LIDAR-DERIVED ELEVATION DATA FOR MAYNARD MOUNTAIN, SOUTHCENTRAL ALASKA, COLLECTED JULY 29, 2022

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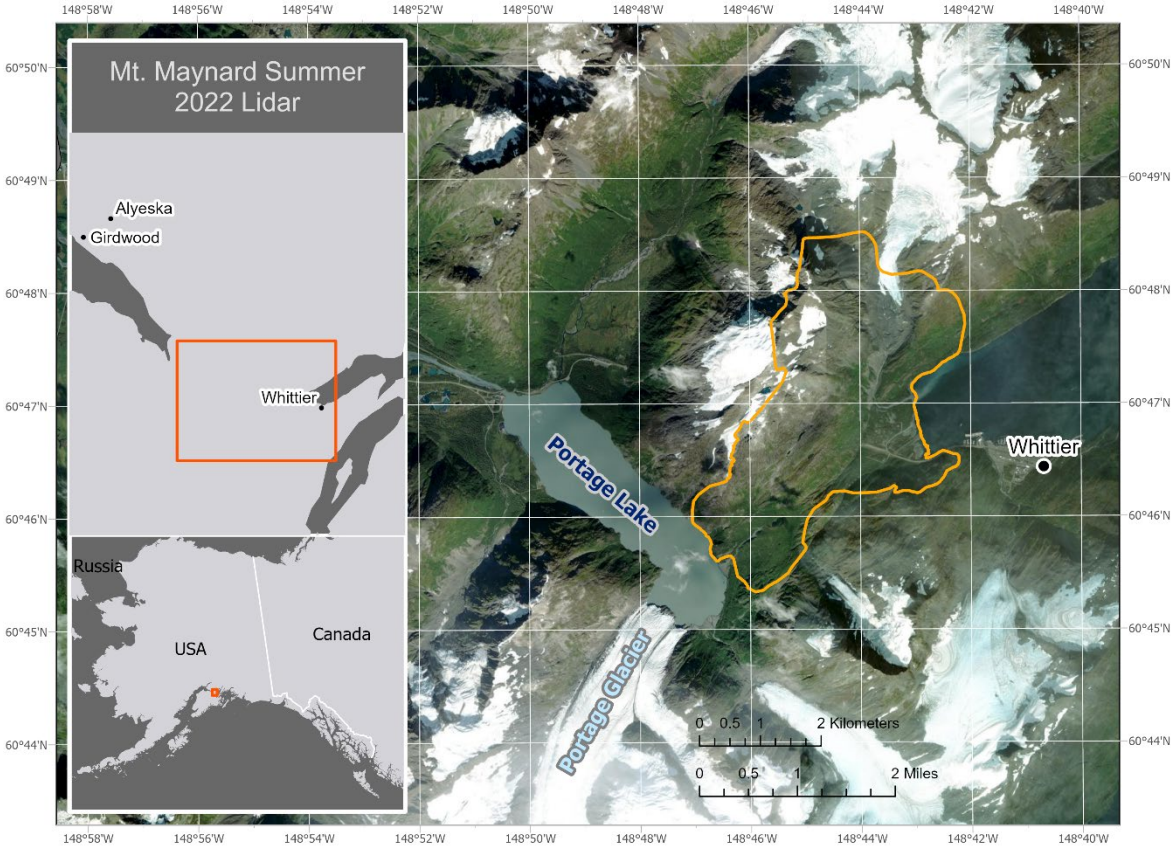
Raw Data File 2024-11



Location map of survey area.

This report has not been reviewed for technical content or for conformity to the editorial standards of DGGS.

2024
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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LIDAR-DERIVED ELEVATION DATA FOR MAYNARD MOUNTAIN, SOUTHCENTRAL ALASKA, COLLECTED JULY 29, 2022

Jenna M. Zechmann[1], Katreen M. Wikstrom Jones[1], and Gabriel J. Wolken[1]

INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital surface model (DSM), digital terrain model (DTM), and an intensity model of Maynard Mountain near Whittier, Southcentral Alaska, during leaf-on conditions (cover figure). The survey provides snow-free surface elevations for use in landslide hazard assessment. Ground control data and aerial lidar data were collected July 29, 2022, and subsequently merged and processed using a suite of geospatial processing software. This data collection is released as a Raw Data File with an open end-user license. All files are available to download on the DGGS website at https://doi.org/10.14509/31173.

