QUALITY ASSESSMENT REPORT

N5745W13645P

LOWER SOUTHEAST
ALASKA MID ACCURACY DEM

October 7, 2014

Prepared by

Fugro Earthdata Inc
7320 Executive Way
Frederick, MD 21704
301-948-8550
www.fugroearthdata.com

Section 1 – Fugro EarthData - ISO9001:2008

Fugro EarthData, Inc., located in Frederick, Maryland, has developed and implemented a quality, health & safety, and environmental (QHSE) system to better satisfy the needs of its customers and employees, and to aid in the management and growth of the company.

With innovation and quality as guiding principles, Fugro EarthData uses advanced technologies and ISO 9001:2008-certified quality system mandates to expand traditional mapping and GIS applications. From mainstreaming airborne GPS into orthophoto production to developing a dual-band IFSAR mapping system, Fugro EarthData continuously improves services that benefit customers in every market segment.

The original certificate of registration to ISO 9001:1994 was received in April of 2000, revised to ISO 9001:2000 in October of 2003 and revised to ISO 9001:2008 in March of 2013.

Quality Control and Assurance

A key component to the effectiveness of Fugro EarthData's quality management system is the ongoing process of auditing and updating production and management procedures and related tools. In a business where technology and the associated production processes are constantly changing and improving, it is imperative that procedures, forms, and metrics are constantly reviewed and updated. The following are key components to Fugro EarthData's quality management system that are an integral part of Fugro EarthData's approach to this project:

- **Criteria for Remedial Action** - Production processes are based on decades of successful completion of projects and contain elements that have been incorporated in response to both internal and customer specified requests. Any time a new specification or new production process is introduced; the criteria for remedial action must be reviewed and modified to reflect a change in approach.
- **Remedial Actions** - Any quality issue is of immediate concern and must be mitigated at the earliest possible opportunity in order to maintain the project's production schedule. The quality management system has procedures that are part of the project management process to verify that the project plan has addressed all of the project's specifications, which eliminates many quality-related issues as the project progresses.
- **Verification Criteria** - The quality management system contains an array of metrics which are used to monitor cycle times for each production process as well as time expended for rework. These existing tools will

provide a means to verify that the quality issue has been successfully mitigated. The level of inspection can also be varied throughout the life of the project in response to different issues that may arise.

- **Notification** - Technical staff members will evaluate and solve an array of problems that will occur throughout the life of any project and will document the nature of the problem and the process used to resolve the problem. In the vast majority of these cases, the quality of the end product is not affected and the delivery schedule is not disrupted. Open communication is a key element of Fugro EarthData's procedure for project management and Dewberry will be immediately informed of any quality issues that will affect the project schedule. Fugro EarthData is committed to the delivery of data products that meet all aspects of the project specifications for quality and accuracy.
- **Commitment to Quality** - Each aspect of Fugro EarthData's quality management plan addresses issues that affect the project schedule as opposed to the quality of the resulting products. Fugro EarthData is committed to providing Dewberry and USGS with products that are of the highest possible standards regardless of any issues that may arise.

Certificate of Registration

nqa global assurance

This is to certify that the Quality Management System of:

Fugro EarthData, Inc.

7320 Executive Way
Frederick, MD 21704

(See appendix for additional locations)

applicable to:

Design, development and production of spatial data, mapping and geographic information systems technologies and services

has been assessed and approved by
National Quality Assurance, U.S.A., against the provisions of:

ISO 9001: 2008

For and on behalf of
NQA, USA, 4 Post Office Square,
Acton, MA 01720

ANAB ACCREDITED

Certificate Number: 10569
EAC Code: 33, 34
First Issued: April 15, 2000
Valid Until: March 1, 2016
Reissued: March 1, 2013

Certificate of Registration

nqa global assurance

Appendix to Certificate Number 10569

Includes Facilities Located at:

Fugro EarthData, Inc.
Certificate Number 10569
7320 Executive Way
Frederick MD 21704
US

Design, development and production of spatial data, mapping and geographic information systems technologies and services

