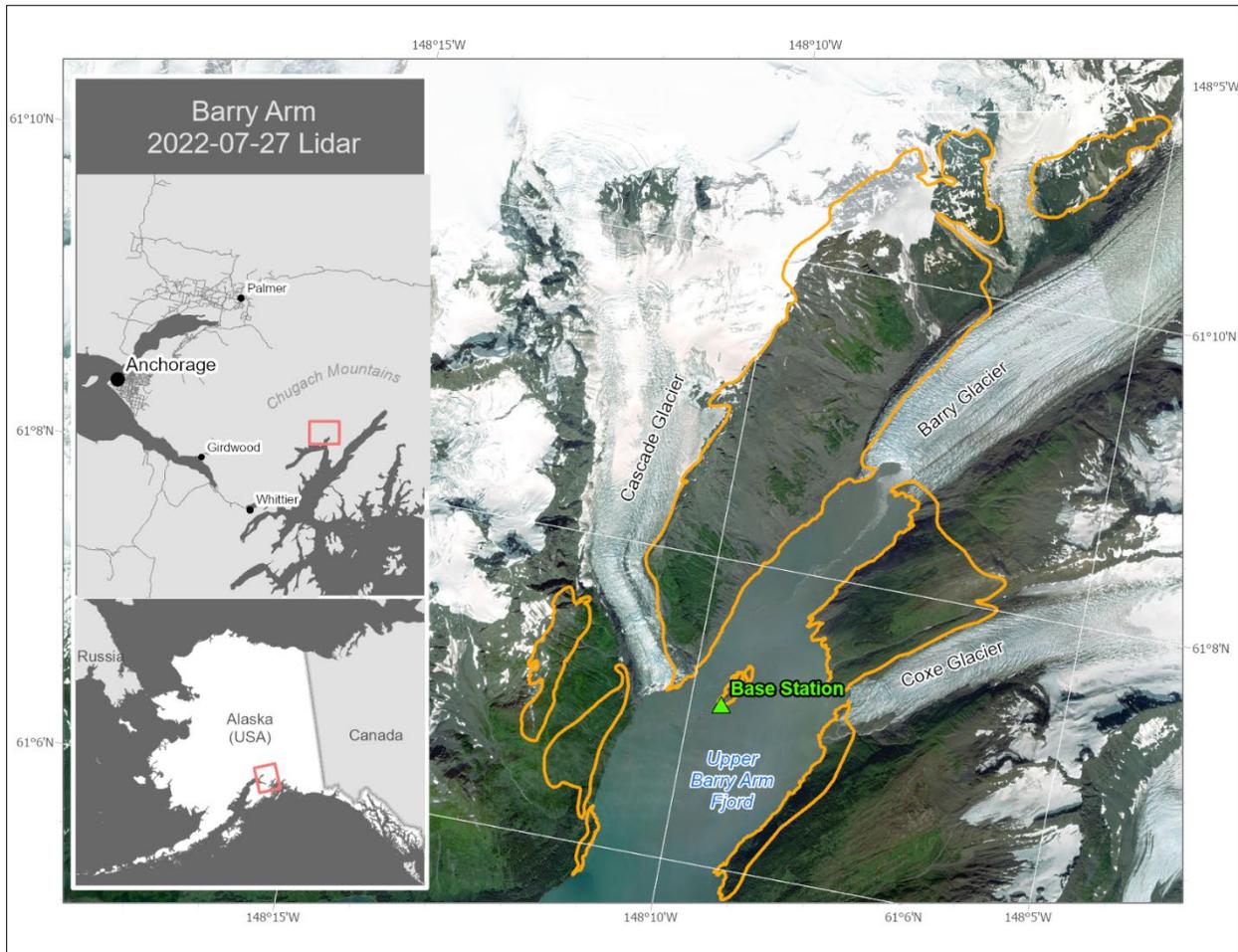


LIDAR-DERIVED ELEVATION DATA FOR UPPER BARRY ARM FJORD, SOUTHCENTRAL ALASKA, COLLECTED JULY 27, 2022

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

Raw Data File 2026-9



Location map of the survey area with an orthometric image.

