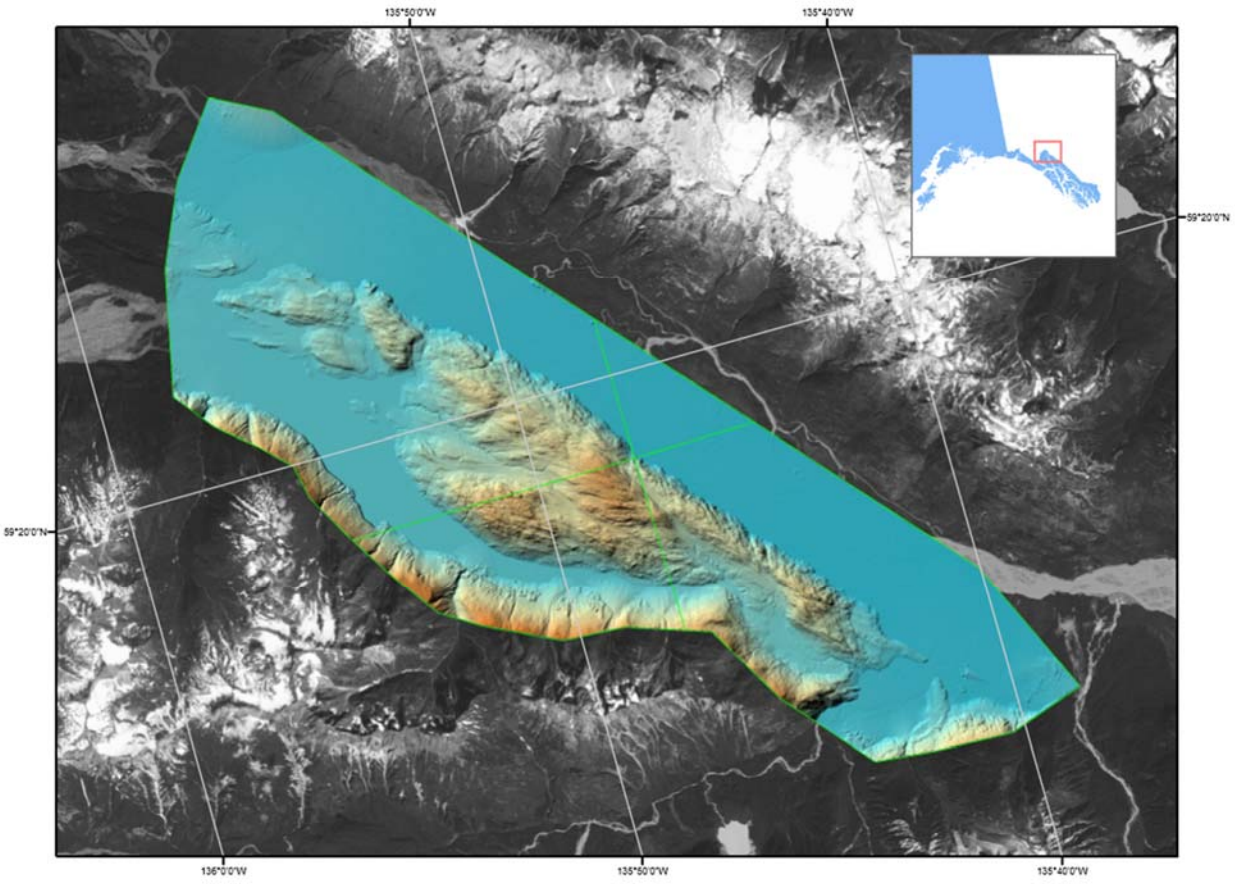
HIGH-RESOLUTION LIDAR DATA FOR THE CHILKAT RIDGE AREA, ALASKA

Ronald P. Daanen and Katreen Wikstrom Jones

Raw Data File 2019-7



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DIVISION OF GEOLOGICAL & GEOPHYSICAL SURVEYS

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HIGH-RESOLUTION LIDAR DATA FOR THE CHILKAT RIDGE AREA, ALASKA

Ronald P. Daanen[1] and Katreen Wikstrom Jones[1]

ABSTRACT

The State of Alaska Division of Geological & Geophysical Surveys (DGGS) used lidar to produce a digital terrain model (DTM) and digital surface model (DSM) over ridgelines along the Chilkat River just north of Haines, Alaska. The lidar and Global Navigation Satellite System (GNSS) data were collected on November 15–16, 2018, and processed using Terrasolid. This data collection is being released as a Raw Data File with an open end-user license. All files can be downloaded free of charge from the DGGS website.