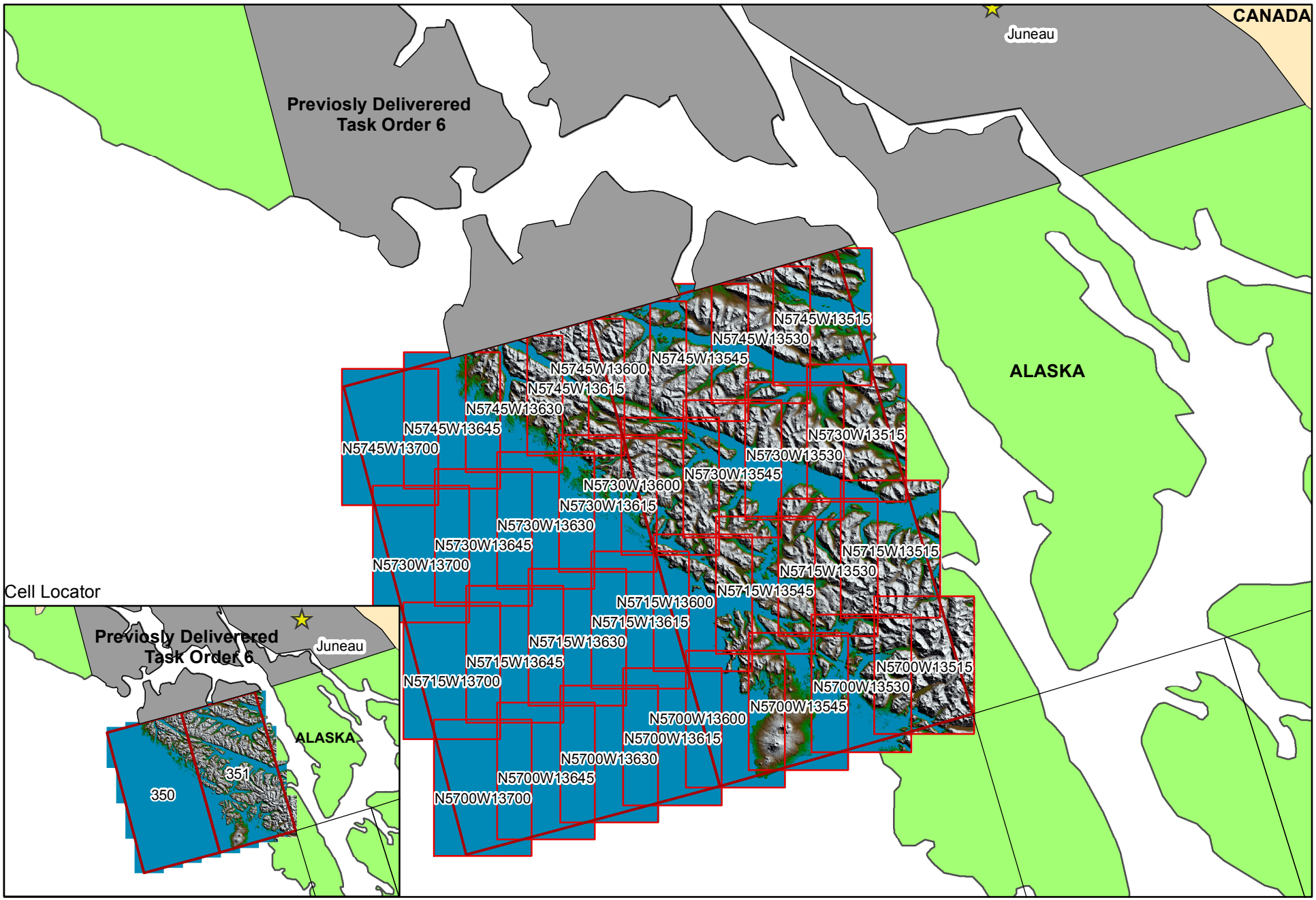
Fugro EarthData, Inc.
Certificate Number 10569
18227 Airpark Drive
Hagerstown MD 21742
US

Acquisition of spatial data

First Issued: April 15, 2000
Valid Until: March 1, 2016
Reissued: March 1, 2013

Section 2 - Delivery Area
Lower SouthEast Tiles
Cell 350 and 351

Total Area of Deliverable AOI: 13353.5 sqkm



Section 3 – Project Inspection Overview

Data Quality Information

- **Horizontal and Vertical Accuracy Validation** - Prior to acquisition ground reflectors were placed in project area and surveyed for their precise location. Proprietary Fugro EarthData software is used to locate reflector sites in GeoSAR DTM and DSM. Reflector locations in GeoSAR DTM and DSM are compared to surveyed ground locations using proprietary Fugro EarthData software to evaluate horizontal and vertical accuracy.