Publications in the DGGs RDF series provide elevation data, field observations, or analytical results. The data have been reviewed for clarity and consistency but have not undergone technical peer review.

2026
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LIDAR-DERIVED ELEVATION DATA FOR UPPER BARRY ARM FJORD, SOUTHCENTRAL ALASKA, COLLECTED JULY 27, 2022

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INTRODUCTION

The Alaska Division of Geological & Geophysical Surveys (DGGS) used aerial lidar to produce a classified point cloud, digital terrain model (DTM), surface model (DSM), and intensity model for Upper Barry Arm fjord with focus on the Barry Arm landslide, northeast of Whittier in Prince William Sound, southcentral Alaska, during near snow-free ground conditions. The goal of the survey is to provide snow-free surface elevation data to assess landslide movement using repeat surveys during snow-free conditions. Airborne data and ground control were collected on July 27, 2022, and subsequently processed in Terrasolid and ArcGIS. These data are provided as a Raw Data File under an open end-user license and are available on the DGGS website (<http://doi.org/10.14509/32062>).

LIST OF DELIVERABLES

- Classified Points
- DSM, DTM, and hydro-enforced DTM
- Intensity Image
- Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR laser scanner with a global navigation satellite system (GNSS) and a Northrop Grumman LN-200C inertial measurement unit (IMU) integrated 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 820 m (ranges assume ≥ 20 percent natural reflectance). This survey was conducted with a pulse refresh rate of 200,000 to 600,000 pulses per second and a scan rate of 60 to 200 lines per second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 100–300 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 was approximately 26 km²; however, all derived raster products and statistical analyses exclude glaciers and water bodies, which lie *outside* the orange-outlined areas of interest shown in the cover figure.

Weather Conditions and Flight Times

The survey area was accessed by air from Merrill Field Airport in Anchorage. The flight started at 11:29 am AKDT and ended at 1:50 pm AKDT (fig. 1). The weather throughout the survey was fair and cloudless.

