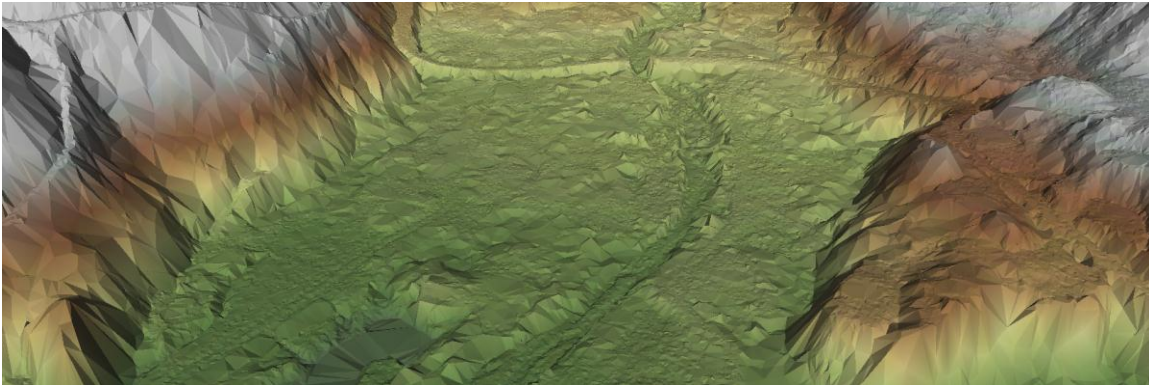




FEMA

Risk Mapping, Assessment, and Planning
(Risk MAP) Fiscal Year 2011

Elevation Data Quality Assurance Report for Cordova, Alaska December 30, 2011



Submitted to:

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Cordova Alaska Independent Quality Assurance Report
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1.0 EXECUTIVE SUMMARY

Under FEMA task order HSFE10-11-J-00076 STARR has completed elevation data acquisition for Cordova, Alaska. The goal of this project is to create a classified bare-earth digital terrain dataset with a vertical accuracy Root Mean Square Error of 18.5cm capable of supporting 2 foot contours.

2.0 OVERVIEW

STARR partner Greenhorne and O'Mara performed an independent quality assurance review on the All Return Point Cloud and Bare Earth datasets. This validates the quality of LiDAR data for use in Risk MAP projects that support the National Flood Insurance Program. This document summarizes the review process and results for Cordova Alaska.

2.1 Project Requirements

The following table summarizes the project requirements for data acquisition based upon the agreed upon scope of work under FEMA task order HSFE10-11-J-00076.

Table 15 LiDAR Project Requirements

FEMA Region 10 Cordova, Alaska LiDAR Acquisition	
Collection/Processing Area	32 square miles
Breaklines Required	No
Specification Level	Highest
Nominal Pulse Spacing	1 m
DEM Post Spacing	2 m DEM with 2 ft. contour accuracy
Vertical Accuracy, 95% Confidence Level FVA/CVA	24.5 cm/ 36.3 cm
Coordinate System	UTM Zone 6N
Horizontal Datum and Linear Units	NAD 83 Meters
Vertical Datum and Linear Units	NAVD 88 US Survey Foot

2.2 Guidelines and Specifications

All quality assurance activities completed for this project are in accordance with guidelines and specifications identified below.

Table 16 Guidance and QA Activities Matrix

	FEMA PM 61	USGS LiDAR Base Spec v13	ASPRS LAS v1.2	FEMA Appendix A	FEMA Appendix M
Vendor Submittal	X	X	X		X
Macro Review	X	X		X	
Micro Review	X	X	X	X	
Vertical Accuracy	X	X		X	X

Links to guidelines and specifications used in this report:

1. Federal Emergency Management Agency, Procedure Memorandum No. 61 - Standards for Lidar and Other High Quality Digital Topography, <http://www.fema.gov/library/viewRecord.do?id=4345>
2. U.S. Geological Survey National Geospatial Program, LiDAR Guidelines and Base Specification, Version 13-ILMF 2010, <http://lidar.cr.usgs.gov/USGS-NGP%20Lidar%20Guidelines%20and%20Base%20Specification%20v13%28ILMF%29.pdf>
3. American Society for Photogrammetry and Remote Sensing, LAS v1.2, http://www.asprs.org/a/society/committees/standards/asprs_las_format_v12.pdf
4. Federal Emergency Management Agency, Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying [includes guidance on Light Detection and Ranging Systems (LIDAR)] http://www.fema.gov/library/file;jsessionid=1E39C93AF9CD18EE125B3DFCA5A874B8.Worker2Library?type=publishedFile&file=frm_gsaa.pdf&fileid=2daefcd0-df08-11e0-9bf5-001cc4568fb6
5. Federal Emergency Management Agency, Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix M: data Capture Standards http://www.fema.gov/library/file;jsessionid=1E39C93AF9CD18EE125B3DFCA5A874B8.Worker2Library?type=publishedFile&file=frm_gsam.pdf&fileid=cf85c9b0-df0f-11e0-9bf5-001cc4568fb6

3.0 LIDAR DATA REVIEW

Greenhorne & O'Mara, Inc. utilizes commercial software and proprietary scripts/applications to review LiDAR data. These tools, combined with guidelines and specifications, are incorporated into a standardized quality assurance workflow. The following table summarizes software and proprietary scripts/applications used in the review.

Table 17 Software used in quality assurance review

ESRI ArcGIS ArcInfo	LiDAR Data Processing
ESRI 3D Analyst Extension	Visual Analysis of LiDAR Data
ESRI Spatial Analyst Extension	Grid Analysis for LiDAR Data
LP360 ArcMap Extension	Visual Analysis of LiDAR Data
SIS Topo Analyst	Vertical Accuracy Quality Assurance
Proprietary Scripts/Applications	Working with LAS files

3.1 Quality Assurance Process

The following workflow was implemented for performing the independent quality assurance review for LiDAR data. Vendor submitted deliverables are reviewed and confirmed before the data reviews are initiated.

3.1.1 Macro Level Data Review

These review activities are completed for 100% of the All Returns Point Cloud and Bare Earth LiDAR data.

1. LiDAR Coverage and Completeness
2. LAS Header Review
3. Data Voids
4. Point Density

3.1.2 Micro Level Data Review

These review activities are completed for 5% of the All Returns Point Cloud and 10% of the Bare Earth LiDAR data.

5% Point Cloud

1. Scan lines
2. Overlap percentage
3. Visual review for outliers, blunders, anomalies, etc.
4. Tile edge matching

10% Bare Earth

1. Correct classification
2. Spikes, divots, and other anomalies
3. Artifacts/Structures
4. Channel geometry of streams and drainage features
5. Dense vegetation and open water voids
6. Tile edge matching

3.2 Vendor Submittal Verification

In order to begin a quality assurance review all relevant project information must be submitted for review. The following deliverables are necessary to complete the LiDAR review.

1. Descriptive Project Information
 - a. Metadata and FEMA Compliance Form
 - b. Pre-flight operations report
 - c. Post-flight report
 - i. GPS Base Station Shapefile
 - ii. Project Coverage Shapefile
 - iii. As-Flown Trajectories and Calibration line Shapefiles
 - iv. Flight Logs
2. Survey Data
 - a. Metadata and FEMA Compliance Form
 - b. Ground Control
 - i. Accuracy Report
 - ii. Image Chips and Survey Pictures
 - iii. Spatial Data (Shapefile, kml/kmz, and csv containing coordinates)
 - iv. Final Report and Final Coordinates
 - c. FVA/CVA
 - i. Accuracy Report
 - ii. Image Chips and Survey Pictures
 - iii. Spatial Data (Shapefile, kml/kmz, and csv containing coordinates)
 - iv. Final Report and Final Coordinates
 - v. Vertical Accuracy Testing Results
3. Raw Point Cloud LiDAR
 - a. All Returns Swath Data
 - i. LAS v1.2 or v1.3 files
 1. No file greater than 2GB
 - ii. Swath Index Shapefile
 1. Includes Calibration and Cross-Ties
4. Post Processed LiDAR
 - a. Bare-Earth Data
 - i. Tiled LAS v1.2 or v1.3 files
 - ii. Tile Index Shapefile

The following tables confirm that the data provided for independent quality assurance is complete and meets the requirements documented in the task order scope of work.

Table 18 LiDAR Data Requirements

Coordinate System		Projection Zone	
<input checked="" type="checkbox"/> UTM <input type="checkbox"/> State Plane <input type="checkbox"/> Geographic		UTM: 6N State Plane:	
Horizontal Datum		Horizontal Units	
<input type="checkbox"/> NAD 27 <input checked="" type="checkbox"/> NAD 83 (default) <input type="checkbox"/> Other		<input type="checkbox"/> US Survey Foot <input checked="" type="checkbox"/> Meters <input type="checkbox"/> Other	
Vertical Datum		Vertical Units	
<input type="checkbox"/> NAVD 29 <input checked="" type="checkbox"/> NAVD 88 (default) <input type="checkbox"/> Other		<input checked="" type="checkbox"/> US Survey Foot <input type="checkbox"/> Meters <input type="checkbox"/> Other	
LiDAR Description		Data Format	
<input checked="" type="checkbox"/> All Returns <input checked="" type="checkbox"/> Bare Earth <input type="checkbox"/> Other		<input checked="" type="checkbox"/> LAS v1.0-3 <input type="checkbox"/> LAS v1.4 <input type="checkbox"/> Ascii <input type="checkbox"/> Other	
Flood Risk and Terrain Slope Vertical Accuracy 95% Confidence Level FVA/CVA			
Specification Level	Vertical Accuracy	LiDAR Nominal Pulse Spacing	
<input checked="" type="checkbox"/> Highest <input type="checkbox"/> High <input type="checkbox"/> Medium <input type="checkbox"/> Low	<input checked="" type="checkbox"/> 24.5cm/36.3cm <input type="checkbox"/> 49cm/72.6cm <input type="checkbox"/> 98cm/145cm <input type="checkbox"/> 147cm/218cm	<input checked="" type="checkbox"/> ≤ 1.0 meters <input type="checkbox"/> ≤ 2.0 meters <input type="checkbox"/> ≤ 3.5 meters <input type="checkbox"/> ≤ 5.0 meters	
Equivalent Contour Accuracy			
Contour Accuracy	Specification Level	RMSEz	NSSDA Accuracy 95% confidence level SVA (target) CVA (mandatory)
<input checked="" type="checkbox"/> 2 foot	<input checked="" type="checkbox"/> Highest	<input checked="" type="checkbox"/> 0.61 ft or 18.5 cm	<input checked="" type="checkbox"/> 1.19 ft or 36.3 cm
<input type="checkbox"/> 4 foot	<input type="checkbox"/> High	<input type="checkbox"/> 1.22 ft or 37.1 cm	<input type="checkbox"/> 2.38 ft or 72.6 cm
<input type="checkbox"/> 8 foot	<input type="checkbox"/> Medium	<input type="checkbox"/> 2.43 ft or 73.9 cm	<input type="checkbox"/> 4.77 ft or 1.45 m
<input type="checkbox"/> 12 foot	<input type="checkbox"/> Low	<input type="checkbox"/> 3.65 ft or 1.11m	<input type="checkbox"/> 7.15 ft or 2.18 m
Optional Deliverables			
DEMs		Breaklines	
<input type="checkbox"/> ESRI Float GRID <input type="checkbox"/> ESRI Integer GRID		<input type="checkbox"/> Hydrologically-Conditioned	
<input type="checkbox"/> Ascii <input type="checkbox"/> Floating Point (.flt)		<input type="checkbox"/> Hydrologically-Enforced	
<input type="checkbox"/> ERDAS Imagine <input type="checkbox"/> Other		<input type="checkbox"/> 3D Polyline <input type="checkbox"/> 3D Polygon <input type="checkbox"/> Other	

Table 19 LiDAR Submittal Checklist

Project Name: Cordova, Alaska		Date Delivered: 12/15/2011	
Acquisition: Aerometric, Inc.		Survey: Compass Data, Inc.	
Post Processing: Aerometric, Inc.		Breaklines: N/A	Topographic Products: N/A
Acquisition/Processing Point of Contact: Name: Jason Mann Mailing Address: 2014 Merrill Field Drive Cordova, AK 99501 Phone Number: 907-272-4495 Email: jmann@aerometric.com		Survey Point of Contact: Name: Philipp Hummel Mailing Address: 12353 E. Easter Ave, Suite 200, Centennial, CO 80112 Phone Number: 303-627-4058 Email: phummel@compassdatainc.com	
Dataset	Included	Comments	
Descriptive Project Information			
Metadata	Y		
Compliance Form	Y		
Pre-Flight Report	Y		
Post Flight Report	Y		
GPS Base Station Shapefile	Y		
Project Coverage Shapefile	Y		
As-Flown Trajectories	Y		
Final Flight Lines	Y		
Flight Logs	Y		
Survey Data			
Metadata	Y		
Compliance Form	Y		
Ground Control			
Accuracy Report	Y		
Image Chips	Y		
Survey Pictures	Y		
Shapefile and Final Coords	Y		
Final Report	Y		
FVA/CVA			
Accuracy Report	Y		
Image Chips	Y		
Survey Pictures	Y		
Shapefile and Final Coords	Y		
Final Report	Y		
Testing Results	Y		
Raw Point Cloud LiDAR			
LAS v1.2 or 1.3 Files < 2GB	Y		
Swath Index	Y		
Post Processed LiDAR			
LAS Files v1.2 or 1.3	Y		
LAS Tile Index	Y		

3.3 Data Acquisition and Ground Survey

Data acquisition and ground survey reports were provided and checked for compliance with guidelines and specifications.

Table 20 General acquisition requirements

Item Reviewed	Pass/Fail
Leaf-off conditions required	Pass
Area shall be free of snow and of flood condition with rivers remaining in their channels and near average heights	Pass
Extraneous environmental conditions such as rain, fog, or smoke shall be avoided	Pass

3.3.1 Pre-Flight Report

The pre-flight operations and planning report was submitted to Greenhorne & O'Mara, Inc. in November 2011 for review.

Table 21 Pre-Flight Operations Checklist

Project: Cordova, Alaska	Vendor: Aerometric, Inc.		
Date Received: 11/7/11	Date Reviewed: 12/16/11		
Items Reviewed		Pass/Fail	Comments
Planned flight lines (sufficient coverage, spacing, length)		Pass	
Planned flight line Shapefile		Pass	
Planned GPS stations		Pass	
Planned Ground Control		Pass	
Calibration Plans		Pass	
Vendor Quality Procedures		Pass	
LiDAR sensor scan set – scan angle, sidelap, design pulse		Pass	
Aircraft utilizes ABGPS		Pass	
Sensor supports project design pulse density		Pass	
Type of aircraft – supports project design parameters		Pass	
Reflight procedure – tracking, documenting, processing		Pass	
Project design supports accuracy requirements of project		Pass	
Project design accounts for land cover and terrain types		Pass	
Notes:			

3.3.2 Ground Control Survey Report

The ground control survey report was submitted to Greenhorne & O'Mara, Inc. in December 2011 for review.

Table 22 Ground Survey Checklist

Project: Cordova, Alaska	Vendor: Compass Data, Inc.		
Date Received: 12/13/11	Date Reviewed: 12/15/11		
Items Reviewed		Pass/Fail	Comments
Survey is referenced to NGS control monuments in the NSRS using appropriate horizontal and vertical control		Pass	
Base station locations are the “best” horizontal (second order or better) and vertical (third order or better) available and have a stability of “C” or better		Pass	
New control conforms to the Standards and Specifications for Geodetic Control Networks (1984), FGCC		Pass	
Primary control monuments established with GPS meet or exceed NOS NGS-58 “Guidelines for Establishing GPS-Derived Ellipsoidal Heights (Standards: 2 cm and 5 cm)” using the appropriate and latest geoid model and should be monumented to maintain stability and reoccupation if necessary		Pass	
Ground control stations meet local network accuracy at the 95% accuracy level of 2 cm horizontally and vertically		Pass	
Supporting documentation submitted such as processing reports, minimally and constrained 3-D least squares adjustment, pictures, of the stations, etc.		Pass	
Notes:			

3.3.3 Post-Flight Report

The post-flight report was submitted to Greenhorne & O'Mara, Inc. in December 2011 for review.

Table 23 Post-Flight Report Checklist

Project: Cordova, Alaska	Vendor: Aerometric, Inc.	
Date Received: 12/15/11	Date Reviewed:12/20/11	
Items Reviewed	Pass/Fail	Comments
GPS Base Station Information		
Name	Pass	
Latitude/Longitude Coordinates	Pass	
Heights	Pass	
Maximum PDOP	Pass	PDOP plots included
Location Map	Pass	
Correct Shapefile	Pass	
GPS/IMU		
GPS quality - Max horizontal variance (cm)	Pass	PDOP Plots
GPS quality - Max vertical variance (cm)	Pass	PDOP Plots
Notes on GPS Quality	Pass	
GPS Separation Plot	Pass	
GPS Altitude Plot	Pass	
PDOP Plot	Pass	
GPS Distance From Base Stations Plot	Pass	
Coverage		
Verification of Area of Interest Coverage	Pass	
Correct Shapefile	Pass	
Flights		
Final Flight Lines	Pass	
Calibration Lines	Pass	
As-Flown Trajectories	Pass	
Correct Shapefiles	Pass	
Control		
Ground Control and Base Station Layout	Pass	Base station layout provided, ground control layout provided in survey data
Correct Shapefile	Pass	
Data Verification and Quality Control		
Verification Process Documented	Pass	
Quality Control Procedures Documented	Pass	
Notes:		

3.3.4 Flight Logs

The flight logs were submitted to Greenhorne & O'Mara, Inc. in December 2011 for review as an appendix to the post-flight report.

Table 24 Flight Log Checklist

Project: Cordova, Alaska		Vendor: Aerometric, Inc.	
Date Received: 11/23/11 and 11/29/11		Date Reviewed: 12/20/11	
Items Reviewed		Pass/Fail	Comments
Job Number and Name		Pass	
Lift Number		Pass	
Block or Area of Interest Designator		Pass	
Date		Pass	
Aircraft Type		Pass	
Aircraft Tail Number		Pass	
Pilot Name		Pass	
Operator Name		Pass	
Airport of Operations		Pass	Cordova
GPS Base Station Names		Pass	
Flight Line Number		Pass	
Flight Line Direction		Pass	
Flight Line Start		Pass	
Flight Line Stop		Pass	
Flight Line Altitude		Pass	
Flight Line Scan Angle		Pass	
Flight Line Scan Rate		Pass	
Flight Line Speed		Pass	
Flight Line Conditions		Pass	
Flight Line Comments		Pass	
AGC Switch Settings		N/A	
Laser Pulse Rate Settings		Pass	
Mirror Rate Settings		Pass	
Field of View Settings		Pass	
Settings Comments		Pass	
Notes: All information is present on either the Condense Flight Log, or on the daily mission sheets, or both.			

3.4 Macro Review Results

Activity 1: LiDAR Coverage and Completeness

The Cordova, Alaska collection area is composed of 2 areas of interest. Each area was tested to insure both the Point Cloud and Bare Earth datasets meet project coverage requirements. All Project area AOIs meet project LiDAR coverage expectations.

Figure 8 Cordova, Alaska LiDAR Areas of Interests



Figure 9 Six Mile Subdivision Area of Interest

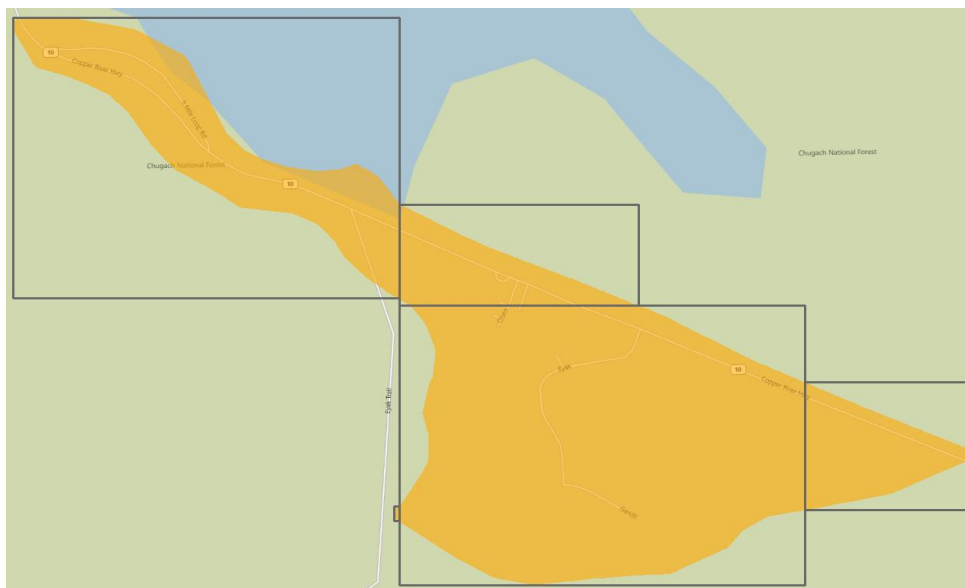
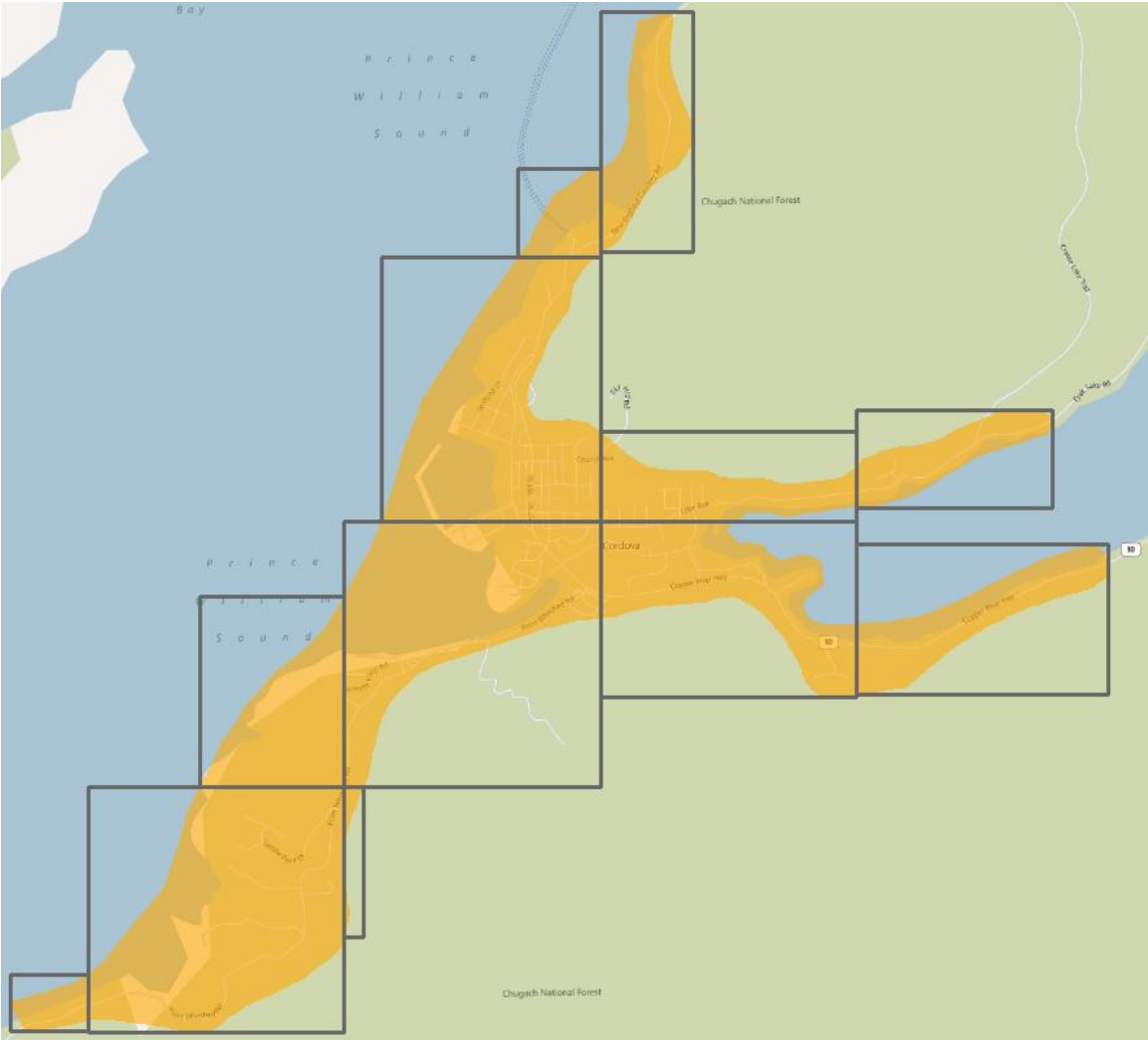


Figure 10 Cordova Area of Interest



Activity 2: LAS Header Review Results

Point Cloud and Bare Earth LAS files were run through a LAS header parser to check the Variable length records, point information, returns, GPS timestamps, classification, intensity values, etc.

Table 25 LAS Header Review Results

Date: Wednesday December 21, 2011	
Point Cloud LAS Files Reviewed: 17	Bare Earth LAS Files Reviewed: 17
General Information	
LAS Version (version 1.2 or 1.3)	PASS
Horizontal Datum (NAD 1983)	PASS
Projection (UTM or Stateplane with correct Zone)	PASS
Horizontal Units (Meters or US Survey Feet)	PASS
Vertical Datum (NAVD 1988)	PASS
Vertical Units (Meters or US Survey Feet)	PASS
LAS Header Contents	
file signature (Should be LASF)	PASS
file source ID: (Should match swath or 0 for tiles)	PASS
system identifier (Should be Sensor Hardware, matches metadata process step for collection)	PASS
generating software (Should be the software package used to create file, matches metadata process step for data processing)	PASS
point data format (1,3,4, or 5)	PASS
number of point records greater than zero	PASS
number of points by return (has at least 3 returns)	PASS
number of points by return equals number of point records	PASS
scale factor x y z (has 2 decimal places)	PASS
offset x y z (should be 0, 0, 0)	PASS
min x y z (xy greater than 0, xy is also used to check file name)	PASS
max x y z (xy greater than 0, z range is reasonable)	PASS
intensity (Must be included))	PASS
edge_of_flight_line (Must be included and be equal to 0 or 1)	PASS
scan_direction_flag (Must be included and be equal to 0 or 1)	PASS
number_of_returns_of_given_pulse (Must be included and have at least 3 returns)	PASS
return_number Must be included and match returns of pulse value)	PASS
classification (Must be included. 1 for Raw Point Cloud or 1, 2, 7, 8, 11 for classified data)	PASS
scan_angle_rank (Must be included. Nadir field of view value must not be greater than 34 degrees)	PASS
gps_time (Must be included and have precision to make unique)	PASS

Activity 3: Data Void Results

From section 1.5 of the USGS LiDAR Guidelines and Base Specification version 13:

Data Voids [areas $\Rightarrow (4 \times \text{NPS})^2$, measured using 1st-returns only] within a single swath (tile) are not acceptable, except:

- where caused by water bodies
- where caused by areas of low near infra-red (NIR) reflectivity such as asphalt or composition roofing
- where appropriately filled-in by another swath

To insure the LiDAR data provided is in compliance with this specification Point Cloud LAS files were tested using an ESRI Geoprocessing model. This model uses the density grid created by the proceeding activity. The no data values from the intensity grid are extracted and converted to a polygon feature class. These polygons are dissolved to aggregate the void areas. The area is calculated and compared to the $(4 \times \text{NPS})^2$ value (16 square meters). If an area is determined to be \Rightarrow the void tolerance it is retained, all values less than the tolerance are deleted. Each area is then reviewed using intensity grids, orthos, and other reference datasets to determine if they are acceptable. All areas were found to be in compliance with the USGS specification.

Figure 11 Cordova Data Void Examples

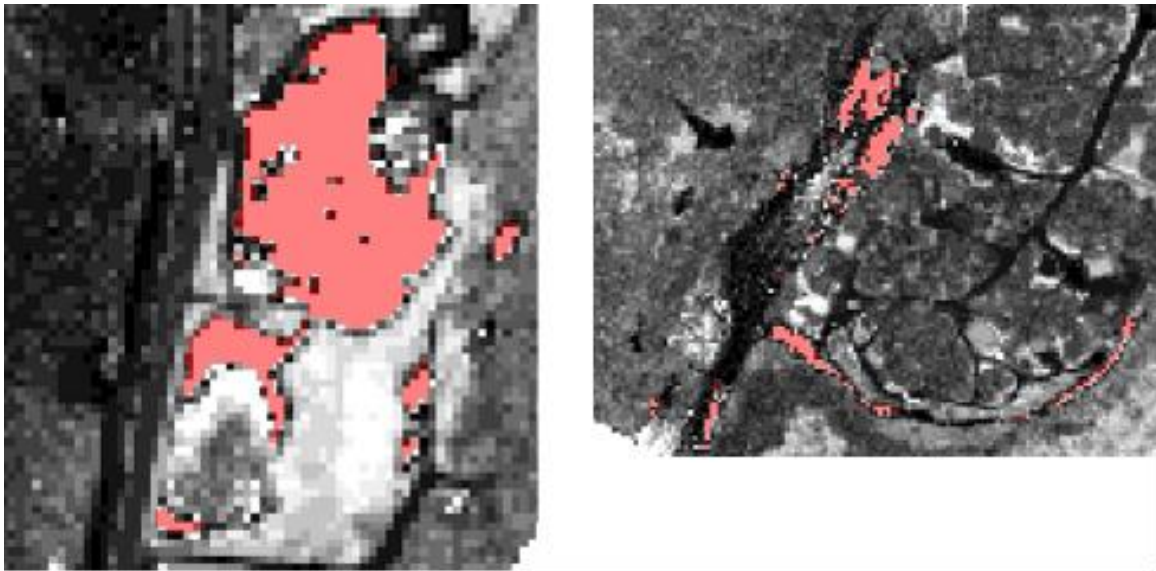


Figure 12 Cordova Data Void Example



Activity 4: Point Density Results

From section 1.6 of the USGS LiDAR Guidelines and Base Specification version 13:

The spatial distribution of geometrically usable points is expected to be uniform and free from clustering. In order to ensure uniform densities throughout the dataset:

- A regular grid, with cell size equal to the design NPS*2 will be laid over the data.
- At least 90% of the cells in the grid shall contain at least 1 lidar point.
- Assessment to be made against single swath, first return data located within the geometrically usable center portion (typically ~90%) of each swath (tile).

To insure the LiDAR data provided is in compliance with this specification Point Cloud and LAS files were tested by creating a raster with a cell size of 2 meters (NPS=1) for each tile as well as the larger areas of interest. All areas were found to be in compliance with the USGS specification. The table below summarizes the results. Area units are in square meters.

Date: December 21, 2011	
Cordova Area of Interest	
17 Point Cloud LAS Files Tested	PASS
17 Bare Earth LAS Files Tested	PASS
Total Area: 2198825 No Data Area: 19421 Percent of Cells with LiDAR: 99.1%	PASS

3.5 Micro Review Results

Task 1: 5% Point Cloud Review – Since there were only 17 total tiles the entire dataset was reviewed.

Figure 13 Point Cloud Tiles Reviewed

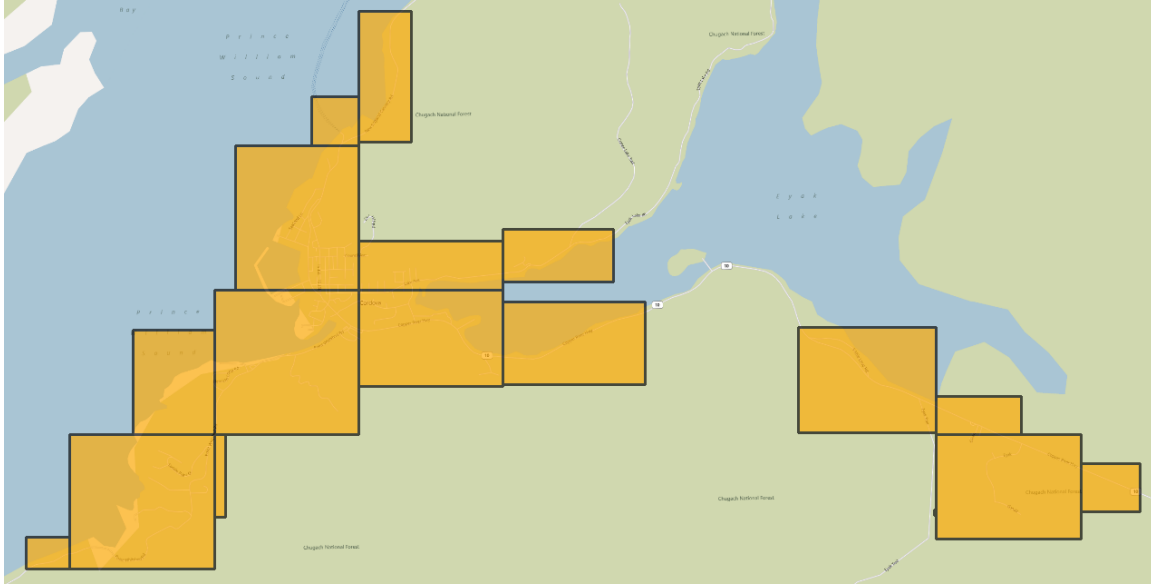


Table 26 5% Point Cloud Review Results

Point Cloud LAS Tiles Reviewed				
Tile Name	Scan Lines	Overlap	Visual Anomalies	Tile Edge Matching
05646710.las	PASS	PASS	PASS	PASS
05736710.las	PASS	PASS	PASS	PASS
05766710.las	PASS	PASS	PASS	PASS
05666710.las	PASS	PASS	PASS	PASS
05676710.las	PASS	PASS	PASS	PASS
05756710.las	PASS	PASS	PASS	PASS
05756711.las	PASS	PASS	PASS	PASS
05666711.las	PASS	PASS	PASS	PASS
05736711.las	PASS	PASS	PASS	PASS
05706711.las	PASS	PASS	PASS	PASS
05676711.las	PASS	PASS	PASS	PASS
05696711.las	PASS	PASS	PASS	PASS
05696713.las	PASS	PASS	PASS	PASS
05706713.las	PASS	PASS	PASS	PASS
05676713.las	PASS	PASS	PASS	PASS
05676714.las	PASS	PASS	PASS	PASS
05696714.las	PASS	PASS	PASS	PASS

Task 2: 10% Bare Earth Review - Since there were only 17 total tiles the entire dataset was reviewed.

Figure 14 Bare Earth Tiles Reviewed

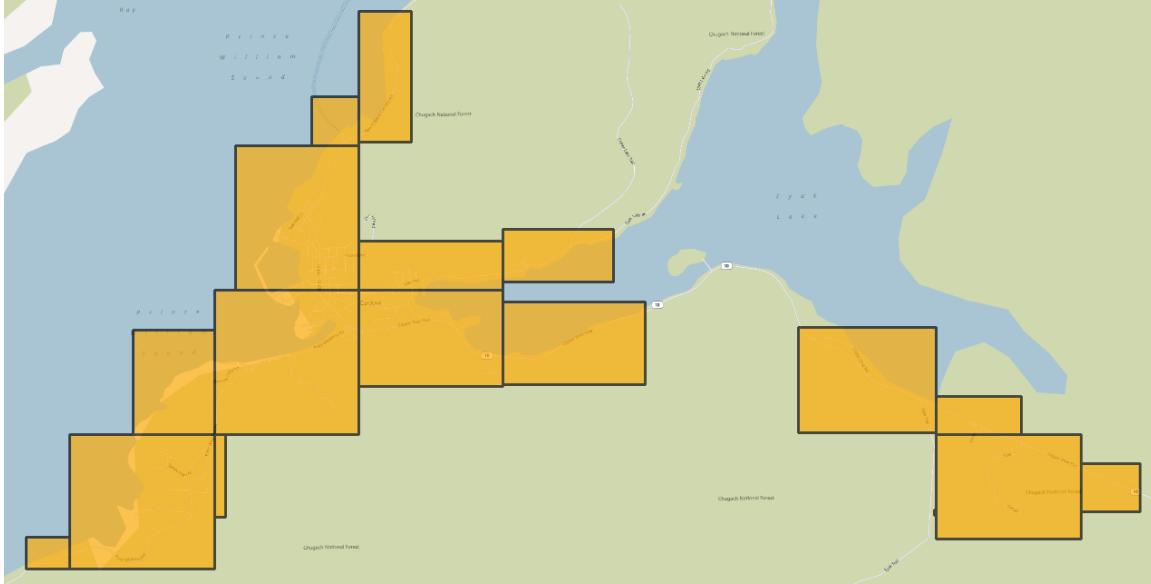


Table 27 10% Bare Earth Review Results

Point Cloud LAS Tiles Reviewed						
Tile Name	Classification	Anomalies	Artifacts and Structures	Drainage Features	Open Water Voids	Tile Edge Matching
05646710.las	PASS	PASS	PASS	PASS	PASS	PASS
05736710.las	PASS	PASS	PASS	PASS	PASS	PASS
05766710.las	PASS	PASS	PASS	PASS	PASS	PASS
05666710.las	PASS	PASS	PASS	PASS	PASS	PASS
05676710.las	PASS	PASS	PASS	PASS	PASS	PASS
05756710.las	PASS	PASS	PASS	PASS	PASS	PASS
05756711.las	PASS	PASS	PASS	PASS	PASS	PASS
05666711.las	PASS	PASS	PASS	PASS	PASS	PASS
05736711.las	PASS	PASS	PASS	PASS	PASS	PASS
05706711.las	PASS	PASS	PASS	PASS	PASS	PASS
05676711.las	PASS	PASS	PASS	PASS	PASS	PASS
05696711.las	PASS	PASS	PASS	PASS	PASS	PASS
05696713.las	PASS	PASS	PASS	PASS	PASS	PASS
05706713.las	PASS	PASS	PASS	PASS	PASS	PASS
05676713.las	PASS	PASS	PASS	PASS	PASS	PASS
05676714.las	PASS	PASS	PASS	PASS	PASS	PASS
05696714.las	PASS	PASS	PASS	PASS	PASS	PASS

4.0 VERTICAL ACCURACY VERIFICATION

Fundamental Vertical Accuracy (FVA) checkpoints are located only in open terrain, where there is a high probability that the sensor will have detected the ground surface without influence from surrounding vegetation and/or buildings. Checkpoints are located on flat or uniformly sloping terrain and at least five (5) meters away from a change in slope. Checkpoints are located randomly across the acquisition area. At least 20 FVA points were collected for each test.

Consolidated Vertical Accuracy (CVA) checkpoints are collected randomly across different land use types using the ASPRS NSSDA land cover types. The points are located in flat areas with no substantial elevation breaks within a five meter radius. The CVA assessment incorporates a representative sample of the FVA assessment points into the dataset to save on the total number of points collected. CVA points were not collected for any land class comprising less than 10% of the total project area; this may have resulted in less than 4 land classes being collected in a particular area. At least 15 CVA points were collected and 5 FVA points used, for a total of at least 20 points for the CVA testing. All points were collected at three times the accuracy of the surface being checked. Thus to check a 24.5cm surface the points were collected accurate to 8cm.

Tests were conducted when processing by the LiDAR vendor was complete and points were called for. The surveyor provided the point coordinates in an excel spreadsheet to the LiDAR vendor. The LiDAR vendor found the corresponding elevation from a surface created from the LiDAR points, filled in the spreadsheet and returned it to the surveyor who compared the elevation of the LiDAR data with that of the accuracy check point, calculated the difference and reported their findings both in terms of $RMSE_z$ and at the 95% confidence level (computed as $RMSE_z \times 1.9600$). LiDAR datasets passing the quality control checks were delivered to STARR for quality assurance approval.

Tested 36.0 cm consolidated vertical accuracy at 95th percentile in: open terrain, forest terrain, and urban terrain. The Root Mean Square Error for the elevation differences between GPS control points and LiDAR points is 15.8 cm calculated with 43 supplemental vertical accuracy points (SVA).

The vertical accuracy requirements based on flood risk and terrain slope are met with 10.2cm and 36.0 cm for both FVA and CVA testing. The mandatory requirements for the highest specification for vertical accuracy, 95% confidence levels are < 24.5cm for FVA and <36.3cm for CVA.

Independent review of submitted FVA and CVA survey data with vendor provided LAS files. Survey data points containing field collected GPS elevation values were buffered by 10 meters. LiDAR points contained within the buffered areas are selected and used to create a TIN. The TIN facet z value closest to the x and y control point location is compared to the height of the survey point. The height difference is evaluated statistically and compared to the submitted FVA and CVA testing results to insure the vertical accuracy meets project expectations. The report attached to this document summarizes the results of this assessment.

5.0 CONCLUSIONS

Based upon the submittal verification, acquisition reports, macro/micro reviews and vertical accuracy confirmation, the Cordova, Alaska dataset meets all applicable project specifications defined in FEMA task order HSFE10-11-J-00076 dated July 15, 2011. This data meets and exceeds all project requirements for FEMA Risk MAP elevation acquisition and can be used for flood risk analysis.

Table 28 Credits

LiDAR Procurement	FEMA
Acquisition and Processing	STARR partner Aerometric, Inc.
Ground Control and FVA/CVA survey	STARR partner Compass Data, Inc.
Quality Assurance and Delivery	STARR partner Greenhorne & O'Mara, Inc.

Approvals

QA Team Lead: James L. Huffines

Date: 12/30/2011



APPENDIX A: Macro Testing Results

MODULE 2 CONSISTENCY CHECKS

FileName	46 of 46
CreationDate	46 of 46
Version	46 of 46
FileSourceIDHeader	0 of 46
GeneratingSoftware	46 of 46
SystemID	46 of 46
ProjectID	46 of 46
MaxHeaderX	46 of 46
MaxHeaderY	46 of 46
MaxHeaderZ	46 of 46
MinHeaderX	46 of 46
MinHeaderY	46 of 46
MinHeaderZ	46 of 46
DataFormat	46 of 46
NumVLR	46 of 46
PointDataRecordLength	46 of 46
FileSize	46 of 46
MinStatsX	46 of 46
MinStatsY	46 of 46
MinStatsZ	46 of 46
MaxStatsX	46 of 46
MaxStatsY	46 of 46
MaxStatsZ	46 of 46
OffsetX	46 of 46
OffsetY	46 of 46
OffsetZ	46 of 46
ScaleX	46 of 46
ScaleY	46 of 46
ScaleZ	46 of 46
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Header1stRet	46 of 46
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Header3rdRet	46 of 46
Header4thRet	46 of 46
Header5thRet	46 of 46
StatsTotal	46 of 46
Stats1stRet	46 of 46
Stats2ndRet	46 of 46
Stats3rdRet	46 of 46
Stats4thRet	46 of 46
Stats5thRet	46 of 46
MinIntensityRange	46 of 46
MaxIntensityRange	46 of 46
MinEdgeOfFlightLine	46 of 46
MaxEdgeOfFlightLine	46 of 46
MinScanDirection	46 of 46
MaxScanDirection	46 of 46
MinScanAngle	46 of 46
MaxScanAngle	46 of 46
MinReturn	46 of 46
MaxReturn	46 of 46
MinPointSourceID	46 of 46
MaxPointSourceID	46 of 46
GpsStartTime	46 of 46
GpsEndTime	46 of 46
Projection	46 of 46
VertDatum	46 of 46
HorzDatum	46 of 46
EPSGCode	46 of 46
VertUnits	46 of 46

las_swath_header.log

Thursday December 22,2011 01:14 PM ----> LAS Header Review

General Project Information for Cordova Alaska Raw Point Cloud LiDAR data.

LAS Version: 1.2
Horizontal Datum: NAD 1983
Projection: UTM Zone 6N
XY (Horizontal) Units: Linear Meter
Vertical Datum: NAVD88 - Geoid09 (Alaska only) (Feet)
Z Units: Vertical Foot US Survey

LAS Header Review Completed!
Thursday December 22,2011 01:27 PM
Reviewed 46 LAS files in the E:\Alaska\Cordova\LAS_Strips directory.

Header Items Reviewed:

Coordinate System Information...

LAS Version (version 1.2 or 1.3)
Horizontal Datum (NAD 1983)
Projection (UTM or Stateplane with correct Zone)
Horizontal Units (Meters or US Survey Feet)
Vertical Datum (NAVD 1988)
Vertical Units (Meters or US Survey Feet)

LAS Header Contents...

file signature (Should be LASF)
file source ID: (Should match swath or 0 for tiles)
system identifier (Should be Sensor Hardware, matches metadata

process step for collection)

generating software (Should be the software package used to create
file, matches metadata process step for data processing)
point data format (1,3,4, or 5)
number of point records greater than zero
number of points by return (has at least 3 returns)
number of points by return equals number of point records
scale factor x y z (has 2 decimal places)
offset x y z (should be 0, 0, 0)
min x y z (xy greater than 0, xy is also used to check file name)
max x y z (xy greater than 0, z range is reasonable)
intensity (Must be included)
edge_of_flight_line (Must be included and be equal to 0 or 1)
scan_direction_flag (Must be included and be equal to 0 or 1)
number_of_returns_of_given_pulse (Must be included and have at least

3 returns)

return_number (Must be included and match returns of pulse value)
classification (Must be included. 1 for Raw Point Cloud or 1, 2, 7,
8, 11 for classified data)
scan_angle_rank (Must be included. Nadir field of view value must
not be greater than 34 degrees)
gps_time (Must be included and have precision to make unique)

If any errors present in LAS Header files, please review and contact responsible
vendor immediately.

LasSwath1	LasSwath2	LasSwath1area	LasSwath2area	overlapArea	percentOverlap
00001.las	00002.las	2432367.459	2592611.31	1369504.565	56.303
00001.las	00003.las	2432367.459	2530601.076	711111.5462	29.235
00001.las	00002.las	2432367.459	2592611.31	1369504.565	56.303
00001.las	00003.las	2432367.459	2530601.076	711111.5462	29.235
00002.las	00003.las	2592611.31	2530601.076	1342464.192	51.780
00002.las	00004.las	2592611.31	2377165.922	864849.0224	33.358
00002.las	00003.las	2592611.31	2530601.076	1342464.192	51.780
00002.las	00004.las	2592611.31	2377165.922	864849.0224	33.358
00003.las	00004.las	2530601.076	2377165.922	1381409.59	54.588
00003.las	00005.las	2530601.076	2126439.472	878747.1547	34.725
00003.las	00004.las	2530601.076	2377165.922	1381409.59	54.588
00003.las	00005.las	2530601.076	2126439.472	878747.1547	34.725
00004.las	00005.las	2377165.922	2126439.472	1193352.581	50.201
00004.las	00006.las	2377165.922	1689798.55	734993.8011	30.919
00004.las	00005.las	2377165.922	2126439.472	1193352.581	50.201
00004.las	00006.las	2377165.922	1689798.55	734993.8011	30.919
00005.las	00006.las	2126439.472	1689798.55	1201390.135	56.498
00005.las	00007.las	2126439.472	1618717.037	616674.0567	29.000
00005.las	00006.las	2126439.472	1689798.55	1201390.135	56.498
00005.las	00007.las	2126439.472	1618717.037	616674.0567	29.000
00006.las	00007.las	1689798.55	1618717.037	766410.2639	45.355
00006.las	00007.las	1689798.55	1618717.037	766410.2639	45.355
00007.las	00008.las	1618717.037	1341084.389	690125.3612	42.634
00007.las	00009.las	1618717.037	1483148.468	388427.0693	23.996
00007.las	00008.las	1618717.037	1341084.389	690125.3612	42.634
00007.las	00009.las	1618717.037	1483148.468	388427.0693	23.996
00008.las	00009.las	1341084.389	1483148.468	658863.1552	49.129
00008.las	00009.las	1341084.389	1483148.468	658863.1552	49.129
00009.las	00010.las	1483148.468	1209059.351	608185.0254	41.006
00009.las	00010.las	1483148.468	1209059.351	608185.0254	41.006
00010.las	00011.las	1209059.351	1365540.041	617700.3241	51.089
00010.las	00011.las	1209059.351	1365540.041	617700.3241	51.089
00011.las	00012.las	1365540.041	1080579.104	492365.1046	36.056
00011.las	00012.las	1365540.041	1080579.104	492365.1046	36.056
00013.las	00014.las	1107090.929	1289576.38	360737.5459	32.584
00013.las	00014.las	1107090.929	1289576.38	360737.5459	32.584
00014.las	00015.las	1289576.38	3412734.668	810204.8572	62.827
00014.las	00016.las	1289576.38	3498021.339	288641.4497	22.383
00014.las	00015.las	1289576.38	3412734.668	810204.8572	62.827
00014.las	00016.las	1289576.38	3498021.339	288641.4497	22.383
00015.las	00016.las	3412734.668	3498021.339	2069845.652	60.651
00015.las	00016.las	3412734.668	3498021.339	2069845.652	60.651
00016.las	00017.las	3498021.339	2994548.013	1650595.851	47.187
00016.las	00018.las	3498021.339	3269684.957	788177.5129	22.532
00016.las	00017.las	3498021.339	2994548.013	1650595.851	47.187
00016.las	00018.las	3498021.339	3269684.957	788177.5129	22.532

00017.las	00018.las	2994548.013	3269684.957	1867214.008	62.354
00017.las	00019.las	2994548.013	3120114.939	843397.9583	28.164
00017.las	00018.las	2994548.013	3269684.957	1867214.008	62.354
00017.las	00019.las	2994548.013	3120114.939	843397.9583	28.164
00018.las	00019.las	3269684.957	3120114.939	1718464.428	52.557
00018.las	00020.las	3269684.957	2980459.835	713813.1113	21.831
00018.las	00019.las	3269684.957	3120114.939	1718464.428	52.557
00018.las	00020.las	3269684.957	2980459.835	713813.1113	21.831
00019.las	00020.las	3120114.939	2980459.835	1617214.51	51.832
00019.las	00020.las	3120114.939	2980459.835	1617214.51	51.832
00020.las	00021.las	2980459.835	2517511.966	1509390.875	50.643
00020.las	00021.las	2980459.835	2517511.966	1509390.875	50.643
00021.las	00022.las	2517511.966	2424552.3	1202195.898	47.753
00021.las	00022.las	2517511.966	2424552.3	1202195.898	47.753
00022.las	00023.las	2424552.3	2028921.335	1100990.385	45.410
00022.las	00023.las	2424552.3	2028921.335	1100990.385	45.410
00023.las	00024.las	2028921.335	1325041.79	534343.767	26.336
00023.las	00024.las	2028921.335	1325041.79	534343.767	26.336
00024.las	00025.las	1325041.79	1137193.283	443621.0074	33.480
00024.las	00025.las	1325041.79	1137193.283	443621.0074	33.480
00026.las	00027.las	1078683.856	1375446.663	414841.7723	38.458
00026.las	00028.las	1078683.856	2005333.822	246895.2744	22.889
00026.las	00027.las	1078683.856	1375446.663	414841.7723	38.458
00026.las	00028.las	1078683.856	2005333.822	246895.2744	22.889
00027.las	00028.las	1375446.663	2005333.822	925593.6232	67.294
00027.las	00029.las	1375446.663	2550832.225	366981.8639	26.681
00027.las	00028.las	1375446.663	2005333.822	925593.6232	67.294
00027.las	00029.las	1375446.663	2550832.225	366981.8639	26.681
00028.las	00029.las	2005333.822	2550832.225	1005113.296	50.122
00028.las	00030.las	2005333.822	1900941.539	531009.7693	26.480
00028.las	00029.las	2005333.822	2550832.225	1005113.296	50.122
00028.las	00030.las	2005333.822	1900941.539	531009.7693	26.480
00029.las	00030.las	2550832.225	1900941.539	1277930.302	50.099
00029.las	00031.las	2550832.225	2324763.617	673168.5155	26.390
00029.las	00030.las	2550832.225	1900941.539	1277930.302	50.099
00029.las	00031.las	2550832.225	2324763.617	673168.5155	26.390
00030.las	00031.las	1900941.539	2324763.617	1027772.183	54.066
00030.las	00032.las	1900941.539	2154763.821	419741.5691	22.081
00030.las	00031.las	1900941.539	2324763.617	1027772.183	54.066
00030.las	00032.las	1900941.539	2154763.821	419741.5691	22.081
00031.las	00032.las	2324763.617	2154763.821	1219890.006	52.474
00031.las	00033.las	2324763.617	2538132.906	686296.7973	29.521
00031.las	00032.las	2324763.617	2154763.821	1219890.006	52.474
00031.las	00033.las	2324763.617	2538132.906	686296.7973	29.521
00032.las	00033.las	2154763.821	2538132.906	1202995.864	55.830
00032.las	00034.las	2154763.821	1766910.542	498042.8243	23.114
00032.las	00033.las	2154763.821	2538132.906	1202995.864	55.830

00032.las	00034.las	2154763.821	1766910.542	498042.8243	23.114
00033.las	00034.las	2538132.906	1766910.542	1180380.306	46.506
00033.las	00035.las	2538132.906	2148222.61	511768.8439	20.163
00033.las	00034.las	2538132.906	1766910.542	1180380.306	46.506
00033.las	00035.las	2538132.906	2148222.61	511768.8439	20.163
00034.las	00035.las	1766910.542	2148222.61	857510.1059	48.532
00034.las	00036.las	1766910.542	1786967.387	378157.4788	21.402
00034.las	00035.las	1766910.542	2148222.61	857510.1059	48.532
00034.las	00036.las	1766910.542	1786967.387	378157.4788	21.402
00035.las	00036.las	2148222.61	1786967.387	943424.6333	43.917
00035.las	00037.las	2148222.61	2284160.365	540778.3311	25.173
00035.las	00036.las	2148222.61	1786967.387	943424.6333	43.917
00035.las	00037.las	2148222.61	2284160.365	540778.3311	25.173
00036.las	00037.las	1786967.387	2284160.365	999226.807	55.917
00036.las	00038.las	1786967.387	2202828.016	375492.8495	21.013
00036.las	00037.las	1786967.387	2284160.365	999226.807	55.917
00036.las	00038.las	1786967.387	2202828.016	375492.8495	21.013
00037.las	00038.las	2284160.365	2202828.016	1419554.257	62.148
00037.las	00038.las	2284160.365	2202828.016	1419554.257	62.148
00038.las	00039.las	2202828.016	1592489.004	989005.9661	44.897
00038.las	00039.las	2202828.016	1592489.004	989005.9661	44.897
00039.las	00040.las	1592489.004	1044120.712	384365.376	24.136
00039.las	00040.las	1592489.004	1044120.712	384365.376	24.136
00040.las	01003.las	1044120.712	1156098.884	612359.2383	58.648
00040.las	01003.las	1044120.712	1156098.884	612359.2383	58.648
01001.las	01002.las	760695.5389	1487966.492	152855.6908	20.094
01001.las	01002.las	760695.5389	1487966.492	152855.6908	20.094
01005.las	01006.las	1058116.047	915106.3009	244246.0837	23.083
01005.las	01006.las	1058116.047	915106.3009	244246.0837	23.083

las_swath_Spatial_Distribution.log

Friday December 30, 2011 12:00 PM ----> LAS NPS Review
NPS X 2 GRID -- 90% of cells should have LiDAR point inside.
Processing 46 LAS Files.

00001.las ::>PASS<:: spatial distribution = 98

00002.las ::>PASS<:: spatial distribution = 98

00003.las ::>PASS<:: spatial distribution = 98

00004.las ::>PASS<:: spatial distribution = 98

00005.las ::>PASS<:: spatial distribution = 98

00006.las ::>PASS<:: spatial distribution = 98

00007.las ::>PASS<:: spatial distribution = 98

00008.las ::>PASS<:: spatial distribution = 98

00009.las ::>PASS<:: spatial distribution = 98

00010.las ::>PASS<:: spatial distribution = 98

00011.las ::>PASS<:: spatial distribution = 98

00012.las ::>PASS<:: spatial distribution = 98

00013.las ::>PASS<:: spatial distribution = 98

00014.las ::>PASS<:: spatial distribution = 98

00015.las ::>PASS<:: spatial distribution = 98

00016.las ::>PASS<:: spatial distribution = 98

00017.las ::>PASS<:: spatial distribution = 98

00018.las ::>PASS<:: spatial distribution = 98

00019.las ::>PASS<:: spatial distribution = 98

las_swath_Spatial_Distribution.log

00020.las ::>PASS<:: spatial distribution = 98

00021.las ::>PASS<:: spatial distribution = 98

00022.las ::>PASS<:: spatial distribution = 98

00023.las ::>PASS<:: spatial distribution = 98

00024.las ::>PASS<:: spatial distribution = 98

00025.las ::>PASS<:: spatial distribution = 98

00026.las ::>PASS<:: spatial distribution = 98

00027.las ::>PASS<:: spatial distribution = 98

00028.las ::>PASS<:: spatial distribution = 98

00029.las ::>PASS<:: spatial distribution = 98

00030.las ::>PASS<:: spatial distribution = 98

00031.las ::>PASS<:: spatial distribution = 98

00032.las ::>PASS<:: spatial distribution = 98

00033.las ::>PASS<:: spatial distribution = 98

00034.las ::>PASS<:: spatial distribution = 98

00035.las ::>PASS<:: spatial distribution = 98

00036.las ::>PASS<:: spatial distribution = 98

00037.las ::>PASS<:: spatial distribution = 98

00038.las ::>PASS<:: spatial distribution = 98

00039.las ::>PASS<:: spatial distribution = 98

00040.las ::>PASS<:: spatial distribution = 97

las_swath_Spatial_Distribution.log

01001.las ::>PASS<:: spatial distribution = 98

01002.las ::>PASS<:: spatial distribution = 98

01003.las ::>PASS<:: spatial distribution = 97

01004.las ::>PASS<:: spatial distribution = 98

01005.las ::>PASS<:: spatial distribution = 98

01006.las ::>PASS<:: spatial distribution = 98

Filename	Poly_MinX	Poly_MinY	Poly_MaxX	Poly_MaxY	LAS_MinX	LAS_MinY	LAS_MaxX	LAS_MaxY	Tol	Extent_Success
5646710	565048.72	6709613.58	565499.995	6709939.14	565048.72	6709613.58	565499.99	6709939.14	10	TRUE
5736710	574479.57	6710164.51	574499.99	6710219.75	574479.57	6710164.51	574499.99	6710219.75	10	TRUE
5766710	575999.995	6710205.93	576611.13	6710701.71	576000	6710205.93	576611.13	6710701.71	10	TRUE
5756710	574500.03	6709915.25	576000	6710999.995	574500.03	6709915.25	575999.99	6710999.99	10	TRUE
5666710	565499.995	6709606.12	567000	6711000	565500	6709606.12	566999.99	6710999.99	10	TRUE
5676710	567000	6710149.48	567112.87	6711000	567000	6710149.48	567112.87	6710999.99	10	TRUE
5756711	574499.995	6710999.995	575382.68	6711391.57	574500	6711000	575382.68	6711391.57	10	TRUE
5666711	566154.01	6711000	567000	6712081.08	566154.01	6711000	566999.99	6712081.08	10	TRUE
5736711	573069.87	6711029.07	574499.995	6712117.63	573069.87	6711029.07	574499.99	6712117.63	10	TRUE
5706711	569999.995	6711519.99	571471.14	6712373.17	570000	6711519.99	571471.14	6712373.17	10	TRUE
5676711	566999.995	6710999.995	568500	6712500	567000	6711000	568499.99	6712499.99	10	TRUE
5696711	568500	6711504.61	570000	6712500	568500	6711504.61	569999.99	6712499.99	10	TRUE
5696713	568499.995	6712499.995	570000	6713009.5	568500	6712500	569999.99	6713009.5	10	TRUE
5706713	569999.995	6712581.44	571148.54	6713131.53	570000	6712581.44	571148.54	6713131.53	10	TRUE
5676713	567215.41	6712500	568500	6714000	567215.41	6712500	568499.99	6713999.99	10	TRUE
5676714	568014.27	6713999.995	568500	6714502.62	568014.27	6714000	568499.99	6714502.62	10	TRUE
5696714	568499.995	6714033.48	569043.17	6715391.28	568500	6714033.48	569043.17	6715391.28	10	TRUE

MODULE 3 CONSISTENCY CHECKS

FileName	17 of 17
CreationDate	17 of 17
Version	17 of 17
FileSourceIDHeader	0 of 17
GeneratingSoftware	17 of 17
SystemID	17 of 17
ProjectID	17 of 17
MaxHeaderX	17 of 17
MaxHeaderY	17 of 17
MaxHeaderZ	17 of 17
MinHeaderX	17 of 17
MinHeaderY	17 of 17
MinHeaderZ	17 of 17
DataFormat	17 of 17
NumVLR	17 of 17
PointDataRecordLength	17 of 17
FileSize	17 of 17
MinStatsX	17 of 17
MinStatsY	17 of 17
MinStatsZ	17 of 17
MaxStatsX	17 of 17
MaxStatsY	17 of 17
MaxStatsZ	17 of 17
OffsetX	17 of 17
OffsetY	17 of 17
OffsetZ	17 of 17
ScaleX	17 of 17
ScaleY	17 of 17
ScaleZ	17 of 17
HeaderTotal	17 of 17
Header1stRet	17 of 17
Header2ndRet	17 of 17
Header3rdRet	17 of 17
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point_cloud_header.log

Thursday December 22,2011 01:34 PM ----> LAS Header Review

General Project Information for Cordova Alaska Raw Point Cloud LiDAR data.

LAS Version: 1.2
Horizontal Datum: NAD 1983
Projection: UTM Zone 6N
XY (Horizontal) Units: Linear Meter
Vertical Datum: NAVD88 - Geoid09 (Alaska only) (Feet)
Z Units: Vertical Foot US Survey

LAS Header Review Completed!
Thursday December 22,2011 01:38 PM
Reviewed 17 LAS files in the E:\Alaska\Cordova\Point_Cloud directory.

Header Items Reviewed:

Coordinate System Information...

LAS Version (version 1.2 or 1.3)
Horizontal Datum (NAD 1983)
Projection (UTM or Stateplane with correct Zone)
Horizontal Units (Meters or US Survey Feet)
Vertical Datum (NAVD 1988)
Vertical Units (Meters or US Survey Feet)

LAS Header Contents...

file signature (Should be LASF)
file source ID: (Should match swath or 0 for tiles)
system identifier (Should be Sensor Hardware, matches metadata

process step for collection)

generating software (Should be the software package used to create
file, matches metadata process step for data processing)
point data format (1,3,4, or 5)
number of point records greater than zero
number of points by return (has at least 3 returns)
number of points by return equals number of point records
scale factor x y z (has 2 decimal places)
offset x y z (should be 0, 0, 0)
min x y z (xy greater than 0, xy is also used to check file name)
max x y z (xy greater than 0, z range is reasonable)
intensity (Must be included)
edge_of_flight_line (Must be included and be equal to 0 or 1)
scan_direction_flag (Must be included and be equal to 0 or 1)
number_of_returns_of_given_pulse (Must be included and have at least

3 returns)

return_number (Must be included and match returns of pulse value)
classification (Must be included. 1 for Raw Point Cloud or 1, 2, 7,
8, 11 for classified data)
scan_angle_rank (Must be included. Nadir field of view value must
not be greater than 34 degrees)
gps_time (Must be included and have precision to make unique)

If any errors present in LAS Header files, please review and contact responsible
vendor immediately.

LAS_NAME	Version	File Size	Software ID	System ID	Project ID	DataFormat	VLR count	Data Rec Len
5646710	1.2	23295519 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5666710	1.2	496405863 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5666711	1.2	190387059 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676710	1.2	8657091 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676711	1.2	578425059 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676713	1.2	501678487 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676714	1.2	29801067 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696711	1.2	232111679 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696713	1.2	148616883 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696714	1.2	76907707 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5706711	1.2	129244523 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5706713	1.2	96014095 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5736710	1.2	337787 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5736711	1.2	178507051 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5756710	1.2	498626823 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5756711	1.2	64996227 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5766710	1.2	72987959 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28

LAS_NAME	Version	Minimum X	Maximum X	Minimum Y	Maximum Y	Minimum Z	Maximum Z
5646710	1.2	565048.72	565499.99	6709613.58	6709939.14	4.49	315.79
5666710	1.2	565500	566999.99	6709606.12	6710999.99	-28.33	2028.39
5666711	1.2	566154.01	566999.99	6711000	6712081.08	-0.19	968.62
5676710	1.2	567000	567112.87	6710149.48	6710999.99	41.28	337.83
5676711	1.2	567000	568499.99	6711000	6712499.99	-15.66	2051.26
5676713	1.2	567215.41	568499.99	6712500	6713999.99	-29.53	2099.05
5676714	1.2	568014.27	568499.99	6714000	6714502.62	3.86	283.08
5696711	1.2	568500	569999.99	6711504.61	6712499.99	-63.75	2267.18
5696713	1.2	568500	569999.99	6712500	6713009.5	-26.18	2217.6
5696714	1.2	568500	569043.17	6714033.48	6715391.28	2.49	2237.5
5706711	1.2	570000	571471.14	6711519.99	6712373.17	14.77	333.06
5706713	1.2	570000	571148.54	6712581.44	6713131.53	14.28	340.22
5736710	1.2	574479.57	574499.99	6710164.51	6710219.75	40.29	182.21
5736711	1.2	573069.87	574499.99	6711029.07	6712117.63	14.12	2135.45
5756710	1.2	574500.03	575999.99	6709915.25	6710999.99	14.27	1181.65
5756711	1.2	574500	575382.68	6711000	6711391.57	-12.19	255.59
5766710	1.2	576000	576611.13	6710205.93	6710701.71	22.92	151.24

LAS_NAME	Version	Min X Pt.Data	Max X Pt.Data	Min Y Pt.Data	Max Y Pt.Data	Min Z Pt.Data	Max Z Pt.Data
5646710	1.2	565048.71	565499.99	6709613.58	6709939.14	4.49	315.79
5666710	1.2	565500	566999.99	6709606.12	6710999.99	-28.33	2028.39
5666711	1.2	566154.01	566999.99	6711000	6712081.08	-0.19	968.62
5676710	1.2	567000	567112.87	6710149.48	6710999.99	41.28	337.83
5676711	1.2	567000	568499.99	6711000	6712499.99	-15.66	2051.26
5676713	1.2	567215.41	568499.99	6712500	6713999.99	-29.53	2099.05
5676714	1.2	568014.27	568499.99	6714000	6714502.62	3.86	283.07
5696711	1.2	568500	569999.99	6711504.61	6712499.99	-63.75	2267.17
5696713	1.2	568500	569999.99	6712500	6713009.5	-26.18	2217.6
5696714	1.2	568500	569043.17	6714033.48	6715391.28	2.49	2237.5
5706711	1.2	570000	571471.14	6711519.99	6712373.17	14.77	333.06
5706713	1.2	570000	571148.54	6712581.44	6713131.53	14.28	340.22
5736710	1.2	574479.57	574499.99	6710164.51	6710219.75	40.29	182.21
5736711	1.2	573069.87	574499.99	6711029.07	6712117.63	14.12	2135.44
5756710	1.2	574500.03	575999.99	6709915.25	6710999.99	14.27	1181.65
5756711	1.2	574500	575382.68	6711000	6711391.57	-12.19	255.59
5766710	1.2	576000	576611.13	6710205.93	6710701.71	22.92	151.24

LAS_NAME	Version	Offset X	Offset Y	Offset Z	Scale X	Scale Y	Scale Z
5646710	1.2	0	0	0	0.01	0.01	0.01
5666710	1.2	0	0	0	0.01	0.01	0.01
5666711	1.2	0	0	0	0.01	0.01	0.01
5676710	1.2	0	0	0	0.01	0.01	0.01
5676711	1.2	0	0	0	0.01	0.01	0.01
5676713	1.2	0	0	0	0.01	0.01	0.01
5676714	1.2	0	0	0	0.01	0.01	0.01
5696711	1.2	0	0	0	0.01	0.01	0.01
5696713	1.2	0	0	0	0.01	0.01	0.01
5696714	1.2	0	0	0	0.01	0.01	0.01
5706711	1.2	0	0	0	0.01	0.01	0.01
5706713	1.2	0	0	0	0.01	0.01	0.01
5736710	1.2	0	0	0	0.01	0.01	0.01
5736711	1.2	0	0	0	0.01	0.01	0.01
5756710	1.2	0	0	0	0.01	0.01	0.01
5756711	1.2	0	0	0	0.01	0.01	0.01
5766710	1.2	0	0	0	0.01	0.01	0.01

LAS_NAME	Version	Point count	Header 1st Ret.	Header 2nd Ret.	Header 3rd Ret.	Header 4th Ret.	Header 5th Ret.
5646710	1.2	831951	652131	148181	28273	3366	0
5666710	1.2	17728749	14806875	2435444	434781	51649	0
5666711	1.2	6799506	5522270	1078606	180648	17982	0
5676710	1.2	309150	243640	54708	9557	1245	0
5676711	1.2	20658006	19043990	1387516	204583	21917	0
5676713	1.2	17917057	16330265	1352842	207997	25953	0
5676714	1.2	1064292	1027839	31870	4183	400	0
5696711	1.2	8289671	7248158	863629	147476	30408	0
5696713	1.2	5307714	4388666	770750	131542	16756	0
5696714	1.2	2746672	2538423	189478	17329	1442	0
5706711	1.2	4615844	3742397	719364	138721	15362	0
5706713	1.2	3429043	2669334	615357	129264	15088	0
5736710	1.2	12032	7263	3630	1014	125	0
5736711	1.2	6375220	4889791	1192069	257656	35704	0
5756710	1.2	17808069	13978353	3030098	696110	103508	0
5756711	1.2	2321262	1881528	350072	78585	11077	0
5766710	1.2	2606681	1869153	620801	106429	10298	0

LAS_NAME	Version	Point Count	S Stats 1st Ret.	Stats 2nd Ret.	Stats 3rd Ret.	Stats 4th Ret.	Stats 5th Ret.
5646710	1.2	831951	652131	148181	28273	3366	0
5666710	1.2	17728749	14806875	2435444	434781	51649	0
5666711	1.2	6799506	5522270	1078606	180648	17982	0
5676710	1.2	309150	243640	54708	9557	1245	0
5676711	1.2	20658006	19043990	1387516	204583	21917	0
5676713	1.2	17917057	16330265	1352842	207997	25953	0
5676714	1.2	1064292	1027839	31870	4183	400	0
5696711	1.2	8289671	7248158	863629	147476	30408	0
5696713	1.2	5307714	4388666	770750	131542	16756	0
5696714	1.2	2746672	2538423	189478	17329	1442	0
5706711	1.2	4615844	3742397	719364	138721	15362	0
5706713	1.2	3429043	2669334	615357	129264	15088	0
5736710	1.2	12032	7263	3630	1014	125	0
5736711	1.2	6375220	4889791	1192069	257656	35704	0
5756710	1.2	17808069	13978353	3030098	696110	103508	0
5756711	1.2	2321262	1881528	350072	78585	11077	0
5766710	1.2	2606681	1869153	620801	106429	10298	0

LAS_NAME	Version	Min Intensity	Max Intensity	Min Flight Edge	Max Flight Edge	Min Scan Dir.	Max Scan Dir.
5646710	1.2	0	957	0	0	0	1
5666710	1.2	0	1016	0	0	0	1
5666711	1.2	0	1042	0	0	0	1
5676710	1.2	0	540	0	0	0	1
5676711	1.2	0	1022	0	0	0	1
5676713	1.2	0	1058	0	0	0	1
5676714	1.2	0	1001	0	0	0	1
5696711	1.2	0	1015	0	0	0	1
5696713	1.2	0	1006	0	0	0	1
5696714	1.2	0	997	0	0	0	1
5706711	1.2	0	978	0	0	0	1
5706713	1.2	0	969	0	0	0	1
5736710	1.2	0	15	0	0	0	1
5736711	1.2	0	953	0	0	0	1
5756710	1.2	0	1006	0	0	0	1
5756711	1.2	0	1007	0	0	0	1
5766710	1.2	0	441	0	0	0	1

LAS_NAME	Version	Min Scan Angle	Max Scan Angle	Min Return	Max Return	Min Pt Src. ID	Max Pt Src. ID
5646710	1.2	-12	12	1	4	13	16
5666710	1.2	-13	13	1	4	15	1004
5666711	1.2	-13	13	1	4	15	31
5676710	1.2	-12	12	1	4	21	25
5676711	1.2	-15	14	1	4	17	36
5676713	1.2	-13	15	1	4	15	1006
5676714	1.2	-13	12	1	4	16	19
5696711	1.2	-13	13	1	4	26	1006
5696713	1.2	-13	15	1	4	23	1006
5696714	1.2	-13	12	1	4	15	21
5706711	1.2	-13	13	1	4	26	32
5706713	1.2	-13	14	1	4	2	39
5736710	1.2	-11	8	1	4	11	12
5736711	1.2	-14	13	1	4	1	1002
5756710	1.2	-13	13	1	4	1	12
5756711	1.2	-13	13	1	4	1	6
5766710	1.2	-14	14	1	4	1	6

LAS_NAME	Version	GPS Start Time	GPS End Time	Projection	Vert. Datum	Horz. Datum	EPSG Code	Vert. Units	Horz. Units
5646710	1.2	508265.985	509699.9797	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5666710	1.2	508898.5495	516294.276	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5666711	1.2	508916.5362	524143.7551	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676710	1.2	514710.3819	516123.6789	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676711	1.2	510099.7532	525659.0853	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676713	1.2	74537.3279	525809.8084	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676714	1.2	509760.1585	510830.7793	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696711	1.2	76218.75714	525832.1194	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696713	1.2	74538.82477	525648.3256	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696714	1.2	508978.6963	514657.2596	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5706711	1.2	522519.7511	524468.2353	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5706713	1.2	74558.36478	525632.0304	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5736710	1.2	506887.5606	507210.7672	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5736711	1.2	503474.757	507592.0956	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5756710	1.2	503443.3385	507217.509	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5756711	1.2	503454.8355	505286.2537	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5766710	1.2	503435.1547	505308.5513	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter

LAS_NAME	Version	CLASS_COUNT	ID: 1 (Unclassified)
5646710	1.2		831951
5666710	1.2		17728749
5666711	1.2		6799506
5676710	1.2		309150
5676711	1.2		20658006
5676713	1.2		17917057
5676714	1.2		1064292
5696711	1.2		8289671
5696713	1.2		5307714
5696714	1.2		2746672
5706711	1.2		4615844
5706713	1.2		3429043
5736710	1.2		12032
5736711	1.2		6375220
5756710	1.2		17808069
5756711	1.2		2321262
5766710	1.2		2606681

Point_CloudSpatial_Distribution.log

Friday December 30, 2011 12:41 PM ----> LAS NPS Review
NPS X 2 GRID -- 90% of cells should have LiDAR point inside.
Processing 17 LAS Files.

05646710.las ::>PASS<:: spatial distribution = 97

05666710.las ::>PASS<:: spatial distribution = 96

05666711.las ::>PASS<:: spatial distribution = 97

05676710.las ::>PASS<:: spatial distribution = 98

05676711.las ::>PASS<:: spatial distribution = 97

05676713.las ::>PASS<:: spatial distribution = 97

05676714.las ::>PASS<:: spatial distribution = 97

05696711.las ::>PASS<:: spatial distribution = 98

05696713.las ::>PASS<:: spatial distribution = 97

05696714.las ::>PASS<:: spatial distribution = 98

05706711.las ::>PASS<:: spatial distribution = 98

05706713.las ::>PASS<:: spatial distribution = 98

05736710.las ::>PASS<:: spatial distribution = 96

05736711.las ::>PASS<:: spatial distribution = 98

05756710.las ::>PASS<:: spatial distribution = 94

05756711.las ::>PASS<:: spatial distribution = 98

05766710.las ::>PASS<:: spatial distribution = 97

Tile	Boundary_Area	Num_1st_Returns	Num_BE_Returns	1st_Return_Density	BE_Density
5646710	91687.58741	125085	118482	1.364252278	1.292235987
5666710	1451604.246	2150593	2023568	1.481528458	1.394021825
5666711	497441.7515	600727	574681	1.20763285	1.155272951
5676710	22544.92021	13900	13355	0.61654687	0.59237291
5676711	1195632.775	2339599	2158442	1.956787275	1.80527169
5676713	1172377.618	1769545	1647131	1.509364366	1.404949203
5676714	156921.7064	305585	280481	1.9473724	1.787394532
5696711	695427.4544	983898	898548	1.414810407	1.292080136
5696713	394522.4255	428812	409236	1.086914133	1.037294647
5696714	365458.3563	707895	658455	1.937005921	1.80172375
5706711	417454.4541	561157	511636	1.344235268	1.225609153
5706713	262090.8396	303093	287692	1.156442554	1.097680485
5736710	819.8743427	135	290	0.164659379	0.35371274
5736711	414199.9692	471323	445687	1.137911722	1.076018912
5756710	1311907.426	1681934	1660233	1.282052351	1.265510788
5756711	165361.8206	255532	243468	1.545290195	1.472335023
5766710	174123.1714	134518	160002	0.772545084	0.918901251

MODULE 3 CONSISTENCY CHECKS

FileName	17 of 17
CreationDate	17 of 17
Version	17 of 17
FileSourceIDHeader	0 of 17
GeneratingSoftware	17 of 17
SystemID	17 of 17
ProjectID	17 of 17
MaxHeaderX	17 of 17
MaxHeaderY	17 of 17
MaxHeaderZ	17 of 17
MinHeaderX	17 of 17
MinHeaderY	17 of 17
MinHeaderZ	17 of 17
DataFormat	17 of 17
NumVLR	17 of 17
PointDataRecordLength	17 of 17
FileSize	17 of 17
MinStatsX	17 of 17
MinStatsY	17 of 17
MinStatsZ	17 of 17
MaxStatsX	17 of 17
MaxStatsY	17 of 17
MaxStatsZ	17 of 17
OffsetX	17 of 17
OffsetY	17 of 17
OffsetZ	17 of 17
ScaleX	17 of 17
ScaleY	17 of 17
ScaleZ	17 of 17
HeaderTotal	17 of 17
Header1stRet	17 of 17
Header2ndRet	17 of 17
Header3rdRet	17 of 17
Header4thRet	17 of 17
Header5thRet	17 of 17
StatsTotal	17 of 17
Stats1stRet	17 of 17
Stats2ndRet	17 of 17
Stats3rdRet	17 of 17
Stats4thRet	17 of 17
Stats5thRet	17 of 17
MinIntensityRange	17 of 17
MaxIntensityRange	17 of 17
MinEdgeOfFlightLine	17 of 17
MaxEdgeOfFlightLine	17 of 17
MinScanDirection	17 of 17
MaxScanDirection	17 of 17
MinScanAngle	17 of 17
MaxScanAngle	17 of 17
MinReturn	17 of 17
MaxReturn	17 of 17
MinPointSourceID	17 of 17
MaxPointSourceID	17 of 17
GpsStartTime	17 of 17
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bare_earth_header.log

Thursday December 22,2011 01:47 PM ----> LAS Header Review

General Project Information for Cordova Alaska Classified Point Cloud LiDAR data.

LAS Version: 1.2
Horizontal Datum: NAD 1983
Projection: UTM Zone 6N
XY (Horizontal) Units: Linear Meter
Vertical Datum: NAVD88 - Geoid09 (Alaska only) (Feet)
Z Units: Vertical Foot US Survey

LAS Header Review Completed!
Thursday December 22,2011 01:47 PM
Reviewed 17 LAS files in the E:\Alaska\Cordova\Bare_Earth directory.

Header Items Reviewed:

Coordinate System Information...

LAS Version (version 1.2 or 1.3)
Horizontal Datum (NAD 1983)
Projection (UTM or Stateplane with correct Zone)
Horizontal Units (Meters or US Survey Feet)
Vertical Datum (NAVD 1988)
Vertical Units (Meters or US Survey Feet)

LAS Header Contents...

file signature (Should be LASF)
file source ID: (Should match swath or 0 for tiles)
system identifier (Should be Sensor Hardware, matches metadata

process step for collection)

generating software (Should be the software package used to create
file, matches metadata process step for data processing)
point data format (1,3,4, or 5)
number of point records greater than zero
number of points by return (has at least 3 returns)
number of points by return equals number of point records
scale factor x y z (has 2 decimal places)
offset x y z (should be 0, 0, 0)
min x y z (xy greater than 0, xy is also used to check file name)
max x y z (xy greater than 0, z range is reasonable)
intensity (Must be included)
edge_of_flight_line (Must be included and be equal to 0 or 1)
scan_direction_flag (Must be included and be equal to 0 or 1)
number_of_returns_of_given_pulse (Must be included and have at least

3 returns)

return_number (Must be included and match returns of pulse value)
classification (Must be included. 1 for Raw Point Cloud or 1, 2, 7,
8, 11 for classified data)
scan_angle_rank (Must be included. Nadir field of view value must
not be greater than 34 degrees)
gps_time (Must be included and have precision to make unique)

If any errors present in LAS Header files, please review and contact responsible vendor immediately.

LAS_NAME	Version	File Size	Software ID	System ID	Project ID	DataFormat	VLR count	Data Rec Len
5646710	1.2	3772575 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5666710	1.2	64439811 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5666711	1.2	18486519 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676710	1.2	473251 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676711	1.2	67571135 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676713	1.2	51482867 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5676714	1.2	8658435 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696711	1.2	29272651 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696713	1.2	13422075 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5696714	1.2	20255223 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5706711	1.2	16885143 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5706713	1.2	9513051 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5736710	1.2	13547 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5736711	1.2	14913579 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5756710	1.2	52943123 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5756711	1.2	7700975 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28
5766710	1.2	5480379 bytes	Aero-Metric LASLib	MODIFICATION	0	1	5	28

LAS_NAME	Version	Maximum X	Maximum Y	Maximum Z	Minimum X	Minimum Y	Minimum Z
5646710	1.2	565499.99	6709939.14	232.35	565048.72	6709613.58	4.78
5666710	1.2	566999.99	6710999.99	323.69	565500	6709606.12	2.28
5666711	1.2	566999.99	6712081.08	160.29	566154.01	6711000	3.24
5676710	1.2	567112.87	6710999.99	258.86	567000	6710149.48	41.71
5676711	1.2	568499.99	6712499.99	248.93	567000	6711000	0.78
5676713	1.2	568499.99	6713999.99	347.32	567215.41	6712500	1.54
5676714	1.2	568499.99	6714502.62	205.16	568014.27	6714000	4.2
5696711	1.2	569999.99	6712499.99	282.81	568500	6711504.61	12.76
5696713	1.2	569999.99	6713009.5	329.71	568500	6712500	15.53
5696714	1.2	569043.17	6715391.28	217.49	568500	6714033.48	3.71
5706711	1.2	571471.14	6712373.17	243.85	570000	6711519.99	15.37
5706713	1.2	571148.54	6713131.53	282.61	570000	6712581.44	14.72
5736710	1.2	574499.99	6710219.75	77.75	574479.57	6710164.51	40.81
5736711	1.2	574499.99	6712117.63	373.17	573069.87	6711029.07	15.79
5756710	1.2	575999.99	6710999.99	140.44	574500.03	6709915.25	14.64
5756711	1.2	575382.68	6711391.57	85.14	574500	6711000	15.69
5766710	1.2	576611.13	6710701.71	33.34	576000	6710205.93	22.92

LAS_NAME	Version	Min X Pt.Data	Max X Pt.Data	Min Y Pt.Data	Max Y Pt.Data	Min Z Pt.Data	Max Z Pt.Data
5646710	1.2	565048.71	565499.99	6709613.58	6709939.14	4.78	232.35
5666710	1.2	565500	566999.99	6709606.12	6710999.99	2.28	323.69
5666711	1.2	566154.01	566999.99	6711000	6712081.08	3.24	160.28
5676710	1.2	567000	567112.87	6710149.48	6710999.99	41.71	258.86
5676711	1.2	567000	568499.99	6711000	6712499.99	0.78	248.93
5676713	1.2	567215.41	568499.99	6712500	6713999.99	1.54	347.32
5676714	1.2	568014.27	568499.99	6714000	6714502.62	4.2	205.16
5696711	1.2	568500	569999.99	6711504.61	6712499.99	12.76	282.81
5696713	1.2	568500	569999.99	6712500	6713009.5	15.53	329.71
5696714	1.2	568500	569043.17	6714033.48	6715391.28	3.71	217.49
5706711	1.2	570000	571471.14	6711519.99	6712373.17	15.37	243.85
5706713	1.2	570000	571148.54	6712581.44	6713131.53	14.72	282.61
5736710	1.2	574479.57	574499.99	6710164.51	6710219.75	40.81	77.75
5736711	1.2	573069.87	574499.99	6711029.07	6712117.63	15.79	373.17
5756710	1.2	574500.03	575999.99	6709915.25	6710999.99	14.64	140.44
5756711	1.2	574500	575382.68	6711000	6711391.57	15.69	85.14
5766710	1.2	576000	576611.13	6710205.93	6710701.71	22.92	33.34

LAS_NAME	Version	Offset X	Offset Y	Offset Z	Scale X	Scale Y	Scale Z
5646710	1.2	0	0	0	0.01	0.01	0.01
5666710	1.2	0	0	0	0.01	0.01	0.01
5666711	1.2	0	0	0	0.01	0.01	0.01
5676710	1.2	0	0	0	0.01	0.01	0.01
5676711	1.2	0	0	0	0.01	0.01	0.01
5676713	1.2	0	0	0	0.01	0.01	0.01
5676714	1.2	0	0	0	0.01	0.01	0.01
5696711	1.2	0	0	0	0.01	0.01	0.01
5696713	1.2	0	0	0	0.01	0.01	0.01
5696714	1.2	0	0	0	0.01	0.01	0.01
5706711	1.2	0	0	0	0.01	0.01	0.01
5706713	1.2	0	0	0	0.01	0.01	0.01
5736710	1.2	0	0	0	0.01	0.01	0.01
5736711	1.2	0	0	0	0.01	0.01	0.01
5756710	1.2	0	0	0	0.01	0.01	0.01
5756711	1.2	0	0	0	0.01	0.01	0.01
5766710	1.2	0	0	0	0.01	0.01	0.01

LAS_NAME	Version	Point count	Header 1st Ret.	Header 2nd Ret.	Header 3rd Ret.	Header 4th Ret.	Header 5th Ret.
5646710	1.2	134703	125085	7146	2072	400	0
5666710	1.2	2301390	2150593	120701	25377	4719	0
5666711	1.2	660201	600727	45951	11741	1782	0
5676710	1.2	16870	13900	2402	472	96	0
5676711	1.2	2413223	2339599	61221	10811	1592	0
5676713	1.2	1838642	1769545	56198	11007	1892	0
5676714	1.2	309198	305585	3203	368	42	0
5696711	1.2	1045420	983898	50524	9816	1182	0
5696713	1.2	479328	428812	37287	10926	2303	0
5696714	1.2	723369	707895	13924	1414	136	0
5706711	1.2	603009	561157	30938	9276	1638	0
5706713	1.2	339720	303093	24725	10005	1897	0
5736710	1.2	452	135	198	102	17	0
5736711	1.2	532596	471323	45151	13123	2999	0
5756710	1.2	1890794	1681934	157905	41961	8994	0
5756711	1.2	275003	255532	14874	3762	835	0
5766710	1.2	195696	134518	50101	9840	1237	0

LAS_NAME	Version	Point Count	S Stats 1st Ret.	Stats 2nd Ret.	Stats 3rd Ret.	Stats 4th Ret.	Stats 5th Ret.
5646710	1.2	134703	125085	7146	2072	400	0
5666710	1.2	2301390	2150593	120701	25377	4719	0
5666711	1.2	660201	600727	45951	11741	1782	0
5676710	1.2	16870	13900	2402	472	96	0
5676711	1.2	2413223	2339599	61221	10811	1592	0
5676713	1.2	1838642	1769545	56198	11007	1892	0
5676714	1.2	309198	305585	3203	368	42	0
5696711	1.2	1045420	983898	50524	9816	1182	0
5696713	1.2	479328	428812	37287	10926	2303	0
5696714	1.2	723369	707895	13924	1414	136	0
5706711	1.2	603009	561157	30938	9276	1638	0
5706713	1.2	339720	303093	24725	10005	1897	0
5736710	1.2	452	135	198	102	17	0
5736711	1.2	532596	471323	45151	13123	2999	0
5756710	1.2	1890794	1681934	157905	41961	8994	0
5756711	1.2	275003	255532	14874	3762	835	0
5766710	1.2	195696	134518	50101	9840	1237	0

LAS_NAME	Version	Min Intensity	Max Intensity	Min Flight Edge	Max Flight Edge	Min Scan Dir.	Max Scan Dir.
5646710	1.2	0	957	0	0	0	1
5666710	1.2	0	998	0	0	0	1
5666711	1.2	0	866	0	0	0	1
5676710	1.2	0	101	0	0	0	1
5676711	1.2	0	1017	0	0	0	1
5676713	1.2	0	1016	0	0	0	1
5676714	1.2	0	998	0	0	0	1
5696711	1.2	0	987	0	0	0	1
5696713	1.2	0	988	0	0	0	1
5696714	1.2	0	997	0	0	0	1
5706711	1.2	0	978	0	0	0	1
5706713	1.2	0	526	0	0	0	1
5736710	1.2	0	13	0	0	0	1
5736711	1.2	0	935	0	0	0	1
5756710	1.2	0	969	0	0	0	1
5756711	1.2	0	969	0	0	0	1
5766710	1.2	0	441	0	0	0	1

LAS_NAME	Version	Min Scan Angle	Max Scan Angle	Min Return	Max Return	Min Pt Src. ID	Max Pt Src. ID
5646710	1.2	-6	10	1	4	13	16
5666710	1.2	-12	12	1	4	15	1004
5666711	1.2	-12	12	1	4	15	31
5676710	1.2	-4	5	1	4	21	25
5676711	1.2	-11	13	1	4	17	36
5676713	1.2	-11	12	1	4	15	1006
5676714	1.2	-6	5	1	4	16	19
5696711	1.2	-11	12	1	4	26	1006
5696713	1.2	-10	13	1	4	23	1006
5696714	1.2	-12	12	1	4	15	21
5706711	1.2	-9	11	1	4	26	32
5706713	1.2	-5	10	1	4	2	39
5736710	1.2	1	4	1	4	11	12
5736711	1.2	-10	11	1	4	1	1002
5756710	1.2	-11	12	1	4	1	12
5756711	1.2	-10	10	1	4	1	6
5766710	1.2	-11	11	1	4	1	6

LAS_NAME	Version	GPS Start Time	GPS End Time	Projection	Vert. Datum	Horz. Datum	EPSG Code	Vert. Units	Horz. Units
5646710	1.2	508265.985	509699.9797	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5666710	1.2	508898.5495	516294.276	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5666711	1.2	508916.5362	524143.7551	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676710	1.2	514710.3819	516123.6789	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676711	1.2	510099.7532	525659.0853	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676713	1.2	74537.3279	525809.8084	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5676714	1.2	509760.1585	510830.7793	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696711	1.2	76218.75714	525832.1194	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696713	1.2	74538.82477	525648.3256	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5696714	1.2	508978.6963	514657.2596	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5706711	1.2	522519.7511	524468.2353	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5706713	1.2	74558.36478	525632.0304	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5736710	1.2	506887.5606	507210.7672	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5736711	1.2	503474.757	507592.0956	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5756710	1.2	503443.3385	507217.509	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5756711	1.2	503454.8355	505286.2537	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter
5766710	1.2	503435.1547	505308.5513	NAD_1983_UTM_Zone_6N	NAVD88 - Geoid09 (Alaska only) (Feet)	GCS_North_American_1983	7019	Linear_Foot_US_Survey	Linear_Meter

LAS_NAME	Version	CLASS_COUNT ID: 2 (Ground)
5646710	1.2	118482
5666710	1.2	2023568
5666711	1.2	574681
5676710	1.2	13355
5676711	1.2	2158442
5676713	1.2	1647131
5676714	1.2	280481
5696711	1.2	898548
5696713	1.2	409236
5696714	1.2	658455
5706711	1.2	511636
5706713	1.2	287692
5736710	1.2	290
5736711	1.2	445687
5756710	1.2	1660233
5756711	1.2	243468
5766710	1.2	160002

Bare_Earth_Spatial_Distribution.log

Friday December 30, 2011 12:46 PM ----> LAS NPS Review
NPS X 2 GRID -- 90% of cells should have LiDAR point inside.
Processing 17 LAS Files.

05646710.las ::>PASS<:: spatial distribution = 98

05666710.las ::>PASS<:: spatial distribution = 98

05666711.las ::>PASS<:: spatial distribution = 98

05676710.las ::>PASS<:: spatial distribution = 98

05676711.las ::>PASS<:: spatial distribution = 98

05676713.las ::>PASS<:: spatial distribution = 98

05676714.las ::>PASS<:: spatial distribution = 97

05696711.las ::>PASS<:: spatial distribution = 98

05696713.las ::>PASS<:: spatial distribution = 98

05696714.las ::>PASS<:: spatial distribution = 98

05706711.las ::>PASS<:: spatial distribution = 98

05706713.las ::>PASS<:: spatial distribution = 98

05736710.las ::>PASS<:: spatial distribution = 98

05736711.las ::>PASS<:: spatial distribution = 98

05756710.las ::>PASS<:: spatial distribution = 97

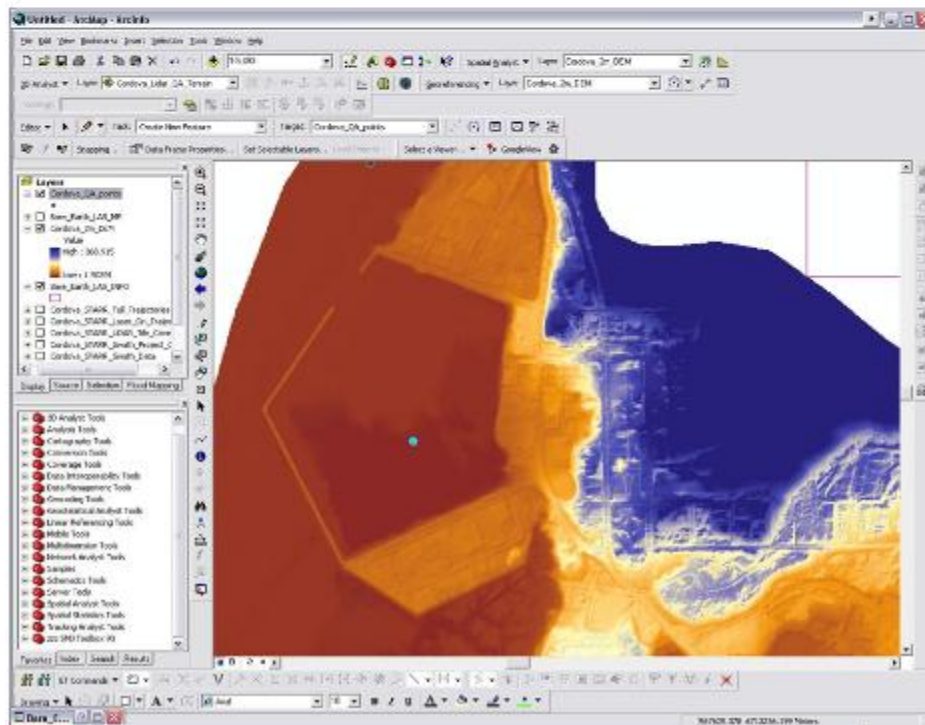
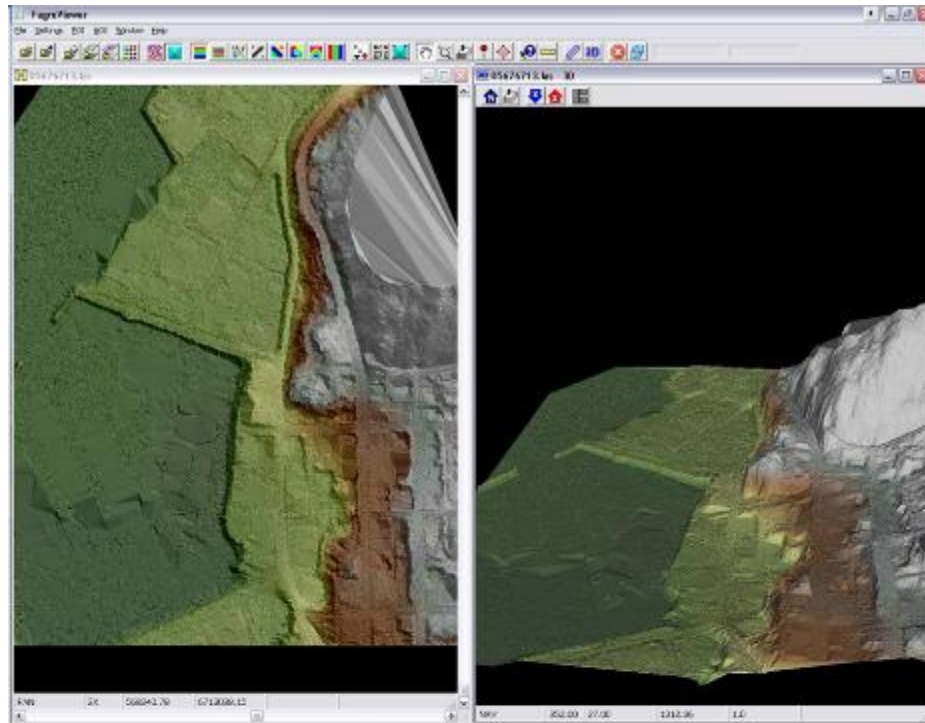
05756711.las ::>PASS<:: spatial distribution = 98

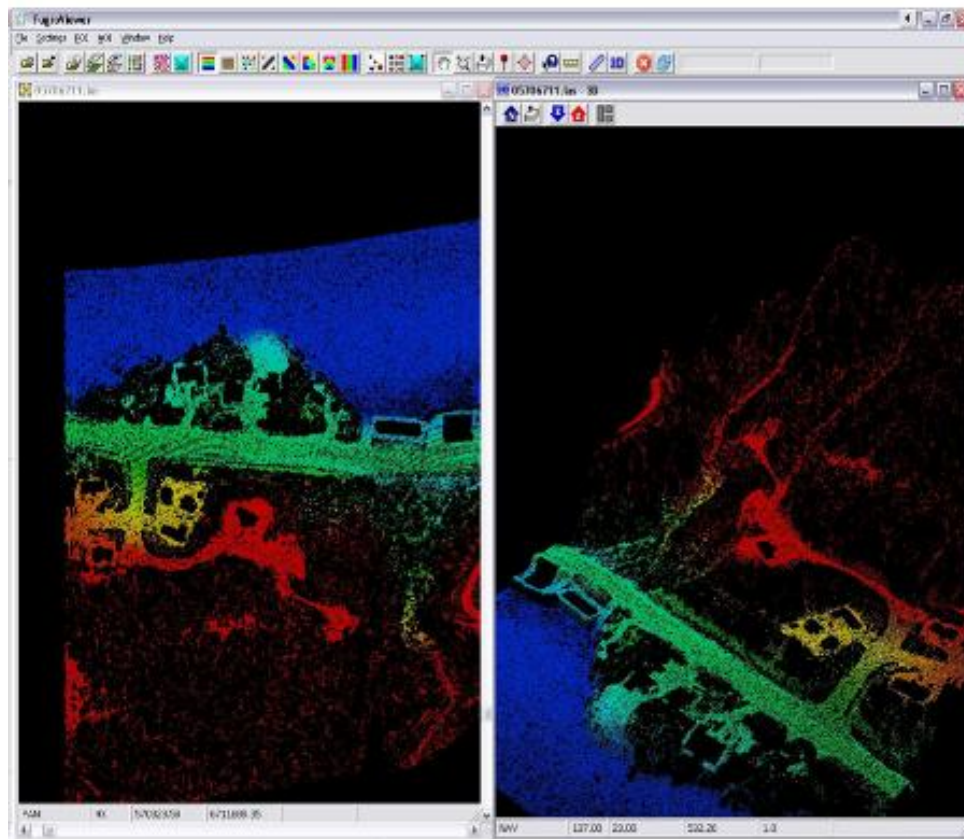
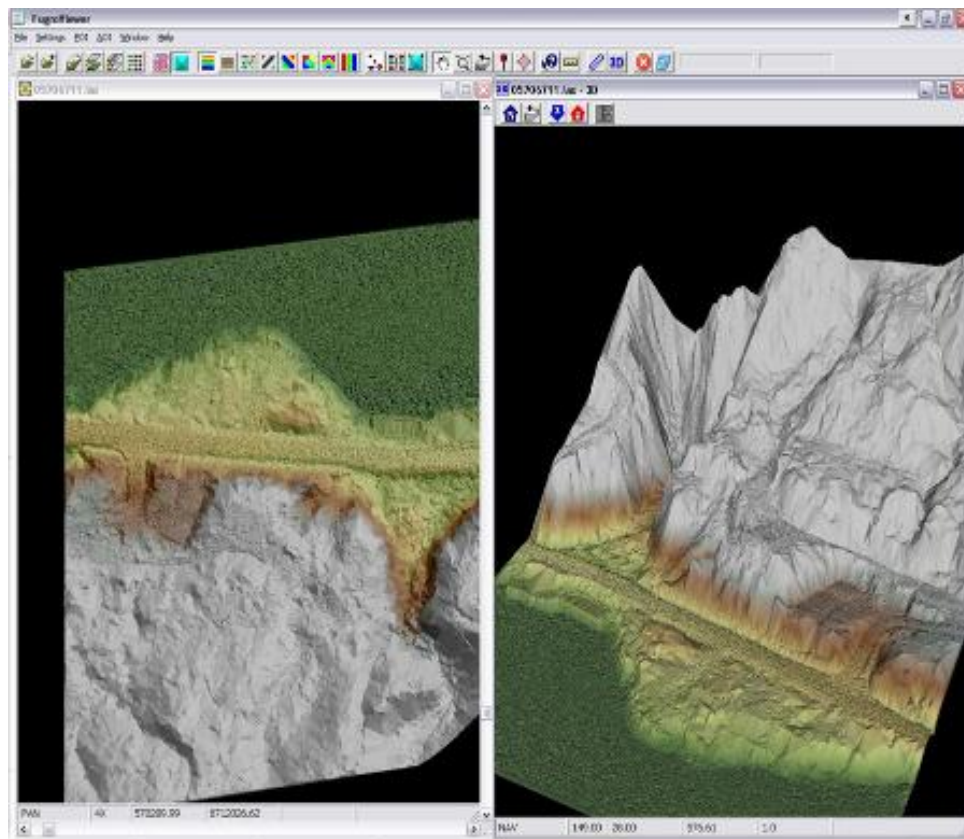
05766710.las ::>PASS<:: spatial distribution = 98

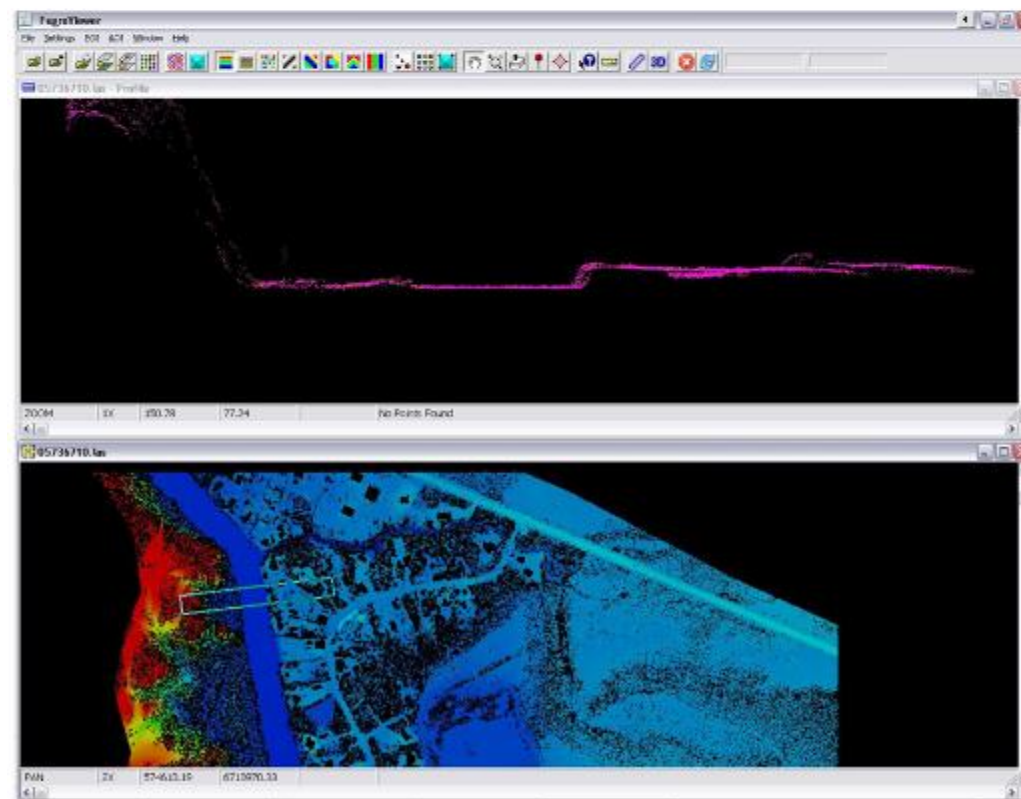
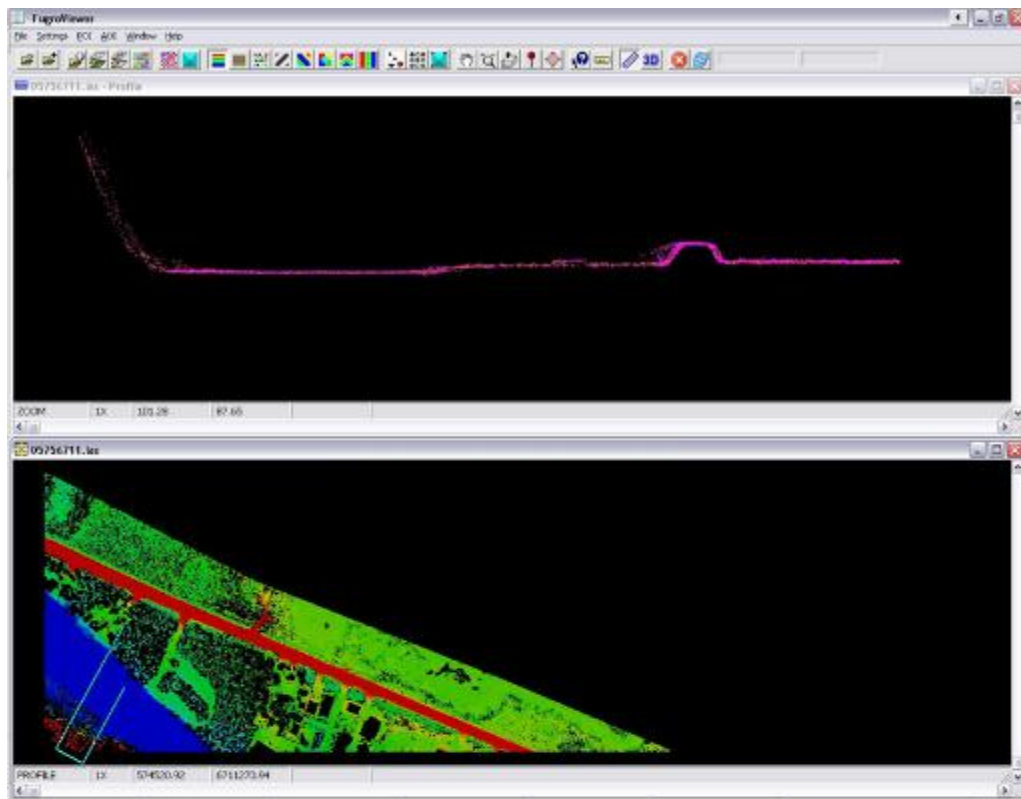
Boundary_	Boundary_Area	Num_1st_Returns	Num_BE_Returns	1st_Return_Density	BE_Density
5646710	91687.58741	125085	118482	1.364252278	1.292235987
5666710	1451604.246	2150593	2023568	1.481528458	1.394021825
5666711	497441.7515	600727	574681	1.20763285	1.155272951
5676710	22544.92021	13900	13355	0.61654687	0.59237291
5676711	1195632.775	2339599	2158442	1.956787275	1.80527169
5676713	1172377.618	1769545	1647131	1.509364366	1.404949203
5676714	156921.7064	305585	280481	1.9473724	1.787394532
5696711	695427.4544	983898	898548	1.414810407	1.292080136
5696713	394522.4255	428812	409236	1.086914133	1.037294647
5696714	365458.3563	707895	658455	1.937005921	1.80172375
5706711	417454.4541	561157	511636	1.344235268	1.225609153
5706713	262090.8396	303093	287692	1.156442554	1.097680485
5736710	819.8743427	135	290	0.164659379	0.35371274
5736711	414199.9692	471323	445687	1.137911722	1.076018912
5756710	1311907.426	1681934	1660233	1.282052351	1.265510788
5756711	165361.8206	255532	243468	1.545290195	1.472335023
5766710	174123.1714	134518	160002	0.772545084	0.918901251

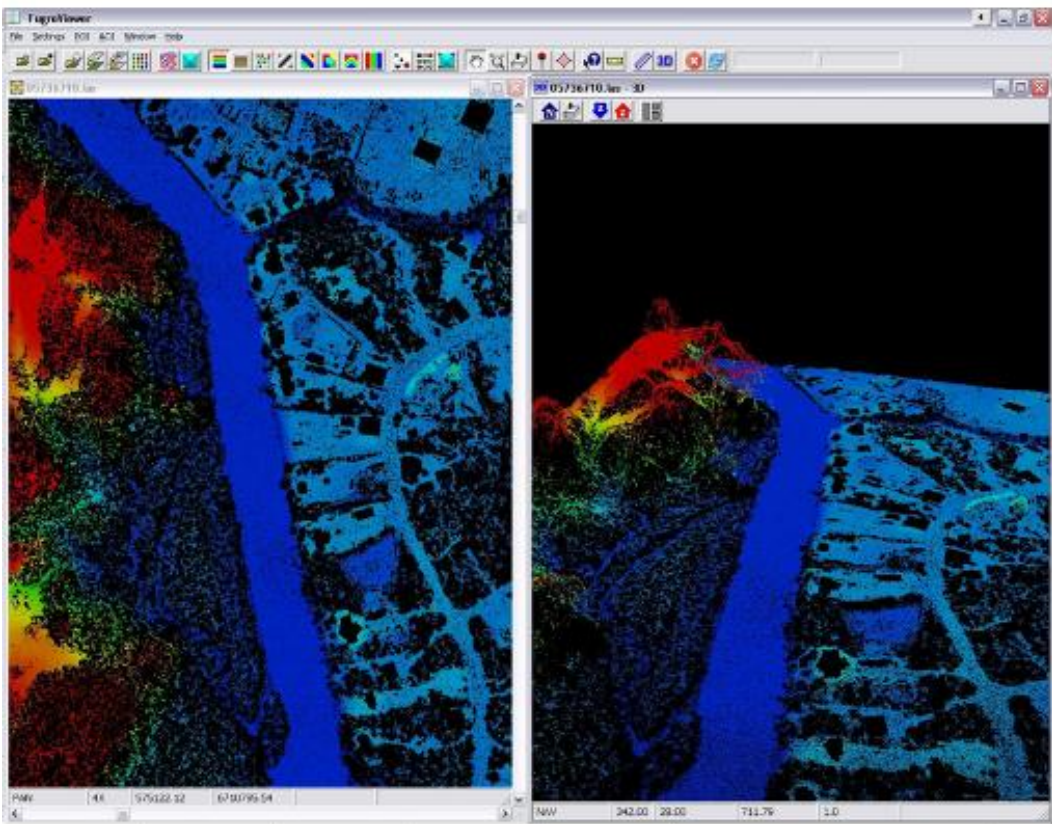
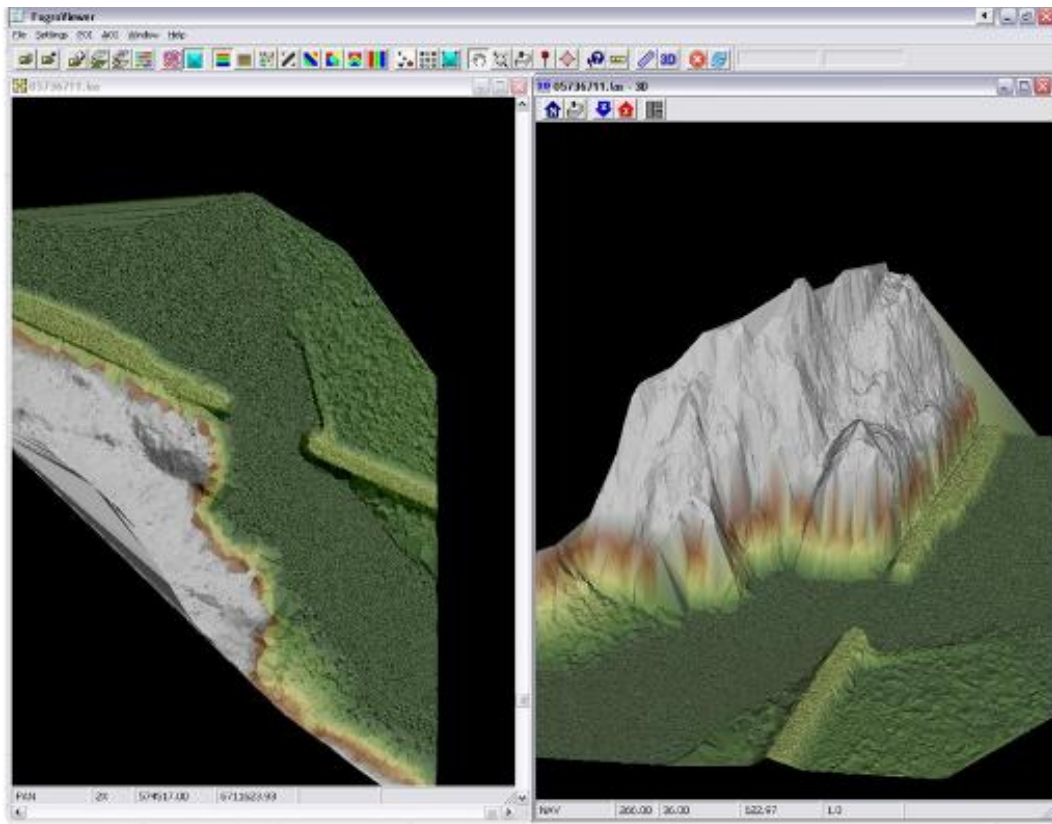
APPENDIX B: Micro Testing Results

The micro review of this dataset did not yield any discernable errors. Images included in this document showcase the high quality dataset provided for review.









APPENDIX C: LiDAR Vertical Accuracy Assessment



Project Information

Prepared By: James L. Huffines
Project Name: FEMA Region 10 Alaska 2011
Sensor Info: Optech Gemini LiDAR system
Required Nominal Pulse Spacing: 1
Vendor Name: Aerometric
Units: US Survey Feet
Percent of Extent Tolerance: Extents Not Checked
Date of Aquisition: Start: 7/6/2011 Finish: 12/15/2011

Metadata Information

Tile Index:

Path: C:\Workspace\FEMA\REGION_10\LiDAR\2011\Cordova\TopoAnalyst\Index\Bare_Earth_Index.shp

Number of Polys: 17

Intensity:

Tile Index Attribute: intensity

Path to Data: C:\Workspace\FEMA\REGION_10\LiDAR\2011\Cordova\TopoAnalyst\Intensity

Number of Data Files Matching Attribute: 17 out of 17

DEM:

Tile Index Attribute: location

Path to Data: C:\Workspace\FEMA\REGION_10\LiDAR\2011\Cordova\TopoAnalyst\DEM

Number of Data Files Matching Attribute: 17 out of 17

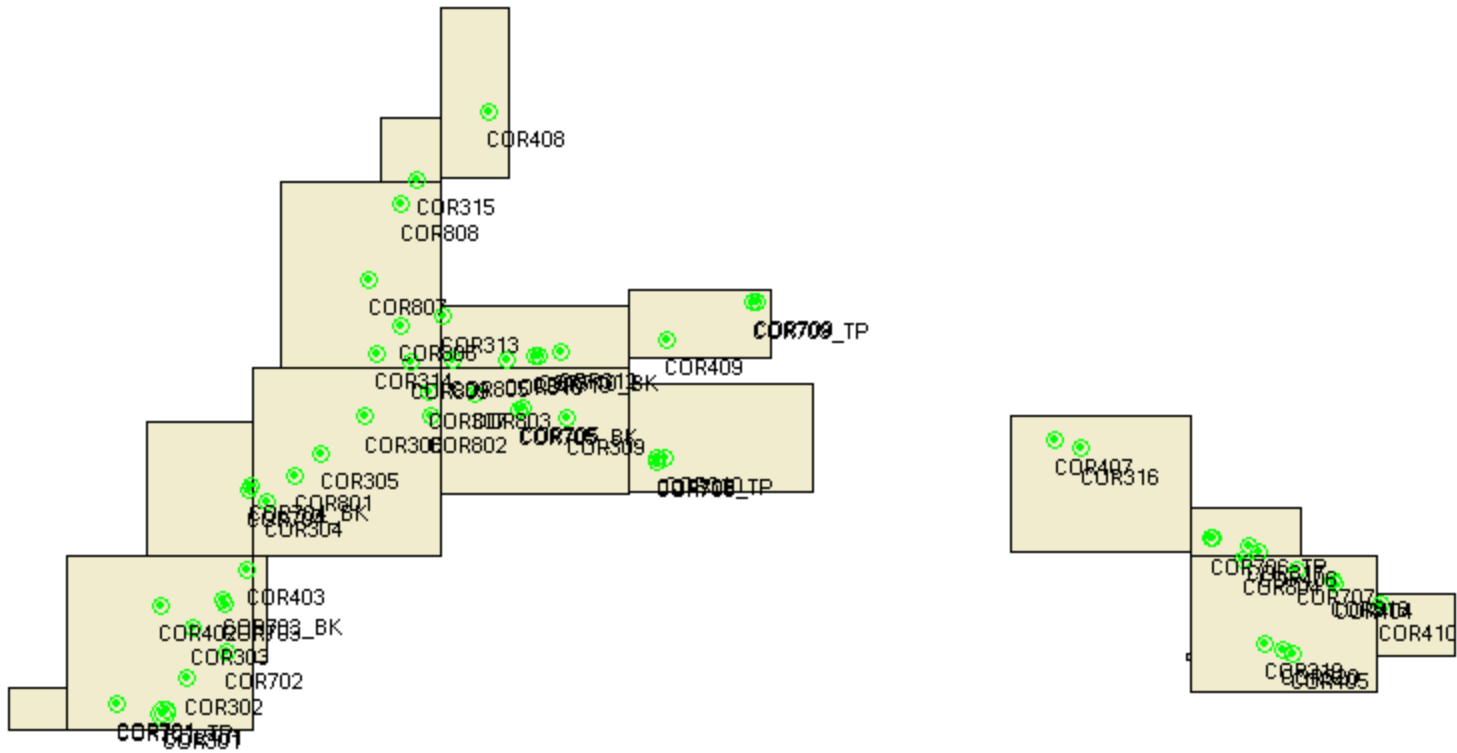
LAS:

Tile Index Attribute: FileName

Path to Data: E:\Alaska\Cordova\Bare_Earth

Number of Data Files Matching Attribute: 17 out of 17

Tiled-Data Area



LiDAR Accuracy Assessment Summary

LC Type	# of Points	FVA	SVA	CVA
LAS				
ALL	56			1.235
BE	14	0.312		
OPEN	4		0.233	
GRASS	10		1.221	
FOREST	18		1.957	
URBAN	10		0.296	
Total	56			
DEM				
ALL	56			1.232
BE	14	0.336		
OPEN	4		0.241	
GRASS	10		1.355	
FOREST	18		1.347	
URBAN	10		0.193	
Total	56			

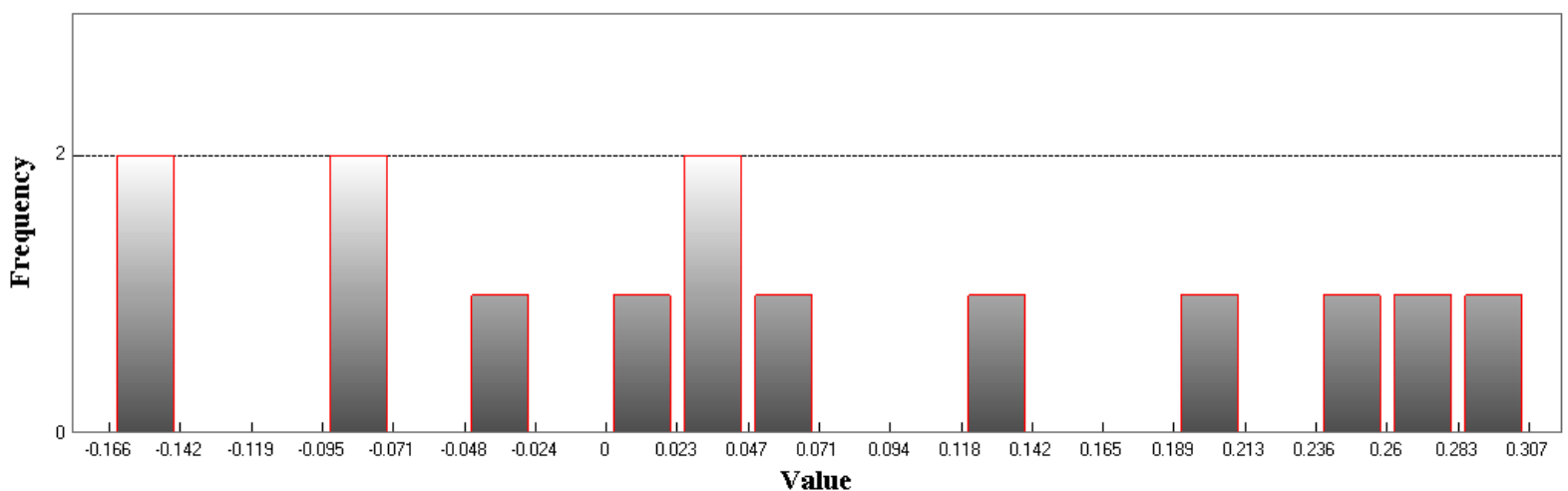
Units: US Survey Feet

LAS

Fundamental Vertical Accuracy

LandCover Type: BE
 Minimum DZ: -0.166
 Maximum DZ: 0.307
 Mean DZ: 0.054
 Mean Magnitude DZ: 0.36
 Number Observations: 14
 Standard Deviation DZ: 0.155
 RMSE Z: 0.159
 95% Confidence Level Z: 0.312
 Units: US Survey Feet

Histogram



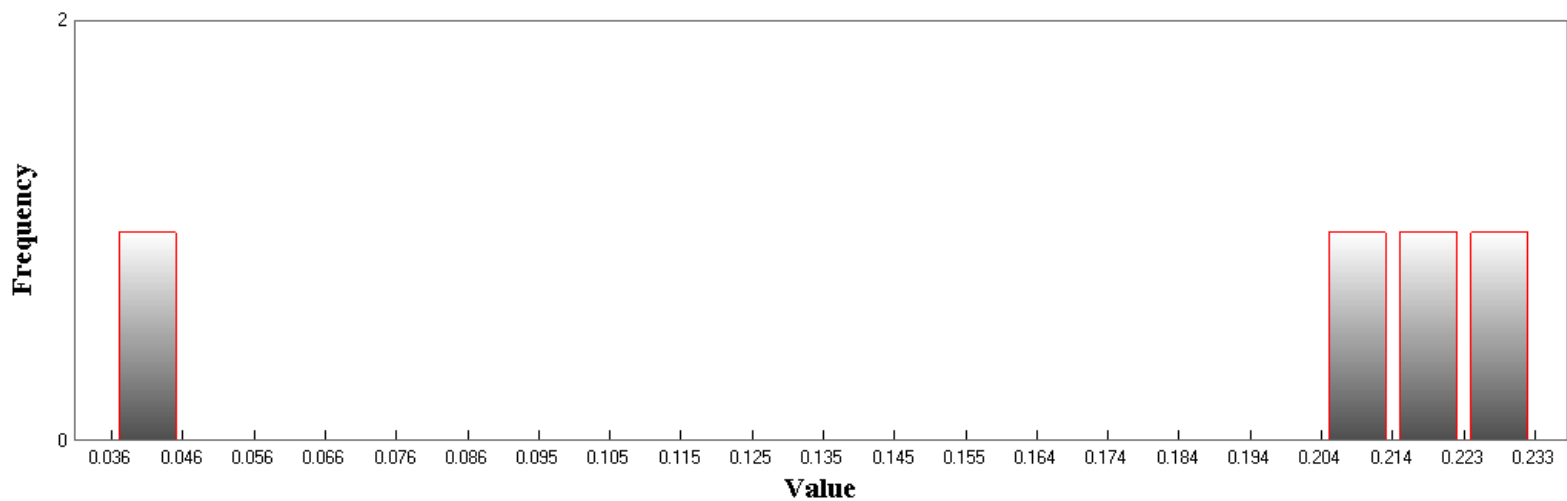
Min: -0.166
 Max: 0.307
 Number Of Bins: 20
 Bin Interval: 0.024

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: OPEN
 Minimum DZ: 0.036
 Maximum DZ: 0.233
 Mean DZ: 0.175
 Mean Magnitude DZ: 0.418
 Number Observations: 4
 Standard Deviation DZ: 0.093
 RMSE Z: 0.192
 95th Percentile: 0.233
 Units: US Survey Feet

Histogram



Min: 0.036
 Max: 0.233
 Number Of Bins: 20
 Bin Interval: 0.01

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: GRASS

Minimum DZ: 0.329

Maximum DZ: 1.221

Mean DZ: 0.735

Mean Magnitude DZ: 0.857

Number Observations: 10

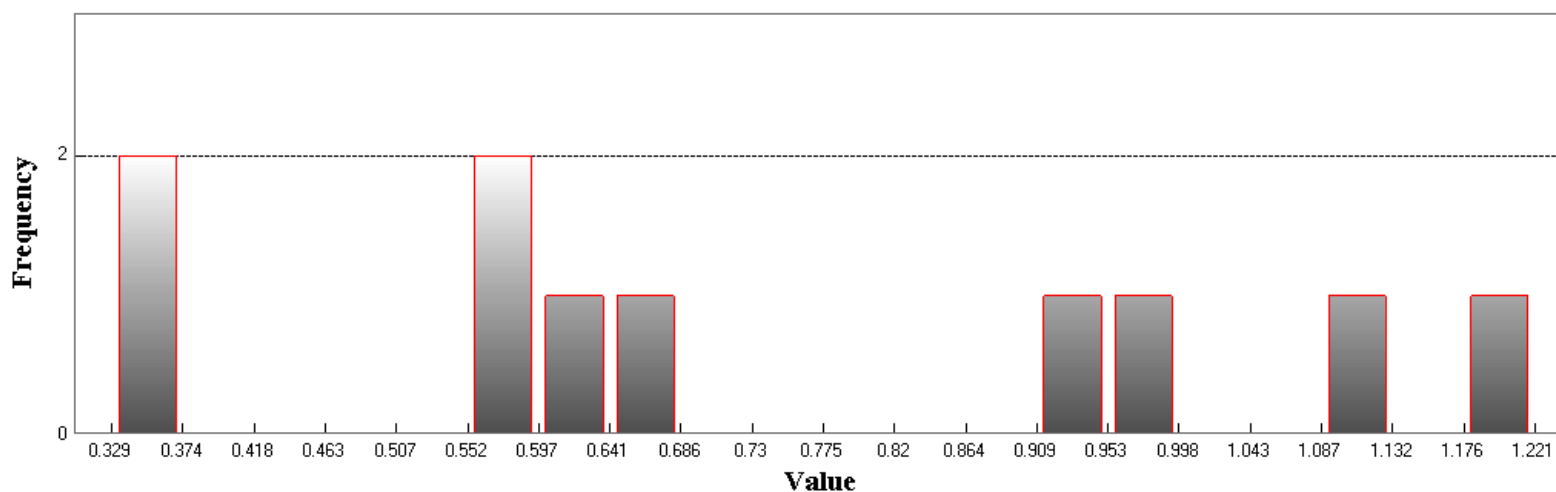
Standard Deviation DZ: 0.316

RMSE Z: 0.793

95th Percentile: 1.221

Units: US Survey Feet

Histogram



Min: 0.329

Max: 1.221

Number Of Bins: 20

Bin Interval: 0.045

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: FOREST

Minimum DZ: -0.504

Maximum DZ: 1.957

Mean DZ: 0.261

Mean Magnitude DZ: 0.64

Number Observations: 18

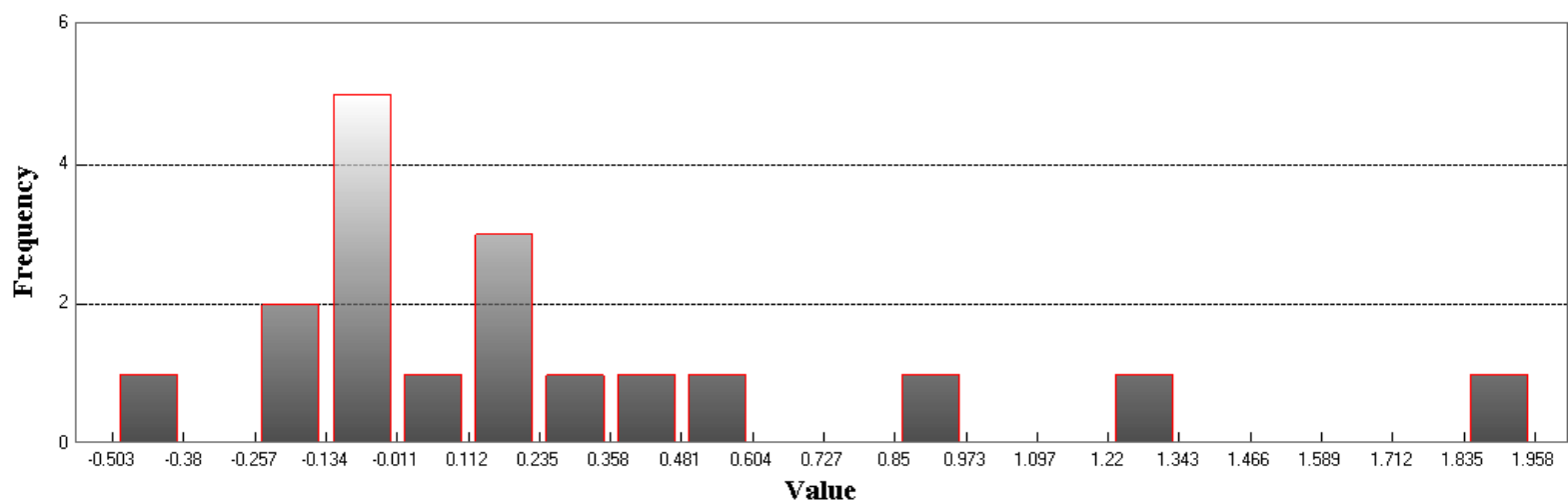
Standard Deviation DZ: 0.6

RMSE Z: 0.639

95th Percentile: 1.957

Units: US Survey Feet

Histogram



Min: -0.504

Max: 1.957

Number Of Bins: 20

Bin Interval: 0.123

LAS (Continued)

Supplemental Vertical Accuracy

LandCover Type: URBAN

Minimum DZ: -0.243

Maximum DZ: 0.296

Mean DZ: 0.046

Mean Magnitude DZ: 0.357

Number Observations: 10

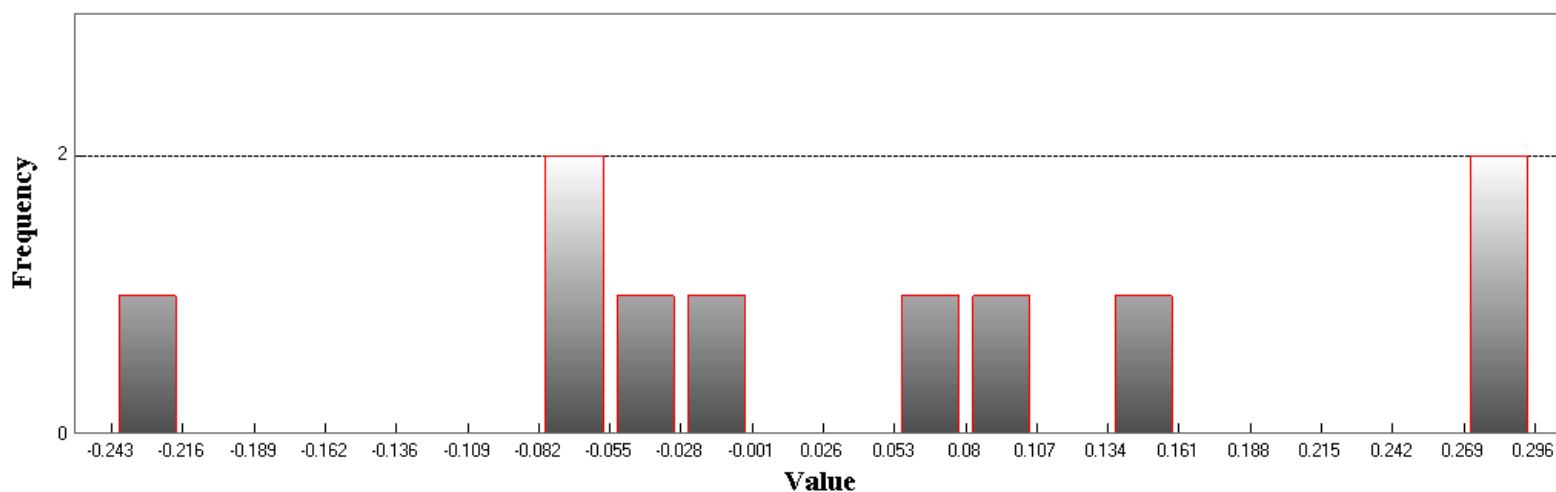
Standard Deviation DZ: 0.164

RMSE Z: 0.162

95th Percentile: 0.296

Units: US Survey Feet

Histogram



Min: -0.243

Max: 0.296

Number Of Bins: 20

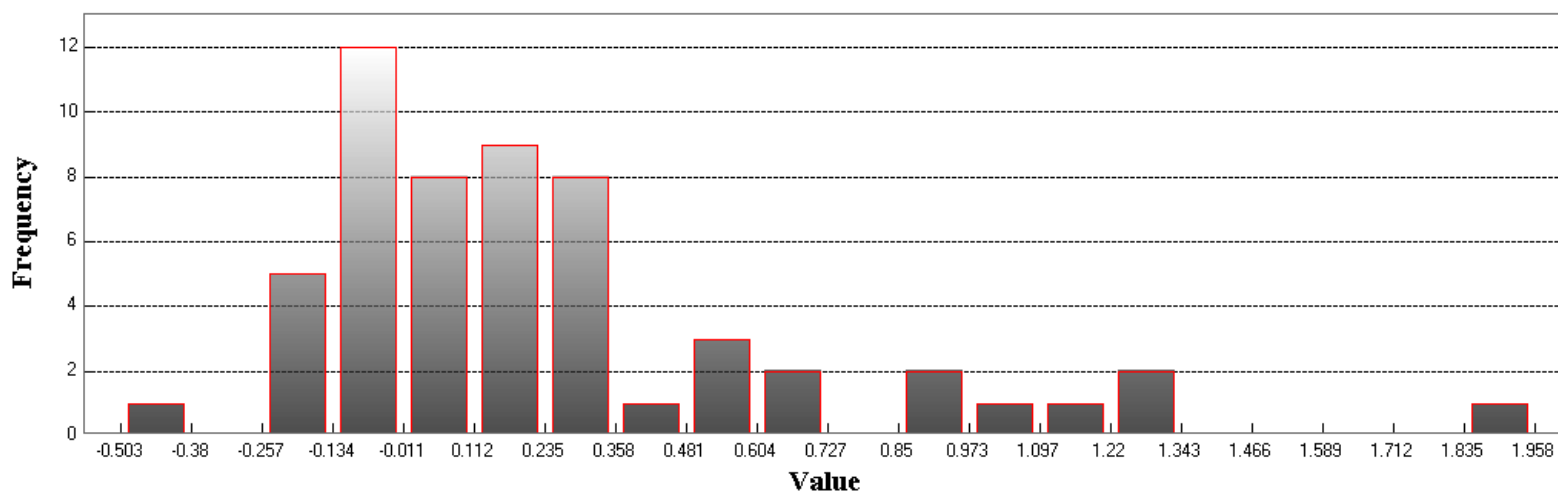
Bin Interval: 0.027

LAS (Continued)

Consolidated Vertical Accuracy

LandCover Type: ALL
 Minimum DZ: -0.504
 Maximum DZ: 1.957
 Mean DZ: 0.249
 Mean Magnitude DZ: 0.575
 Number Observations: 56
 Standard Deviation DZ: 0.446
 RMSE Z: 0.507
 95th Percentile: 1.235
 Units: US Survey Feet

Histogram



Min: -0.504

Max: 1.957

Number Of Bins: 20

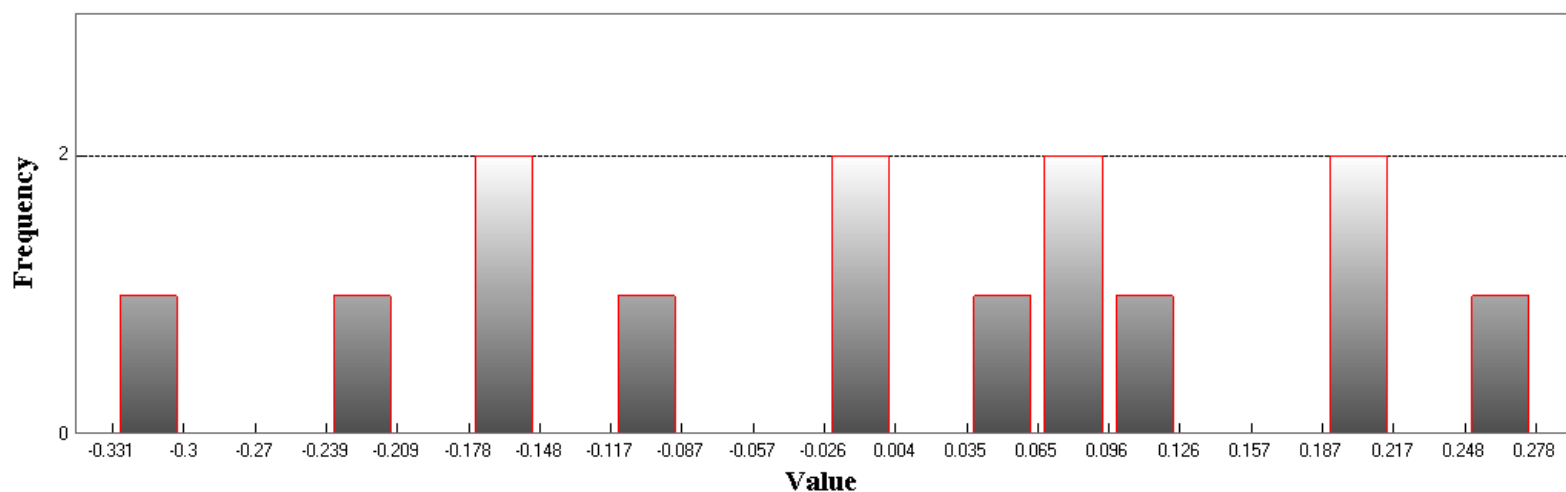
Bin Interval: 0.123

DEM

Fundamental Vertical Accuracy

LandCover Type: BE
 Minimum DZ: -0.33
 Maximum DZ: 0.279
 Mean DZ: -0.003
 Mean Magnitude DZ: 0.382
 Number Observations: 14
 Standard Deviation DZ: 0.178
 RMSE Z: 0.172
 95% Confidence Level Z: 0.336
 Units: US Survey Feet

Histogram



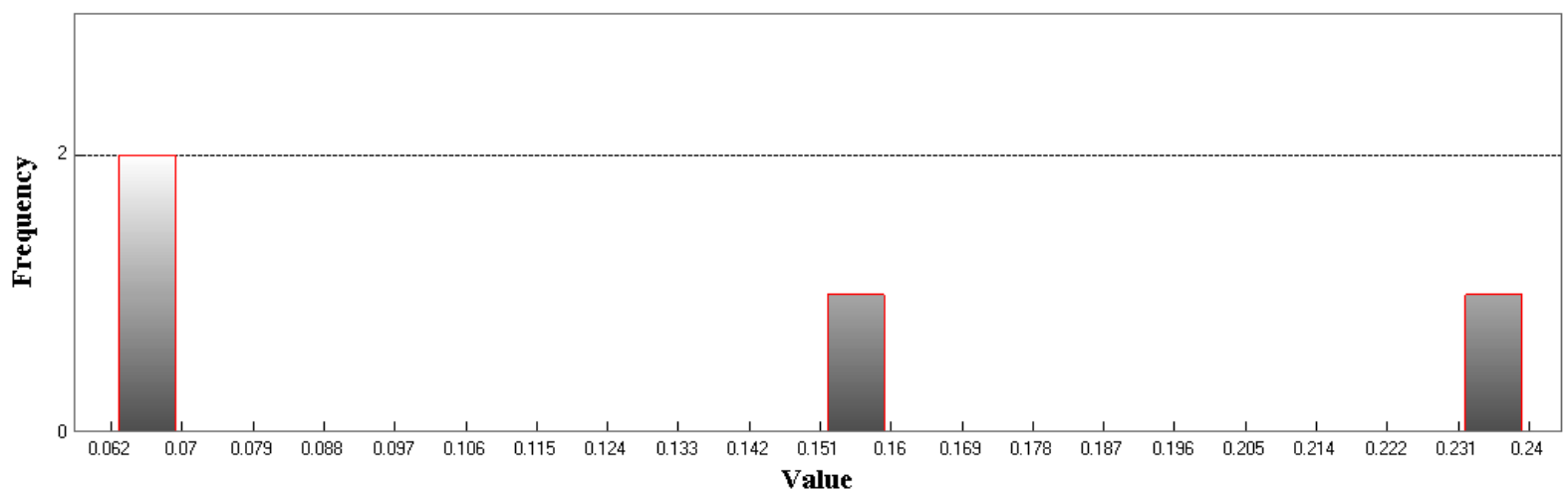
Min: -0.33
 Max: 0.279
 Number Of Bins: 20
 Bin Interval: 0.03

DEM (Continued)

Supplemental Vertical Accuracy

LandCover Type: OPEN
 Minimum DZ: 0.062
 Maximum DZ: 0.241
 Mean DZ: 0.132
 Mean Magnitude DZ: 0.363
 Number Observations: 4
 Standard Deviation DZ: 0.086
 RMSE Z: 0.151
 95th Percentile: 0.241
 Units: US Survey Feet

Histogram



Min: 0.062

Max: 0.241

Number Of Bins: 20

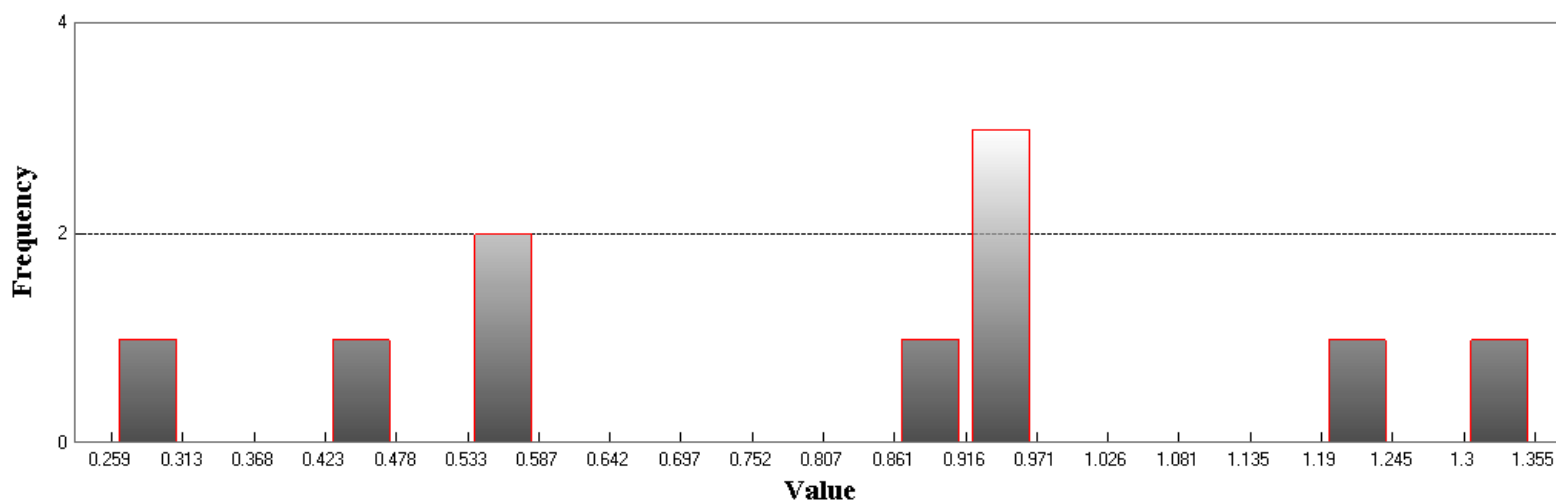
Bin Interval: 0.009

DEM (Continued)

Supplemental Vertical Accuracy

LandCover Type: GRASS
 Minimum DZ: 0.259
 Maximum DZ: 1.355
 Mean DZ: 0.807
 Mean Magnitude DZ: 0.898
 Number Observations: 10
 Standard Deviation DZ: 0.35
 RMSE Z: 0.873
 95th Percentile: 1.355
 Units: US Survey Feet

Histogram



Min: 0.259

Max: 1.355

Number Of Bins: 20

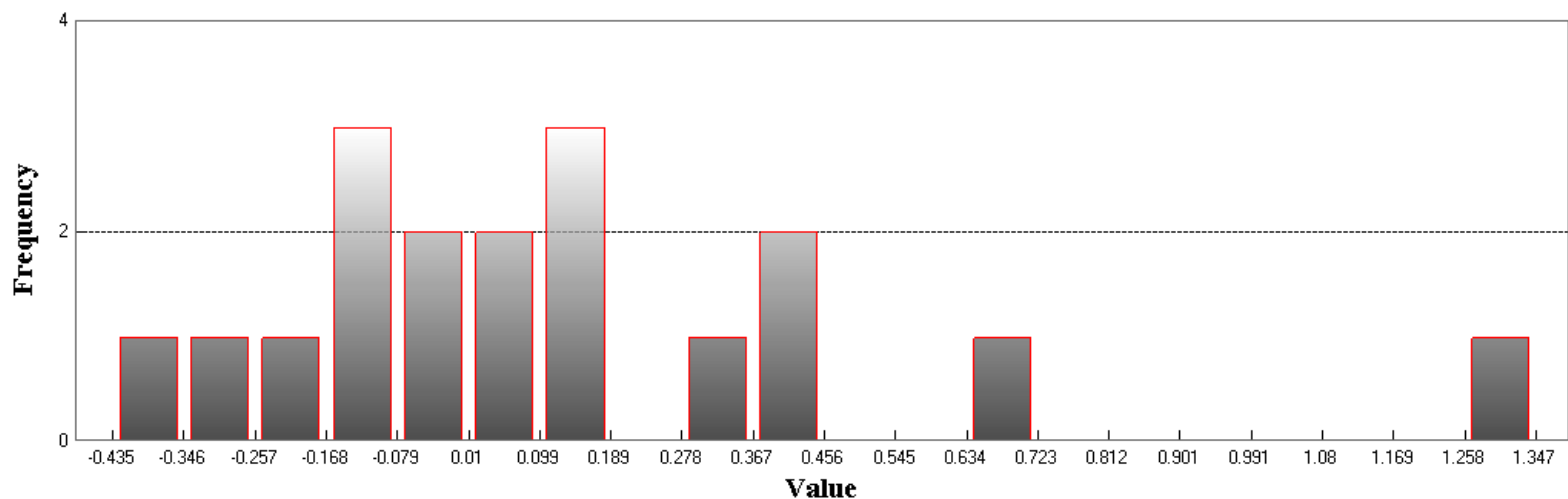
Bin Interval: 0.055

DEM (Continued)

Supplemental Vertical Accuracy

LandCover Type: FOREST
 Minimum DZ: -0.436
 Maximum DZ: 1.347
 Mean DZ: 0.127
 Mean Magnitude DZ: 0.54
 Number Observations: 18
 Standard Deviation DZ: 0.414
 RMSE Z: 0.422
 95th Percentile: 1.347
 Units: US Survey Feet

Histogram



Min: -0.436
 Max: 1.347
 Number Of Bins: 20
 Bin Interval: 0.089

DEM (Continued)

Supplemental Vertical Accuracy

LandCover Type: URBAN

Minimum DZ: -0.193

Maximum DZ: 0.125

Mean DZ: -0.016

Mean Magnitude DZ: 0.313

Number Observations: 10

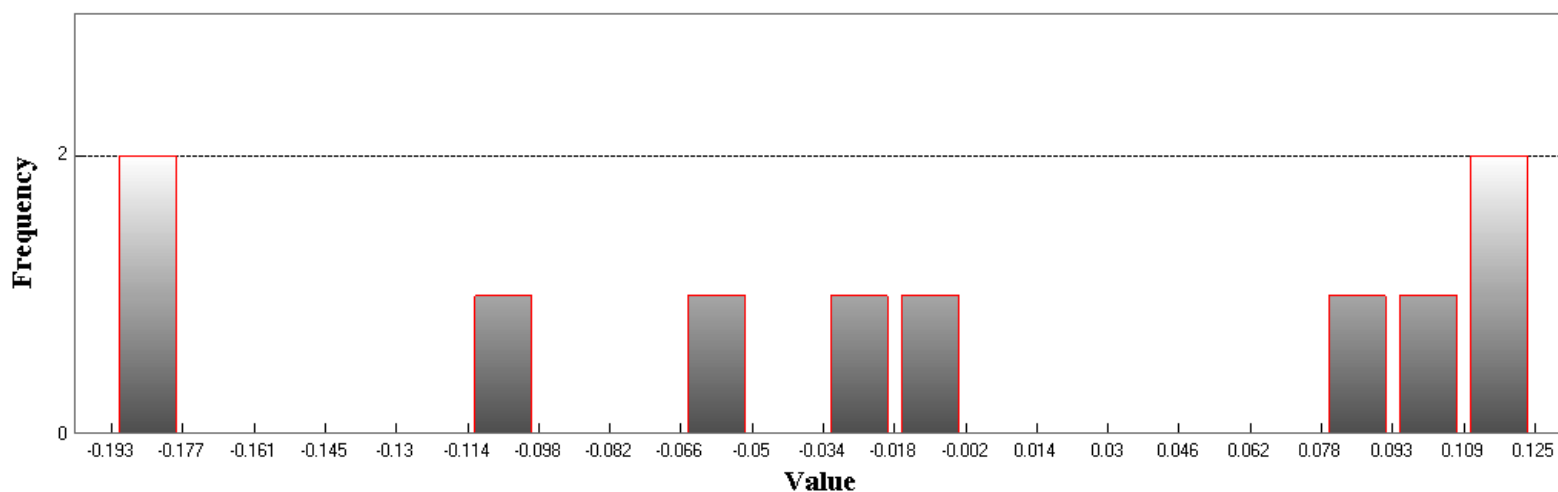
Standard Deviation DZ: 0.119

RMSE Z: 0.114

95th Percentile: 0.193

Units: US Survey Feet

Histogram



Min: -0.193

Max: 0.125

Number Of Bins: 20

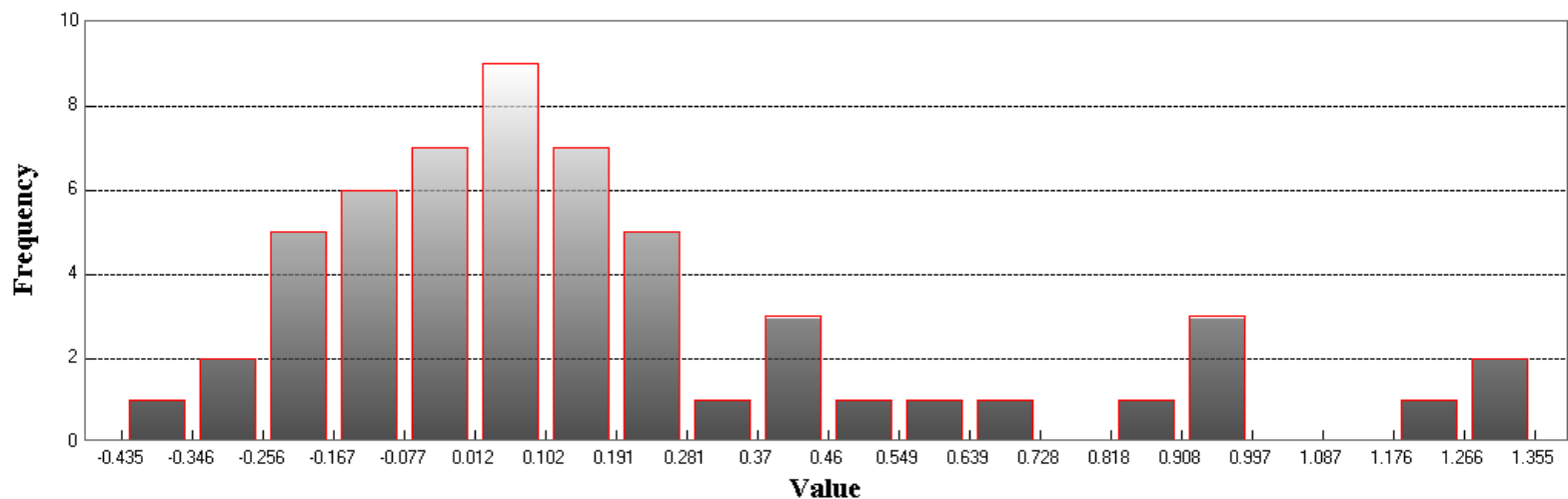
Bin Interval: 0.016

DEM (Continued)

Consolidated Vertical Accuracy

LandCover Type: ALL
 Minimum DZ: -0.436
 Maximum DZ: 1.355
 Mean DZ: 0.191
 Mean Magnitude DZ: 0.549
 Number Observations: 56
 Standard Deviation DZ: 0.414
 RMSE Z: 0.452
 95th Percentile: 1.232
 Units: US Survey Feet

Histogram



Min: -0.436
 Max: 1.355
 Number Of Bins: 20
 Bin Interval: 0.09