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity Image
Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR laser scanner integrated with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU) designed by Phoenix LiDAR Systems. The sensor can collect a maximum of 820,000 points per second at a range of 215 m, or a minimum of 50,000 points per second at a range of 820 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 200,000–400,000 pulses per second and with a scan rate of 100–200 revolutions per second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 120–300 m above ground level, at a ground speed of approximately 40 m/s, and with a scan angle set from 80 to 280 degrees. The total survey area covers approximately 16.6 km^2.

Weather Conditions and Flight Times

The survey area was accessed by air (fig. 1) from the Girdwood Airport. Data collection occurred between 11:00 am and 12:50 pm (AST), and the weather throughout the survey was clear with slight east wind. This was a multi-target survey, where the lidar pointcloud was split into two areas of interest that were processed and published separately. Flightlines that contributed data to this publication are highlighted in figure 1.

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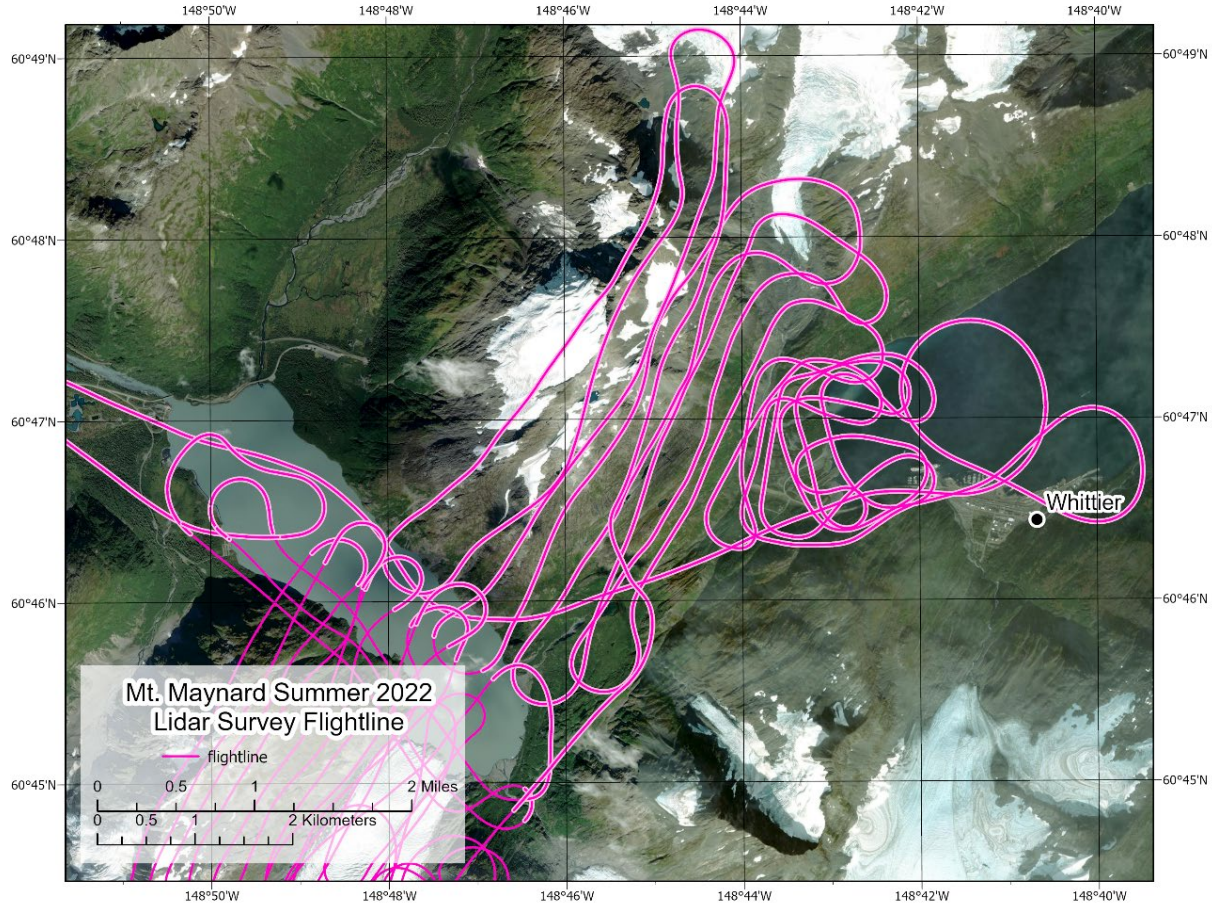

Figure 1. Lidar data collection flightlines. Only data from highlighted sections are used in this publication.