  LiDAR profiler data is automatically filtered to select points in open terrain throughout the project area. The filtered LiDAR data set is then used as control points in analyzing the vertical accuracy of GeoSAR DTM and DSM. Proprietary Fugro EarthData software is utilized for comparing the GeoSAR DTM and DSM to LiDAR control points.

Reflector

- **Establishment of Base Station** - Fugro EarthData established a fixed base station used for differential global positioning of the aircraft during acquisition. The base station was located at Ted Stevens Anchorage International Airport and the FBO was at Million Air in Anchorage Alaska. Precise Latitude 61 09 51.93 (dms), Longitude -149 58 51.93 (dms), Ellipsoidal Height 75.91 (m).

- **Acquisition Inspections** - Once the motion data and respective raw data were collected and delivered, an initial quality check was performed. Preliminary MMP (Motion Measurement Processing) is a proprietary program in which the motion data of each segment was analytically viewed in graphical form for the determination of which data was within specifications and therefore should be used in product. At this point the acceptable raw data were registered to the motion data as 32 bit magnitude and elevation files and were ready to be unwrapped, viewed, and edited.

- **Processing Inspections** - The data is checked for completeness by ensuring that the GeoSAR DEM, ORI, DTM and DSM cover the entire project area. The

signatures of the instances of void occurrences in the DEM are recorded in the void shapefiles for each tile. These voids in the GeoSAR DEM are filled by interpolation or adjusted NED data using proprietary Fugro EarthData software.

Any anomalies in the GeoSAR DEM such as noise, spikes or wells are remediated during a DEM inspection. Proprietary Fugro EarthData software is used to remove identified pixels and interpolate the voids; ensuring logical consistency of the GeoSAR DEM. LiDAR profiler data is used to validate the consistency of the GeoSAR DEM. The GeoSAR DEM, GeoSAR ORI, GeoSAR DTM and GeoSAR DSM are computed using the same bundle adjustment to ensure co-registration between products.

Section 4 – Accuracy Requirements

Void Percentage

After the mosaic process was completed, any remaining voids were identified and filled with GeoSAR interpolation. The percentage of the 15' tile that has been filled is as follows:

N5745W13645P	% of Tile
Total Voids	0.010

Vertical Accuracy

The available LiDAR profiler data collected in the project area during acquisition was processed and run through a proprietary ground control extraction. The process removes blunder points (clouds, low returns, etc…) to create a sub-set of points. This LiDAR sub-set (322 points in the deliverable area) was then intersected with the slope mask to calculate to the accuracy statistics then entire deliverable AOI based on the slope.

Accuracy Summary	**DSM Vertical RMSE**	**DTM Vertical RMSE**
Deliverable RMSE	1.355 m	1.143 m
Specification RMSE	1.85 m	1.85 m
Status	**Pass**	**Pass**

DSM – LiDAR

Slope	**0˚-10˚**	**10-20˚**	**20-30˚**	**Above 30˚**	**Overall**
Number of points	19	2	0	0	21
Standard Deviation (m)	0.934	0.310	-	-	0.898
Mean Difference (m)	-0.982	-1.268	-	-	-1.009
RMSE (m)	1.355	1.306	-	-	1.351

DTM – LiDAR

Slope	0˚-10˚	10-20˚	20-30˚	Above 30˚	Overall
Number of points	19	2	0	0	21
Standard Deviation (m)	0.895	0.363	-	-	0.871
Mean Difference (m)	-0.710	-1.216	-	-	-0.759
RMSE (m)	1.143	1.269	-	-	1.155

The accuracy of the data was also compared against collected ground control points and reflectors.

DSM – Ground Control

	Overall
Number of points	**2**
Standard Deviation (m)	**0.089**
Mean Difference (m)	**-0.534**
RMSE (m)	**-0.541**