INTRODUCTION

This dataset includes point cloud data, a 32-bit digital terrain model, and an intensity image covering a study area near the Chilkat Ridge region of southeast Alaska. The No Data value is set to -3.40282306074e+038. The data release is one of a series of Alaska Division of Geological & Geophysical Surveys (DGGS) publications to present elevation data. The goal is to provide information for the Alaska Division of Forestry on the ground conditions and tree cover on Chilkat Ridge.

LIST OF DELIVERABLES

Classified Points
DSM and DTM
Intensity
Metadata

MISSION PLAN

Aircraft and Instrument

DGGS operates a Riegle VUX1-LR lidar integrated with a GNSS and Northrop Grumman IMU system. The integration was designed by Phoenix Lidar Systems. This survey was flown on a fixed-wing aircraft configuration, using a Cessna 185 operated by Clearwater Air, Inc., of Anchorage, Alaska. Ground control points were collected using a Trimble Navigation Limited GPS consisting of a Trimble R7 base station and R8 rover system.

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Weather Conditions and Flight Times

The lidar data were collected on November 15, 2018, and November 16, 2018. Most of Chilkat Ridge was collected on the first day of the survey, which started at 10:48 AM and ended at 3:58 PM. The sky was mostly clear, with a few persistent low-level fog banks and a temperature just above freezing. The second day of flying was also clear, with less low-hanging fog and temperatures just above freezing. Takeoff for that day was at 8:41 AM and landing was at 11:57 AM. No abnormalities were observed during the flights.

PROCESSING REPORT

Lidar Dataset Processing

Due to dense vegetation and the need to provide a bare earth elevation model with a resolution of 1 m, we designed the survey to collect approximately 40 points per square meter. This resulted in an average of about 3 points per square meter on the ground. We also designed the survey to have significant overlap between scan lines to capture all gaps in the vegetation.

Raw data were processed using Terrasolid software to produce integrated files for navigation correction and a point cloud for calibration. The navigation was corrected using Inertial Explorer software, where the GNNS and IMU data are integrated to establish correct flight path and orientation of the lidar sensor. The data were processed multiple times, resulting in position accuracies illustrated in figure 1.

Internal lidar point cloud data were calibrated using Terrasolid software. The initial accuracy of the point cloud was 8.346 cm. After calibration, the point cloud had an average magnitude accuracy of 6.914 cm.

The point cloud is classified for ground points as well as low, medium, and high vegetation (0.01–0.3 m, 0.3–5 m, and 5–60 m heights above the ground, respectively). Some manual processing was required to eliminate fog and misclassified ground points. All low points and air points are eliminated from the dataset. Lastly, the DSM and DTM were hydroflattened to mean surrounding elevation for all lakes and ponds.