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in Spatial Explorer for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors, corrected in this process, result from ambiguous interpretations of received pulse time intervals and occur more frequently with higher pulse refresh rates. IMU and GNSS data were processed in Inertial Explorer, and flightline information was integrated with the point cloud in Spatial Explorer. We calibrated the point data at an incrementally precise scale of sensor movement and behavior, incorporating sensor velocity, roll, pitch, and yaw fluctuations throughout the survey. For the lidar data collection, the average pulse density is 12.06 pulses/m^2, and the average pulse spacing is 28.8 cm.

We created macros in Terrasolid software and classified points in accordance with the American Society for Photogrammetry & Remote Sensing (ASPRS) 2019 guidelines (ASPRS, 2019). Once classified, we applied a geometric transformation and converted the points from ellipsoidal heights to GEOID12B (Alaska) orthometric heights.

Raster products were derived from the point cloud in ArcGIS Pro. A 20-cm DSM was interpolated from ground, vegetation, bridge deck, and building classes using a triangulation method. A 20-cm DTM was interpolated from all ground class returns, also using a triangulation method. We also produced a 50-cm intensity image for the area using average binning, with no normalization or corrections applied.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified following ASPRS 2019 guidelines (table 1) and contain return and intensity information. For classified ground points (fig. 2), the average point density is 4.62 pts/m^2, and the average spacing is 46.5 cm.

Table 1. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, ≥0.0m, ≤0.5m
4	Medium Vegetation, >0.5m, ≤3m
5	High Vegetation, >3m, ≤60m
6	Building
7	Low Noise
17	Bridge Deck
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including vegetation heights, buildings, bridge decks, etc. The DSM is a single-band, 32-bit GeoTIFF file of 20-cm resolution. No Data value is set to -3.40282306074e+38 (32-bit, floating-point minimum).

Digital Terrain Model

The DTM represents bare earth elevations, excluding vegetation, bridge decks, buildings, etc. The DTM is a single-band, 32-bit GeoTIFF file of 20-cm resolution. No Data value is set to -3.40282306074e+38.

Lidar Intensity Image

The lidar intensity image describes the relative amplitude of reflected signals contributing to the point cloud. Lidar intensity is (1) primarily a function of scanned object reflectance in relation to the signal frequency, (2) dependent on ambient conditions, and (3) not necessarily consistent between separate scans. The intensity image is a single-band, 32-bit GeoTIFF file of 50-cm resolution. No Data value is set to -3.40282306074e+38.

