TETRA TECH

UAF Light Detection and Ranging (LiDAR) and Ortho-Imagery Data Project Report Revilla Corridor

Tetra Tech was contracted by the University of Alaska Fairbanks (UAF) to provide LiDAR and ortho-imagery data for the Road to Resources in Alaska Program. Tetra Tech collected LIDAR data and aerial imagery during the fall of 2013 and the spring/summer of 2014. Included within this document are the various reports required by the contract.

Collection Report

LiDAR data for the Revilla corridor project area was acquired with a Cessna 401 aircraft. The tail number of this aircraft is N34MM.

LiDAR Sensor:
Optech Orion H300

Imagery for the Revilla corridor project area was acquired with a Piper Aztec PA-23-250 Turbo twin aircraft. The tail number of this aircraft is C-FKSK.

Imagery Camera:
Intergraph DMC01 Digital Mapping Camera

Survey Report

Each polygon area contains calibration points as well as independent check points. Check points have been withheld from Tetra Tech. The coordinates with field notes for each area will be provided to GINA directly by the surveyor, McClintock Land Associates.

The Revilla area contains 3 calibration points and 10 independent check points as shown in the diagram below.

TETRA TECH

Revilla
Plan of Survey
McClintock Land Associates
October 2013
N
0
0.75
1.5
3
Miles
Legend
FOREST CHECK POINT
OPEN CHECK POINT
REBAR AND ALCAP OPEN CHECK POINT AND TARGET
BLM Monuments

TETRA TECH

Certification from Surveyor

Revilla

QUALITY CONTROL REVIEW SUMMARY

Max. High Elev. Deviation:	1.00	feet
Max. Low Elev. Deviation:	-0.38	feet
Elevation Deviation Range:	1.38	feet
Elevation Deviation Mean:	0.17	feet
Elevation Deviation RMSE	**0.43**	**feet**

(RMSE = Root Mean Square Error)

CHECK POINTS			SURVEYED Elevation (Feet)	CATEGORY	TIN File Name	LiDAR Elevation (Feet)	Deviation (Feet)
Point Number	Northing (Feet)	Easting (Feet)					
403	1492240.76	3148289.02	1090.30	Open	L31475_14900	1090.42	0.12
404	1474233.49	3137344.83	293.64	Open	L31350_14725	294.64	1.00
405	1460478.58	3164114.69	356.31	Open	L31625_14600	356.33	-0.02
407	1446180.33	3159693.52	2593.03	Open	L31575_14450	2593.40	-0.38
408	1422557.17	3165873.95	652.00	Open	L31650_14225	652.10	-0.10
409	1402643.85	3163650.03	38.88	Open	L31625_14025	38.54	0.34
410	1415487.58	3165612.00	416.77	Forest	L31650_14150	416.90	-0.13
411	1439838.53	3161942.35	603.08	Forest	L31600_14375	602.49	0.59
412	1471102.95	3149636.12	376.09	Forest	L31475_14700	376.02	0.06

TIN CERTIFICATION

Date Prepared: 12/10/2014

Roads to Resources – REVILLA – TIN Surface Model

Prepared by: McClintock Land Associates, Inc.
Prepared for: Tetra Tech, Inc.

I hereby certify that an independent ground survey was performed under my supervision to obtain sampling data to be used to test the reliability of the electronic Triangular Irregular Network (TIN) surface model for Revilla, Alaska. This TIN is based on the Model Key Points Method. For ease of manipulation the surface model was divided into 183 cells as defined by the .dwg files shown on the attached listing.

These files were produced by Tetra Tech, Inc. from a LiDAR survey. The LiDAR data was acquired and calibrated by Aerial Surveys International flown on June 18, 26, 27, July 1, 10, and 11, 2014 and processed by Tetra Tech, Inc. between October 31 and December 8, 2014.

The independent ground survey was performed by McClintock Land Associates, Inc. October 17, 2013 and May 1, 2014 using Static and RTK GPS methods as well as conventional optical methods. Topcon Data Collectors, along with Topcon HiPer GA and GR-3 GNSS receivers were used as well as a Topcon GPT-3005LW Reflectorless Electronic Total Station. Topcon Magnet Field v2.0.1 data collection software was used for the field data collection and Topcon Magnet Office Tools v2.0.1 office software was used for post-processing and adjustments.

The survey data was collected in Alaska State Plane Coordinates, Zone 1 (NAD83) in US Survey Feet. The vertical datum is NAVD88 in feet and elevations were determined as approximate orthometric heights using Geoid Model 2012A. Ties to the NSRS were made using the NGS OPUS Utility. A more detailed description of the methods and control will be contained in the Survey Report for this project.

This TIN was checked using independent QC check points which had been withheld from the TIN producer. The RMS error standard for ASPRS Class 2 Maps for Vertical Accuracy for a 2 foot contour interval map is 2/3 of the contour interval or 1.33 feet. The RMS error between the elevations returned from the TIN and the actual check points was 0.43 feet. This map meets and exceeds that standard.

STATE OF ALASKA
49TH
William McClintock
WILLIAM McCLINTOCK
LS 5480
12-10-14
REGISTERED PROFESSIONAL LAND SURVEYOR

William McClintock
Professional Land Surveyor
McClintock Land Associates, Inc.

12-10-2014
Date

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QA/QC Report

Tetra Tech has performed quality control throughout each step of the acquisition and processing for the Revilla corridor project area. The only difficulty encountered was during the acquisition phase of the project, waiting for suitable weather conditions for collection. Difficult weather conditions were a challenge and caused delays and offsets between LiDAR acquisition, image acquisition and ground survey. Our flight teams remained on-site and acquired LiDAR at a lower altitude that enabled collection below cloud deck. The data was immediately checked for quality to determine if the lower flight altitude would affect the data. There was no adverse effect on the data.

Processing Report

Imagery

The imagery was acquired with a DMC01 digital frame camera on July 12, 2014. The flight took place between 10:20 am and 4:20 pm local time. The camera was equipped with airborne GPS and inertial unit (IMU). The image acquisition was planned in conjunction with survey of ground control points and collection of airborne LiDAR data. An aerotriangulation was performed in the Inpho / Trimble Match-AT version 6.0 software. For orthorectification a digital elevation model with 10ft grid spacing was generated from the LiDAR data. The Orthoimagery was then created in Inpho / Trimble OrthoMaster version 6.0 and mosaicked and color balanced in OrthoVista 6.0. MrSID compressed files were created in Lizardtech Geoexpress 9.

For additional information on the image processing see the AT log file and the camera calibration report and GPS shapefile in the imagery directory. Information regarding the processing is also contained in the xml metadata file accompanying each image (i.e. each individual geotiff tile, the complete MrSID mosaics and the individual unbalanced orthoimages).

Aerotriangulation

The aerotriangulation results are documented in the match-at log file “aat.html”. The AT relies much on the airborne GPS and IMU. In addition we used ground control points 401, 402 and 406 mainly for vertical control and datum shift. Selecting photo-identifiable horizontal control was a challenge in this terrain and identification of the photo ID point was not very satisfying. However, the required accuracy of 8’ rms will be far exceeded based on airborne GPS alone. An additional visual check was performed by overlaying the orthoimagery e.g. with the intensity imagery.

Orthorectification

The imagery was orthorectified in OrthoMaster using a 10ft spacing DEM generated from the LiDAR data, classes 8 and 9.

4 band unbalanced “raw” orthoimages: the raw aerial images were converted from 16 bit to 8 bit, 4-band imagery without any balancing. The imagery was then orthorectified to the full extent of each image. During the orthorectification process images were clipped to the area of interest (AOI) since no DEM is available outside that area.

3 band True Color RGB and Color Infrared CIR mosaics: 8 bit balanced 4 band images were orthorectified. During the orthorectification process images were clipped to the AOI. Overlap between images was not reduced, i.e. orthoimages were rectified to their full extent. Although the most nadir part of each image is to be preferred this allows for the most options to place seamlines (= cut lines) around features such as water bodies or leaning trees and to reduce visibility of seamlines. One of the concerns in the Revilla corridors was image “smear” in the orthoimagery due to the steep terrain. Image smear occurs in steep terrain, at the edge of the image, on terrain surfaces that are facing away from the image center. This situation leads to few image pixels covering a large area on the ground which then leads to smear in the orthoimage when these pixels are stretched during rectification. To eliminate smear this portion of the mosaic will typically be taken from the neighboring flightline. Images were color balanced across the block in OrthoVista and then written out into two set, 3 band RGB and 3 band CIR geotiff tiles. These tiles were combined to a MrSID mosaic in Lizardtech Geoexpress 9. See Figure 1 for organization of the image data delivery.

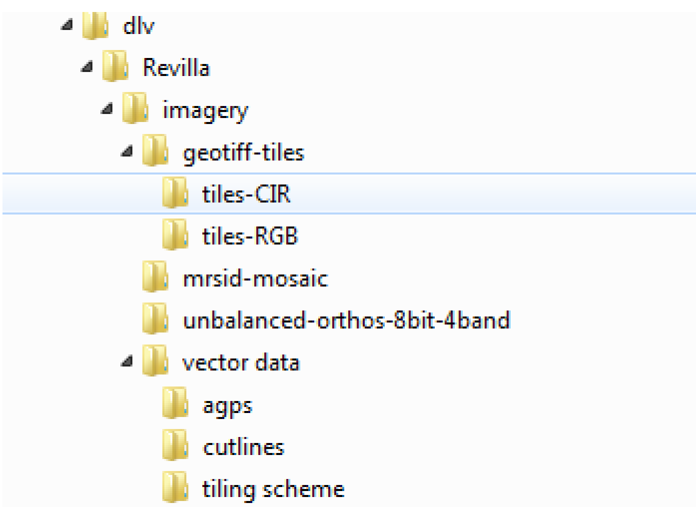

Figure 1: Organization of image data

The LiDAR data for the Revilla corridor area was acquired June 18, 26, 27 and on July 1, 10 and 11 of 2014. SBET and shapefile of the trajectory are located with the point cloud data (see Figure 2 for the organization of LiDAR and LiDAR derived data). The data was post processed through PosPac, Waypoint’s GPS and IMU (inertial measurement unit) post processing software, and LMS, Optech’s LiDAR post processing software. PosPac is used to generate the trajectory file which contains the position (X, Y, Z) from differential GPS observations and the plane’s attitude (roll, pitch, heading) from the IMU. LMS is used to join the discreet point range information to the trajectory information through a common time stamp and to calibrate the data. The calibration is achieved by first identifying common features in the overlap of adjacent flight lines, and then adjustments are applied to the IMU's angular offsets to align the data. Once finished, LMS refines the calibration further through a bundle adjustment to create the final calibrated data set.

Classification of the calibrated LiDAR data set is achieved through the use of TerraScan, the industry standard software from TerraSolid for classifying LiDAR. Individual macros were defined that derive and refine a ground surface, vegetation, and buildings. These macros are also used to eliminate spurious points below the surface and high point artifacts. The Revilla area was then manually checked and edited to eliminate low and high points as well as to ensure that points are classified appropriately.

Breaklines were derived from LiDAR and imagery, which are used in the production of contours and help define water classes in the LiDAR data.

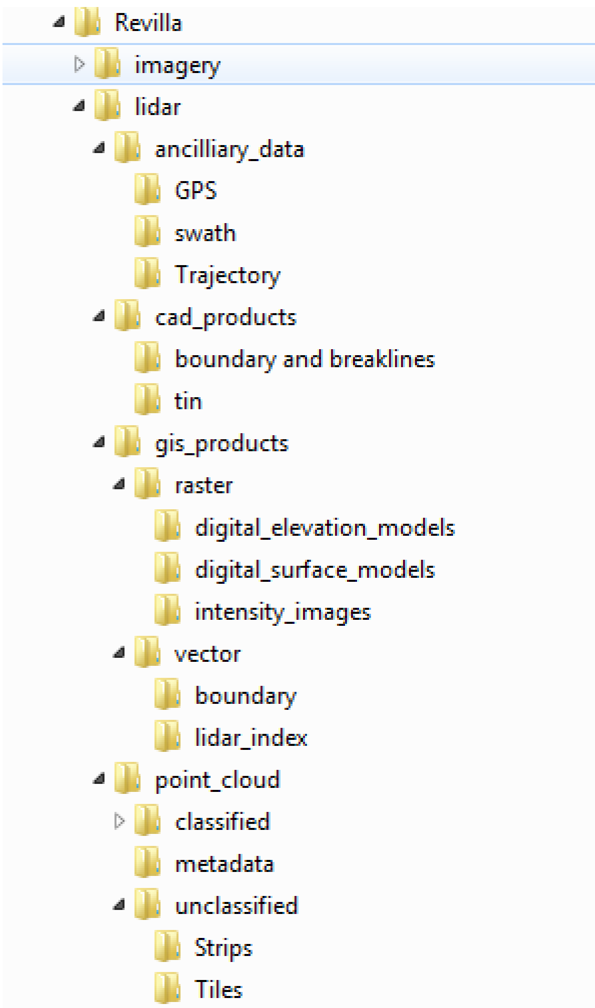

Figure 2: Organization of LiDAR data

DSM

The DSM was created from LiDAR first returns and only-returns. A thinning within 1’ cells was applied to select points that contribute to the DSM. This selection occurred in Terrascan. Points were then imported into a geodatabase. A terrain was created in 3D Analyst from the imported points and subsequently a 3’ spacing grid was generated, using the NATURAL_NEIGHBORS interpolation method.

The ERDAS imagine mosaic tool was then used to clip and tile the DSM at the same time into individual geotiff tiles.

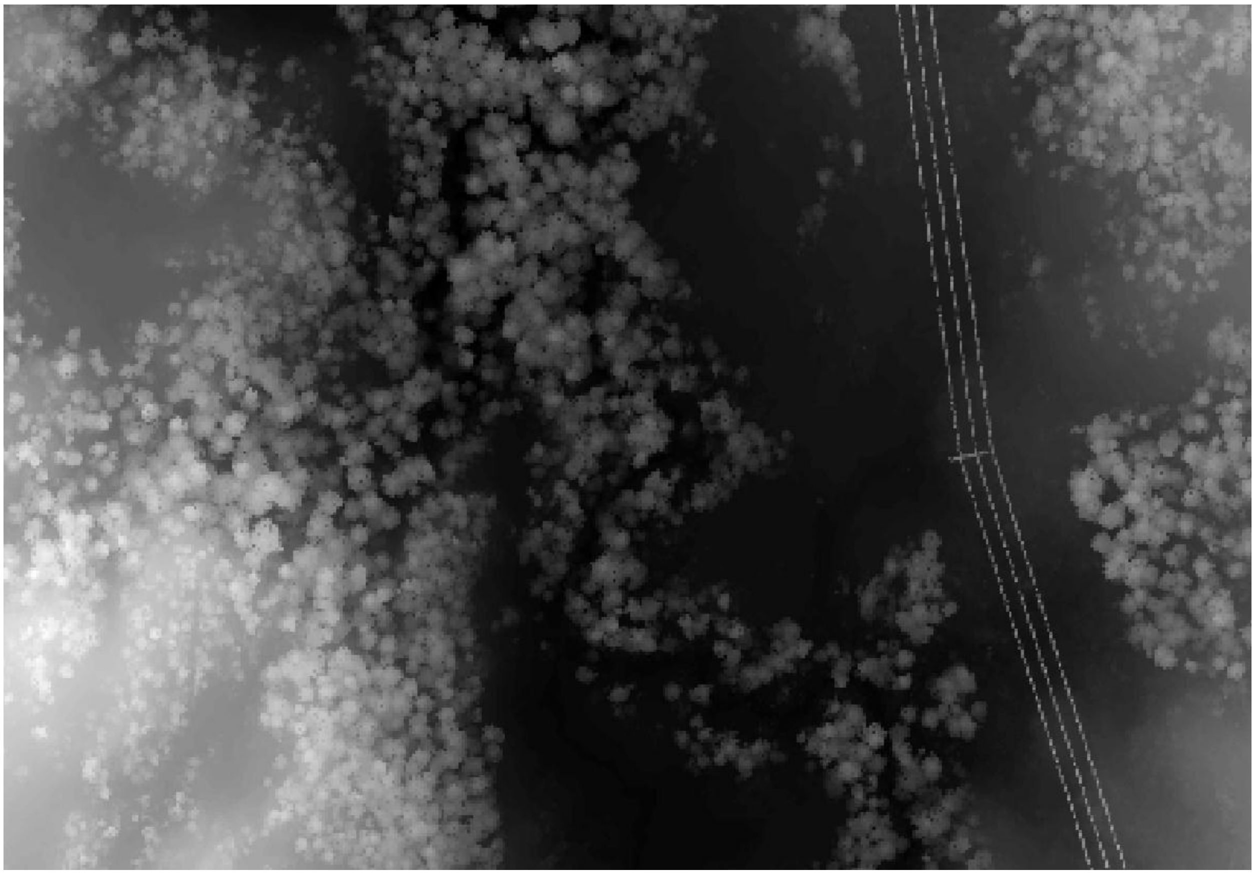

Figure 3: Result, DSM with 3ft grid spacing, tiled and clipped to AOI

DEM

The DEM was created using ESRI 3DAnalyst. The individual steps included:

- Importing all las files into the geodatabase as multipoint, all returns, classes 8 and 9.
- Importing the breaklines as a feature layer.
- Creating a terrain in 3D Analyst from all mass-points.

- Creating a 3’ spacing grid, using the NATURAL_NEIGHBORS interpolation method
- The ERDAS Imagine mosaic tool was then used to clip and tile the DEM at the same time into individual geotiff tiles (Figure 4).

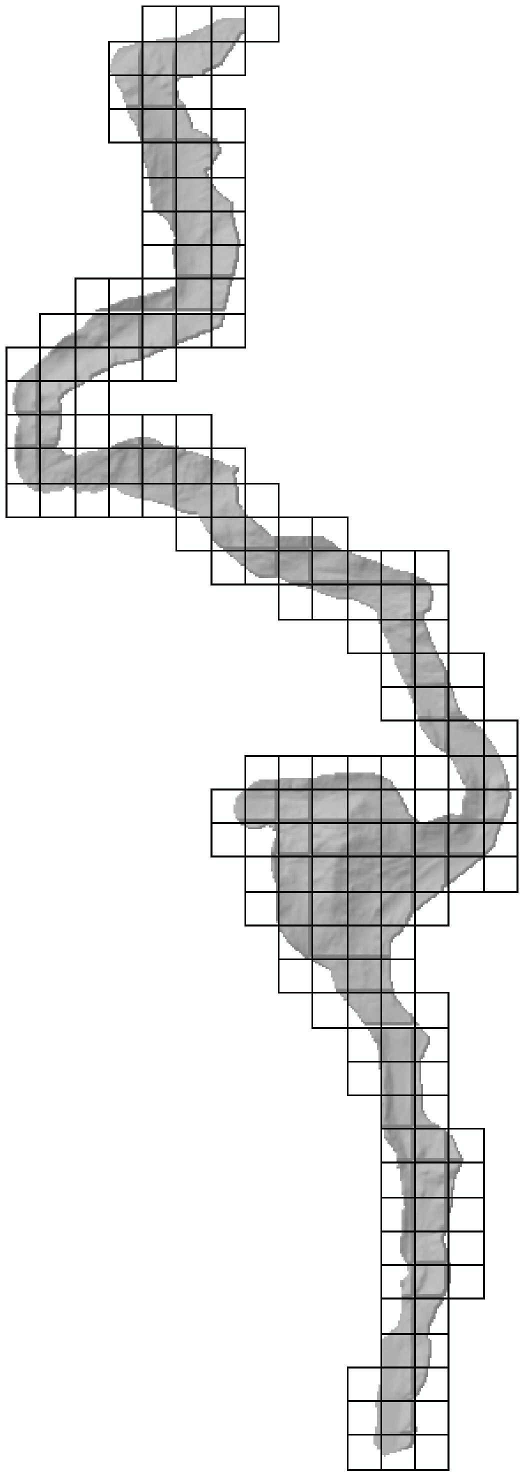

Figure 4: DEM as a shaded relief overlaid with the tiling scheme.

Intensity Image

- The intensities were exported from the LAS files in the LP360 software to one ESRI grid with 3ft. spacing.
- The grid was then exported in ESRI to a geotiff with data type float.
- The geotiff was again clipped to the AOI and tiled to the LiDAR tiling scheme in ERDAS Imagine.

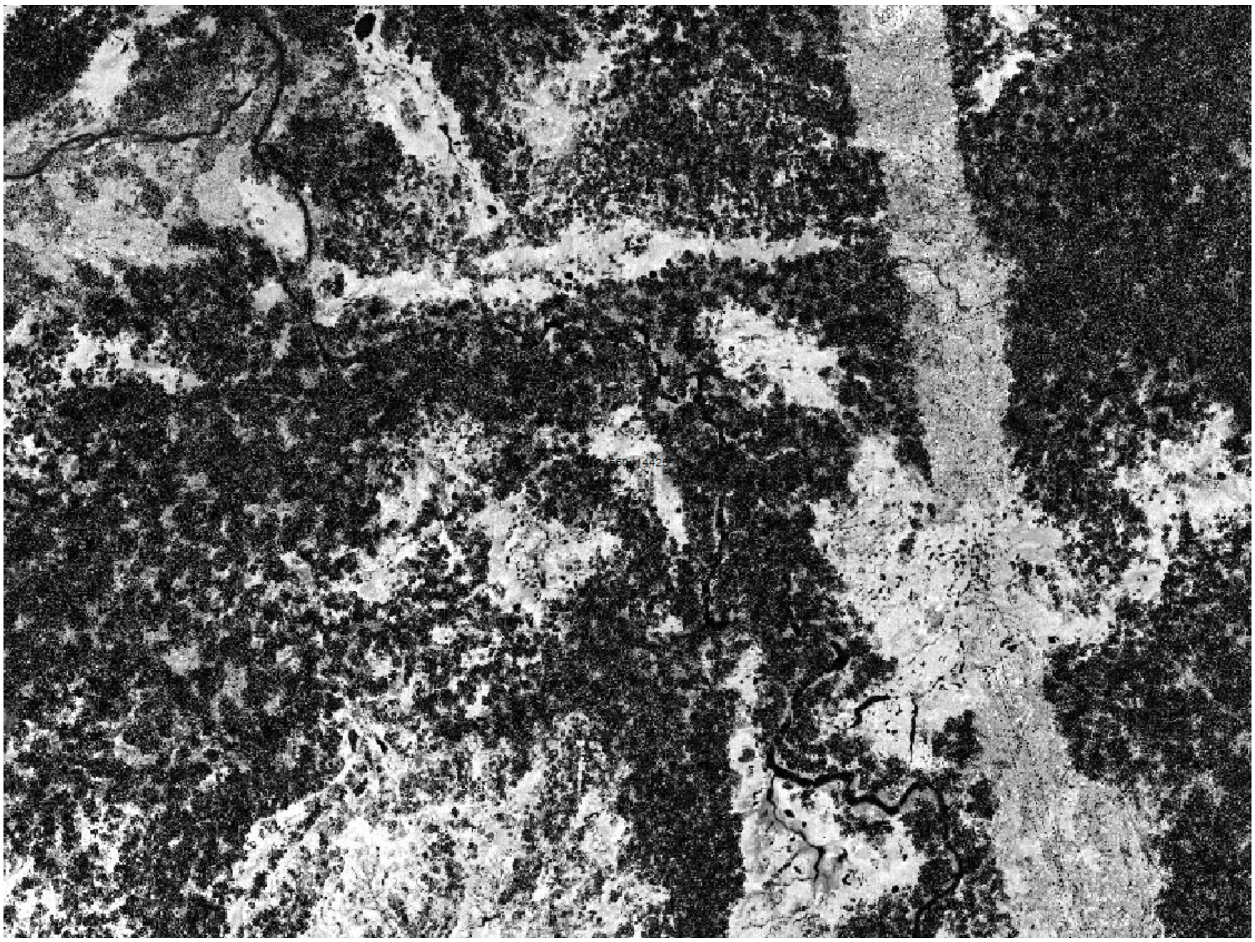

Figure 5: Intensity image, 3ft spacing, float values.

TIN

TIN creation based model key points

In producing a TIN from LiDAR data, it is common practice to use model key points and breaklines. Model key points are thinned from the LiDAR ground points to represent the terrain, and allow for an accurate but less dense data set. Model key points are exported from the las files into csv format, with a 150 ft. over edge beyond the tile boundary. Breaklines are imported directly into the Civil3D file, while the csv is referenced externally to create the TIN. There were a total of 37 million model keypoints in the Revilla polygon in 182 tiles.