

# **SURVEY REPORT**

FOR

## **VALDEZ, ALASKA LOW ALTITUDE LIDAR**

**AERO-METRIC, INC.**

**June 2009**

**USGS CONTRACT NO. 07CRCN0002**

**USGS TASK ORDER NO: 070020009**

## Table of Contents

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Overview .....	1
Lidar Acquisition Planning.....	1
Lidar Acquisition.....	1
Lidar Processing .....	2
Lidar Accuracy .....	3
Deliverables.....	4
Conclusions .....	4

## Overview

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During 2007, the United States Geological Survey (USGS) awarded the contract number 07CRCN0002 to Aero-Metric, to provide aerial imagery and lidar acquisition, and digital orthophoto production. This report will focus on the low altitude/high resolution lidar acquisition portion of the contract. High altitude/ low resolution lidar was also collected for this contract and will be discussed in another report.

On October 16, 2007 airborne lidar was collected to acquire some of the high resolution lidar area. This mission was named 43Q28907A. Other missions were flown in 2007 to collect high resolution lidar, but due to sensor malfunctions, the data collected was found to be of unacceptable quality.

Optech repaired the sensor and tests have shown the system is operating properly. The remainder of the project was acquired in October of 2008.

## Lidar Acquisition Planning

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The lidar data for this project was collected with Aero-Metric's Optech Gemini-167 Airborne lidar system (Serial Number 03SEN145). All flight planning and acquisition was completed using Optech's ALTM-Nav, version 1.0.67b (flight planning and lidar control software). All flight lines were flown with 55% side lap in order to achieve 0.30-meter nominal point spacing. The following are the planned lidar settings for acquiring the data for this project.

- Flying Height (Above Ground): 1800 meters
- Laser Pulse Rate: 70 kHz
- Mirror Scan Frequency: 62.6 Hz
- Scan Angle (+/-): 5.3°
- Side Lap: 55 %
- Ground Speed: 145 kts

## Lidar Acquisition

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The lidar data for this portion of this project was acquired during leaf-off and minimal snow conditions. The following are the dates and mission names of the data acquisition.

1. October 16, 2007 (43Q28907A)
2. October 20, 2008 (6GR29408B)
3. October 25, 2008 (6GR29908A)
4. October 31, 2008 (6GR30508B)

Two dual frequency GPS receivers were set up by Aero-Metric during the acquisition phase of this project. Both receivers were located at the Valdez airport, which is situated centrally in the project area. These receivers, along with the National Geodetic Service's (NGS) Continually Operating Reference Station (CORS) POT5 provided a basis for the airborne GPS/IMU (ABGPS/IMU) processing. For more information on the airborne GPS/IMU processing, see the report titled: *Airborne GPS/IMU Accuracy Report for Valdez, Alaska Low Altitude Lidar*, by Aero-Metric, dated June 2009.

## **Lidar Processing**

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The raw lidar data was merged with the processed ABGPS/IMU data using Optech's DASHMap version 3.005. Each flight line was computed individually in LAS 1.1 format.

Final system misalignment and mirror scale corrections were computed using TerraSolid's TerraMatch version 6.005. These corrections were applied to all of the data collected in a mission. Once all of the biases were removed from the data from each mission, all of the data were combined into one dataset.

Automated classification algorithms in TerraSolid's TerraScan, version 8.001 were used to produce the majority of the bare-earth dataset. The remainder of the data was classified using manual classification techniques.

The shorelines of the lakes and port areas were determined manual techniques, starting with digitized shorelines from the orthophotography of the project area. The lidar points then underwent an intensive manual edit to determine with greater accuracy the points which represented the water surface. For the final data products the mean elevation of the water on each lake was used to determine its fixed elevation. The port area's fixed elevation was determined using the highest water point in the port dataset. This value was found to be 4.72 meters. All points below 4.72 meters in the port area were fixed to this elevation, as per the contract.

Upon completion of the bare-earth dataset the final deliverable products were produced. Automation software created by Aero-Metric was used to produce the metadata on a per-tile basis.