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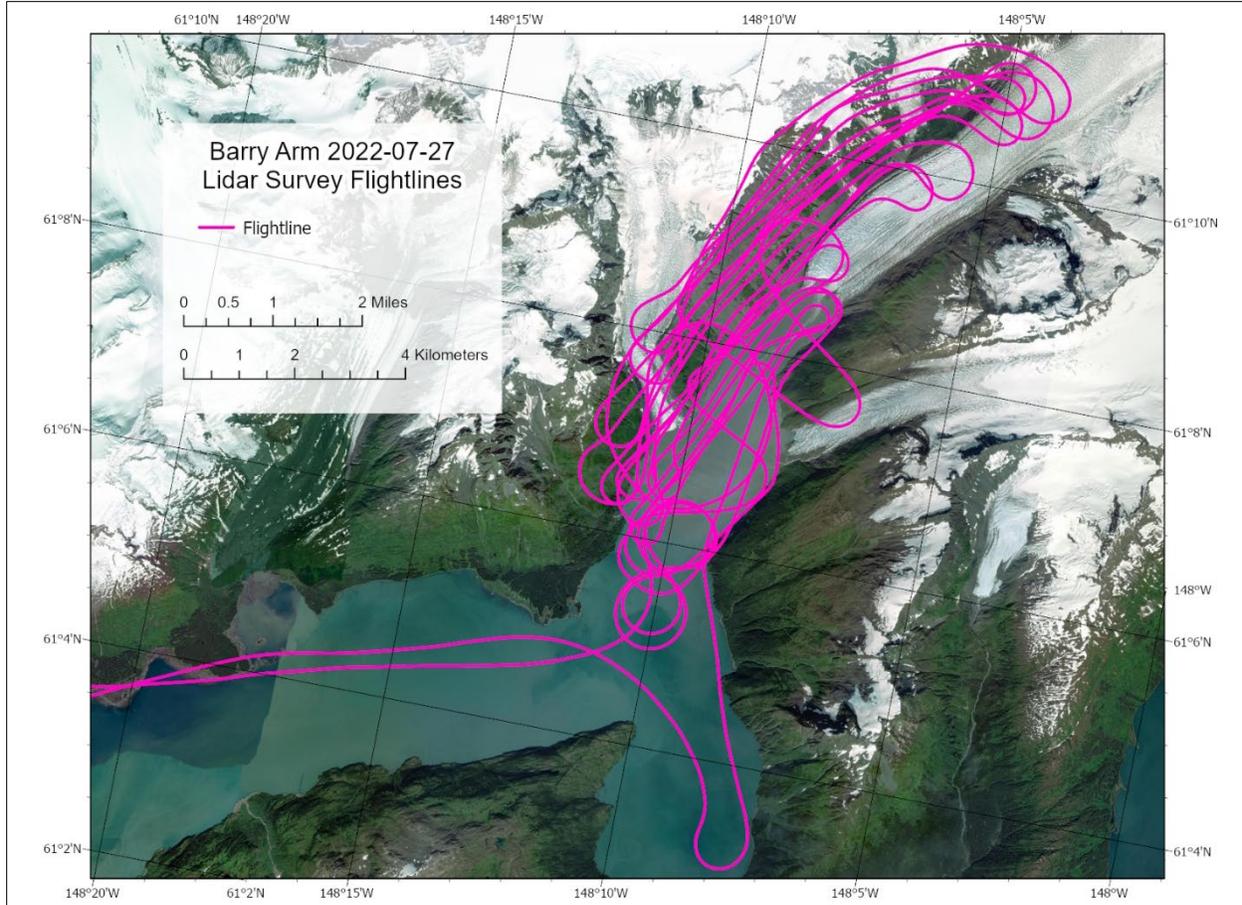


Figure 1. Lidar data collection flightlines.

PROCESSING REPORT

Lidar Dataset Processing

We processed point data in SDCimport for initial filtering and multiple-time-around (MTA) disambiguation. MTA errors corrected in this process stem from ambiguous interpretations of received pulse time intervals and occur more frequently at 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 pulse density is 26.2 pulses/m², and the average pulse spacing is 19.6 cm.

We created a macro (an ordered list of point classification commands tailored to this dataset) in Terrasolid software and classified points in accordance with the American Society for Photogrammetry & Remote Sensing (ASPRS) 2025 guidelines (ASPRS, 2025). 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 50-cm DSM was interpolated from maximum elevation values in ground and vegetation classes using a

triangulation method. A 50-cm DTM was interpolated from all ground-class returns using a triangulation method and minimum elevation values. We also produced a 1-m intensity image for the area using average binning in ArcGIS Pro, with no normalization or corrections applied. Water bodies and glacier surfaces were erased from the derived raster products.

Classified Point Cloud

Classified point cloud data are provided in LAZ format. Data are classified according to the ASPRS 2025 guidelines (table 1) and include return and intensity information. For classified ground points, the average point density is 11 pts/m², and the average spacing is 30.2 cm (fig. 2).

Table 1. Point cloud class code definitions.

Class Code	Description
1	Unclassified
2	Ground
3	Low Vegetation, $\geq 0.0\text{m}$, $< 0.5\text{m}$
4	Medium Vegetation, $\geq 0.5\text{m}$, $< 3\text{m}$
5	High Vegetation, $\geq 3\text{m}$
7	Low Noise
18	High Noise
30	Manually classified

Digital Surface Model

The DSM represents surface elevations, including the heights of vegetation, buildings, power lines, pipes, and bridge decks. The overall DSM is a single-band, 32-bit GeoTIFF file at 50 cm resolution. No Data value is set to $-3.40282306074\text{e}+38$ (32-bit, floating-point minimum).

