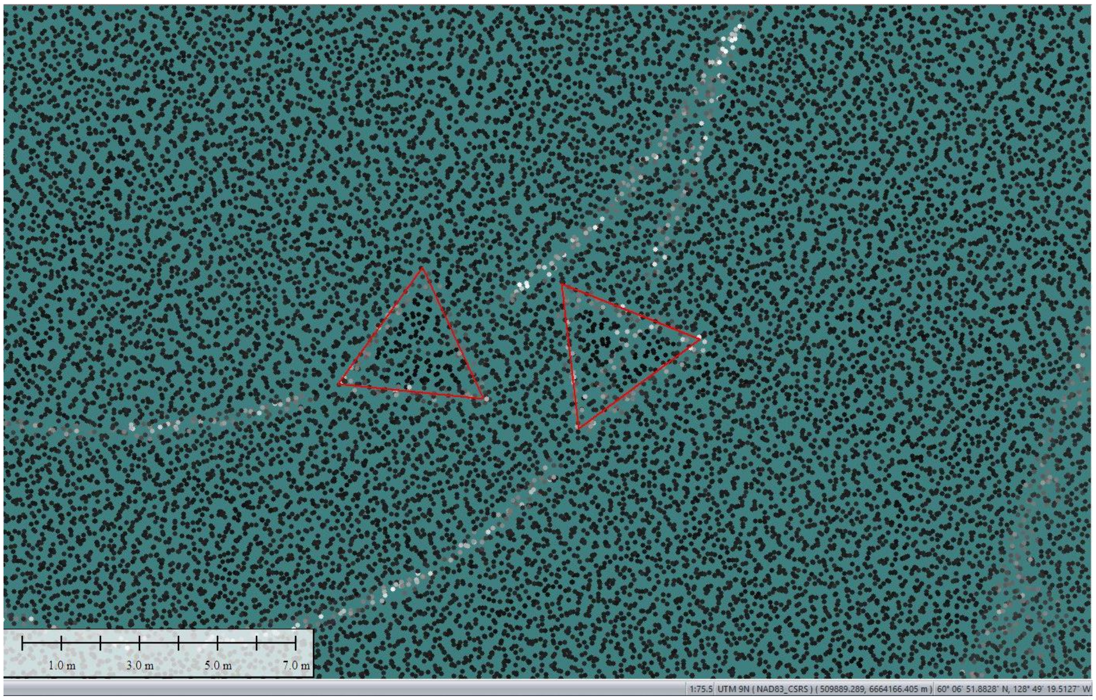

Figure 3 - Comparing LiDAR Horizontal Accuracy: Red lines are extracted from existing LiDAR data and overlaid on the current data.

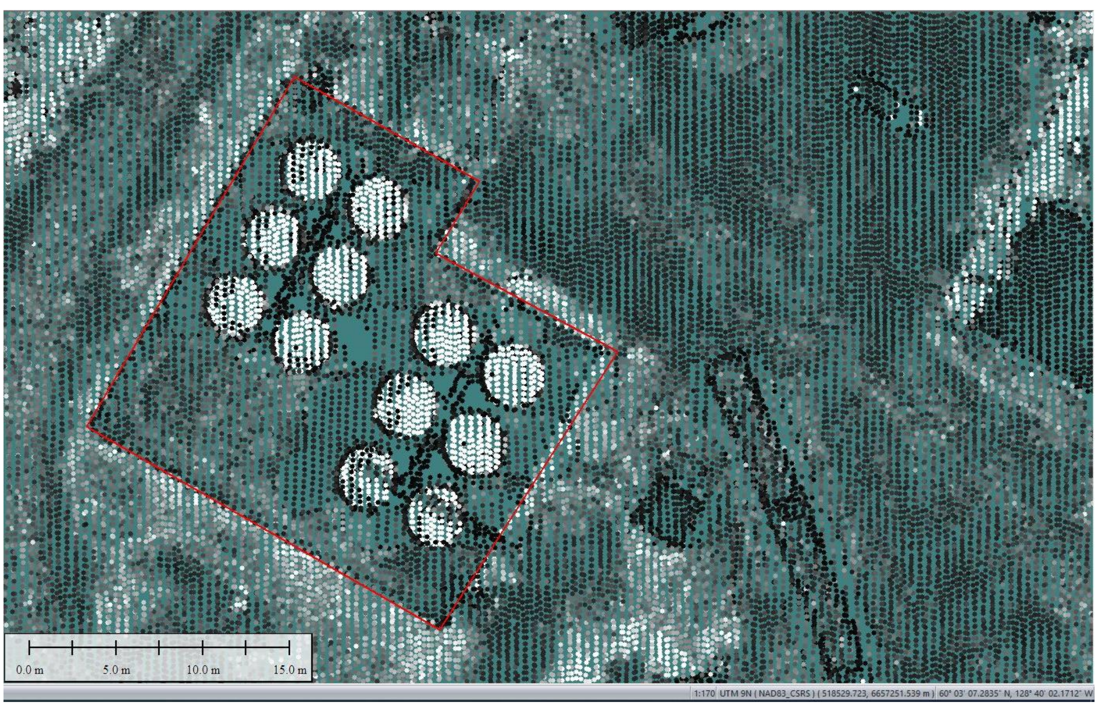

Figure 4 - Comparing LiDAR Horizontal Accuracy: Red lines are extracted from existing LiDAR data and overlaid on the current data.

