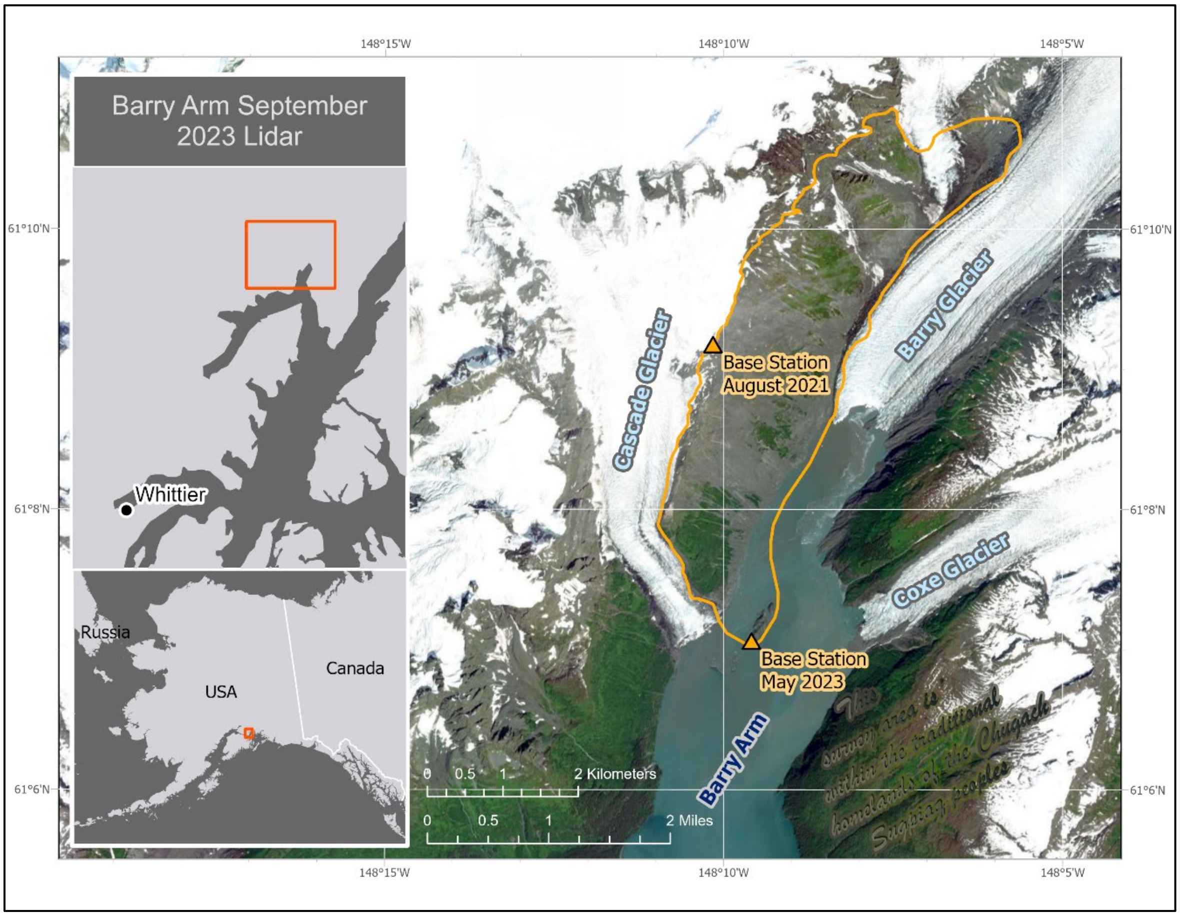
LIDAR-DERIVED ELEVATION DATA FOR BARRY ARM, SOUTHCENTRAL ALASKA, COLLECTED SEPTEMBER 19, 2023

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

Raw Data File 2025-8



Location map of survey area.

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

2025
STATE OF ALASKA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

STATE OF ALASKA
Mike Dunleavy, Governor

DEPARTMENT OF NATURAL RESOURCES
John Boyle, Commissioner

DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS
Jennifer Athey, Acting State Geologist & Director

Publications produced by the Division of Geological & Geophysical Surveys are available to download from the DGGS website (dggs.alaska.gov). Publications on hard-copy or digital media can be examined or purchased in the Fairbanks office:

Alaska Division of Geological & Geophysical Surveys (DGGS)
3354 College Road | Fairbanks, Alaska 99709-3707
Phone: 907.451.5010 | Fax 907.451.5050
dggspubs@alaska.gov | dggs.alaska.gov

DGGS publications are also available at:

Alaska State Library, Historical
Collections & Talking Book Center
395 Whittier Street
Juneau, Alaska 99801

Alaska Resource Library and
Information Services (ARLIS)
3150 C Street, Suite 100
Anchorage, Alaska 99503

Suggested citation:
Zechmann, J.M., Wolken, G.J., and Wikstrom Jones, K.M., 2025, Lidar-derived elevation data for Barry Arm, Southcentral Alaska, collected September 19, 2023: Alaska Division of Geological & Geophysical Surveys Raw Data File 2025-8, 9 p. https://doi.org/10.14509/31520

LIDAR-DERIVED ELEVATION DATA FOR BARRY ARM, SOUTHCENTRAL ALASKA, COLLECTED SEPTEMBER 19, 2023

Jenna M. Zechmann[1], Gabriel J. Wolken[1], and Katreen M. Wikstrom Jones[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 Barry Arm, Southcentral Alaska, during leaf-on conditions (cover figure). The survey provides snow-free surface elevations for use in landslide change detection. Aerial lidar data were collected September 19, 2023, and ground control data were collected August 2, 2021, and May 5, 2023, 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/10.14509/31520.

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity Image
Metadata

MISSION PLAN

Aerial Lidar Survey Details

DGGS used a Riegl VUX1-LR[22] laser scanner with a global navigation satellite system (GNSS) and Northrop Grumman LN-200C inertial measurement unit (IMU) integrated by Phoenix LiDAR Systems. The sensor can collect a maximum of 1,500,000 points/second at a range of 230 m, or a minimum of 50,000 points/second at 1000 m (ranges assume ≥ 20 percent natural reflectance). The scanner operated with a pulse refresh rate of 400,000 pulses/second at a scan rate of 130 revolutions/second. We used a Cessna 180 Skywagon fixed-wing platform to survey from an elevation of approximately 180–400 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 12.2 km^2 (cover figure).

Weather Conditions and Flight Times

The survey area was accessed by air (fig. 1) during a flight from Cordova Municipal Airport to Merrill Field Airport in Anchorage. Data were collected from 5:30 pm to 6:10 pm (AKST). The weather was partly cloudy with no wind. For a base station occupation to later correct survey flightlines, we relied on data from a continuously operating GNSS station maintained by the Alaska Earthquake Center (AEC) and located on the ridgetop west of Barry Arm (fig. 1).

[1] Alaska Division of Geological & Geophysical Surveys, 3354 College Road, Fairbanks, AK 99709