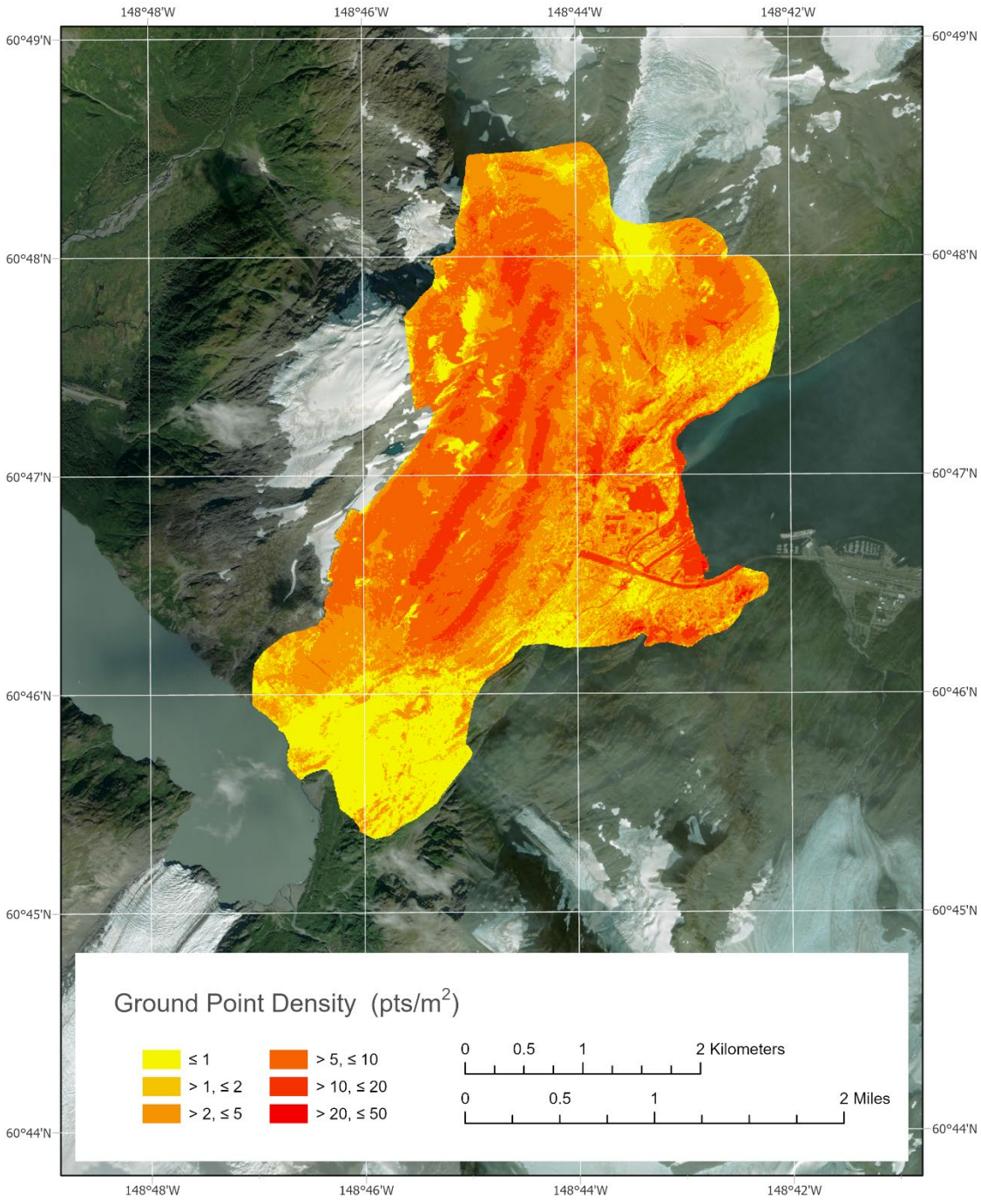

Figure 2. Ground point density for the survey, displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control points were collected on July 29, 2022. We deployed a Trimble R10 GNSS receiver to provide a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R10 GNSS receiver/Mesa3 controller. The Whittier

Airport served as the base station location. We collected 141 ground control points and checkpoints for calibration and to assess the vertical accuracy of the point cloud. Checkpoints were collected on bare earth (gravel or pavement).

Coordinate System and Datum

We processed and delivered all data in NAD83 (2011) UTM6N and vertical datum NAVD88 GEOID12B.

Horizontal Accuracy

Horizontal accuracy was not measured for this collection.

Vertical Accuracy

We measured a mean offset of +43.9 cm between 113 control points and the point cloud (app. 1). This offset was reduced to -0.3 cm (app. 2) by applying a constant vertical correction to the lidar point data. We used 28 checkpoints to determine the vertical accuracy of the point cloud ground class using a Triangulated Irregular Network (TIN) approach. The project vertical accuracy has a root mean square error (RMSE) of 4.4 cm (app. 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 7.6 cm RMSE.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey, except for holes in upper elevation areas where snow or glacier ice resulted in a lack of laser point returns.

ACKNOWLEDGMENTS

This survey area is within the traditional homelands of the Dena'ina and Chugach Sugpiaq peoples. This work was funded by the State of Alaska and the U.S. Geological Survey. We thank Clearwater Air for their aviation expertise and contribution to these data products. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2019, LAS Specification 1.4 - R15. https://www.asprs.org/wp-content/uploads/2019/07/LAS_1_4_r15.pdf