7. Deliverables

Final output data is provided in NAD83(CSRS) UTM Zone 09 and the elevations are based on CGVD28-HTv2 and CGVD2013 datums. The deliverables include:

- Classified LiDAR data in las and xyz file formats. 1km² tiles. Files are separated by bare-earth (ground points, BE filename suffix) and non-bare-earth points (above ground points, NBE filename suffix)
- LiDAR model key points in xyz format
- Index map
- 20 cm-pixel, 8-bit natural colour RGB orthophoto in 1km² Geotiff tiles and ecw ortho-mosaic formats
- Project report
- Metadata

Appendix A

LiDAR Flight Parameters

2024-08-02 Flight Parameters

Flight Line Label	Swath Width [m]	Alt MSL [m]	Length [m]	Scan Pattern	Used Laser Pulse Rate [Hz]	Used Scan Rate [Hz]	FOV [deg]	Flown Line Direction [deg]	Line begin time [UTC]	Line end time [UTC]
020	1369	2503	38418	Circle	1960000	150	40	269.8	21:09:23	21:18:17
021	1369	2503	38247	Circle	1960000	150	40	89.8	21:20:21	21:28:52
022	1369	2503	38914	Circle	1960000	150	40	269.8	21:31:20	21:40:15
023	1369	2503	38619	Circle	1960000	150	40	89.7	21:42:37	21:51:15
024	1369	2503	39407	Circle	1960000	150	40	269.8	21:53:44	22:02:55
025	1369	2503	40727	Circle	1960000	150	40	89.7	22:04:57	22:14:06
026	1369	2503	41083	Circle	1960000	150	40	269.7	22:16:33	22:26:02
027	1369	2503	41209	Circle	1960000	150	40	89.7	22:28:33	22:37:39
028	1369	2503	41582	Circle	1960000	150	40	269.8	22:40:11	22:50:01
029	1369	2503	40951	Circle	1960000	150	40	89.7	22:52:22	23:01:25
030	1369	2503	41889	Circle	1960000	150	40	269.7	23:03:53	23:13:32
031	1369	2503	41354	Circle	1960000	150	40	89.7	23:15:35	23:24:39
033	1310	2403	14605	Circle	1960000	150	40	359.5	21:00:40	21:04:09

2024-08-08 Flight Parameters

Flight Line Label	Swath Width [m]	Alt MSL [m]	Length [m]	Scan Pattern	Used Laser Pulse Rate [Hz]	Used Scan Rate [Hz]	FOV [deg]	Flown Line Direction [deg]	Line begin time [UTC]	Line end time [UTC]
001	1369	2607	3657	Circle	1960000	150	40	89.9	17:44:54	17:45:48
002	1369	2520	17859	Circle	1960000	150	40	269.9	17:48:21	17:52:37
003	1369	2520	20771	Circle	1960000	150	40	89.7	17:54:19	17:58:59
004	1369	2503	24930	Circle	1960000	150	40	269.9	18:00:41	18:06:25
005	1369	2503	26461	Circle	1960000	150	40	89.7	18:08:14	18:14:04
006	1369	2503	27961	Circle	1960000	150	40	269.8	18:15:47	18:22:18
007	1369	2503	29959	Circle	1960000	150	40	89.7	18:24:03	18:30:47
008	1369	2503	31890	Circle	1960000	150	40	269.7	18:32:19	18:39:39
009	1369	2503	31929	Circle	1960000	150	40	89.6	18:41:08	18:48:17
010	1369	2503	32034	Circle	1960000	150	40	269.7	18:49:50	18:57:15
011	1369	2503	31361	Circle	1960000	150	40	89.8	18:58:35	19:05:36
012	1369	2503	29787	Circle	1960000	150	40	269.7	19:07:11	19:13:58
013	1369	2503	30264	Circle	1960000	150	40	89.7	19:15:33	19:22:27
014	1369	2503	30275	Circle	1960000	150	40	269.8	19:24:03	19:30:58
015	1369	2503	33060	Circle	1960000	150	40	89.8	19:32:31	19:39:59
016	1369	2503	33383	Circle	1960000	150	40	269.7	19:41:16	19:48:51

017	1369	2503	35210	Circle	1960000	150	40	89.7	19:50:07	19:58:03
018	1369	2503	37182	Circle	1960000	150	40	269.7	19:59:36	20:08:03
019	1369	2503	38411	Circle	1960000	150	40	89.7	20:09:29	20:18:09
032	1310	2405	26422	Circle	1960000	150	40	359.9	17:34:08	17:40:03