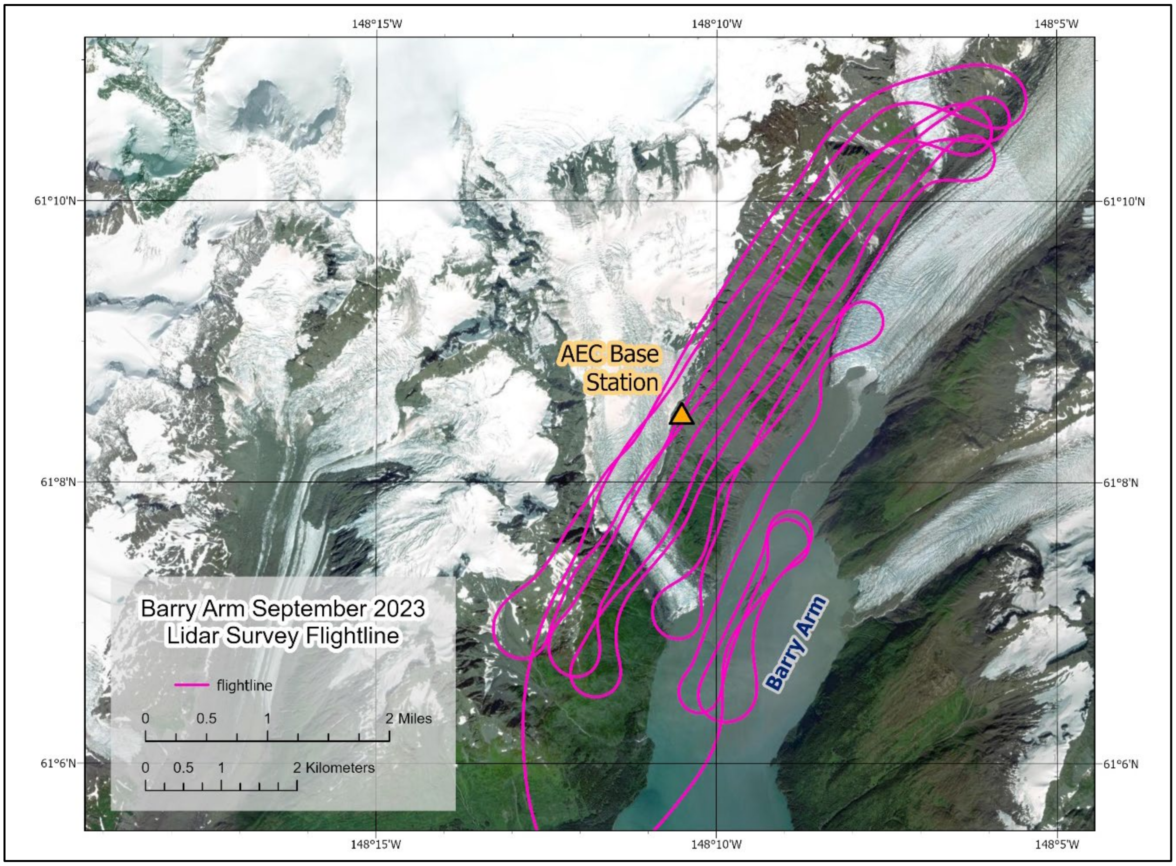


Figure 1. Lidar data collection flightline.

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 9.4 pulses/m^2, and the average pulse spacing is 32.7 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) 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 maximum ground and vegetation classes using a triangulation method. A 20-cm

DTM was interpolated from all ground-class returns using a triangulation method and minimum values. We also produced a 50-cm intensity image using average binning in ArcGIS Pro, 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, the average point density (fig. 2) is 4.8 pts/m^2, and the average spacing is 45.5 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, ≤40m
7	Low Noise
18	High Noise
30	Noise (manually classified)

Digital Surface Model

The DSM represents surface elevations, including heights of vegetation. 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. 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.

SURVEY REPORT

Ground Survey Details

Ground control points were collected August 2, 2021, and May 5, 2023. For the 2021 collection, we deployed a Trimble R10-2 GNSS base receiver to provide a base station occupation and real-time kinematic (RTK) corrections to points we surveyed with a rover Trimble R10-2 GNSS receiver/Mesa controller. The ridgetop between Cascade Glacier and Barry Arm served as the base station location (cover figure). We collected 105 ground control points and checkpoints across the survey area to use for calibration and to assess the vertical accuracy of point clouds generated from multiple repeat Barry Arm surveys; 56 of these points were used for this lidar acquisition, and the remainder were excluded due to insufficient pointcloud overlap.

