1 INTRODUCTION

This report contains a summary of the LiDAR data acquisition and processing for the **EKLUTNA GLACIER – ARRA LiDAR TASK ORDER**.

1.1 Contact Info

Questions regarding the technical aspects of this report should be addressed to:

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1.2 Purpose

AERO-METRIC, INC. acquired highly accurate Light Detection and Ranging (LiDAR) data for an area that comprises of approximately 160 square miles for the United State Geological Survey. AERO-METRIC's Optech Gemini LiDAR system was used in the collection of data for this project.

1.3 Project Location

The project area is located over Eklutna Glacier in the Chugach Mountains. This area is about 30 miles East of Anchorage, Alaska. The project area of interest was defined and supplied by USGS in June of 2010.

1.4 Project Spatial Reference System

All products for this project are delivered in: UTM, NAD 83, Meters; NAVD88, Meters

All data and products reference GEOID09 (Alaska), which is the most recent geoid model approved by the NGS. Due to the remoteness of the project, no direct ties to published monuments were completed for this project.

1.5 Time Period

LiDAR data acquisition, control and QC surveys were completed between September 16th, 2010 and October 24th, 2010. A total of 6 flight missions were flown over the project areas with the first 3 flights being rejected due to data

quality concerns. See Section 3 for a sketch of the acquisition missions and Section 7 of the report for each flight log. QC surveys were completed between October 22nd and 23rd, 2010.

1.6 Project Scope

This project involves new LiDAR data acquisition at a nominal pulse spacing of 1.9 meters. As documented in our proposal dated March 26, 2010 we were to achieve a TIN accuracy of 15cm. The accuracy as tested and published in this report has met vertical accuracy requirements specified by the client.

1.7 Conditions Affecting Progress

- Overcast conditions throughout the summer provided relatively few windows of opportunity for flight until September.

2 GEODETIC CONTROL

2.1 Control Scope

Geodetic control for this project was based on the position of AERO-METRIC's privately operated continuously operating reference station (AM03) on Merrill Field, in Anchorage, Alaska. The location of this station allowed for average GPS baselines of approximately 32 miles, with no baseline exceeding 38 miles.

This GPS station collects 2 Hz data, and is situated on the rooftop of a hangar, with virtually no obstructions in any direction. The NAD83 (CORS96) position of AM03's Antenna Reference Point (ARP) is as follows:

- Latitude: 61° 12' 53.49604" N
- Longitude: 149° 50' 36.33693" W
- Ellipsoid Height: 56.421 meters

3 LiDAR ACQUISITION & PROCEDURES

3.1 Acquisition Time Period

Initial LiDAR data acquisition and Airborne GPS control surveys were completed on September 16th, 2010, with two gap areas being re-flown on October 9th, 2010. Data analysis led to the discovery of irreconcilable sensor errors that caused several point density issues throughout the project area, and so a complete re-acquisition was undertaken on October 23rd, 2010. This re-acquisition required 3 missions in all, two to cover the project area, and the third to fill in gaps.

3.2 LiDAR Planning

The LiDAR data for this project was collected with Aero-Metric's Optech Gemini Airborne LiDAR system (Serial Number 03SEN145). All flight planning and acquisition was completed using Optech's ALTM-Nav, version 2.1.25b (flight planning and LiDAR control software).

The following are the acquisition settings for the first two missions:

- Flying Height (Above Ground): 3000 meters
- Laser Pulse Rate: 33 kHz
- Mirror Scan Frequency: 20 Hz
- Scan Angle (+/-): 15°
- Side Lap: 60 %
- Ground Speed: 150 kts
- Nominal Point Spacing: 1.939 meters

The following are the acquisition settings for the third (gap) mission:

- Flying Height (Above Ground): 2000 meters
- Laser Pulse Rate: 33 kHz
- Mirror Scan Frequency: 24 Hz
- Scan Angle (+/-): 16°
- Side Lap: 60 %
- Ground Speed: 150 kts
- Nominal Point Spacing: 1.638 meters

3.3 LiDAR Acquisition

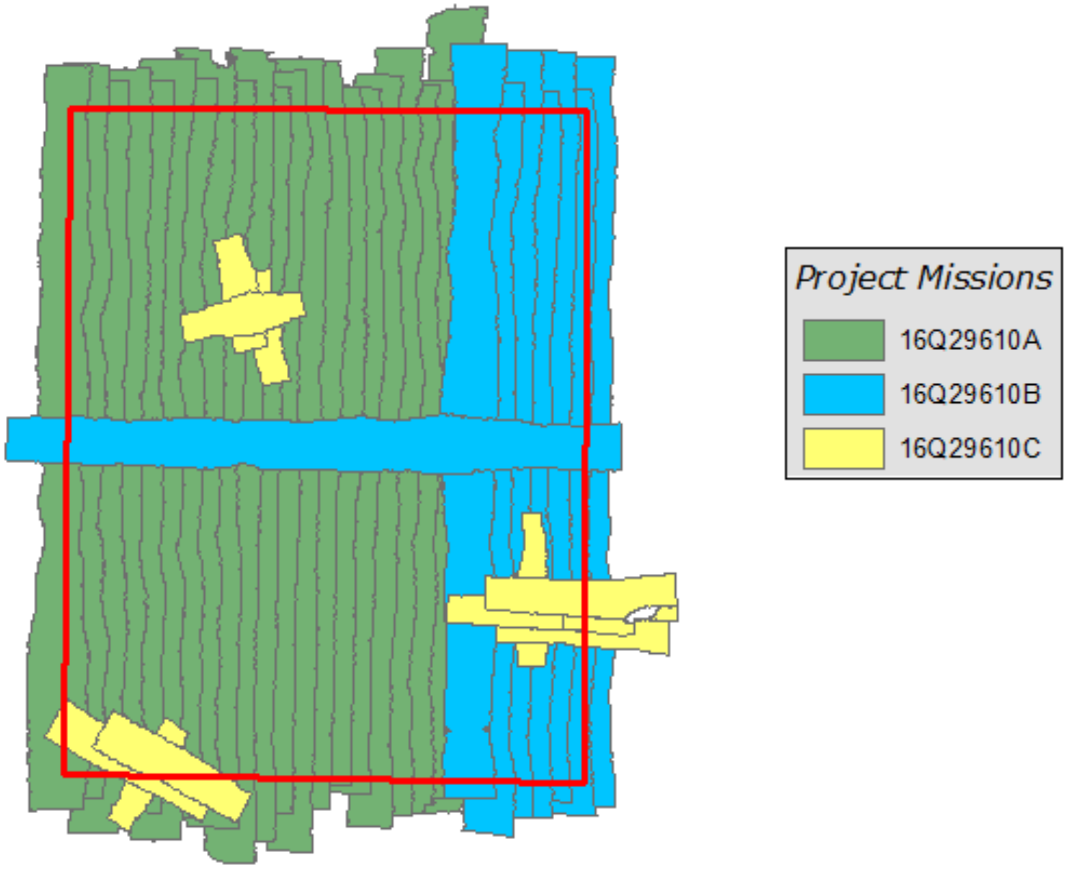
A total of 3 flight missions were required to cover the project area. The missions were flown using the above planned values. See below for a sketch of the acquisition missions and Appendix A of the report for each flight log.

Airborne GPS and IMU trajectories for the LiDAR sensor where also acquired during the time of flight.

The first mission was approximately 4 hours long; the second about 2.5. Before take-off, the LiDAR system and the Airborne GPS and IMU system were initiated for a period of five minutes and then again after landing for another five minutes. The missions acquired data according to the planned flight lines and included cross flights. The cross flights were flown perpendicular to the planned flight lines and their data used in the in-situ calibration of the sensor.

3.3 LiDAR Trajectory Processing

The airborne positioning of all missions was based on control station AM03. The red polygon indicates the extents of the project boundary.



4 QC SURVEYS

AERO-METRIC performed a QC survey on October 8th over open, identifiable surfaces to determine the presence of any vertical bias within the LiDAR data set. Real Time Kinematic GPS methods were utilized to perform this survey. The results of the analysis that followed led to a vertical bias adjustment of -0.265 meters being applied to the LiDAR data.