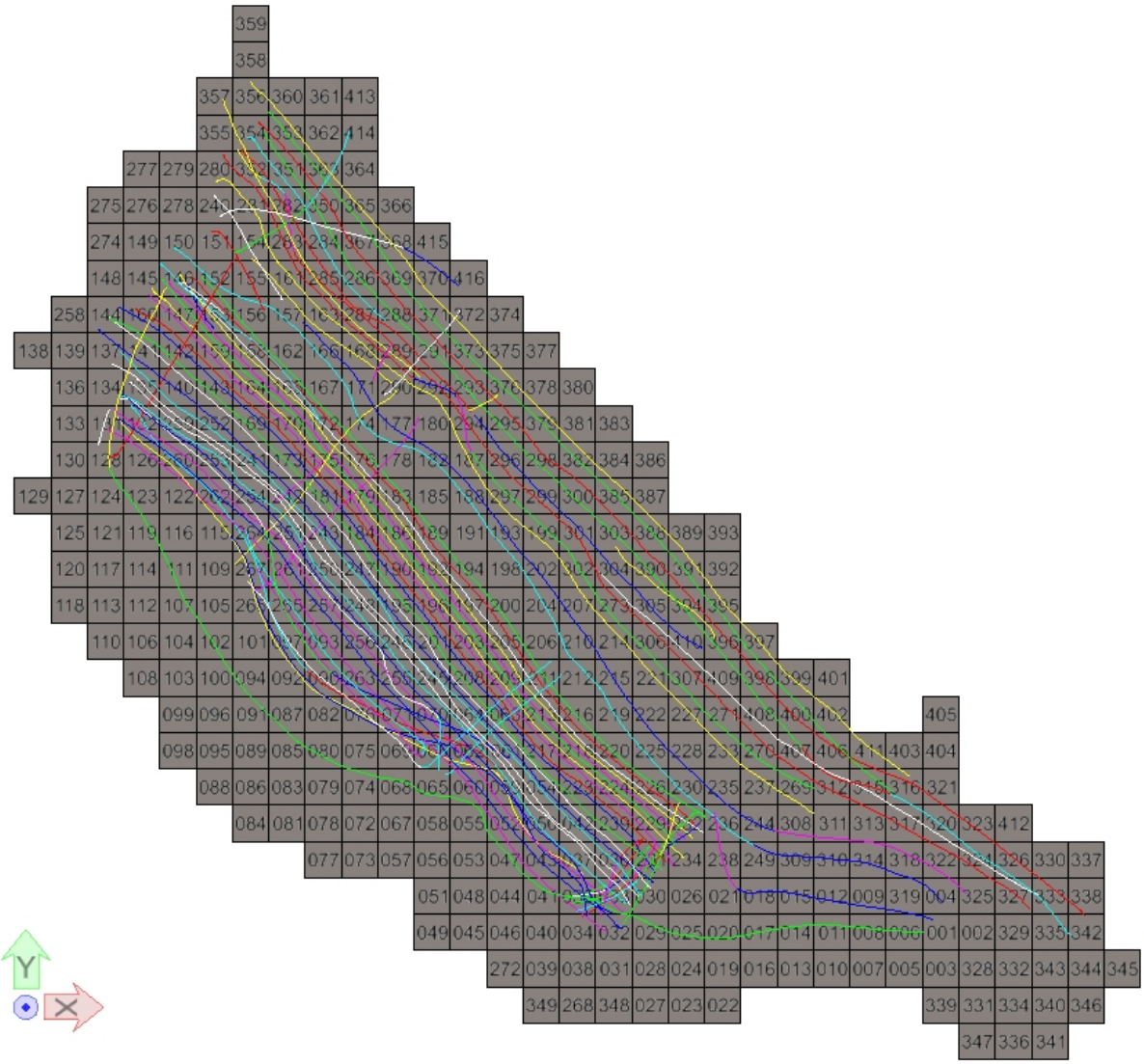

Figure 1. Flight lines included in the point cloud data. The lidar swath width averages 750 meters wide centered on the flight line but is dependent on local terrain. The point cloud tiles, labeled with las file numbers, are 1 km wide.

DTM

The ground points from the final point cloud were used to build the digital terrain model in ArcGIS. The point cloud was loaded as a las dataset and filtered for ground points. The remaining points were used in a las dataset-to-raster conversion tool. Rasters, with a ground pixel resolution of 1 meter, were derived from mean values from a 2-meter sampling distance.

DSM

The digital surface model was created from the first returns in the point cloud. Due to a large number of points in vegetation, we used a binning method with natural neighbor gap-filling.

The 1 m bins did not gap-fill correctly in the entire dataset, however, so we opted to store the DSM in a 2-m-resolution raster.

Intensity

The intensity raster is provided using the ground points only. The raster resolution is 1m.