Digital Terrain Model

The DTM represents bare-earth elevations, excluding vegetation, bridge decks, buildings, and similar features. The overall DTM is a single-band, 32-bit GeoTIFF file at 50 cm resolution. No Data value is set to $-3.40282306074\text{e}+38$.

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 1-m resolution. No Data value is set to $-3.40282306074\text{e}+38$.

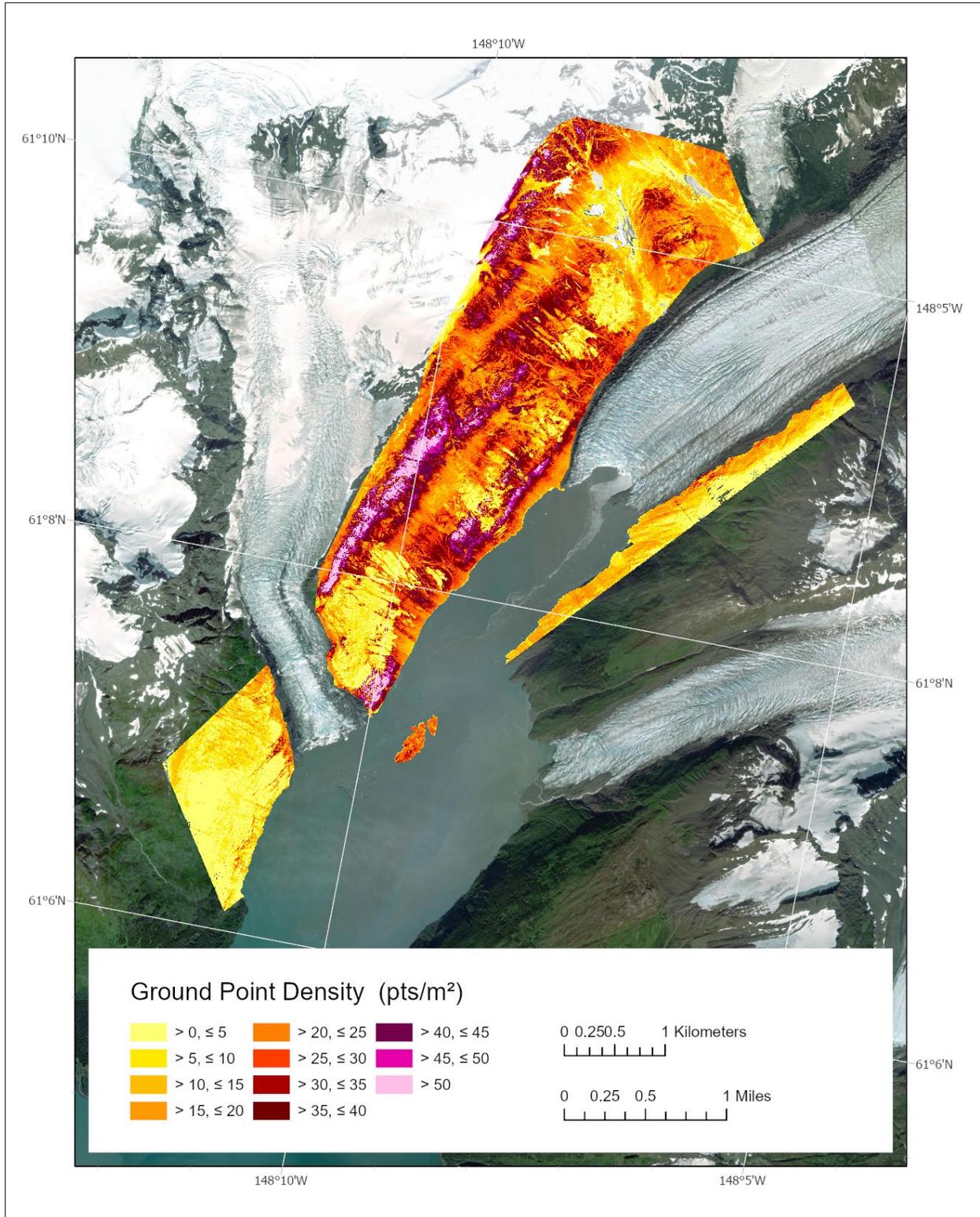


Figure 2. Ground point density for the survey displayed as a raster.

SURVEY REPORT

Ground Survey Details

Ground control and checkpoints were collected on July 27, 2022. A Trimble R10-2 GNSS receiver with an internal antenna was deployed on the southern tip of the island below the landslide. It provided a base station occupation and real-time kinematic (RTK) corrections to points surveyed with a rover Trimble R10-2 GNSS receiver (internal antenna). We collected 73 ground control and check points across the survey area to use for calibration and to assess the vertical accuracy of point clouds generated from multiple repeat Barry Arm surveys; 71 of these were used for this lidar acquisition, and the remainder were excluded due to insufficient point cloud overlap. Checkpoints were collected on bare earth or minimally vegetated surface.

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; it is considered inherent in the airborne GPS/IMU solution.

Vertical Accuracy

We measured a vertical mean offset of -7.6 cm between 56 control points and the point cloud (app. 1). This offset was reduced to +1.3 cm by applying a constant vertical correction to the lidar point data. We used 15 checkpoints to determine the non-vegetated vertical accuracy (NVA) of the point cloud ground class, using a triangulation-based approach. Project NVA was calculated to have a root mean square error (RMSE) of 9.4 cm (app. 2). Relative accuracy was evaluated based on interswath overlap consistency, yielding an RMSE of 2.9 cm.

Data Consistency and Completeness

This is a full-release dataset. There was no over-collect. Data quality is consistent throughout the survey, save for gaps over bodies of water, glaciers, and snow-covered surfaces.

ACKNOWLEDGMENTS

These data products were funded by the U.S. Geological Survey Cooperative Agreement Grant #G21AC10362 and collected and processed by DGGS. We thank Clearwater Air for their aviation expertise and contribution to these data products.

REFERENCES

The American Society for Photogrammetry & Remote Sensing (ASPRS), 2025, LAS Specification 1.4 - R16. <https://publicdocuments.asprs.org/las-v14-r16-2025>

APPENDIX 1: GROUND CONTROL POINTS

GCP	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	437488.493	6776454.695	8.111	8.14	0.029
2	437487.745	6776455.47	8.061	8.08	0.019
3	437492.552	6776458.051	9.615	9.63	0.015
4	437501.304	6776462.046	9.864	9.88	0.016
5	437502.207	6776459.714	9.394	9.43	0.036
6	437509.001	6776468.295	10.88	10.9	0.02
7	437504.688	6776476.88	8.942	8.96	0.018
8	437508.148	6776482.664	10.694	10.71	0.016
9	437508.785	6776483.122	10.679	10.69	0.011
10	437511.669	6776482.462	10.549	10.58	0.031
11	437514.356	6776505.024	12.711	12.73	0.019
12	437508.704	6776500.934	11.63	11.66	0.03
13	437509.065	6776502.382	11.795	11.8	0.005
14	437504.077	6776509.524	13.486	13.49	0.004
15	437503.374	6776513.125	13.389	13.4	0.011
16	437502.934	6776520.358	12.676	12.68	0.004
17	437495.714	6776508.843	15.289	15.3	0.011
18	437493.835	6776507.75	15.172	15.19	0.018
19	437494.038	6776505.654	15.069	15.09	0.021
20	437492.722	6776506.163	15.118	15.14	0.022
21	437492.149	6776506.37	15.119	15.13	0.011
22	437492.92	6776505.685	15.086	15.11	0.024
23	437489.165	6776502.981	14.638	14.65	0.012
24	437480.281	6776497.017	12.852	12.86	0.008
25	437045.68	6780387.658	1289.885	1289.56	-0.325
26	437032.549	6780370.256	1285.571	1285.5	-0.071
27	437029.21	6780362.888	1284.509	1284.45	-0.059
28	436881.293	6779651.902	1082.028	1081.94	-0.088
29	436881.574	6779613.272	1077.565	1077.46	-0.105
30	436878.023	6779559.375	1083.938	1083.86	-0.078
31	436878.672	6779555.834	1084.665	1084.61	-0.055
32	436877.302	6779552.042	1084.511	1084.45	-0.061
33	436876.834	6779550.482	1084.467	1084.38	-0.087
34	436884.149	6779519.775	1082.734	1082.65	-0.084
35	436876.001	6779506.761	1081.73	1081.47	-0.26
36	436876.348	6779506.377	1081.644	1081.36	-0.284
37	436864.716	6779493.197	1077.129	1076.8	-0.329
38	436919.494	6779608.21	1070.778	1070.69	-0.088
39	436925.503	6779599.375	1071.038	1070.93	-0.108
40	436939.101	6779586.8	1070.056	1069.96	-0.096

41	438464.148	6777743.439	10.243	10.13	-0.113
42	438463.458	6777738.12	9.69	9.63	-0.06
43	438454.754	6777734.505	8.231	8.19	-0.041
44	438438.33	6777720.901	8.98	8.85	-0.13
45	438436.914	6777719.49	8.951	8.77	-0.181
46	438429.634	6777698.593	5.698	5.5	-0.198
47	438429.075	6777697.524	5.713	5.5	-0.213
48	438413.618	6777690.325	5.147	4.96	-0.187
49	438412.196	6777685.616	3.989	3.89	-0.099
50	438399.845	6777676.952	4.128	3.97	-0.158
51	438402.825	6777676.655	4.121	3.82	-0.301
52	438395.896	6777686.643	6.075	5.88	-0.195
53	438392.303	6777688.523	5.636	5.43	-0.206
54	438386.864	6777676.49	6.756	6.64	-0.116
55	438382.106	6777671.618	5.58	5.3	-0.28
56	437519.303	6776477.394	9.792	9.8	0.008
Average dz (m)	-0.076				
Minimum dz (m)	-0.329				
Maximum dz (m)	0.036				
Average magnitude error (m)	0.091				
Root mean square error (m)	0.13				
Standard deviation (m)	0.106				

APPENDIX 2: CHECKPOINTS

Check Point	Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
1	437507.941	6776467.645	10.728	10.82	0.092
2	437497.484	6776462.593	10.304	10.39	0.086
3	437506.021	6776481.212	10.576	10.67	0.094
4	437514.216	6776504.175	12.732	12.8	0.068
5	437502.909	6776514.968	13.338	13.43	0.092
6	437493.421	6776505.873	15.097	15.2	0.103
7	437481.136	6776499.878	12.826	12.91	0.084
8	437043.432	6780375.611	1286.067	1286.08	0.013
9	436884.733	6779603.496	1078.149	1077.95	-0.199
10	436881.55	6779534.396	1082.655	1082.68	0.025
11	436913.967	6779612.912	1072.23	1072.26	0.03
12	438465.227	6777739.331	10.175	10.17	-0.005
13	438428.334	6777706.542	7.549	7.47	-0.079
14	438408.443	6777683.249	4.091	3.92	-0.171
15	438391.045	6777680.337	6.496	6.46	-0.036
Average dz (m)	0.013				
Minimum dz (m)	-0.199				
Maximum dz (m)	0.103				
Average magnitude error (m)	0.078				
Root mean square error (m)	0.094				
Standard deviation (m)	0.097				