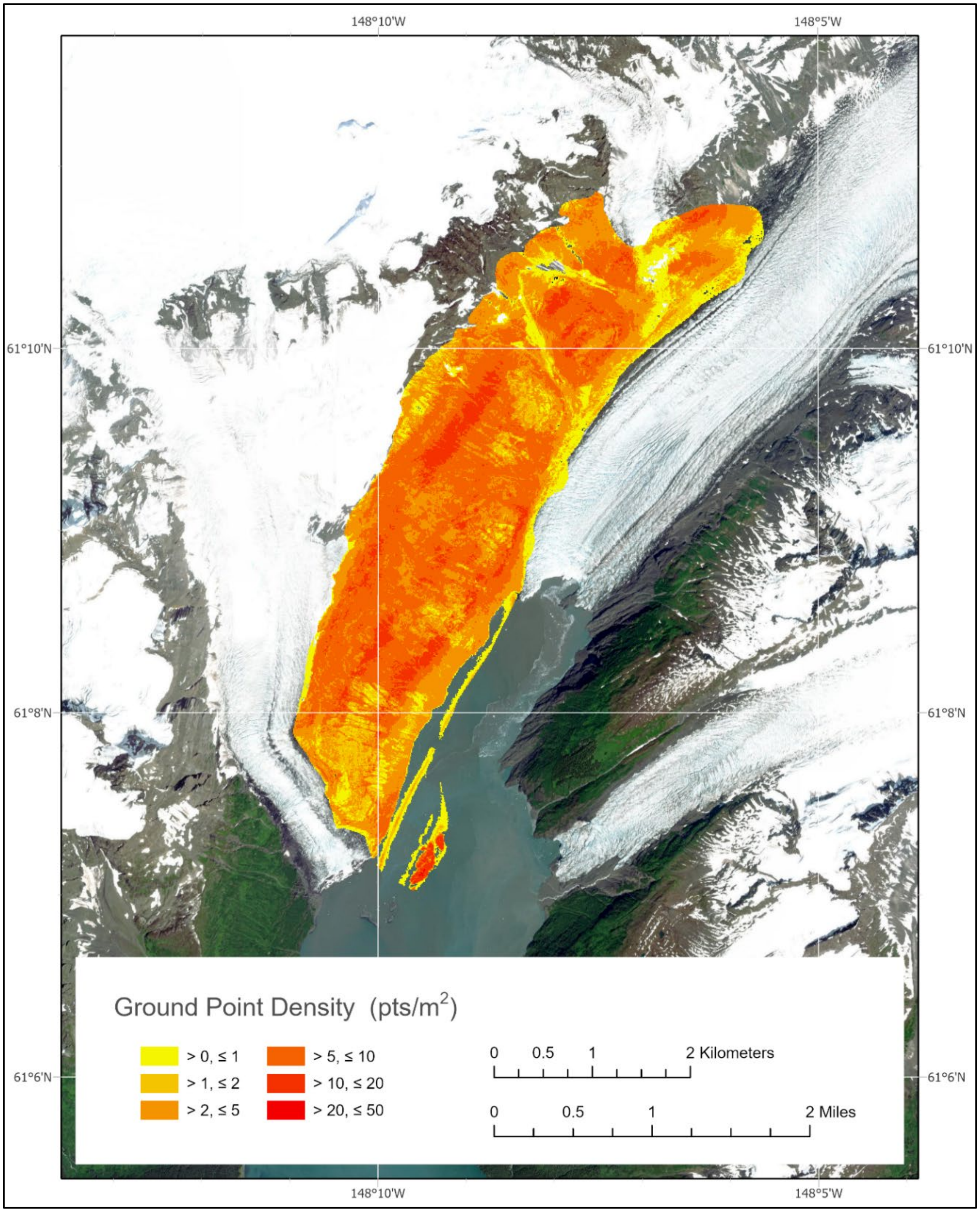


Figure 2. Ground point density for the survey displayed as a raster.

For the 2023 collection, we deployed a Trimble R10-2 GNSS base receiver and surveyed points with a rover Trimble R10-2 GNSS receiver/Mesa controller. A bedrock island in Barry Arm served as the base station location (cover figure). We collected 130 ground control points and checkpoints across the survey area, 13 of which were used for this lidar acquisition, while the remainder were excluded due to insufficient point cloud overlap or the presence of snow at the time of the ground survey.

The checkpoints and ground control points used for this lidar survey were collected on bare earth.

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 elevation offset of +46.7 cm between 35 control points and the point cloud (app. 1). This offset was reduced to -1.9 cm (app. 2) by applying a constant vertical correction to the lidar point data. We used 34 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 9.9 cm (app. 2). We evaluated the relative accuracy for this dataset as the interswath overlap consistency and measured it at 7.0 cm RMSE.

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 areas of snow and ice.

ACKNOWLEDGMENTS

This work was funded by the U.S. Geological Survey grant # G21AC10362-00. We thank Clearwater Air for their expertise and contribution to these data products and Melanie Werdon for her review. 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 Point Name	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
gcp-4	437058.827	6780400.879	1295.400	1295.904	0.504
gcp-5	437054.594	6780397.253	1294.016	1294.596	0.580
gcp-29	437088.870	6780440.945	1292.380	1293.018	0.638
gcp-37	436975.099	6779635.912	1075.672	1076.071	0.399
gcp-42	436949.320	6779622.057	1072.704	1073.177	0.473
gcp-45	436937.724	6779607.323	1071.544	1072.039	0.495
gcp-47	436918.522	6779599.607	1069.176	1069.639	0.463
gcp-50	436906.431	6779573.191	1072.142	1072.604	0.462
gcp-52	436918.523	6779572.037	1069.914	1070.415	0.501
gcp-53	436924.172	6779571.326	1068.907	1069.374	0.467
gcp-55	436932.645	6779587.755	1070.549	1070.993	0.444
gcp-57	436957.455	6779599.315	1067.907	1068.200	0.293
gcp-58	436965.996	6779602.904	1068.447	1068.897	0.450
gcp-61	436956.732	6779616.716	1072.569	1073.038	0.469
gcp-63	436953.125	6779647.614	1079.447	1079.872	0.425
gcp-66	436971.662	6779659.677	1085.193	1085.654	0.461
gcp-67	436975.012	6779661.649	1085.281	1085.728	0.447
gcp-68	436985.368	6779663.919	1084.218	1084.670	0.452
gcp-71	436982.483	6779686.568	1083.866	1084.346	0.480
gcp-94	436592.398	6778649.584	962.478	962.919	0.441
gcp-96	436588.366	6778640.594	959.776	960.250	0.474
gcp-97	436588.917	6778636.982	958.671	959.118	0.447
gcp-98	436591.200	6778626.033	954.376	954.785	0.409
gcp-100	436608.470	6778614.810	951.441	951.846	0.405
gcp-101	436610.775	6778598.689	951.043	951.463	0.420
gcp-104	436610.352	6778688.805	971.184	971.597	0.413
gcp-105	436613.441	6778691.722	971.276	971.655	0.379
gcp106	437523.774	6776481.505	8.780	9.077	0.297
gcp107	437530.348	6776484.939	8.044	8.858	0.814
gcp108	437540.171	6776487.054	11.251	11.844	0.593
gcp109	437546.819	6776489.962	12.571	12.957	0.386
gcp114	437581.525	6776514.456	17.651	18.429	0.778
gcp116	437586.385	6776523.799	18.782	19.316	0.534
gcp118	437604.031	6776541.898	24.663	24.800	0.137
gcp122	437601.763	6776568.119	31.671	32.185	0.514

GCP Point Name	Easting (m)	Northing (m)	GCP Z (m)	Pointcloud Z (m)	Elevation Difference (Pointcloud Z – GCP Z) (m)
Average elevation difference (dZ) (m)	0.467				
Minimum dZ (m)	0.137				
Maximum dZ (m)	0.814				
Average magnitude error (m)	0.467				
Root mean square error (m)	0.482				
Standard deviation (m)	0.120				

APPENDIX 2: CHECK POINTS

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z – Checkpoint Z) (m)
gcp-12	437022.557	6780377.885	1288.017	1288.206	0.189
gcp-23	436990.202	6780326.567	1273.356	1273.270	-0.086
gcp-27	437082.153	6780424.195	1294.989	1295.029	0.040
gcp-36	436964.760	6779629.317	1077.254	1077.194	-0.060
gcp-38	436963.103	6779634.428	1076.268	1076.232	-0.036
gcp-39	436960.595	6779637.334	1076.617	1076.653	0.036
gcp-40	436948.525	6779626.284	1074.222	1074.216	-0.006
gcp-43	436946.623	6779621.922	1072.890	1072.883	-0.007
gcp-46	436928.422	6779600.630	1070.792	1070.822	0.030
gcp-48	436917.625	6779595.206	1068.922	1068.937	0.015
gcp-49	436905.318	6779581.203	1070.197	1070.223	0.026
gcp-51	436901.680	6779565.845	1072.082	1072.117	0.035
gcp-54	436937.288	6779587.286	1069.924	1069.957	0.033
gcp-56	436950.137	6779594.366	1067.711	1067.651	-0.060
gcp-60	436950.348	6779608.775	1071.814	1071.672	-0.142
gcp-62	436962.613	6779617.696	1073.150	1073.159	0.009
gcp-64	436962.433	6779659.836	1082.926	1082.922	-0.004
gcp-65	436967.307	6779657.003	1084.498	1084.537	0.039
gcp-69	436986.677	6779668.900	1084.118	1084.102	-0.016
gcp-70	436984.730	6779683.694	1084.641	1084.639	-0.002
gcp-72	436975.510	6779678.285	1084.678	1084.690	0.012
gcp-73	436971.259	6779668.536	1084.270	1084.281	0.011
gcp-74	436973.685	6779731.717	1082.878	1082.943	0.065
gcp-75	436962.718	6779722.840	1082.648	1082.695	0.047
gcp-92	436605.882	6778670.821	969.553	969.503	-0.050
gcp-93	436605.888	6778670.814	969.551	969.504	-0.047
gcp-99	436612.238	6778626.464	952.355	952.430	0.075
gcp-102	436614.546	6778617.461	951.865	951.811	-0.054
gcp-103	436606.210	6778687.874	971.054	970.970	-0.084
gcp112	437565.545	6776507.951	18.312	18.479	0.167
gcp113	437570.736	6776502.505	16.658	16.394	-0.264
gcp119	437605.125	6776534.466	23.161	23.073	-0.088
gcp121	437592.498	6776564.054	30.789	30.601	-0.188
gcp126	437599.926	6776599.488	35.046	34.751	-0.295
Average elevation	-0.019				

Check Point Name	Easting (m)	Northing (m)	Checkpoint Z (m)	Corrected Pointcloud Z (m)	Elevation Difference (Corrected Pointcloud Z – Checkpoint Z) (m)
difference (dZ) (m)					
Minimum dZ (m)	-0.295				
Maximum dZ (m)	0.189				
Average magnitude error (m)	0.068				
Root mean square error (m)	0.099				
Standard deviation (m)	0.099				