SURVEY REPORT

Ground Control

Surveyed ground control, captured with a Trimble RTK GPS, provided both control points for calibration and checkpoints for accuracy assessment of the lidar point cloud. A snow crust was observed on most ground surfaces but was less than 5 cm thick and highly variable. This crust of snow is not expected to affect the elevation map beyond the overall accuracy capability of the survey. All points collected were in natural terrain with variable amounts of vegetated cover.

Control point adjustment involves a linear transformation of the entire lidar point cloud based on the mean elevation difference between surveyed ground data and an interpolated TIN (triangular irregular network) of the point cloud. The collected control points compared with lidar ground points had an average difference of -3 cm that was used to correct the elevation of all points in the point cloud. The quality of the control and checkpoints is summarized in Appendices 1 and 2.

Geometric accuracy of the point cloud is similarly estimated using a derived TIN in conjunction with surveyed ground data. The final elevation difference of the ground point elevation and the bare earth model, calculated as the average error compared to checkpoints, was 0.5 cm (Appendix 1). The Root Mean Square Error of the final data layers for the bare earth elevation between the checkpoints and lidar ground points is 8.5 cm.

Coordinate system and Datum

All data were processed and delivered in UTM NAD83 (2011) and vertical datum NAVD88 with a GEOID correction following the latest GEOID12B for Alaska.

QA/QC REPORT

The quality of the data is discussed in the previous paragraphs as average elevation compared to an independent dataset. The second aspect of the quality of the data is related to point density distribution over the survey area (fig. 2). The average point density is 40 points per square meter, with ground returns of 3 points per square meter.