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
1	405704.538	6739219.031	19.306	19.758	0.452
2	405709.310	6739220.501	19.222	19.659	0.437
3	405714.121	6739202.650	19.414	19.812	0.398
4	405728.209	6739210.602	19.137	19.574	0.437
5	405731.184	6739194.114	19.352	19.770	0.418
6	405738.219	6739213.854	18.969	19.380	0.411
7	405741.242	6739223.464	18.805	19.246	0.441
8	405752.844	6739185.512	19.147	19.574	0.427
9	405760.972	6739209.891	18.719	19.133	0.414
10	405770.349	6739203.781	18.670	19.088	0.418
11	405773.868	6739177.383	19.023	19.447	0.424
12	405792.444	6739194.259	18.484	18.930	0.446
13	405796.265	6739168.759	18.809	19.224	0.415
14	405803.240	6739203.833	18.154	18.588	0.434
15	405813.974	6739199.719	18.108	18.522	0.414
16	405829.566	6739193.952	17.916	18.335	0.419
17	405830.019	6739156.213	18.516	18.928	0.412
18	405837.756	6739179.405	18.088	18.508	0.420
19	405846.657	6739176.020	17.991	18.404	0.413
20	405852.444	6739166.296	18.056	18.477	0.421
21	405861.679	6739160.802	18.003	18.407	0.404
22	405869.951	6739141.596	18.141	18.562	0.421
23	405885.460	6739135.873	17.994	18.412	0.418
24	405907.684	6739130.216	17.760	18.196	0.436
25	405916.791	6739128.175	17.662	18.100	0.438
26	405933.052	6739131.170	17.405	17.831	0.426
27	405947.688	6739130.776	17.185	17.620	0.435
28	405980.431	6739127.465	16.821	17.235	0.414
29	405990.376	6739108.375	16.509	16.909	0.400
30	405992.538	6739123.787	16.650	17.091	0.441
31	405999.010	6739116.867	16.638	17.057	0.419
32	406008.677	6739118.524	16.500	16.967	0.467
33	406020.533	6739115.765	16.392	16.822	0.430
34	406030.452	6739185.467	14.107	14.547	0.440
35	406032.386	6739200.089	13.705	14.144	0.439
36	406033.445	6739168.557	14.480	14.933	0.453
37	406033.640	6739157.110	14.945	15.392	0.447
38	406034.025	6739207.563	13.505	13.896	0.391
39	406035.754	6739145.061	15.395	15.887	0.492
40	406042.012	6739125.894	16.123	16.559	0.436

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
41	406042.821	6739242.425	12.905	13.234	0.329
42	406049.983	6739245.585	12.413	12.818	0.405
43	406062.819	6739263.125	11.943	12.336	0.393
44	406076.298	6739272.474	11.656	12.012	0.356
45	406077.147	6739167.436	11.779	12.220	0.441
46	406087.503	6739283.298	11.527	11.890	0.363
47	406095.371	6739153.616	11.452	11.902	0.450
48	406109.034	6739147.483	11.650	12.102	0.452
49	406111.311	6739301.707	11.192	11.581	0.389
50	406117.003	6739307.120	11.150	11.541	0.391
51	406121.509	6739137.592	11.552	11.999	0.447
52	406133.483	6739131.222	11.506	11.923	0.417
53	406135.254	6739321.164	10.927	11.332	0.405
54	406140.782	6739325.272	10.862	11.260	0.398
55	406143.216	6739125.961	11.392	11.829	0.437
56	406151.449	6739117.261	11.295	11.748	0.453
57	406154.522	6739333.933	10.607	10.998	0.391
58	406157.488	6739113.236	11.190	11.631	0.441
59	406161.826	6739106.933	11.170	11.630	0.460
60	406168.648	6739084.749	11.358	11.804	0.446
61	406169.111	6739073.323	11.461	11.874	0.413
62	406169.227	6739097.079	11.217	11.637	0.420
63	406169.599	6739089.547	11.243	11.687	0.444
64	406172.148	6739067.662	11.415	11.853	0.438
65	406175.543	6739349.986	10.508	10.893	0.385
66	406178.628	6739356.194	10.900	11.300	0.400
67	406182.076	6739060.986	11.512	11.964	0.452
68	406184.274	6739355.940	10.435	10.813	0.378
69	406190.425	6739064.718	11.399	11.811	0.412
70	406192.479	6739092.472	11.087	11.543	0.456
71	406193.078	6739076.995	11.080	11.563	0.483
72	406195.544	6739364.151	10.362	10.744	0.382
73	406196.005	6739085.060	10.961	11.371	0.410
74	406198.741	6739097.764	10.986	11.406	0.420
75	406211.100	6739374.455	10.302	10.688	0.386
76	406228.573	6739384.932	10.191	10.603	0.412
77	406238.345	6739390.016	10.138	10.552	0.414
78	406248.690	6739393.263	10.010	10.421	0.411
79	406277.401	6739404.404	10.174	10.649	0.475
80	406323.067	6739368.415	7.844	8.285	0.441
81	406324.512	6739384.461	7.563	8.016	0.453
82	406329.714	6739434.891	7.108	7.549	0.441