Global Positioning Services, Inc performed an independent QC survey on October 22nd and 23rd across the project area in open terrain to as independent QC of the LiDAR surface. A combination of Fast Static, Rapid Static, and Real Time Kinematic GPS methods were utilized to perform this survey. These points were collected to assess Fundamental Vertical Accuracy. Additional information regarding the QC control survey can be found in the control survey report.

5 FINAL LiDAR PROCESSING

5.1 ABGPS and IMU Processing

The Applanix POSPac software, version 4.4, was used to determine both the ABGPS trajectory and the blending of inertial data.

Airborne GPS

Applanix - POSGPS
Utilizing carrier phase ambiguity resolution on the fly (i.e., without initialization). The solution to sub-decimeter kinematic positioning without the operational constraint of static initialization as used in semi-kinematic or stop-and-go positioning was utilized for the airborne GPS post-processing.

The processing technique used by Applanix, Inc. for achieving the desired accuracy is Kinematic Ambiguity Resolution (KAR). KAR searches for ambiguities and uses a special method to evaluate the relative quality of each intersection (RMS). The quality indicator is used to evaluate the accuracy of the solution for each processing computation. In addition to the quality indicator, the software will compute separation plots between any two solutions, which will ultimately determine the acceptance of the airborne GPS post processing.

Inertial Data

Applanix - POSProc
The post-processing of inertial and aiding sensor data (i.e. airborne GPS post processed data) is to compute an optimally blended navigation solution. The Kalman filter-based aided inertial navigation algorithm generates an accurate (in the sense of least-square error) navigation solution that will retain the best characteristics of the processed input data. An example of inertial/GPS sensor blending is the following: inertial data is smooth in the short term. However, a free-inertial navigation solution has errors that grow without bound with time. A GPS navigation solution exhibits short-term noise but has errors that are bounded. This optimally blended navigation solution will retain the best features of both, i.e. the blended navigation solution has errors that are smooth and bounded.
The resultant processing generates the following data:

- Position: Latitude, Longitude, Altitude
- Velocity: North, East, and Down components
- 3-axis attitude: roll, pitch, true heading
- Acceleration: x, y, z components
- Angular rates: x, y, z components

The airborne GPS and blending of inertial and GPS post-processing were completed in multiple steps.

1. The collected data was transferred the field data collectors to the main computer. Data was saved under the project number and separated between LiDAR missions.

2. The aircraft raw data (IMU and GPS data combined) was run through Applanix POSPac's extractor program. This separated the IMU and GPS data. In addition to the extracting of data, it provided the analyst the first statistics on the overall flight.

3. Executing POSGPS program to derive accurate GPS positions for all flights:
   Applanix POSGPS
   The software utilized for the data collected was PosGPS, a kinematic on-the-fly (OTF) processing software package. Post processing of the data is computed from each base station (Note: only base stations within the flying area were used) in both a forward and backward direction. This provides the analyst the ability to Quality Check (QC) the post processing, since different ambiguities are determined from different base stations and also with the same data from different directions.

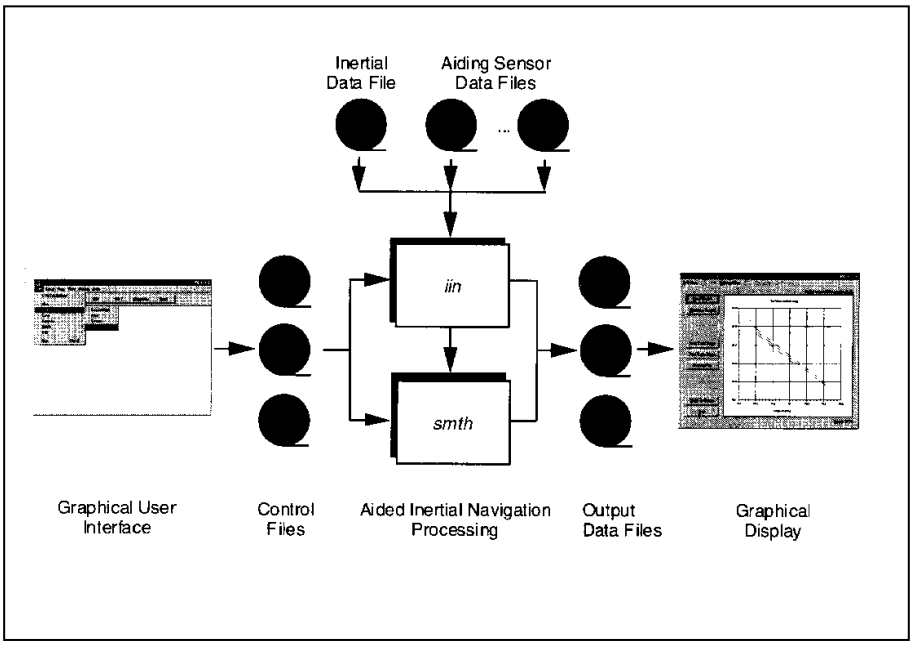
   The trajectory separation program is designed to display the time of week that the airborne or roving antenna traveled, and compute the differences found between processing runs. Processed data can be compared between a forward/reverse solution from one base station, a reverse solution from one base station and a forward solution from the second base station, etc. For the Applanix POSGPS processing, this is considered the final QC check for the given mission. If wrong ambiguities were found with one or both runs, the analyst would see disagreements from the trajectory plot, and re-processing would continue until an agreement was determined.

   Once the analyst accepts a forward and reverse processing solution, the trajectory plot is analyzed and the combined solution is stored in a file format acceptable for the IMU post processor.

4. When the processed trajectory (either through POSGPS) data was accepted after quality control analysis, the combined solution is stored in a file format acceptable for the IMU post processor (i.e. POSProc).

5. Execute POSProc.
   POSProc comprises a set of individual processing interface tools that execute and provide the following functions:

Diagram 3 shows the organization of these tools, and is a function of the



POSProc processing components.

- Integrated Inertial Navigation (*iin*) Module.
  The name *iin* is a contraction of Integrated Inertial Navigation. *iin* reads inertial data and aiding data from data files specified in a processing environment file and computes the aided inertial navigation solution. The inertial data comes from a strapdown IMU. *iin* outputs the navigation data between start and end times at a data rate as specified in the environment file. *iin* also outputs Kalman filter data for analysis of estimation error statistics and smoother data that the smoothing program *smth* uses to improve the navigation solution accuracy.[3]
  iin implements a full strapdown inertial navigator that solves Newton's equation of motion on the earth using inertial data from a strapdown IMU. The inertial navigator implements coning and sculling compensation to handle potential problems caused by vibration of the IMU. [3]

- Smoother Module (*smth*).
  smth is a companion processing module to *iin*. *smth* is comprised of two individual functions that run in sequence. *smth* first runs the *smoother function* and then runs the *navigation correction function*. [3]

  The *smth* smoother function performs backwards-in-time processing of the forwards-in-time blended navigation solution and Kalman filter data generated by *iin* to compute smoothed error estimates. *smth* implements a modified Bryson-Frazier smoothing algorithm

specifically designed for use with the *iin* Kalman filter. The resulting smoothed strapdown navigator error estimates at a given time point are the optimal estimates based on all input data before and after the given time point. In this sense, *smth* makes use of all available information in the input data. *smth* writes the smoothed error estimates and their RMS estimation errors to output data files. [3]

The *smth* navigation correction function implements a feedforward error correction mechanism similar to that in the *iin* strapdown navigation solution using the smoothed strapdown navigation errors. s*mth* reads in the smoothed error estimates and with these, corrects the strapdown navigation data. The resulting navigation solution is called a Best Estimate of Trajectory (BET), and is the best obtainable estimate of vehicle trajectory with the available inertial and aiding sensor data. [3]

The above mentioned modules provide the analyst the following statistics to ensure that the most optimal solution was achieved: a log of the *iin* processing, the Kalman filter Measurement Residuals, Smoothed RMS Estimation Errors, and Smoothed Sensor Errors and RMS.

5.2 LiDAR "Point Cloud" Processing

The ABGPS/IMU post processed data along with the LiDAR raw measurements were processed using Optech Incorporated's LiDAR Mapping Suite software (LMS). This software was used to match the raw LiDAR measurements with the computed ABGPS/IMU positions and attitudes of the LiDAR sensor. The result was a "point cloud" of LiDAR measured points referenced to the ground control system.