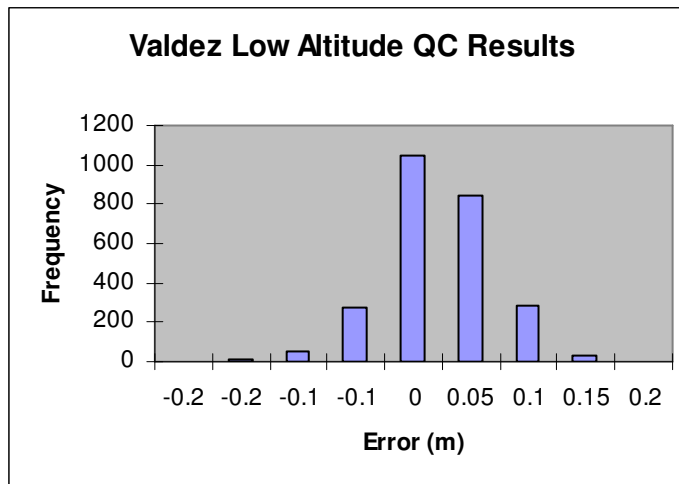
## Lidar Accuracy

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The final lidar dataset was verified using 2554 GPS surveyed ground truth points. These points were collected by Aero-Metric along the roads throughout the developed areas of the project, using Real-Time Kinematic (RTK) GPS techniques. The ground truth points were compared against the lidar using TerraScan, which computes the difference between each ground truth point and the lidar generated surface. These differences are recorded in an output file in ASCII format. This file is imported into Microsoft Excel, where a statistical analysis is performed. The full lidar control check analysis is included in the deliverables for this project, named Valdez\_Low\_Altitude\_QC\_Results.pdf

The ground truth data is located on the delivered hard drive, in ASCII format, named Valdez\_Road\_Profile\_UTM6m\_G06\_PENZ.txt

For this dataset the vertical accuracy, assessed at the 95% confidence interval ( $1.96 \times \text{RMSE}$ ) was 0.092 meters, on hard surfaces.



**Figure 1: Histogram of QC data check**

## Deliverables

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**Point Cloud Data:** All returns in LAS format and American Standard Code for Information interchange (ASCII), comma delimited, Class, X, Y, Z format. The tile size is 1 km x 1 km.

**Bare-Earth Processed Elevation Data (Surface Model):** Derived from the bare-earth processed data is in ASCII, comma delimited format. The following are the deliverable parameters:

- Grid Resolution: 0.3 meter
- Bare-earth surface includes the top of water bodies, not underwater terrain.
- Elevation values within open water have been flattened to the best estimate of surface water level.
- The tile size is 1 km x 1 km.

**First Return Processed Elevation Data (Surface Model):** Raster of the first return surface where cell heights are highest recorded value within each cell. Voids have been filled with bare-earth surface data. The following are the deliverable parameters:

- Grid Resolution: 1 meter 16 bit floating point GeoTIFF format.
- The tile size is 1 km x 1 km.
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**Intensity Image:** 1-meter resolution, 8-Bit GeoTIFF with corresponding world (\*.tfw) file of the 1<sup>st</sup> return data.

**Supplemental Ground Control:** Ground truth data used to verify the accuracy of the lidar data, in ASCII comma delimited format, Point Number, Easting, Northing, Elevation. The data is in the project datum.

**Airborne GPS/IMU Data:** 200 Hz Smoothed Best Estimated Trajectory data for each mission flown, in binary format.

**FDGC Compliant Metadata:** Tile level metadata for all delivered lidar datasets, in .xml format.

**Lidar Index:** An index depicting the tiling scheme of all the lidar data collected for this project. Multiple data formats were delivered: .dwg, .dxf, .dgn, and .pdf.

## Conclusions

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The lidar data included in this delivery was acquired for a planned point spacing of approximately 0.30 meter. The vertical accuracy, assessed at the 95% confidence interval was 0.092 meters, on hard, open surfaces. The accuracy of the lidar data was not verified on all surface types, and accuracies may be degraded in areas of steep terrain or heavy vegetation.