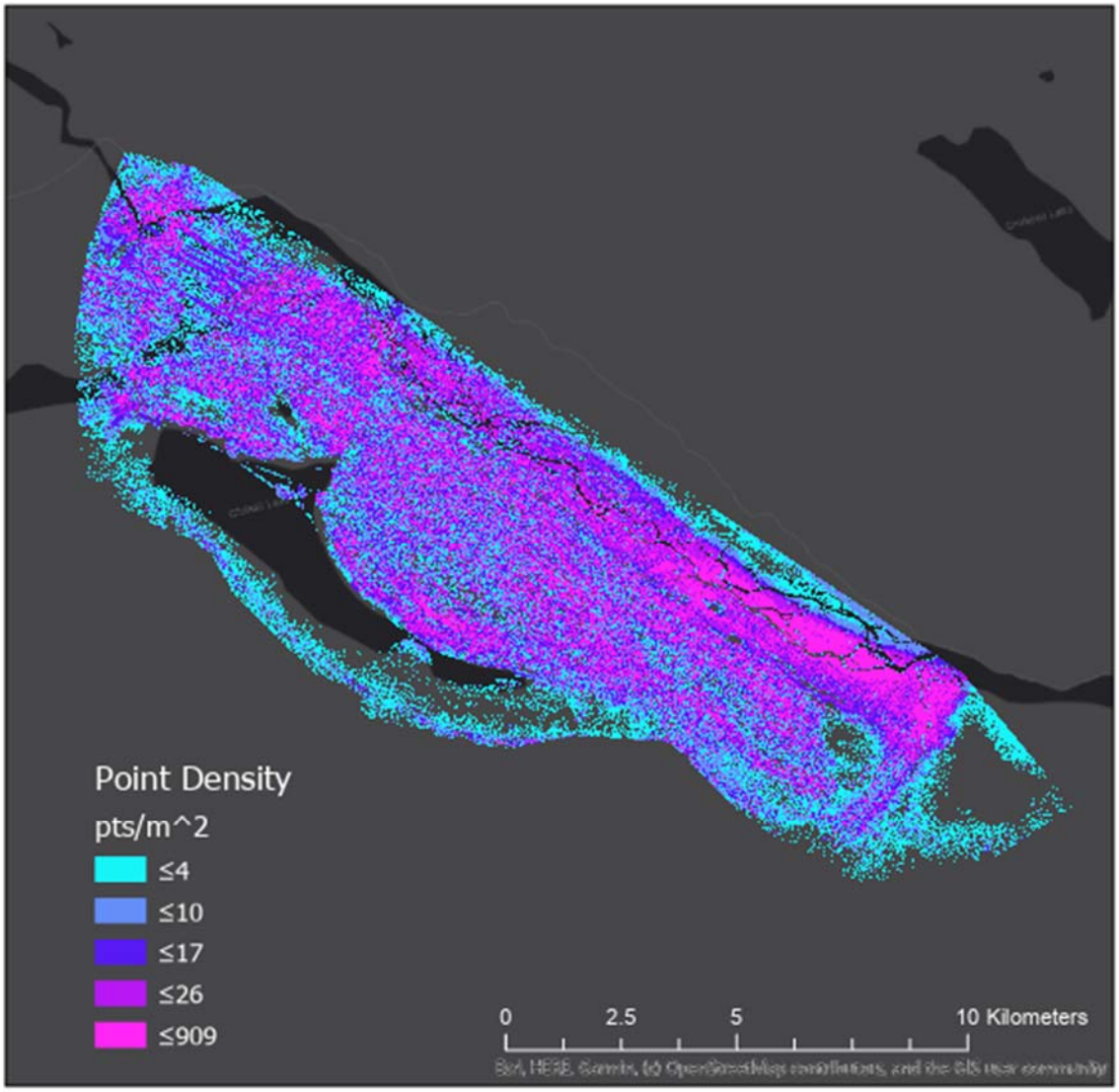

Figure 2. Ground point density displayed as a 1-meter raster for the survey, with 50 percent transparency over the hillshade derived from the DTM; cells without data are shown in white.

Appendix 1. Checkpoints

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
gcp48day2	1	445277.2	6581641	67.319	removed	*
gcp-52day1	2	456397.5	6578681	20.252	20.42	0.168
gcp130day2	3	449208.4	6584774	39.548	39.71	0.162
gcp91day2	4	453149	6573180	60.599	60.75	0.151
gcp27day2	5	445532	6581742	66.287	66.43	0.143
gcp100day2	6	450588.1	6574668	60.304	60.43	0.126
gcp28day2	7	445576.5	6581745	65.741	65.86	0.119
gcp-53day1	8	456370.1	6578719	20.306	20.4	0.094
gcp132day2	9	449247.6	6584774	39.459	39.55	0.091
gcp-36day1	10	452578.4	6581795	34.073	34.15	0.077
gcp-23day1	11	467974.2	6569095	9.452	9.52	0.068
gcp-47day1	12	457455.8	6577192	18.687	18.73	0.043
gcp-46day1	13	457826.1	6576663	17.37	17.41	0.04
gcp81day2	14	455067.6	6576432	19.481	19.52	0.039
gcp-34day1	15	452541.7	6581926	34.633	34.67	0.037
gcp-22day1	16	468001.3	6569083	9.515	9.55	0.035
gcp29day2	17	445596.5	6581739	65.492	65.52	0.028
gcp11day2	18	450424.3	6579756	226.263	226.29	0.027
gcp-27day1	19	452457.3	6581849	33.262	33.28	0.018
gcp-56day1	20	456241.2	6578905	20.407	20.42	0.013
gcp69day2	21	451315.3	6580492	27.937	27.93	-0.007
gcp62day2	22	449836.6	6582579	41.02	41.01	-0.01
gcp-20day1	23	468000.5	6569091	9.42	9.4	-0.02
gcp149day2	24	451656	6583383	34.163	34.14	-0.023
gcp6day2	25	453974.9	6575010	535.946	535.92	-0.026
gcp-44day1	26	457933.2	6576547	19.617	19.59	-0.027
gcp126day2	27	448326.3	6584968	38.8	38.77	-0.03
gcp-24day1	28	452450.5	6581898	33.215	33.18	-0.035
gcp58day2	29	448480.7	6583537	43.977	43.94	-0.037
gcp60day2	30	448445.3	6583561	43.903	43.86	-0.043
gcp63day2	31	449831.5	6582559	41.024	40.97	-0.054
gcp33day2	32	445677.6	6581646	65.639	65.58	-0.059
gcp147day2	33	451624.1	6583432	34.35	34.29	-0.06
gcp148day2	34	451630.3	6583410	34.452	34.39	-0.062
gcp-37day1	35	452633.7	6581770	34.213	34.15	-0.063
gcp135day2	36	450934.6	6583951	35.929	35.86	-0.069
gcp-42day1	37	457876.9	6576624	19.474	19.4	-0.074
gcp8day2	38	453993.3	6575011	536.019	535.94	-0.079
gcp146day2	39	451617.3	6583423	34.339	34.25	-0.089