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
83	406332.077	6739365.723	7.626	8.056	0.430
84	406338.045	6739427.083	6.954	7.376	0.422
85	406343.147	6739442.295	6.735	7.186	0.451
86	406346.192	6739413.775	6.976	7.452	0.476
87	406352.579	6739387.771	7.601	8.051	0.450
88	406368.417	6739415.867	6.891	7.393	0.502
89	406375.543	6739461.317	5.596	6.069	0.473
90	406387.758	6739398.306	6.952	7.386	0.434
91	406389.023	6739474.440	5.119	5.609	0.490
92	406403.672	6739482.974	4.861	5.351	0.490
93	406413.777	6739427.844	6.719	7.207	0.488
94	406429.174	6739503.977	4.572	5.083	0.511
95	406433.849	6739487.953	4.616	5.053	0.437
96	406440.772	6739491.310	4.571	5.046	0.475
97	406441.103	6739517.475	4.454	4.969	0.515
98	406450.397	6739516.964	4.471	4.959	0.488
99	406451.613	6739495.697	4.520	4.980	0.460
100	406459.898	6739507.286	4.441	4.888	0.447
101	406462.848	6739543.174	4.359	4.845	0.486
102	406467.337	6739281.229	5.604	6.081	0.477
103	406484.085	6739288.691	5.482	6.035	0.553
104	406501.672	6739297.661	5.527	6.072	0.545
105	406504.462	6739284.414	5.574	6.027	0.453
106	406505.667	6739309.907	5.377	5.858	0.481
107	406506.264	6739305.268	5.402	5.878	0.476
108	406518.721	6739292.121	5.490	5.951	0.461
109	406524.718	6739296.091	5.454	5.959	0.505
110	406537.765	6739325.520	5.403	5.914	0.511
111	406553.968	6739330.721	5.481	5.993	0.512
112	406559.609	6739333.582	5.510	5.981	0.471
113	406570.073	6739339.868	5.500	6.004	0.504
Average elevation difference (m)	0.439				
Minimum dz (m)	0.329				
Maximum dz (m)	0.553				
Average magnitude error (m)	0.439				
Root mean square error (m)	0.440				

GCP	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
Standard deviation (m)	0.038				

APPENDIX 2: CHECK POINTS

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z -– Checkpoint Z) (m)
1	405690.649	6739226.029	19.371	19.385	0.014
2	405718.497	6739213.793	19.194	19.181	-0.013
3	405752.233	6739220.845	18.675	18.654	-0.021
4	405781.000	6739198.156	18.579	18.567	-0.012
5	405816.349	6739161.285	18.648	18.636	-0.012
6	405848.212	6739149.394	18.366	18.346	-0.020
7	405894.803	6739133.141	17.900	17.867	-0.033
8	405959.265	6739130.507	17.032	17.032	0.000
9	406002.703	6739121.933	16.524	16.512	-0.012
10	406033.078	6739177.545	14.246	14.228	-0.018
11	406035.937	6739131.917	15.896	15.924	0.028
12	406070.883	6739267.692	11.745	11.665	-0.080
13	406096.644	6739290.305	11.382	11.288	-0.094
14	406129.960	6739316.834	10.999	10.959	-0.040
15	406147.645	6739325.900	10.665	10.622	-0.043
16	406164.932	6739341.914	10.550	10.476	-0.074
17	406171.910	6739078.211	11.375	11.360	-0.015
18	406193.114	6739071.932	11.199	11.194	-0.005
19	406211.989	6739105.879	10.666	10.645	-0.021
20	406282.167	6739411.699	10.133	10.145	0.012
21	406334.306	6739436.764	6.972	6.948	-0.024
22	406355.446	6739413.477	6.971	7.014	0.043
23	406395.933	6739434.967	6.483	6.551	0.068
24	406435.089	6739508.674	4.552	4.610	0.058
25	406455.875	6739530.090	4.394	4.484	0.090
26	406489.951	6739273.787	5.519	5.549	0.030
27	406510.129	6739286.911	5.514	5.575	0.061
28	406550.687	6739333.527	5.489	5.534	0.045
Average elevation difference (m)	-0.003				
Minimum dz (m)	-0.094				
Maximum dz (m)	0.090				
Average magnitude error (m)	0.035				
Root mean square error (m)	0.044				

Check Point	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z -– Checkpoint Z) (m)
Standard deviation (m)	0.045				