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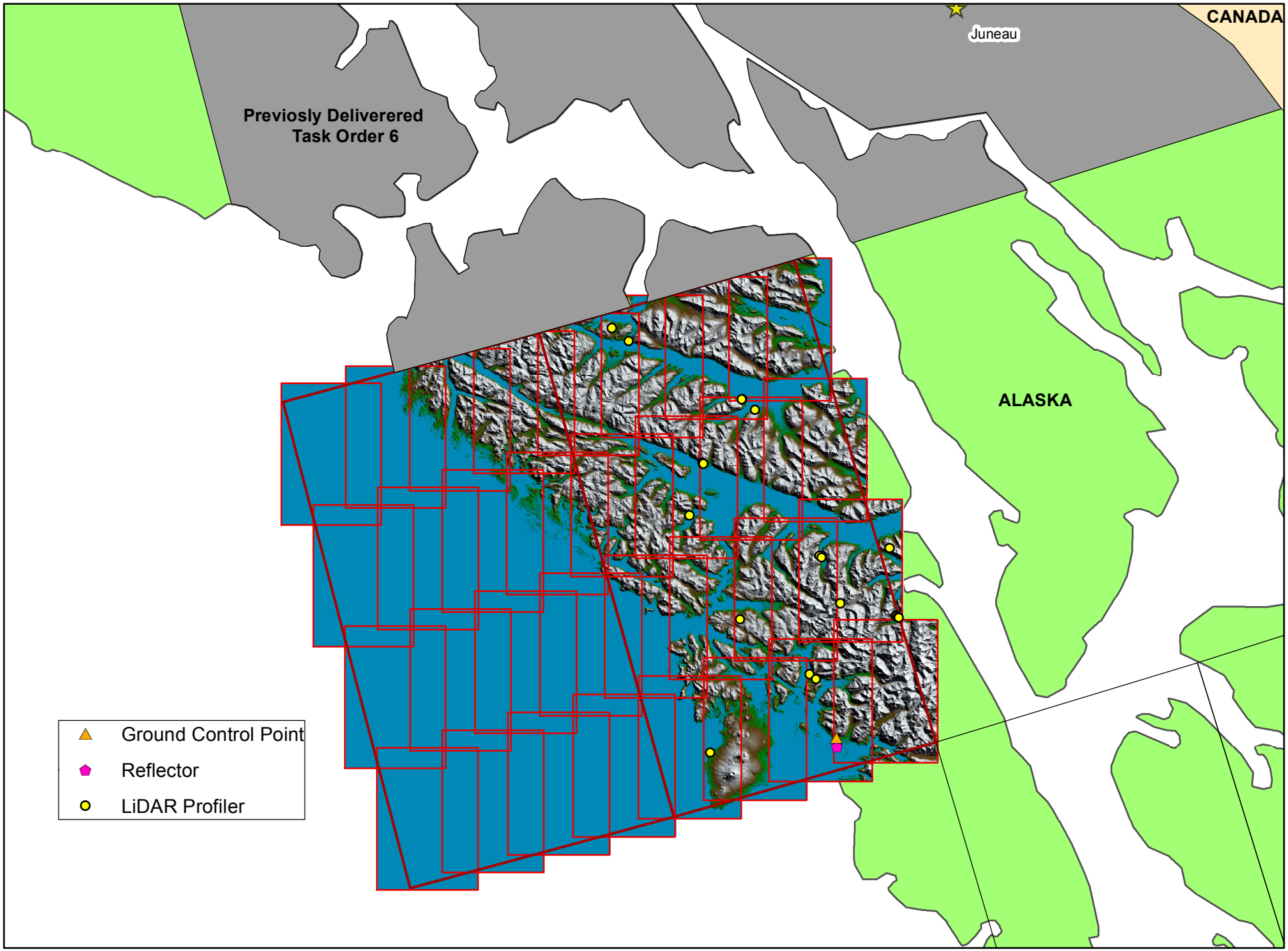
DTM – Ground Control

	Overall
Number of points	**2**
Standard Deviation (m)	**0.858**
Mean Difference (m)	**0.413**
RMSE (m)	**0.952**

Ground Control



FUGRO EARTHDATA, INC.

Data Review Report HD01-09-00-02

Cover Sheet

Alaska Mid-Accuracy DEM

On 10/7/2014 a review was completed on Tile N5745W13645P. This review was completed by the undersigned. Data recorded on the following pages has been recorded as evidence of the criteria validated during this review. Notation of Pass/Fail relative to meeting said criteria has been noted.

The undersigned recommends shipment of N5745W13645P. based on its ability to meet the criteria established for the contract.

Ben Downey	_____	Date: 10/7/2014
[Insert Reviewer Name]	_____	Date: _____
[Insert Reviewer Name]	_____	Date: _____
[Insert Reviewer Name]	_____	Date: _____

Summary Report:

FUGRO EARTHDATA, INC.