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	Dz (m)
gcp159day2	40	452394.3	6582459	34.221	34.13	-0.091
gcp7day2	41	453979.3	6575020	535.882	535.79	-0.092
gcp140day2	42	450954.4	6583961	36.606	36.51	-0.096
gcp142day2	43	450916.6	6583995	36.821	36.7	-0.121
gcp112day2	44	448009.6	6585968	85.432	85.29	-0.142
gcp162day2	45	452411	6582385	34.68	34.53	-0.15
gcp114day2	46	448051.8	6585932	87.134	86.97	-0.164
gcp122day2	47	448218.1	6585827	92.734	removed	*
gcp106day2	48	447909.9	6586079	80.231	removed	*
gcp-10day1	49	469261	6567800	9.399	outside	*
gcp161day2	50	452405.4	6582400	34.412	outside	*
gcp20day2	51	445353.2	6581608	67.808	outside	*
gcp22day2	52	445405.2	6581613	67.605	outside	*
gcp25day2	53	445460.6	6581673	67.012	outside	*
gcp26day2	54	445485.9	6581701	66.725	outside	*
gcp37day2	55	445516.3	6581502	66.497	outside	*
gcp42day2	56	445231.6	6581552	68.48	outside	*
gcp47day2	57	445269.8	6581658	68.386	outside	*
gcp49day2	58	445288.1	6581624	68.192	outside	*
gcp76day2	59	453713.8	6578205	22.312	outside	*
hain319sday1	60	469531.4	6567800	11.418	outside	*
Average dz	-0.005					
Minimum dz	-0.164					
Maximum dz	0.168					
Average magnitude of deviation	0.071					
Root mean square	0.085					
Standard deviation (n=45)	0.086					

Appendix 2. Control Points

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	DZ (m)
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gcp38day2	1	445484.3	6581506	66.261	removed	*
gcp17day2	2	447647.2	6580958	75.708	removed	*
gcp13day2	3	447642.4	6580935	75.654	removed	*
gcp14day2	4	447630.6	6580946	75.772	removed	*
gcp90day2	5	453147.3	6573189	60.652	60.83	0.178
gcp92day2	6	453148.9	6573175	60.534	60.7	0.166
gcp155day2	7	452430.7	6582380	35.135	35.3	0.165
gcp89day2	8	459224.1	6570722	13.72	13.88	0.16
gcp86day2	9	459214.3	6570707	13.758	13.91	0.152
gcp87day2	10	459207.9	6570714	13.76	13.91	0.15
gcp-55day1	11	456310.2	6578802	20.303	20.45	0.147
gcp5day2	12	454881.6	6574193	447.094	447.24	0.146
gcp16day2	13	447639.9	6580958	75.786	75.93	0.144
gcp72day2	14	452557.5	6578937	23.951	24.09	0.139
gcp88day2	15	459218.2	6570722	13.817	13.95	0.133
gcp84day2	16	456967.7	6573558	15.138	15.27	0.132
gcp15day2	17	447630.4	6580957	75.831	75.96	0.129
gcp133day2	18	449271.9	6584776	38.842	38.96	0.118
gcp-54day1	19	456343.2	6578757	20.236	20.35	0.114
gcp93day2	20	453142.2	6573178	60.535	60.64	0.105
gcp3day2	21	454878.9	6574210	447.188	447.29	0.102
gcp70day2	22	452565.7	6578952	24.011	24.11	0.099
gcp2day2	23	454865.1	6574213	447.195	447.29	0.095
gcp83day2	24	456974.4	6573562	15.148	15.24	0.092
gcp-58day1	25	456145.1	6579038	20.649	20.74	0.091
gcp131day2	26	449225.6	6584774	39.63	39.72	0.09
gcp94day2	27	453142.3	6573178	60.552	60.64	0.088
gcp97day2	28	450571.4	6574655	60.849	60.93	0.081
gcp-29day1	29	452461.8	6581635	28.189	28.27	0.081
gcp-61day1	30	454642.6	6580691	27.859	27.94	0.081
gcp71day2	31	452568.3	6578942	23.959	24.04	0.081
gcp-19day1	32	467978.6	6569101	9.41	9.49	0.08
gcp85day2	33	456964.6	6573560	15.14	15.22	0.08
gcp-31day1	34	452497.1	6581572	28.29	28.36	0.07
gcp-25day1	35	452447	6581882	33.221	33.29	0.069
gcp-57day1	36	456198.2	6578965	20.442	20.51	0.068
gcp-28day1	37	452451	6581690	28.404	28.47	0.066
gcp-30day1	38	452485.8	6581591	28.337	28.4	0.063
gcp10day2	39	450423.6	6579770	226.066	226.12	0.054

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	DZ (m)
gcp134day2	40	449308.7	6584778	38.206	38.26	0.054
gcp73day2	41	453721	6578233	21.958	22.01	0.052
gcp-48day1	42	457459.8	6577159	18.642	18.69	0.048
gcp-60day1	43	454762.1	6580570	26.683	26.73	0.047
gcp-32day1	44	452508.5	6581615	28.256	28.3	0.044
gcp78day2	45	455094.8	6576448	19.599	19.64	0.041
gcp95day2	46	450529.3	6574667	60.832	60.87	0.038
gcp65day2	47	449785.3	6582562	41.467	41.5	0.033
gcp-39day1	48	452676.5	6581857	45.989	46.02	0.031
gcp-41day1	49	452932.7	6581367	41.789	41.82	0.031
gcp-50day1	50	457478.5	6577277	19.35	19.38	0.03
gcp4day2	51	454884.6	6574200	447.132	447.16	0.028
gcp79day2	52	455089.5	6576426	19.524	19.55	0.026
gcp-51day1	53	457470.7	6577338	19.267	19.29	0.023
gcp53day2	54	446706.9	6584290	39.587	39.61	0.023
gcp67day2	55	451323.8	6580504	27.928	27.95	0.022
gcp51day2	56	446673.3	6584306	40.012	40.03	0.018
gcp68day2	57	451317.1	6580498	27.892	27.91	0.018
gcp82day2	58	455059.5	6576454	19.507	19.52	0.013
gcp99day2	59	450642.4	6574656	60.418	60.43	0.012
gcp9day2	60	453981.3	6574999	536.051	536.06	0.009
gcp80day2	61	455072.8	6576400	19.461	19.47	0.009
gcp152day2	62	452457.7	6582244	35.224	35.23	0.006
gcp96day2	63	450544.7	6574661	60.475	60.48	0.005
gcp55day2	64	448452.2	6583594	43.536	43.54	0.004
gcp98day2	65	450615.6	6574659	60.519	60.52	0.001
gcp-38day1	66	452620.3	6581799	34.52	34.52	0
gcp-35day1	67	452564.2	6581834	33.854	33.85	-0.004
gcp66day2	68	449775.3	6582580	41.554	41.55	-0.004
gcp12day2	69	450411.6	6579750	226.275	226.27	-0.005
gcp-40day1	70	452732.8	6581885	52.048	52.04	-0.008
hain320sday2	71	452453.8	6581862	33.32	33.31	-0.01
hain320sday2	72	452453.8	6581862	33.32	33.31	-0.01
gcp52day2	73	446697.3	6584307	39.591	39.58	-0.011
gcp34day2	74	445631.4	6581599	65.762	65.75	-0.012
gcp129day2	75	448341.2	6584957	38.735	38.72	-0.015
gcp-26day1	76	452449	6581862	33.146	33.13	-0.016
gcp-49day1	77	457472.8	6577189	19.718	19.7	-0.018
gcp61day2	78	449816.6	6582593	41.051	41.03	-0.021
gcp-21day1	79	468026.8	6569079	9.453	9.43	-0.023
gcp64day2	80	449810.6	6582541	41.393	41.37	-0.023

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	DZ (m)
gcp151day2	81	451713.4	6583319	33.756	33.73	-0.026
gcp59day2	82	448457.6	6583542	44.007	43.98	-0.027
gcp-33day1	83	452469.4	6581945	33.627	33.6	-0.027
gcp127day2	84	448336.7	6584977	39.204	39.16	-0.044
gcp57day2	85	448488.8	6583561	43.844	43.8	-0.044
gcp56day2	86	448475	6583585	43.54	43.49	-0.05
gcp-59day1	87	454804.7	6580555	26.104	26.05	-0.054
gcp128day2	88	448371.8	6584980	40.469	40.41	-0.059
gcp154day2	89	452442.5	6582320	35.383	35.32	-0.063
gcp154day2	90	452442.5	6582320	35.383	35.32	-0.063
gcp141day2	91	450934	6583978	36.73	36.66	-0.07
gcp150day2	92	451691.1	6583342	33.915	33.84	-0.075
gcp150day2	93	451691.1	6583342	33.915	33.84	-0.075
gcp-43day1	94	457913.8	6576587	19.685	19.61	-0.075
gcp156day2	95	452422.5	6582421	35.459	35.38	-0.079
gcp156day2	96	452422.5	6582421	35.459	35.38	-0.079
gcp160day2	97	452400.1	6582430	34.184	34.1	-0.084
gcp160day2	98	452400.1	6582430	34.184	34.1	-0.084
gcp1day2	99	452454.8	6581866	33.256	33.17	-0.086
gcp-45day1	100	457854.5	6576668	19.149	19.06	-0.089
gcp143day2	101	450914.6	6583978	36.55	36.46	-0.09
gcp144day2	102	450909.2	6583966	36.67	36.58	-0.09
gcp145day2	103	450930.1	6583940	36.251	36.16	-0.091
gcp159day2	104	452394.3	6582459	34.221	34.13	-0.091
gcp153day2	105	452450	6582282	35.385	35.29	-0.095
gcp153day2	106	452450	6582282	35.385	35.29	-0.095
gcp157day2	107	452409	6582491	35.448	35.33	-0.118
gcp158day2	108	452390.9	6582489	34.626	34.5	-0.126
gcp158day2	109	452390.9	6582489	34.626	34.5	-0.126
gcp113day2	110	448033	6585947	86.398	86.27	-0.128
gcp136day2	111	450951.7	6583935	35.68	35.54	-0.14
gcp115day2	112	448062.2	6585924	87.487	87.34	-0.147
gcp139day2	113	450970.4	6583947	36.485	36.33	-0.155
gcp125day2	114	448262.8	6585794	94.283	94.12	-0.163
gcp124day2	115	448268.1	6585798	94.367	94.18	-0.187
gcp111day2	116	447998.6	6585978	84.958	84.77	-0.188
gcp137day2	117	450973.8	6583926	36.194	36	-0.194
gcp138day2	118	450986.1	6583935	36.451	36.25	-0.201
gcp116day2	119	448080.6	6585911	88.144	87.94	-0.204
gcp123day2	120	448251.7	6585808	93.823	93.6	-0.223
gcp119day2	121	448137.3	6585875	90.043	89.81	-0.233

FID		Easting (m)	Northing (m)	Known Z (m)	Laser Z (m)	DZ (m)
gcp117day2	122	448109.2	6585892	89.143	removed	*
gcp120day2	123	448170.9	6585855	91.24	removed	*
gcp121day2	124	448189.9	6585844	91.87	removed	*
gcp118day2	125	448124.8	6585883	89.596	removed	*
Average dz		0.000				
Minimum dz		-0.233				
Maximum dz		0.178				
Mean magnitude of deviation		0.077				
Root mean square		0.096				
Standard deviation (n=117)		0.096				