5.3 LIDAR CALIBRATION

Introduction

The purpose of the LiDAR system calibration is to refine the system parameters in order for the post-processing software to produce a "point cloud" that best fits the actual ground.

The following report outlines the calibration techniques employed for this project.

Calibration Procedures

AERO-METRIC routinely performs two types of calibrations on its Optech Gemini LiDAR system. The first calibration, system calibration, is performed whenever the LiDAR system is installed in the aircraft. This calibration is performed to define the system parameters affected by the physical misalignment of the system versus aircraft. The second calibration, in-situ calibration, is performed for each mission using that missions data. This calibration is performed to refine the system parameters that are affected by the on site conditions as needed.

System Calibration and Correction Software

Optech has developed a proprietary calibration software in December of 2009 that performs system calibration. The results from this new software achieved excellent results and an accuracy that meets the project requirements.

This new calibration tool incorporates Optech's proprietary optical sensor models to compute laser point positions and provide laser point calibration improvements on a per flightline basis for the entire project area. It furthermore calculates planar surfaces at different angles from each flight line and then uses a robust least squares solution to compute the orientation parameters at the optical level instead of the traditional methods relating to the ground points. Determining and correcting at the optical level is critical when correcting the data especially when working in terrain and aggressive design parameters as found in this project. Each flight line was computed individually and output in LAS 1.2 format.

In-situ Calibration

The in-situ calibration is performed as needed using the mission's data. This calibration is performed to refine the system parameters that are affected by the on site conditions.

For each mission, LiDAR data for at least one cross flight is acquired over the mission's acquisition site. The processed data of the cross flight is compared to the perpendicular flight lines using either the Optech proprietary software or TerraSolid's TerraMatch software (or a combination of both) to determine if any systematic errors are present. In this calibration, the data of individual flight lines are compared against each other and their systematic errors are corrected in the final processed data.

5.4 LiDAR Processing

LAS files were imported, verified, and parsed into manageable, tiled grids using GeoCue version 7.0.34.0. GeoCue allows for ease of data management and process tracking.

The first step after the data has been processed and calibrated is to perform a relative accuracy assessment of the flightlines in relation to each other. To perform this assessment, Aero-Metric uses GeoCue to create Orthophotos colored by elevation differences. These images provide a visual interpretation of how well flightlines match, and are a useful tool and determining either the success or need to re-evaluate the in-situ calibration procedure.

In addition to the relative accuracy assessment, Aero-Metric utilizes proprietary, in-house software to confirm that the data density requirements have been met. Initially a grid was placed according the version 12 specification that is based on the nominal post spacing. The results indicated that the density of the sampled tiles achieved only 88.8% of the specified data density criteria. However, using the latest USGS specification, version 13, which modifies the requirements to allow 2 times the nominal post spacing our data easily meets the desired density requirements. Below are the statistics resulting from this procedure:

Version 12 – 2 meter grid
Total number of cells: 95681412
Total number of cells with no points: 10680256
Percentage of cells with 1 point or more: 88.8%

Version 13 – 4 meter grid
Total number of cells: 23920362
Total number of cells with no points: 24594
Percentage of cells with 1 point or more: 99.9%

Once both the accuracy between swaths and data density is accepted, an automated classification algorithm is performed using TerraSolid's TerraScan, version 10.011. This will produce the majority of the bare-earth datasets.

The remainder of the data was classified using manual classification techniques. The majority of the manual edit removed points misclassified as ground (class 2) to unclassified (class 1). Erroneous low points and high point are classified to class 7.

5.4 Check Point Validation

The data was verified using the twenty-four (445) ground control check points collected by Aero-Metric, Inc. TerraScan then computes the vertical differences between the surveyed elevation and the LiDAR derived elevation for each point. The RMSE (95^{th} Confidence Interval as defined by the NSSDA) of the lidar dataset is 0.214 meters.

A report listing the differences and common statistics was created and can be found in Appendix B of this report.

5.5 Hydro-Flattening

In accordance with this task order's specifications, breaklines were collected along water bodies within the project area using QCoherent's LP360. These breaklines were assigned elevations within the deliverable datum, based upon the elevations of the surrounding LiDAR data.

Once all necessary breaklines were collected and assigned appropriate elevations, they were used as hydro-enforcement in the following manner:

1) All points within the breaklines were classified as class 9, water.
2) All ground points within 1 meter of the exterior of the breaklines were classified as class 10, withheld ground
3) All DEM files generated containing relevant bodies of water held the elevations assigned to the breaklines within the extents of said lines

5.6 LiDAR Data Delivery

Raw Point Cloud Data:

- LAS, version 1.2
- GPS times recorded as Adjusted GPS Time
- Full swaths delivered as 1 file per swath which did not exceed 2GB

Classified Point Cloud Data:

- 3000m x 3000m tiles
- 200 * NPS (400m) buffered extents
- LAS, version 1.2
- GPS times recorded as Adjusted GPS Time
- Classification schemed:
  - Code 1 – Processed, but unclassified
  - Code 2 – Bare-Earth Ground
  - Code 7 – Noise
  - Code 9 – Water
  - Code 10 – Ignored Ground (Breakline proxmimty)

3 Meter Bare-Earth DEMs:

- 3000m x 3000m tiles
- 200 * NPS (400m) buffered extents
- ERDAS .IMG Format

The 3 meter bare-earth DEMs were created in the following manner. First, 32-bit binary float raster files were exported from QCoherent's LP360 from classified bare-earth data using collected 3D breaklines for hydro flattening. The raster files were then imported into Global Mapper v11.02 and converted to ERDAS .IMG format.

Breaklines used in hydro-flattening will be delivered in ESRI Shapefile format.

6 CONCLUSION

Because of the rigorous procedures and use of new technology, this project will serve the USGS and all users requiring the provided LiDAR derivative products for the Eklutna Glaciers project area well into the future. Although this project tested the limits of both the equipment and personnel, the results are extremely accurate and reliable.

APPENDIX A – FLIGHT LOGS

Flight Log

Project Number : 6100611 Eklutna Glacier
S/N : 03SEN145
Operator : Patrick Powell
Pilot(s) : Robert McSheehy
Aircraft : 16Q
Airport : MRI
Mission : 16Q29610A
Date : October 23, 2010
Julian Day : 296
Temperature : 42
Visibility : Clear
Clouds : Thin / None

Statistics

Laser Time : 01:27:56

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG
18:20:19.716	18:24:29.012	28	4242	33	20.00	15.00	OFF	NAR	ON	359
18:27:48.108	18:32:13.104	26	4291	33	20.00	15.00	OFF	NAR	ON	179
18:35:47.8	18:39:50.796	26	4354	33	20.00	15.00	OFF	NAR	ON	359
18:43:31.792	18:47:52.888	25	4325	33	20.00	15.00	OFF	NAR	ON	179
18:51:23.584	18:55:27.58	24	4320	33	20.00	15.00	OFF	NAR	ON	359
18:59:18.776	19:03:57.471	23	4330	33	20.00	15.00	OFF	NAR	ON	179
19:07:22.168	19:11:24.764	22	4360	33	20.00	15.00	OFF	NAR	ON	359
19:14:59.86	19:19:28.156	21	4270	33	20.00	15.00	OFF	NAR	ON	179
19:23:30.952	19:27:34.448	20	4292	33	20.00	15.00	OFF	NAR	ON	359
19:30:43.345	19:35:31.44	19	4244	33	20.00	15.00	OFF	NAR	ON	179
19:38:48.537	19:42:54.932	17	4198	33	20.00	15.00	OFF	NAR	ON	359
19:46:14.729	19:50:40.325	17	4267	33	20.00	15.00	OFF	NAR	ON	179
19:53:40.922	19:57:58.018	15	4369	33	20.00	15.00	OFF	NAR	ON	359
20:01:09.014	20:05:31.31	15	4299	33	20.00	15.00	OFF	NAR	ON	179
20:08:32.307	20:12:18.204	14	4310	33	20.00	15.00	OFF	NAR	ON	359
20:15:38.8	20:19:45.596	13	4206	33	20.00	15.00	OFF	NAR	ON	179
20:22:45.693	20:26:47.189	12	4337	33	20.00	15.00	OFF	NAR	ON	359
20:30:02.986	20:34:30.182	11	4302	33	20.00	15.00	OFF	NAR	ON	179
20:37:13.379	20:41:08.776	9	4316	33	20.00	15.00	OFF	NAR	ON	359
20:44:51.472	20:49:01.768	9	4218	33	20.00	15.00	OFF	NAR	ON	179
20:52:18.765	20:56:44.461	8	4327	33	20.00	15.00	OFF	NAR	ON	359

18:24:31.212 GMT : Comment

LINE 28N FLOWN,

18:32:20.304 GMT : Comment

LINE 27S FLOWN,

18:39:54.796 GMT : Comment

LINE 26N FLOWN,

18:47:52.588 GMT : Comment

LINE 25S FLOWN, SOME BAD RETURNS

18:55:36.78 GMT : Comment

LINE 24N FLOWN,

19:03:56.271 GMT : Comment

LINE 23S FLOWN,

19:11:24.264 GMT : Comment

LINE 22N FLOWN,

19:19:31.456 GMT : Comment

LINE 21S FLOWN,

19:27:38.048 GMT : Comment

LINE 20N FLOWN,

19:35:39.64 GMT : Comment

LINE 19S FLOWN,

19:43:01.032 GMT : Comment

LINE 18N FLOWN,

19:50:44.325 GMT : Comment

LINE 17S FLOWN,

19:58:22.317 GMT : Comment

LINE 16N FLOWN,

20:05:34.81 GMT : Comment

LINE 15S FLOWN,

20:12:19.003 GMT : Comment

LINE 14N FLOWN,

20:19:47.596 GMT : Comment

LINE 13S FLOWN,

20:26:48.389 GMT : Comment

LINE 12N FLOWN,

20:35:49.081 GMT : Comment

LINE 11S FLOWN,

20:49:01.568 GMT : Comment

LINE 9S FLOWN,

20:56:55.06 GMT : Comment

LINE 8N FLOWN,

21:07:29.35 GMT : Comment

LINE 7S FLOWN

Flight Log

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S/N : 03SEN145
Operator : Patrick Powell
Pilot(s) : Robert McSheehy
Aircraft : 16Q
Airport : MRI
Mission : 16Q29610B
Date : October 23, 2010
Julian Day : 296
Temperature : 42
Visibility : Clear
Clouds : None

Statistics

Laser Time : 00:45:21

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG
22:22:16.436	22:22:37.336	33	3362	33	20.00	15.00	OFF	NAR	ON	88.77
22:29:48.229	22:33:08.925	33	4404	33	20.00	15.00	OFF	NAR	ON	88.77
22:38:25.02	22:42:52.315	1	4333	33	20.00	15.00	OFF	NAR	ON	179
22:45:49.112	22:49:43.408	2	4343	33	20.00	15.00	OFF	NAR	ON	359
22:52:37.805	22:57:03.301	3	4353	33	20.00	15.00	OFF	NAR	ON	179
23:00:04.298	23:03:59.394	4	4347	33	20.00	15.00	OFF	NAR	ON	359
23:07:16.291	23:11:46.886	6	4342	33	20.00	15.00	OFF	NAR	ON	179
23:15:03.483	23:19:03.879	6	4317	33	20.00	15.00	OFF	NAR	ON	359
23:22:28.976	23:26:51.472	7	4334	33	20.00	15.00	OFF	NAR	ON	179
23:32:14.166	23:35:17.863	32	3681	33	20.00	15.00	OFF	NAR	ON	315
23:38:29.86	23:41:44.057	31	3552	33	20.00	15.00	OFF	NAR	ON	135
23:44:46.054	23:48:02.151	30	3541	33	20.00	15.00	OFF	NAR	ON	315
23:51:26.148	23:54:47.644	29	3702	33	20.00	15.00	OFF	NAR	ON	135
23:58:51.54	00:00:20.939	29	3690	33	20.00	15.00	OFF	NAR	ON	135

22:22:48.136 GMT : Comment

TEST STRIP

22:33:09.325 GMT : Comment

CROSSFLIGHT 33E FLOWN,

22:42:57.415 GMT : Comment

LINE 1S FLOWN,

22:49:47.108 GMT : Comment

LINE 2N FLOWN,

22:57:01.401 GMT : Comment

LINE 3S FLOWN,

23:03:59.494 GMT : Comment

LINE 4N FLOWN,

23:11:44.287 GMT : Comment

LINE 5S FLOWN,

23:19:04.479 GMT : Comment

LINE 6N FLOWN,

23:26:50.372 GMT : Comment

LINE 7S FLOWN,

23:35:16.463 GMT : Comment

LINE 32N FLOWN,

23:41:44.657 GMT : Comment

LINE 31S FLOWN,

23:48:00.551 GMT : Comment

LINE 30N FLOWN,

23:55:00.644 GMT : Comment

LINE 29S FLOWN,

00:00:21.039 GMT : Comment

CROSSFLIGHT W 29-32

Flight Log

Project Number : 6100611 Eklutna Glacier
S/N : 03SEN145
Operator : Patrick Powell
Pilot(s) : Robert McSheehy
Aircraft : 16Q
Airport : MRI
Mission : 16Q29610B
Date : October 23, 2010
Julian Day : 296
Temperature : 42
Visibility : Clear
Clouds : None

Statistics

Laser Time : 00:09:55

START	STOP	LINE#	ALT	PRF	FREQ	ANGLE	MP	DIV	RC	HDG
02:33:14.91	02:33:38.31	4	1973	33	24.00	16.00	OFF	NAR	ON	118
02:34:49.409	02:35:12.508	4	2559	33	24.00	16.00	OFF	NAR	ON	118
02:35:49.108	02:36:09.907	4	2848	33	24.00	16.00	OFF	NAR	ON	118
02:38:50.504	02:39:58.903	4	2907	33	24.00	16.00	OFF	NAR	ON	118
02:43:16.7	02:44:16.999	5	3110	33	24.00	16.00	OFF	NAR	ON	298
02:47:27.296	02:48:12.095	6	2749	33	24.00	16.00	OFF	NAR	ON	30.04
02:50:35.292	02:51:19.392	1	2982	33	24.00	16.00	OFF	NAR	ON	345
02:54:37.288	02:55:23.087	2	2994	33	24.00	16.00	OFF	NAR	ON	165
02:57:57.885	02:58:47.384	3	3137	33	24.00	16.00	OFF	NAR	ON	76.12
03:00:49.482	03:01:47.181	10	2868	33	24.00	16.00	OFF	NAR	ON	179.44
03:05:33.277	03:06:36.776	7	2718	33	24.00	16.00	OFF	NAR	ON	270
03:09:29.973	03:10:44.472	8	2720	33	24.00	16.00	OFF	NAR	ON	90
03:13:28.869	03:14:37.168	9	2919	33	24.00	16.00	OFF	NAR	ON	270

02:34:03.609 GMT : Comment

TEST STRIP

02:36:22.307 GMT : Comment

TEST STRIP WITH SHUTTERS IN OPEN POSITION

02:39:58.603 GMT : Comment

LINE 4E FLOWN,

02:44:15.599 GMT : Comment

LINE 5W FLOWN,

02:48:10.795 GMT : Comment

LINE 6N FLOWN,

02:51:19.592 GMT : Comment

LINE 1N FLOWN,

02:55:22.688 GMT : Comment

LINE 2S FLOWN,

02:58:44.484 GMT : Comment

LINE 3E FLOWN,

03:01:47.181 GMT : Comment

LINE 10S FLOWN,

03:06:36.776 GMT : Comment

LINE 7W FLOWN,

03:10:42.972 GMT : Comment

LINE 8E FLOWN,

03:14:36.068 GMT : Comment

LINE 9W FLOWN,

APPENDIX B – CHECK POINT RESULTS

Statistical Summary:

Mean : -0.043 meters
Mode : -0.052 meters
Kurtosis : 3.738
Skew : 0.123
Minimum dz : -0.488 meters
Maximum dz : 0.45 meters
DZ Range : 0.938 meters
Count : 445
RMSE : 0.109 meters
RMSE*1.96 (95% CI – NSSDA) : 0.214 meters

Number	Easting	Northing	Known Z	Laser Z	Dz	Dz^2
10144	385002	6810453	306.518	306.03	-0.488	0.238144
10145	384991.5	6810455	306.411	305.93	-0.481	0.231361
10143	385012.7	6810450	306.522	306.09	-0.432	0.186624
10146	384981.4	6810457	306.311	305.92	-0.391	0.152881
10142	385022.2	6810446	306.525	306.18	-0.345	0.119025
10141	385031.8	6810442	306.502	306.21	-0.292	0.085264
10559	384807.2	6810478	302.469	302.2	-0.269	0.072361
10106	385284.1	6810365	302.492	302.25	-0.242	0.058564
20143	384901.6	6810468	305.069	304.84	-0.229	0.052441
10535	384547.4	6810553	302.689	302.47	-0.219	0.047961
10555	384765.1	6810487	300.282	300.07	-0.212	0.044944
10048	385909.9	6810256	278.684	278.48	-0.204	0.041616
10157	384582.8	6810539	302.384	302.18	-0.204	0.041616
20168	384482.7	6810584	301.371	301.17	-0.201	0.040401
10548	384691.3	6810510	301.392	301.2	-0.192	0.036864
10171	384447.4	6810596	300.735	300.55	-0.185	0.034225
10100	385340.9	6810360	301.822	301.64	-0.182	0.033124
10101	385330.5	6810358	301.881	301.7	-0.181	0.032761
10534	384538	6810558	302.7	302.52	-0.18	0.0324
10002	385992.8	6810203	273.608	273.43	-0.178	0.031684
10104	385299	6810355	302.068	301.89	-0.178	0.031684
20145	384812.4	6810481	302.718	302.54	-0.178	0.031684
10056	385988.3	6810199	273.425	273.25	-0.175	0.030625
10129	385226.9	6810359	302.994	302.82	-0.174	0.030276
10536	384556.6	6810548	302.671	302.5	-0.171	0.029241
10549	384702.7	6810507	301.079	300.91	-0.169	0.028561
10154	384612.8	6810526	302.109	301.94	-0.169	0.028561
20038	385620.8	6810419	300.438	300.27	-0.168	0.028224
10040	385991.7	6810203	273.606	273.44	-0.166	0.027556
20144	384823.6	6810479	303.395	303.23	-0.165	0.027225
10550	384713.1	6810504	300.829	300.67	-0.159	0.025281
10558	384797.1	6810480	301.729	301.57	-0.159	0.025281

10139	385125.9	6810395	304.709	304.55	-0.159	0.025281
10027	385895.9	6810280	280.647	280.49	-0.157	0.024649
10147	384694.9	6810513	301.297	301.14	-0.157	0.024649
20010	385324.6	6810354	301.994	301.84	-0.154	0.023716
10159	384564.1	6810548	302.643	302.49	-0.153	0.023409
10153	384623.2	6810524	302.142	301.99	-0.152	0.023104
10541	384606.1	6810525	302.222	302.07	-0.152	0.023104
10537	384566.2	6810542	302.562	302.41	-0.152	0.023104
10136	385154.8	6810382	304.122	303.97	-0.152	0.023104
10160	384554.3	6810553	302.739	302.59	-0.149	0.022201
20115	385361.5	6810365	301.786	301.64	-0.146	0.021316
10161	384545.3	6810559	302.774	302.63	-0.144	0.020736
20142	384912.5	6810466	305.113	304.97	-0.143	0.020449
20584	384783	6810483	300.819	300.68	-0.139	0.019321
10546	384663.1	6810514	302.169	302.03	-0.139	0.019321
10543	384631.6	6810518	302.259	302.12	-0.139	0.019321
20562	384529.7	6810563	302.649	302.51	-0.139	0.019321
20121	385296.8	6810354	302.058	301.92	-0.138	0.019044
10098	385361.8	6810365	301.757	301.62	-0.137	0.018769
10545	384652.9	6810515	302.267	302.13	-0.137	0.018769
20131	385190.3	6810368	303.606	303.47	-0.136	0.018496
20587	384814.4	6810477	302.915	302.78	-0.135	0.018225
10169	384467.3	6810590	300.864	300.73	-0.134	0.017956
10045	385884.7	6810283	281.363	281.23	-0.133	0.017689
10560	384823.8	6810475	303.493	303.36	-0.133	0.017689
10552	384733.9	6810495	300.34	300.21	-0.13	0.0169
10108	385285.6	6810385	303.33	303.2	-0.13	0.0169
10155	384603	6810530	302.169	302.04	-0.129	0.016641
10126	385258.9	6810355	302.458	302.33	-0.128	0.016384
10132	385195.3	6810366	303.568	303.44	-0.128	0.016384
10544	384642.7	6810517	302.257	302.13	-0.127	0.016129
10133	385185.1	6810369	303.717	303.59	-0.127	0.016129
10162	384536.1	6810564	302.756	302.63	-0.126	0.015876
10047	385900.1	6810269	279.835	279.71	-0.125	0.015625
10167	384487.2	6810583	301.565	301.44	-0.125	0.015625
10163	384526	6810569	302.694	302.57	-0.124	0.015376
10150	384655.2	6810519	302.143	302.02	-0.123	0.015129
10005	385951.7	6810289	279.312	279.19	-0.122	0.014884
10051	385923.7	6810228	276.461	276.34	-0.121	0.014641
10539	384585.9	6810533	302.321	302.2	-0.121	0.014641
10557	384786.7	6810482	301.07	300.95	-0.12	0.0144
20007	385293.5	6810351	302.17	302.05	-0.12	0.0144
10107	385284.3	6810375	302.89	302.77	-0.12	0.0144
20111	385403.8	6810378	301.699	301.58	-0.119	0.014161
20589	384836.6	6810473	304.149	304.03	-0.119	0.014161
10553	384743.8	6810492	300.167	300.05	-0.117	0.013689
20585	384793.8	6810481	301.475	301.36	-0.115	0.013225
20140	384940	6810462	305.485	305.37	-0.115	0.013225
10074	385610.1	6810422	301.124	301.01	-0.114	0.012996
10083	385515.5	6810411	303.164	303.05	-0.114	0.012996
10174	384417.3	6810606	301.613	301.5	-0.113	0.012769

10542	384615.8	6810522	302.193	302.08	-0.113	0.012769
20586	384804.3	6810479	302.193	302.08	-0.113	0.012769
10004	385958.3	6810281	278.662	278.55	-0.112	0.012544
20163	384531.2	6810566	302.681	302.57	-0.111	0.012321
20148	384778.4	6810487	300.59	300.48	-0.11	0.0121
20158	384580.8	6810539	302.35	302.24	-0.11	0.0121
10001	385985.6	6810196	273.299	273.19	-0.109	0.011881
10551	384723.4	6810499	300.639	300.53	-0.109	0.011881
10556	384776	6810484	300.548	300.44	-0.108	0.011664
20094	385580.3	6810422	302.258	302.15	-0.108	0.011664
20126	385242.3	6810357	302.688	302.58	-0.108	0.011664
20132	385180.4	6810371	303.708	303.6	-0.108	0.011664
20160	384561.6	6810550	302.617	302.51	-0.107	0.011449
20117	385340.2	6810360	301.766	301.66	-0.106	0.011236
10033	385940.6	6810206	274.404	274.3	-0.104	0.010816
20017	385398.5	6810373	301.704	301.6	-0.104	0.010816
20599	385083.2	6810413	305.664	305.56	-0.104	0.010816
10049	385912.8	6810246	277.893	277.79	-0.103	0.010609
20556	384455.6	6810590	300.693	300.59	-0.103	0.010609
20154	384622.1	6810524	302.101	302	-0.101	0.010201
10538	384575.7	6810537	302.421	302.32	-0.101	0.010201
10109	385292.9	6810392	303.531	303.43	-0.101	0.010201
10028	385901.2	6810271	279.89	279.79	-0.1	0.01
10170	384457.3	6810593	300.67	300.57	-0.1	0.01
20006	385280.5	6810372	302.819	302.72	-0.099	0.009801
20081	385717	6810403	294.548	294.45	-0.098	0.009604
20146	384801.5	6810483	301.867	301.77	-0.097	0.009409
20103	385487.6	6810403	302.757	302.66	-0.097	0.009409
10105	385288.8	6810355	302.146	302.05	-0.096	0.009216
10085	385495	6810405	302.916	302.82	-0.096	0.009216
10052	385931.8	6810220	275.655	275.56	-0.095	0.009025
10168	384477.3	6810587	301.155	301.06	-0.095	0.009025
10151	384644.6	6810520	302.145	302.05	-0.095	0.009025
20129	385210.7	6810362	303.294	303.2	-0.094	0.008836
20110	385414.3	6810381	301.753	301.66	-0.093	0.008649
10127	385248.5	6810356	302.553	302.46	-0.093	0.008649
10177	384387.1	6810615	302.933	302.84	-0.093	0.008649
10173	384428	6810602	301.132	301.04	-0.092	0.008464
20175	384400.6	6810611	302.372	302.28	-0.092	0.008464
10072	385631.5	6810421	299.951	299.86	-0.091	0.008281
10102	385320.3	6810356	301.911	301.82	-0.091	0.008281
10540	384596.6	6810528	302.231	302.14	-0.091	0.008281
20025	385484.1	6810399	302.661	302.57	-0.091	0.008281
10097	385372.4	6810369	301.73	301.64	-0.09	0.0081
10175	384407.1	6810609	302.11	302.02	-0.09	0.0081
10137	385145.3	6810386	304.26	304.17	-0.09	0.0081
10003	385965.1	6810274	277.999	277.91	-0.089	0.007921
20581	384749.1	6810490	300.049	299.96	-0.089	0.007921
20588	384825.2	6810475	303.529	303.44	-0.089	0.007921
10131	385205.2	6810363	303.408	303.32	-0.088	0.007744
10043	385881.3	6810302	282.527	282.44	-0.087	0.007569

10176	384397.1	6810612	302.567	302.48	-0.087	0.007569
20151	384747	6810495	300.106	300.02	-0.086	0.007396
20553	384415.4	6810602	301.646	301.56	-0.086	0.007396
10099	385352.1	6810363	301.786	301.7	-0.086	0.007396
20118	385329.4	6810357	301.856	301.77	-0.086	0.007396
20011	385335.4	6810355	301.886	301.8	-0.086	0.007396
20559	384494.3	6810577	301.926	301.84	-0.086	0.007396
20155	384611.4	6810527	302.046	301.96	-0.086	0.007396
20128	385221.1	6810360	303.106	303.02	-0.086	0.007396
20172	384440.9	6810598	300.765	300.68	-0.085	0.007225
10554	384754	6810489	300.094	300.01	-0.084	0.007056
20557	384468.8	6810585	300.914	300.83	-0.084	0.007056
20093	385590.5	6810423	301.934	301.85	-0.084	0.007056
20552	384402	6810607	302.344	302.26	-0.084	0.007056
20161	384551.5	6810555	302.694	302.61	-0.084	0.007056
10135	385164.9	6810377	303.934	303.85	-0.084	0.007056
20033	385566.6	6810418	302.553	302.47	-0.083	0.006889
20133	385170.8	6810375	303.863	303.78	-0.083	0.006889
20135	385149.8	6810384	304.163	304.08	-0.083	0.006889
20583	384772	6810485	300.362	300.28	-0.082	0.006724
20558	384481.8	6810581	301.382	301.3	-0.082	0.006724
10148	384676.4	6810516	301.862	301.78	-0.082	0.006724
10032	385934.4	6810215	275.281	275.2	-0.081	0.006561
10007	385939.1	6810305	280.441	280.36	-0.081	0.006561
10094	385403.2	6810378	301.701	301.62	-0.081	0.006561
20109	385424.7	6810384	301.821	301.74	-0.081	0.006561
10158	384573.4	6810543	302.521	302.44	-0.081	0.006561
10134	385174.8	6810373	303.821	303.74	-0.081	0.006561
10039	385983.8	6810195	273.3	273.22	-0.08	0.0064
20045	385813.7	6810372	289.529	289.45	-0.079	0.006241
20165	384512.2	6810574	302.438	302.36	-0.078	0.006084
10180	384356.9	6810625	303.808	303.73	-0.078	0.006084
10090	385445.8	6810390	302.107	302.03	-0.077	0.005929
20602	385279.6	6810402	303.797	303.72	-0.077	0.005929
20580	384737.8	6810494	300.206	300.13	-0.076	0.005776
20137	385130.7	6810393	304.546	304.47	-0.076	0.005776
20139	385110.2	6810403	305.026	304.95	-0.076	0.005776
20086	385666	6810416	297.845	297.77	-0.075	0.005625
20555	384442.2	6810594	300.725	300.65	-0.075	0.005625
20174	384410.9	6810608	301.875	301.8	-0.075	0.005625
10179	384367.1	6810622	303.555	303.48	-0.075	0.005625
10115	385312.2	6810413	303.905	303.83	-0.075	0.005625
20565	384563.7	6810544	302.534	302.46	-0.074	0.005476
10084	385505.2	6810408	303.054	302.98	-0.074	0.005476
20549	384361.5	6810620	303.634	303.56	-0.074	0.005476
20593	384880.7	6810468	304.624	304.55	-0.074	0.005476
10130	385216.2	6810361	303.203	303.13	-0.073	0.005329
20002	385247.9	6810395	304.143	304.07	-0.073	0.005329
20173	384430.6	6810601	301.012	300.94	-0.072	0.005184
10547	384673.2	6810513	301.962	301.89	-0.072	0.005184
10124	385278.9	6810358	302.192	302.12	-0.072	0.005184

10138	385135.6	6810391	304.402	304.33	-0.072	0.005184
20061	385951.9	6810288	279.201	279.13	-0.071	0.005041
20596	385049	6810429	306.171	306.1	-0.071	0.005041
10066	385696.6	6810408	295.81	295.74	-0.07	0.0049
20564	384551.7	6810551	302.639	302.57	-0.069	0.004761
20551	384388.6	6810611	302.859	302.79	-0.069	0.004761
10077	385578.7	6810422	302.288	302.22	-0.068	0.004624
10178	384377.1	6810619	303.268	303.2	-0.068	0.004624
20152	384643.5	6810520	302.137	302.07	-0.067	0.004489
20579	384726.7	6810498	300.486	300.42	-0.066	0.004356
20171	384451.4	6810595	300.626	300.56	-0.066	0.004356
10076	385589.4	6810422	301.946	301.88	-0.066	0.004356
20167	384492.7	6810581	301.805	301.74	-0.065	0.004225
20164	384521.5	6810571	302.575	302.51	-0.065	0.004225
20138	385120.2	6810398	304.805	304.74	-0.065	0.004225
10172	384437.5	6810599	300.854	300.79	-0.064	0.004096
20008	385304.5	6810352	302.134	302.07	-0.064	0.004096
20566	384575.1	6810538	302.394	302.33	-0.064	0.004096
20136	385140	6810388	304.334	304.27	-0.064	0.004096
20162	384541.4	6810560	302.733	302.67	-0.063	0.003969
20550	384375	6810615	303.293	303.23	-0.063	0.003969
20159	384571.6	6810544	302.482	302.42	-0.062	0.003844
10166	384496.7	6810580	302.001	301.94	-0.061	0.003721
10164	384516.2	6810573	302.541	302.48	-0.061	0.003721
20548	384348.1	6810625	303.971	303.91	-0.061	0.003721
20141	384922.7	6810464	305.211	305.15	-0.061	0.003721
20597	385063.8	6810422	305.97	305.91	-0.06	0.0036
20036	385599.3	6810420	301.469	301.41	-0.059	0.003481
20130	385200.4	6810364	303.459	303.4	-0.059	0.003481
10152	384633.4	6810522	302.147	302.09	-0.057	0.003249
20000	385252.5	6810412	304.417	304.36	-0.057	0.003249
10035	385957.8	6810194	273.275	273.22	-0.055	0.003025
10096	385382.3	6810371	301.715	301.66	-0.055	0.003025
20157	384590.2	6810535	302.195	302.14	-0.055	0.003025
20034	385577.7	6810419	302.233	302.18	-0.053	0.002809
10165	384506.2	6810577	302.303	302.25	-0.053	0.002809
20170	384462	6810591	300.712	300.66	-0.052	0.002704
20567	384586.8	6810532	302.232	302.18	-0.052	0.002704
20088	385644	6810420	299.181	299.13	-0.051	0.002601
10533	384388.4	6810611	302.841	302.79	-0.051	0.002601
10081	385536	6810416	303.101	303.05	-0.051	0.002601
20116	385350.8	6810362	301.76	301.71	-0.05	0.0025
20120	385307.7	6810355	301.98	301.93	-0.05	0.0025
10156	384593.2	6810534	302.21	302.16	-0.05	0.0025
20001	385245.4	6810405	304.31	304.26	-0.05	0.0025
20592	384870.5	6810469	304.57	304.52	-0.05	0.0025
10031	385929	6810224	275.959	275.91	-0.049	0.002401
10025	385886	6810298	282.039	281.99	-0.049	0.002401
20069	385933.5	6810301	280.398	280.35	-0.048	0.002304
10149	384666.4	6810518	302.068	302.02	-0.048	0.002304
20123	385274.9	6810355	302.278	302.23	-0.048	0.002304

20582	384760.6	6810488	300.106	300.06	-0.046	0.002116
20037	385609.9	6810419	300.955	300.91	-0.045	0.002025
20598	385073.3	6810417	305.825	305.78	-0.045	0.002025
10065	385707.4	6810405	295.104	295.06	-0.044	0.001936
10103	385310.1	6810355	302.043	302	-0.043	0.001849
20177	384378.8	6810618	303.183	303.14	-0.043	0.001849
20067	385920.6	6810317	281.502	281.46	-0.042	0.001764
10010	385921.4	6810330	282.292	282.25	-0.042	0.001764
20085	385676.5	6810414	297.142	297.1	-0.042	0.001764
20091	385611.6	6810422	301.002	300.96	-0.042	0.001764
20560	384506.5	6810573	302.321	302.28	-0.041	0.001681
20156	384600.8	6810531	302.07	302.03	-0.04	0.0016
20178	384368.1	6810622	303.49	303.45	-0.04	0.0016
10093	385413.4	6810381	301.739	301.7	-0.039	0.001521
20569	384610.5	6810523	302.109	302.07	-0.039	0.001521
20125	385253.2	6810356	302.509	302.47	-0.039	0.001521
20600	385285.2	6810377	302.869	302.83	-0.039	0.001521
10050	385916.8	6810235	277.198	277.16	-0.038	0.001444
10022	385873.4	6810327	284.247	284.21	-0.037	0.001369
20568	384598.6	6810527	302.137	302.1	-0.037	0.001369
10023	385876.8	6810317	283.536	283.5	-0.036	0.001296
10059	385783.7	6810381	290.626	290.59	-0.036	0.001296
10068	385675.3	6810414	297.266	297.23	-0.036	0.001296
20114	385372	6810368	301.686	301.65	-0.036	0.001296
20591	384859.2	6810471	304.546	304.51	-0.036	0.001296
20166	384502.5	6810578	302.184	302.15	-0.034	0.001156
20590	384847.9	6810472	304.414	304.38	-0.034	0.001156
10036	385987.2	6810199	273.432	273.4	-0.032	0.001024
20068	385925.5	6810308	280.912	280.88	-0.032	0.001024
10092	385423.6	6810384	301.812	301.78	-0.032	0.001024
20571	384634.5	6810518	302.152	302.12	-0.032	0.001024
20563	384540.7	6810557	302.642	302.61	-0.032	0.001024
10095	385392.3	6810374	301.69	301.66	-0.03	0.0009
20561	384518.3	6810568	302.55	302.52	-0.03	0.0009
20601	385284.2	6810392	303.42	303.39	-0.03	0.0009
20179	384357.5	6810625	303.759	303.73	-0.029	0.000841
20072	385931.5	6810322	281.468	281.44	-0.028	0.000784
20578	384715.7	6810503	300.698	300.67	-0.028	0.000784
20009	385314.6	6810352	302.008	301.98	-0.028	0.000784
10118	385272.6	6810410	303.988	303.96	-0.028	0.000784
20603	385271.6	6810409	303.988	303.96	-0.028	0.000784
20019	385418.3	6810378	301.707	301.68	-0.027	0.000729
20095	385569.7	6810422	302.557	302.53	-0.027	0.000729
10038	385974.2	6810191	273.176	273.15	-0.026	0.000676
20570	384622.5	6810520	302.096	302.07	-0.026	0.000676
10082	385525.7	6810413	303.216	303.19	-0.026	0.000676
10046	385891.7	6810275	280.565	280.54	-0.025	0.000625
20575	384681.2	6810511	301.605	301.58	-0.025	0.000625
20169	384472.4	6810588	300.944	300.92	-0.024	0.000576
10091	385434.6	6810387	301.933	301.91	-0.023	0.000529
20574	384669.7	6810513	301.963	301.94	-0.023	0.000529

20176	384389.6	6810615	302.803	302.78	-0.023	0.000529
20058	385971.3	6810265	277.232	277.21	-0.022	0.000484
20554	384428.8	6810598	301.082	301.06	-0.022	0.000484
20112	385393.2	6810375	301.662	301.64	-0.022	0.000484
20113	385382.6	6810372	301.672	301.65	-0.022	0.000484
10053	385937.7	6810212	274.911	274.89	-0.021	0.000441
10116	385302.2	6810412	303.881	303.86	-0.021	0.000441
10006	385945.2	6810297	279.85	279.83	-0.02	0.0004
10026	385891	6810289	281.34	281.32	-0.02	0.0004
20153	384632.9	6810522	302.1	302.08	-0.02	0.0004
20079	385738	6810396	293.159	293.14	-0.019	0.000361
20107	385445.2	6810390	302.047	302.03	-0.017	0.000289
20104	385476.4	6810400	302.597	302.58	-0.017	0.000289
20013	385355.3	6810360	301.776	301.76	-0.016	0.000256
10064	385718.1	6810402	294.455	294.44	-0.015	0.000225
20149	384768.5	6810490	300.145	300.13	-0.015	0.000225
20577	384704.4	6810507	300.875	300.86	-0.015	0.000225
10079	385556.2	6810420	302.855	302.84	-0.015	0.000225
20087	385655.1	6810418	298.493	298.48	-0.013	0.000169
20015	385376.4	6810366	301.773	301.76	-0.013	0.000169
10120	385261.4	6810390	303.913	303.9	-0.013	0.000169
20059	385964.7	6810273	277.912	277.9	-0.012	0.000144
20573	384658.1	6810515	302.131	302.12	-0.011	0.000121
20083	385696.6	6810409	295.75	295.74	-0.01	0.0001
10067	385685.9	6810411	296.588	296.58	-0.008	0.000064
20005	385273.9	6810380	303.398	303.39	-0.008	0.000064
20082	385706.3	6810406	295.177	295.17	-0.007	0.000049
20108	385435	6810387	301.927	301.92	-0.007	0.000049
10080	385546.2	6810418	303.037	303.03	-0.007	0.000049
20595	385019	6810442	306.157	306.15	-0.007	0.000049
20018	385408.3	6810376	301.646	301.64	-0.006	0.000036
20119	385318.6	6810356	301.886	301.88	-0.006	0.000036
10089	385455.4	6810393	302.216	302.21	-0.006	0.000036
10112	385323.9	6810395	303.675	303.67	-0.005	0.000025
20594	384890.7	6810466	304.625	304.62	-0.005	0.000025
10019	385866	6810357	286.343	286.34	-0.003	0.000009
20026	385493.8	6810402	302.803	302.8	-0.003	0.000009
10060	385771.3	6810385	291.212	291.21	-0.002	0.000004
20106	385455.1	6810393	302.22	302.22	0	0
20060	385958.3	6810280	278.539	278.54	0.001	0.000001
10071	385642.7	6810420	299.299	299.3	0.001	0.000001
10563	385271.5	6810412	304.097	304.1	0.003	0.000009
10073	385620.1	6810422	300.564	300.57	0.006	0.000036
20099	385528.2	6810414	303.134	303.14	0.006	0.000036
20012	385345.2	6810358	301.802	301.81	0.008	0.000064
10110	385303.5	6810393	303.56	303.57	0.01	0.0001
20062	385947.6	6810298	279.818	279.83	0.012	0.000144
20150	384758.6	6810492	300.008	300.02	0.012	0.000144
20576	384692.8	6810509	301.198	301.21	0.012	0.000144
20105	385464.9	6810396	302.358	302.37	0.012	0.000144
10125	385269.1	6810355	302.337	302.35	0.013	0.000169

10000	385976.7	6810191	273.226	273.24	0.014	0.000196
20089	385632.6	6810421	299.823	299.84	0.017	0.000289
20035	385588.3	6810420	301.893	301.91	0.017	0.000289
10057	385997.3	6810216	274.122	274.14	0.018	0.000324
10122	385277.9	6810379	303.132	303.15	0.018	0.000324
10117	385282.6	6810409	303.932	303.95	0.018	0.000324
20572	384646.3	6810516	302.171	302.19	0.019	0.000361
10054	385943.4	6810204	274.049	274.07	0.021	0.000441
20053	385937.2	6810210	274.819	274.84	0.021	0.000441
20039	385632.1	6810418	299.768	299.79	0.022	0.000484
20147	384790.2	6810485	301.078	301.1	0.022	0.000484
20016	385387.3	6810370	301.658	301.68	0.022	0.000484
10111	385313.7	6810393	303.638	303.66	0.022	0.000484
20065	385934.9	6810325	281.496	281.52	0.024	0.000576
10030	385924	6810233	276.655	276.68	0.025	0.000625
20014	385365.6	6810363	301.745	301.77	0.025	0.000625
20022	385448	6810388	302.075	302.1	0.025	0.000625
20122	385285.8	6810354	302.164	302.19	0.026	0.000676
10088	385465.1	6810396	302.363	302.39	0.027	0.000729
10123	385280.9	6810368	302.502	302.53	0.028	0.000784
10121	385271	6810387	303.551	303.58	0.029	0.000841
20052	385932.7	6810219	275.51	275.54	0.03	0.0009
20127	385231.6	6810358	302.899	302.93	0.031	0.000961
20027	385503.5	6810405	302.949	302.98	0.031	0.000961
20030	385534.2	6810413	303.028	303.06	0.032	0.001024
20029	385523.1	6810410	303.068	303.1	0.032	0.001024
10034	385948	6810199	273.686	273.72	0.034	0.001156
20073	385923.3	6810329	282.104	282.14	0.036	0.001296
10024	385881.2	6810308	282.804	282.84	0.036	0.001296
10087	385474.9	6810399	302.574	302.61	0.036	0.001296
20057	385995.1	6810209	273.833	273.87	0.037	0.001369
10015	385891.8	6810379	285.652	285.69	0.038	0.001444
20023	385457.9	6810391	302.222	302.26	0.038	0.001444
20048	385892.3	6810288	281.077	281.12	0.043	0.001849
10069	385664.5	6810416	297.946	297.99	0.044	0.001936
20020	385428.2	6810381	301.781	301.83	0.049	0.002401
10029	385918.5	6810242	277.449	277.5	0.051	0.002601
20066	385924.5	6810326	281.899	281.95	0.051	0.002601
20084	385686.7	6810411	296.489	296.54	0.051	0.002601
20092	385601.1	6810423	301.469	301.52	0.051	0.002601
20050	385901.9	6810270	279.758	279.81	0.052	0.002704
20098	385538.1	6810416	303.067	303.12	0.053	0.002809
20041	385773.8	6810381	291.005	291.06	0.055	0.003025
20096	385558.9	6810420	302.825	302.88	0.055	0.003025
20071	385939.5	6810316	280.873	280.93	0.057	0.003249
10114	385322.4	6810410	303.973	304.03	0.057	0.003249
20004	385264.8	6810384	303.88	303.94	0.06	0.0036
20024	385467.8	6810394	302.349	302.41	0.061	0.003721
20003	385255.6	6810389	304.097	304.16	0.063	0.003969
10070	385653.7	6810418	298.645	298.71	0.065	0.004225
10009	385926.7	6810321	281.654	281.72	0.066	0.004356

20101	385507.5	6810409	303.053	303.12	0.067	0.004489
20031	385545	6810415	302.941	303.01	0.069	0.004761
10562	385037.5	6810434	306.05	306.12	0.07	0.0049
20124	385264	6810355	302.419	302.49	0.071	0.005041
10119	385262.5	6810412	304.119	304.19	0.071	0.005041
20032	385555.8	6810417	302.775	302.85	0.075	0.005625
10017	385872	6810375	286.604	286.68	0.076	0.005776
20100	385518	6810411	303.163	303.24	0.077	0.005929
10113	385329.9	6810403	303.973	304.05	0.077	0.005929
20043	385793.5	6810376	290.152	290.23	0.078	0.006084
10075	385599.8	6810422	301.532	301.61	0.078	0.006084
20051	385930.1	6810229	276.17	276.25	0.08	0.0064
20064	385941.1	6810317	280.89	280.97	0.08	0.0064
10561	384883.9	6810467	304.498	304.58	0.082	0.006724
10062	385744.9	6810394	292.727	292.81	0.083	0.006889
10018	385865.7	6810367	286.845	286.93	0.085	0.007225
10037	385994.3	6810207	273.644	273.73	0.086	0.007396
20047	385887	6810296	281.854	281.94	0.086	0.007396
20080	385727.5	6810399	293.884	293.97	0.086	0.007396
10044	385878.9	6810292	282.128	282.22	0.092	0.008464
20046	385873.7	6810325	284.097	284.19	0.093	0.008649
20097	385548.6	6810419	302.956	303.05	0.094	0.008836
10042	385891.5	6810301	281.885	281.98	0.095	0.009025
20049	385896.9	6810278	280.382	280.48	0.098	0.009604
10016	385881.7	6810378	286.131	286.23	0.099	0.009801
10078	385567.7	6810421	302.61	302.71	0.1	0.01
10008	385932.8	6810313	281.018	281.12	0.102	0.010404
10055	385969.6	6810192	273.185	273.29	0.105	0.011025
20075	385913.4	6810347	283.353	283.46	0.107	0.011449
10086	385484.9	6810402	302.729	302.84	0.111	0.012321
20021	385438.2	6810385	301.938	302.05	0.112	0.012544
20102	385497.6	6810406	302.915	303.03	0.115	0.013225
20090	385622.1	6810422	300.414	300.53	0.116	0.013456
10128	385237.3	6810358	302.754	302.87	0.116	0.013456
20040	385763.9	6810384	291.569	291.69	0.121	0.014641
10061	385760.8	6810388	291.839	291.96	0.121	0.014641
20042	385783.7	6810378	290.512	290.64	0.128	0.016384
20063	385945.1	6810308	280.341	280.47	0.129	0.016641
20078	385748.1	6810393	292.558	292.69	0.132	0.017424
20074	385917.7	6810337	282.68	282.82	0.14	0.0196
20028	385513.3	6810408	303.027	303.17	0.143	0.020449
10058	385803.8	6810377	289.704	289.85	0.146	0.021316
10063	385734.2	6810397	293.391	293.55	0.159	0.025281
20070	385942.6	6810306	280.336	280.5	0.164	0.026896
20077	385767.9	6810386	291.401	291.57	0.169	0.028561
20054	385944.4	6810202	273.77	273.94	0.17	0.0289
10021	385870.8	6810337	284.76	284.93	0.17	0.0289
10012	385909.4	6810356	283.846	284.02	0.174	0.030276
20076	385909.4	6810357	283.95	284.13	0.18	0.0324
20056	385963.2	6810195	273.095	273.29	0.195	0.038025
20044	385803.5	6810373	289.689	289.9	0.211	0.044521

10013	385905.4	6810366	284.475	284.7	0.225	0.050625
10020	385868.2	6810347	285.484	285.73	0.246	0.060516
10041	385996.3	6810212	273.746	274.04	0.294	0.086436
10011	385916.4	6810339	282.613	282.94	0.327	0.106929
20055	385952.9	6810197	273.04	273.49	0.45	0.2025