Data Review Report HD01-09-00-02

Overall Review

Tile Number: N5745W13645P

Assessor(s): Ben Downey

Data Format

Image displays in the correct position as indicated by the file name and the tile diagram	**Pass**	BD	10/7/2014
Horizontal Datum - NAD83 CORS96 EPOCH 2003.0 Alaska Albers	**Pass**	BD	10/7/2014
Vertical Datum - NAVD88 GEOID 09 Alaska Albers	**Pass**	BD	10/7/2014
Elevation Data - Orthometric Height	**Pass**	BD	10/7/2014
Image overlays correctly with the adjoining images	**Pass**	BD	10/7/2014
Minimum 350 meters of overlap in X and Y	**Pass**	BD	10/7/2014
File Size - 200MB or less when compressed (zipped)	**Pass**	BD	10/7/2014
Tile Size - 15 minute quadrangle	**Pass**	BD	10/7/2014
Data Voids - For Alaska Albers projection the void value shall be - 10,000 and for geographic projection shall be -32767. These areas must be identified in the quality mask.	**Pass**	BD	10/7/2014

Review of Controls Reports against:

1) LiDAR profile data	**Pass**	BD	10/7/2014
2) NED data	**Pass**	BD	10/7/2014

Total Criteria Pass:	11
Total Criteria Fail:	0
Overall Acceptance:	**Pass**

Comments in relation to tile acceptance:

Data Review Report HD01-09-00-02

Tile Review

Tile Number: N5745W13645P

Project Name: Alaska Mid-Accuracy DEM

1. DSM - Digital Surface Model

5 meter post spacing	**Pass**	BD	10/7/2014
Vertical accuracy 3 meters - 90% confidance for 1-10° slope	**Pass**	BD	10/7/2014

[Insert section 1 comments if applicable or enter N/A]

2. DTM - Digital Terrain Model

5 meter post spacing	**Pass**	BD	10/7/2014
Vertical accuracy 3 meters - 90% confidance for 1-10° slope	**Pass**	BD	10/7/2014

[Insert section 2 comments if applicable or enter N/A]

3. Slope Mask

Shape File / Polygons			**Pass**	BD	10/7/2014
Slope Classification			**Pass**	BD	10/7/2014
Terrain	*Slope*	*Max Interp-Pixels*			
Low	0-10°	100	**Pass**	BD	10/7/2014
Mod	>10-20°	50	**Pass**	BD	10/7/2014
High	>20-30°	30	**Pass**	BD	10/7/2014
Extreme	>30°	16	**Pass**	BD	10/7/2014
Void Percentage Not Greater than 5% per 15' tile			**Pass**	BD	10/7/2014

4. ORI - Orthorectified Radar Image

5 meter pixels - GeoTiff Format - 8bit	**Pass**	BD	10/7/2014
RMSE - all not exceed 5.682 meters	**Pass**	BD	10/7/2014
Shall Match Adjacent Tiles Radiometrically	**Pass**	BD	10/7/2014

[Insert section 4 comments if applicable or enter N/A]

5. Hydro Enforcement

Monotonicity	**Pass**	BD	10/7/2014
Lakes - Length Greater than 150m - Width Greater than 50m - constant elevation at least 1m below surrounding terrain	**Pass**	BD	10/7/2014
Double Line Drains Greater than 50m extending 150m or more in length -at least 1m below surrounding terrain	**Pass**	BD	10/7/2014
Coastal Water shall be set to Zero meters	**Pass**	BD	10/7/2014
Coastal Shorelines must be continueous no gaps	**Pass**	BD	10/7/2014
Islands are greater than 30m in length shall be capture - Bare earth height greater than 10meters above water	**Pass**	BD	10/7/2014

[Insert section 5 comments if applicable or enter N/A]

6. HRTe3 Format

30 minute quadrangle	Select...		

[Insert section 6 comments if applicable or enter N/A]

7. Metadata

FGDC Compliant	**Pass**	BD	10/7/2014
Swath Locator Diagram w/grid of Qtr Quad w/project area key map	**Pass**	BD	10/7/2014
Swath collection time must be include along with flight bearing	**Pass**	BD	10/7/2014
Formats		BD	10/7/2014
.xlm	**Pass**	BD	10/7/2014
.html	**Pass**	BD	10/7/2014
.txt	**Pass**	BD	10/7/2014

[Insert section 7 comments if applicable or enter N/A]

8. File Naming

Name Compliant	**Pass**	BD	10/7/2014

[Insert section 8 comments if applicable or enter N/A]

Total Criteria Pass:	27
Total Criteria Fail:	0
Tile Acceptance:	**Pass**

Comments in relation to tile acceptance: