FINAL PROJECT REPORT

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Project Name: Acquisition of LiDAR and Imagery Derived Products for PNG

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Document Control			
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1.0 Introduction

AAM was engaged by Geoscience Australia to undertake a LiDAR survey over the towns of Vanimo, Wewak, Madang and Lae in Papua New Guinea and the coastal sections that join them. Acquisition was undertaken between May 5th and July 13th 2012. Rain, low cloud and other weather related challenges were faced in this aerial LiDAR survey.

AAM deployed its Optech ALTM Orion M200 for this project. This sensor is capable of detecting multiple returns, with a minimum of 4 potential returns for each outbound laser pulse as well as recording the intensity of each return.

The planned point density for the survey was an average density of 3.3pts/m^2 for the town areas and 0.85pts/m^2 for the coastal sections. The actual average point spacing achieved was 0.43m across the 509m wide swath.

The vertical accuracy for this data set is +/-0.30m, and the horizontal accuracy is +/-0.80m. This data is presented in terms of WGS84 UTM zones 54/55 and PNGMG94 zones 54/55. The vertical data is presented in terms of WGS84 Ellipsoidal, PNG94 Ellipsoidal, MSL (EGM20008), MSL (PNG08).

This *Project Report* addresses the following topics as specified in the contract:

1. how each of the contract specifications has been met,
2. a statement of consistency with any specified standards,
3. results of independent accuracy tests,
4. metadata statements
5. extra-ordinary issues that may have affected the nature or delivery of the project
6. other project information of note.

2.0 Contract Specifications Confirmed

2.1 Category of Elevation Capture and Laser Flight Settings

The survey undertaken was ICSM Category 1:

- Absolute vertical accuracy: 1 sigma 0.30m or better in areas of open, flat terrain.
- Absolute horizontal accuracy: 1 sigma 0.80m or better in areas of open, flat terrain.

The category of elevation is assigned based on based on LiDAR system specifications and settings used for project acquisition. The following Table shows the LiDAR system settings used for acquisition.

Laser Flight Settings		
Description	Towns/Coastal	Units
Sensor ID	Optech ALTM Orion M200	
Flying Height	700/1200	m
Swath Overlap	20/25	%
Swath Width	509/872	m
Scan Field of View (FOV)	40/40	Degrees
Half Scan Angle	20/20	Degrees
Scan Frequency	40/49	Hz
Maximum Number of Returns	4/4	
Echo Separation Distance	0.7/0.7	m
Footprint Size	0.162/0.3	m
Pulse Rate Frequency	150/150	KHz
Estimated Horizontal Accuracy	0.8/0.8	m
Estimated Vertical Accuracy	0.3/0.3	m
Average Point Spacing	0.42/0.85	Pts/m^2
Average Density of Ground Strikes	4.7/1.2	Pts/m^2

The Figure below displays the LiDAR system accuracy specifications as presented by Optech for the ALTM Orion M200.

Parameter	M 200
Operational envelope [1,2]	200 - 2500 m AGL, nominal
Laser wavelength [3]	1064 nm
Horizontal accuracy [2]	1/5, 500 x altitude
Elevation accuracy [2]	<5-15 cm; 1σ
Effective laser repetition rate	50 - 200 kHz
Position and orientation system	POS AV™ 510 (OEM) GPS/GNSS/L-Band receiver

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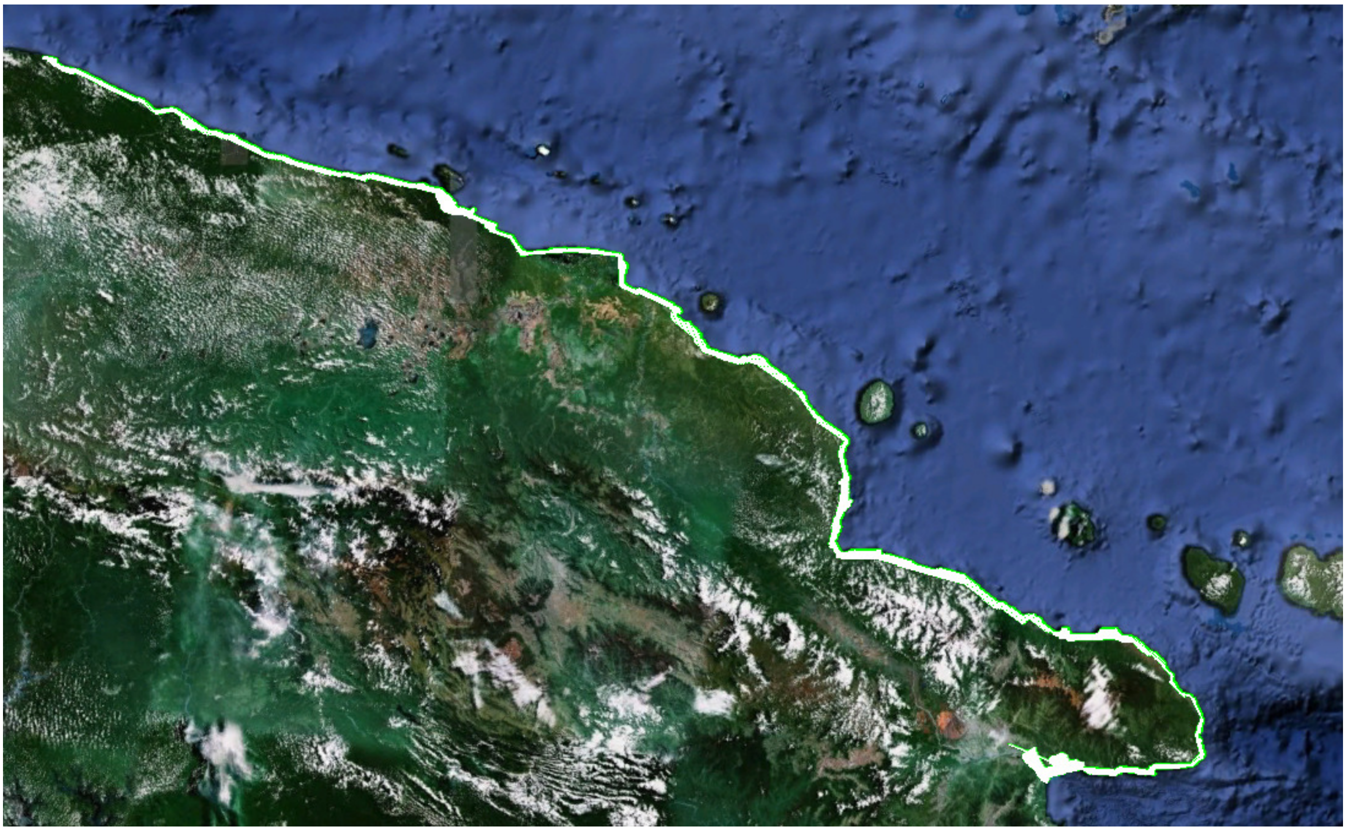
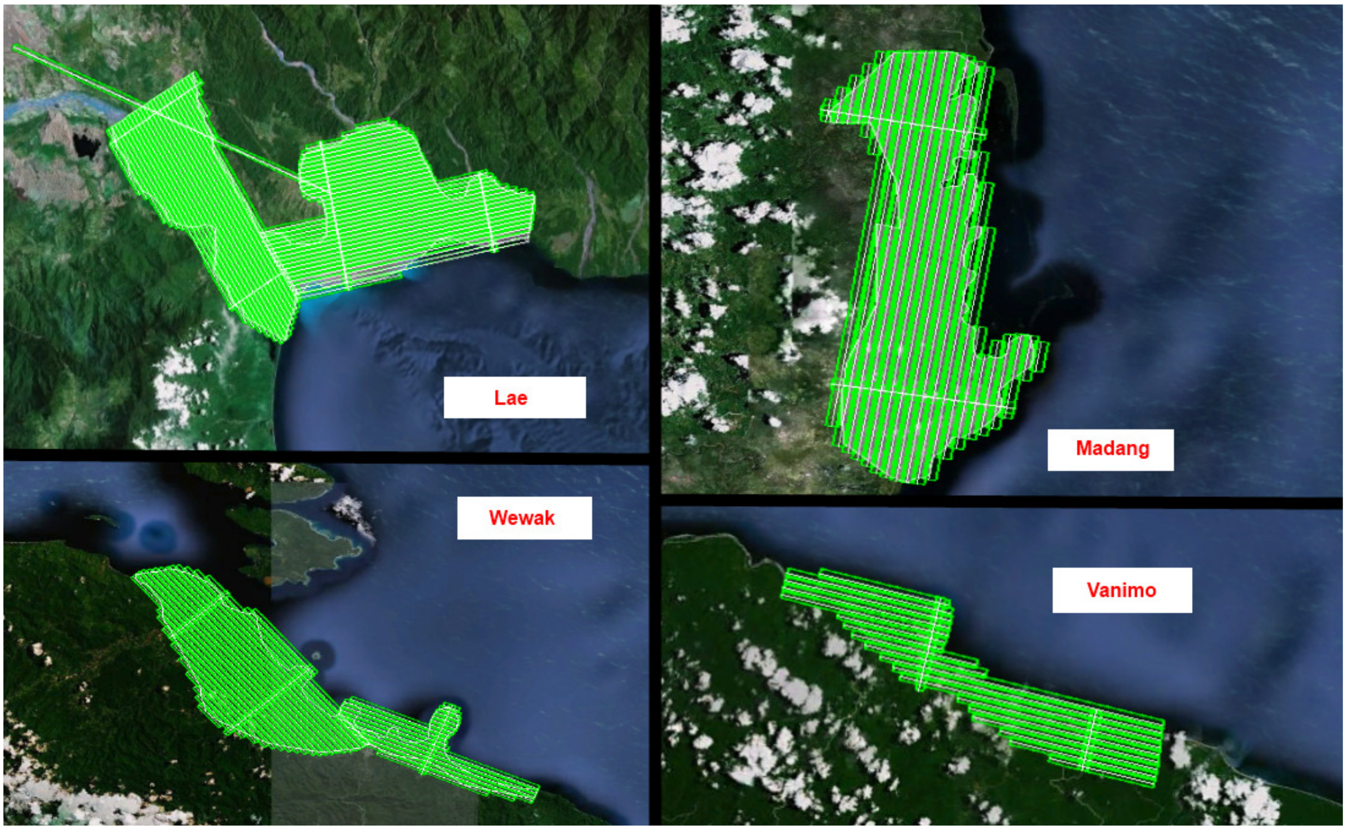
1 20% reflective target
2 Dependent on selected operational parameters using nominal 50° FOV in standard atmospheric conditions
3 NOHD (unaided) = 7 m; (ANSI Z136.1-2000)

2.2 Coverage

The four town sites cover an area of approximately 629sqkm and are interconnected by the three coastal sections.



Full Site Overview



Individual Towns Overview

2.3 Horizontal Datum

The survey was coordinated in terms WGS84.

2.4 Vertical Datum

For data presented in WGS84 all elevation data has been presented in Mean Sea Level (MSL) EGM2008. For data presented in PNGMG94 all elevation data had been presented in MSL, PNG08. Ellipsoidal data has also been presented.

The EGM2008 Geoid Surface is significantly offset from true MSL due to Mean Dynamic Topography (MDT) of the ocean surface near to the equator. This is largely due to thermal expansion of the ocean which raises the sea level above the equipotential surface. In PNG this offset is between 0.8m and 1.5m. In 2011 a new model for PNG was released called PNG08 which is based on EGM2008 with a offset plane correction based on tide gauge measurements made around the PNG mainland, including Madang, Bogia and Aitape. The precision of the model is 0.1m at 1σ along the North coast of PNG. Spot levels have been provided in this height datum.

MSLPNG08 = hPNG94 – NPNG94

hPNG94 – PNG94 ellipsoid height.
NPNG08 – N value from the PNG08 2.5' geoid model.

The below table demonstrates the relationship between EGM2008 and PNG08 for a number of the land survey stations used. A full list of PNG08 heights is available for all of the land survey points collected.

Location	Point Number	Description	ITRF08 Ellipsoid Ht	PNG94 Ellipsoid Ht	EGM2008	PNG08 (N val)	MSL PNG08
Nadzab	ST 31024 (NADZ)	GIP in conc	148.80	148.87	77.12	72.68	76.19
Bubia	ST 31021 (BUBI)	GIP in conc	106.84	106.91	34.86	72.99	33.92
Situm	ST 31029 (SITU)	GIP in conc	169.80	169.87	97.68	73.11	96.75
Lae Old Airport	ST 31022 (LAEO)	Bolt in conc	84.37	84.44	12.40	72.96	11.47
Madang Airport	GS 15495 (MAD1)	brass plaque	73.15	73.22	5.95	68.32	4.89
Wewak Airport	PSM 15497 (WEWK)	brass plaque	83.87	83.94	6.05	79.06	4.88
Vanimo	PM 63/1 (VANI)	GIP in conc	80.51	80.58	3.44	78.40	2.18
Unitech Sports	PSM 9799 (9799)	brass plaque	130.25	130.32	58.35	72.90	57.41
Nadzab Airport	PSM 31481	brass plaque	137.25	137.32	65.55	72.71	64.61
Mount Hanseman	AA 053	brass plaque	460.87	460.94	393.26	68.75	392.20
Madang Airport	PSM7624	brass plaque	70.87	70.94	3.70	68.29	2.64
Wewak	GS 9388	brass plaque	140.91	140.98	63.01	79.16	61.82
Wewak	PSM 3439	brass plaque	125.18	125.25	47.23	79.19	46.05
Vanimo Airport	PSM 71	brass plaque	80.59	80.66	3.43	78.49	2.17
Vanimo Airport	VAN2000	brass plaque	83.31	83.38	6.11	78.53	4.85

2.5 Map Projection

The survey data is presented in terms of WGS84 UTM zones 54/55 and PNGMG94 zones 54/55

2.6 Survey Control

The primary survey control points (GPS Base stations) were established at the airports of Nadzab, Madang, Vanimo and Wewak.

The central base stations were coordinated using AUSPOS (24 hour periods, multiple days) and checked against a number of surrounding State Survey Control Points.

All reference and check point surveys were coordinated relative to the nearest base station. All base station, reference points, and check points were coordinated against local survey marks.

Summary of the datum used throughout the project is below:

Horizontal:
The horizontal datum was established directly from AUSPOS for each base station. The Base stations accuracies were subsequently checked by control survey from established coordinated survey marks.

Vertical:
Ellipsoid - Established directly from AUSPOS as per the horizontal datum.
MSL - Each base station, reference point survey, and check point survey was linked to surrounding MSL marks, thereby providing them a "local " MSL datum in their immediate vicinity.

2.7 Data Tiling and File naming

Data is provided in tiles 1km by 1km to the following filenaming convention:

Intensity and RGB Imagery

Naming Convention for LiDAR intensity or other forms of imagery: *ProjectNameYYYY-INT-GSD_xxxyyyy_zz_wwww_hhhh.ecw*		
ProjectName	*PNGVanimoLidarr*	A meaningful description of the total survey area of interest. Do not use "_" as part of the Project Name
YYYY	*2012*	Year of survey
INT/RGB	*-INT*	Intensity image file identifier. Use RGB for 3 band natural colour imagery or RGBI for 4 band infrared
GSD	*-002*	Ground sampling distance or resolution of image in metres.
xxxyyyy	*_4806558 (480,000mE) (6558,000mN)*	Easting and northing value (whole kilometre) of the south- west corner of the tile. A single "_" must be used to separate the remaining file name components.
zz	*_56*	UTM zone of the file
wwww	*_0020*	Width of the **dataset or tile** in whole kilometres
hhhh	*_0050*	Height of **dataset or tile** in whole kilometres
For example: PNGVanimoLidar2012-INT-002_4806558_56_0020_0050.ecw		

Unclassified LiDAR

Naming Convention for LiDAR point clouds: *ProjectNameYYYY-UNC-DAT-SWT_xxxyyyy_zz_wwww_hhhh.las*		
ProjectName	*PNGVanimoLidar*	A meaningful description of the total survey area of interest. Do not use "_" as part of the Project Name
YYYY	*2012*	Year of survey
UNC	*-UNC*	Unclassified point cloud. Fully calibrated and adjusted to specified datum
DAT	*-ELL*	Ellipsoidal heights (PNG94)
SWT	*-1..n*	Swath number (1 file per swath)
xxxyyyy	*_4806558 (480,000mE) (6558,000mN)*	Easting and northing value (whole kilometre) of the south- west corner of the tile. A single "_" must be used to separate the remaining file name components.
zz	*_56*	UTM zone of the file
wwww	*_0002*	Width of the tile in whole kilometres
hhhh	*_0002*	Height of the tile in whole kilometres
For example: PNGVanimoLidar2012-RAW-ELL-001_4806558_56_0002_0002.las		

Classified LiDAR

Naming Convention for LiDAR point clouds: ProjectNameYYYY-CL-DAT_xxxyyyy_zz_wwww_hhhh.las		
ProjectName	*PNGVanimoLidar*	A meaningful description of the total survey area of interest. Do not use "_" as part of the Project Name
YYYY	*2012*	Year of survey
CL	*-C2*	classification level.
DAT	*-ELL or MSL*	Specified vertical datums. Ellipsoidal (ELL) or Orthometric (MSL)
xxxyyyy	*_4806558 (480,000mE) (6558,000mN)*	Easting and northing value (whole kilometre) of the south- west corner of the tile. A single "_" must be used to separate the remaining file name components.
zz	*_56*	UTM zone of the file
wwww	*_0002*	Width of the tile in whole kilometres
hhhh	*_0002*	Height of the tile in whole kilometres
For example:	*PNGVanimoLidar2012-C3-MSL_4806558_56_0002_0002.las*	

ESRI Grids

Naming Convention for tiled UTM ESRI GRIDS: *txxxyyyyssppp* *(in addition to folder structure above with UTM GRIDS stored in separate folders, with all projection information defined.)*		
t = surface type.	*e*	Surface type • s – digital Surface model (DSM) • e – digital Elevation model (DEM) • f - canopy Foliage model (CFM) • c - Canopy elevation model (CHM) • h – Hydro digital elevation model (DEMH) • b – Bathymetry • m – Bathymetry and terrain elevations • t – Derived terrain variables (add as necessary)
xxxyyyy	*6458595* (645,000mE) (8,595,000mN)	• Easting and northing value (whole kilometre) of the south- west corner of the tile.
ss	*01*	Tile size (km) (square tile) • 01 – one kilometre • 02 – two kilometre • 05 - five kilometre • 10 – 10 kilometre • _5 (represents half a kilometre)
ppp	*001*	Ground sampling distance (GSD) or pixel size • 0_5 - half a metre • 001 – one metres • 002 – two metres etc
For Example:	*e645859501001*	

<table>
<tr><td colspan="3">Naming Convention for Mosaic (UTM) ESRI GRIDS:
txxxxxxxyyppp
(in addition to folder structure above with UTM GRIDS stored in separate folders, will all projection information defined.)</td></tr>
<tr><td>t = surface type.</td><td>e</td><td>Surface type
• s – digital Surface model (DSM)
• e – digital Elevation model (DEM)
• f - canopy Foliage model (CFM)
• c - Canopy elevation model (CHM)
• h – Hydro digital elevation model (DEMH)
• b – Bathymetry
• m – Bathymetry and terrain elevations
• t – Derived terrain variables (add as necessary)</td></tr>
<tr><td>xxxxxxx</td><td>vanimo</td><td>A meaningful description of the total survey area and or sensor, dataset version etc.</td></tr>
<tr><td>yy</td><td>12</td><td>Year of Survey</td></tr>
<tr><td>ppp</td><td>010</td><td>Ground sampling distance (GSD) or pixel size in metres (UTM)
UTM
• 0_5 - half a metre
• 001 – one metres
• 002 – two metres etc</td></tr>
<tr><td colspan="3">For Example: evanimo12010</td></tr>
</table>

Naming Convention for all other UTM files: *ProjectNameYYYY-SSSS-PPPP-GSD_xxxyyyy_zz_wwww_hhhh.asc*		
ProjectName	*PNGVanimoLidar*	A meaningful description of the total survey area of interest. Do not use "_" as part of the Project Name
YYYY	*2012*	Year of survey
SSSS-PPPP	*-DEM-GRID*	Surface type. • DSM • DEM • HDEM • CHM • CFM • Bathymetry (BAT) • Mixed (MIX). Bathymetry and terrain elevations • TTT (Other terrain variables e.g. slope (SLP). Add as necessary. Product type • Mass points (MASS) • Breaklines (BRK) • TIN (TIN) • GRID (GRID) • Contours (CON) • Cross Sections (CROSS) • Imagery (BIL, TIF, IMG, ECW etc) • Other Use additional field width and more characters if required.
GSD	*-010*	Ground sampling distance or resolution of product where appropriate. Where GSD is not required producers can extend the surface type and product description field.
xxxyyyy	*_4806558* *(480,000mE)* *(6558,000mN)*	Easting and northing value (whole kilometre) of the south- west corner of the tile. A single "_" must be used to separate the remaining file name components.
zz	*_56*	UTM zone of the file
wwww	*_0020*	Width of the **dataset or tile** in whole kilometres
hhhh	*_0050*	Height of **dataset or tile** in whole kilometres
ext		File extension according to format conventions • LAS • xyz ascii format for easting, northing, elevation, intensity • asc – ESRI ascii GRID format • shp • dxf etc
For example:	*PNGVanimoLidar2012-DEM-GRID-010_4806558_56_0020_0050.asc*	

Naming Convention for all other PNG94 files: *ProjectNameYYYY-SSSS-PPPP-GSD_xxxxyyy_wwww_hhhh.ext*		
ProjectName	*PNGVanimoLidar*	A meaningful description of the total survey area of interest. Do not use "_" as part of the Project Name
YYYY	*2012*	Year of survey
SSSS-PPPP	*-DEM-CON*	Surface type. • DSM • DEM • HDEM • CHM • CFM • Bathymetry (BAT) • Mixed (MIX). Bathymetry and terrain elevations • TTT (Other terrain variables e.g. slope (SLP). Add as necessary. Product type • Mass points (MASS) • Breaklines (BRK) • TIN (TIN) • GRID (GRID) • Contours (CON) • Cross Sections (CROSS) • Imagery (BIL, TIF, IMG, ECW etc) • Other Use additional field width and more characters if required.
GSD	*20cm*	Ground sampling distance or resolution of product where appropriate. Where GSD is not required producers can extend the surface type and product description field.
xxxxyyy	*1185324* *(118.5E, 32.4S)*	Lower left ***longitude and latitude*** *(to 1 decimal place)* A single "_" must be used to separate the remaining file name components.
wwww	_0015 (1.5deg)	Width of the **dataset or tile** in whole degrees *(including 1 decimal place)*
hhhh	_0028 (2.8deg)	Height of **dataset or tile** in whole degrees *(including 1 decimal place)*
ext	*shp*	File extension according to format conventions • LAS • xyz ascii format for easting, northing, elevation, intensity • asc – ESRI ascii GRID format • shp • dxf etc
For example: PNGVanimoLidar2012-DEM-CON20cm_1185324_0015_0028.shp		

2.8 Primary LiDAR Point Cloud Data

The LAS files have been provided to ASPRS V1.2 Standards.
LAS file point classifications levels are formatted to comply with ASPRS Standard LiDAR Point Classes.

1	Unclassified
2	Ground
3	Low Vegetation (<1m)
4	Medium Vegetation (>1m – 2m)
5	High Vegetation (>2m)
6	Building
7	Low Point (noise)
8	Model Key-point (mass point)
9	Water
10	Reserved for ASPRS Definition

All returns and intensity has been retained. Overlap data has been retained. LAS files retain all relevant capture data including: point source ID and all flight path, sensor, GPS and processing system data. Refer to Section 2.7 data tiling and file naming for data tiling and file naming specifications.

2.9 Digital Elevation Model (DEM)

ArcGIS Terrains were created from ground classified LIDAR data. One metre ESRI ArcGIS binary grids were derived using a customised ArcGIS macro.

2.10 Digital Surface Model (DSM)

ArcGIS surfaces were created from non-ground classified LIDAR data. One metre ESRI ArcGIS binary grids were derived using a customised ArcGIS macro.

2.11 Canopy Elevation Model (CEM)

A canopy elevation model was produced as two metre ESRI ArcGIS binary grids using ArcGIS with the following methodology:

- All ground surface derived using natural neighbours interpolation [G] *(Floating Point)*
- First return vegetation surface derived using natural neighbours interpolation [V1] *(Floating Point)*
- Height in metres above ground of first vegetation returns [V1] - [G] = [H] *(Floating Point)*
- Mask of all vegetation ALS returns with 1m buffer, reclassified to 0 outside mask and NoData inside [M] *(Integer)*
- Mosaic of canopy height surface and vegetation mask [H] + [M] = CEM *(Floating Point)*

2.12 Foliage Cover Model (FCM)

A foliage cover model was produced as 10 metre ESRI ArcGIS binary grids using ArcGIS with the following methodology:

- Count of all vegetation returns per 10m cell [V] *(Integer)*
- Count of total ALS returns per 10m cell [A] *(Integer)*
- Proportion of all vegetation to total ALS returns expressed as a percentage ([V] / [A]) * 100 = FCM *(Floating Point)*

2.13 Contours

Contours were generated in ESRI Shape file format with 0.5m and 5m intervals.

2.14 Imagery

Imagery has been generated in ECW and TIFF format to the capture extents. Please see details of camera specifications below:

DiMAC cameras bring high-quality imagery to a medium format

- Patented true Forward Motion Compensation technology provides crisp, blur-free imagery (fly lower, faster and longer)
- Temperature stabilization
- Rigorous geometric and radiometric calibration
- Wide choice of lenses
- 1-year comprehensive manufacturer's warranty with 24/7 support

ALTM Multi-Sensor Integration Package

- Custom-engineered multi-sensor mount
- Fully integrated lidar and photo mission planning capability
- Fully integrated sensor control and monitoring capability
- All required interconnect cables
- Full calibration report with lidar/camera boresight values
- Planning, operations, and data-processing training

Parameter	Specification
Camera Module (CM)	
Area sensor	60 MP full-frame CCD 8,984 x 6,732 pixels (effective) 6 µm x 6 µm pixels 53.9 x 40.4 mm (effective)
True Forward Motion Compensation (FMC)	Solid-state electro-mechanical
Lenses	50 mm /70 mm /120 mm /210 mm
Shutter	Electro-mechanical iris mechanism 1/125 to 1/500 sec., f-stops: 4, 5.6, 8, 11, 16
Filter	Standard size RGB and IRC interchangeable filters
Image output	8 or 16 bits per channel 24-bit RGB: 180 MB 48-bit RGB: 360 MB
Capture rate	2.5 sec.
Resolution (GSD)	2 cm to 1 m / <1 inch to 3.3 feet
IT Cube (ITC)	
Control & acquisition computers	PC/104 RoHS-compliant small form-factor embedded computers with minimum: Intel® Core™ Duo LV2400 CPU, 1-GB RAM 4-GB flash disk local storage IEEE 1394 Firewire interface
Removable storage units	500-GB pressurized hard drives - 8,000 images typically
Dimensions (H x W x D)	250 x 250 x 250 mm / 10 x 10 x 10 in
Weight	15 kg / 33 lbs
Input voltage (DC)	24-28 V
Current draw	5 A
Software	
DiOPS	Real-time camera operations and configuration management
CaptureOne	Image development

2.15 Project Plan

Prior to data capture commencement, a Project Plan was submitted to and approved by Geoscience Australia. This Project Plan details work breakdown structure, agreed data capture plans, project milestones and delivery schedules, progress reporting schedules.

2.16 Pre-survey Quality Assurance Plan

Prior to the commencement of aerial LiDAR data capture, AAM prepared and submitted to Geoscience Australia a Quality Assurance Plan that conformed to an identified management system and generally complies with ISO 9001. The Plan addressed the organisation and management of the project, work procedures, environmental considerations, safety and risk control and test procedures.

The Plan also detailed the procedures to be used in verifying that the deliverables meet the required specification including:

- the procedures and methodologies to be used to verify that the deliverables meet the required specifications.

- Details of proposed calibration checks and methodology to be used to establish both reference stations and ground test sites.

2.17 Post-survey Spatial Accuracy Report

Following successful capture of the aerial data a Post Survey Spatial Accurracy report was submitted and approved by Geoscience Australia.

Observed flight runs were provided in ESRI shape file format.

All reference and check points used to verify accuracy were provided in ESRI shape file format.

For analysis of ground comparisons refer to Section 3.0. Accuracy Assessment.

2.18 GPS Base Station Data

GPS data for all occupations of base-stations has been supplied in RINEX format (Receiver Independent Exchange Format

3.0 Accuracy Assessment

Accuracy assessment was undertaken in two phases. Initially a post-survey reference site assessment was conducted to analyse the overall accuracy of the transformed lidar ground strikes relative to MSL. Additional check points were then collected to independently assess the accuracy of the classified data according to different land cover types. In total 2104 field survey points were collected across the lidar capture area.

The independent ground survey was not undertaken in an appropriate method to allow for classification accuracy assessment of landcover classes in the form of an error matrix. The survey did however, allow for a detailed assessment of vertical accuracy across different land cover classes. ID photos were only collected for each survey site and not individual points.

3.1 Project Design Accuracy

Project specifications and technical processes were designed to achieve data accuracies as follows:

Project Design Accuracy			
	Measured Point	**Derived Point**	**Basis of Estimation**
Vertical data		0.15m	Project Design
Horizontal data	< 0.13m		System specifications
Test points	0.05m		Survey methodology used

Notes On Expected Accuracy

- Values shown represent standard error (68% confidence level or 1 sigma), in metres.
- “Derived points” are those interpolated from a terrain model.
- “Measured points” are those observed directly.
- Accuracy estimates for terrain modeling refer to the terrain definition on clear ground. Ground definition in vegetated terrain may contain localized areas with systematic errors or outliers which fall outside this accuracy estimate.
- Laser strikes have been classified into “ground” and “non-ground”, based upon algorithms tailored for major terrain/vegetation combinations existing in the project area. The definition of the ground may be less accurate in isolated pockets of dissimilar terrain/vegetation combinations.

3.2 Reference Site Analysis

Test points were distributed in 17 groups across the four town sites area and located on open clear ground. Comparison of the field test points with elevations interpolated from measured data are summarised in the table below.

Reference Point Site Vertical Accuracy – LiDAR Data			
Reference Point Site	**Mean Difference (m)**	**Std Deviation (m)**	**RMS (m)**
VNMVP1	0.007	0.017	0.019
VNMVP2	0.049	0.044	0.065
VNMVP3	-0.04	0.018	0.044
WWKVP1	-0.006	0.017	0.018
WWKVP2	0.038	0.045	0.058
WWKVP3	0.033	0.045	0.056
WWKVP4	-0.047	0.012	0.049
MDGVP1	-0.03	0.041	0.051
MDGVP2	0.017	0.015	0.023
MDGVP3	0.03	0.017	0.034
MDGVP4	-0.02	0.067	0.07
LAEVP1	-0.027	0.017	0.032
LAEVP2	-0.001	0.03	0.03
LAEVP3	0.007	0.009	0.012
LAEVP4	0.036	0.01	0.037
LAEVP5	0.038	0.013	0.04
LAEVP6	-0.022	0.028	0.035

3.3 Check Point Analysis

For the purposes of independent accuracy assessment check point measurements were taken throughout the project area. Check points were collected for each land cover type across the project extent. The Table below shows the number of check points for each class.

Area	Landcover Class	No. of Points
Lae	Dense Vegetation	32
	Grass	14
	Grass 0.6m	10
	Medium Timber	22
	Medium Vegetation	16
	Scrub Garden	9
	Short Grass	13
	Tall Grass	15
Madang	Dense Trees	11
	Grass	21
	Grass 1.5m	10
Vanimo	Dense Vegetation	10
	Grass	12
	Low Scrub	12
Wewak	Dense Vegetation	20
	Grass	24
	Grass 0.6m	12
	Medium Timber	10
	Medium Vegetation	31

Comparison of the field check points with elevations interpolated from the LiDAR and DEM data resulted in the accuracies shown in the following tables for the landcover classes:

Vertical Accuracy – LiDAR Data					
Area	**Landcover Class**	**No. of Points**	**Mean Difference (m)**	**Std Deviation (m)**	**RMS (m)**
Lae	Dense Vegetation	32	-0.015	0.046	0.048
	Grass	14	+0.041	0.013	0.043
	Grass 0.6m	10	+0.270	0.121	0.293
	Medium Timber	22	+0.048	0.088	0.099
	Medium Vegetation	16	-0.031	0.026	0.040
	Scrub Garden	9	+0.019	0.058	0.057
	Short Grass	13	+0.075	0.014	0.077
	Tall Grass	15	+0.431	0.254	0.496
Madang	Dense Trees	11	+0.009	0.045	0.044
	Grass	21	+0.040	0.055	0.067
	Grass 1.5m	10	+0.194	0.042	0.198
Vanimo	Dense Vegetation	10	+0.133	0.100	0.164
	Grass	12	+0.047	0.011	0.048
	Low Scrub	12	+0.048	0.067	0.080
Wewak	Dense Vegetation	20	+0.211	0.218	0.300
	Grass	24	+0.000	0.038	0.037
	Grass 0.6m	12	+0.083	0.014	0.084
	Medium Timber	10	+0.054	0.074	0.088
	Medium Vegetation	31	-0.026	0.072	0.075

Vertical Accuracy Comparison with Data Specification – LiDAR Data						
Area	**Landcover Class**	**Within ±0.30m**	**Outside ±0.30m**	**Total**	**% Within ±0.30m**	**% Outside ±0.30m**
Lae	Dense Vegetation	32	0	32	100.0	0.0
	Grass	14	0	14	100.0	0.0
	Grass 0.6m	8	2	10	80.0	20.0
	Medium Timber	21	1	22	95.5	4.5
	Medium Vegetation	16	0	16	100.0	0.0
	Scrub Garden	9	0	9	90.0	0.0
	Short Grass	13	0	13	100.0	0.0
	Tall Grass	6	9	15	40.0	60.0
Madang	Dense Trees	11	0	11	100.0	0.0
	Grass	21	0	21	100.0	0.0
	Grass 1.5m	10	0	10	100.0	0.0
Vanimo	Dense Vegetation	10	0	10	100.0	0.0
	Grass	12	0	12	100.0	0.0
	Low Scrub	12	0	12	100.0	0.0
Wewak	Dense Vegetation	14	6	20	70.0	30.0
	Grass	24	0	24	100.0	0.0
	Grass 0.6m	12	0	12	100.0	0.0
	Medium Timber	10	0	10	100.0	0.0
	Medium Vegetation	31	0	31	100.0	0.0

4.0 Metadata

A complete metadata statement consistent with the current ANZLIC standard has been provided for each data product supplied. Metadata documents have been provided in Adobe Reader (.pdf) format. Further for every file in each data product, an .xml document with a complete metadata statement consistent with the current ANZLIC standard has been provided.

4.1 General Capture Specifications

MetaData Elements	
Characteristic	**Description**
Device Name	Optech ALTM Orion M200
IMU Used	SAGEM FMU
Acquisition Start Date	05/05/2012
Acquisition End Date	13/07/2012
Number of Runs	191 (Town Sites)
Number of Cross Runs	11 (Town Sites)
Flight Direction	Variable
Flying Height (AGL)	700m
Half Scan Angle	20
Swath Width	509m
Sidelap	20%
Average Point Spacing	0.43
Laser Pulse Rate	150KHZ
Laser Pulse Mode	Single
Laser return Types	1st, 2nd, 3rd and Last
Laser Intensity	Supplied on all returns
Laser footprint size	0.14m
DEM output pixel size	1m
DSM output pixel size	1m
CHM output pixel size	2m
FCM output pixel size	10m
Horizontal Datum	WGS84 and PNG94
Vertical Datum	WGS84 MSL (EGM08), PNG94 Ellipsoid and MSL (PNG08)
Map Projection	UTM zones 54 & 55 and PNGMG zones 54 & 55
System Calibration Certification	20th June 2012

4.2 Source Data

Source Data				
Item	**Source**	**Description**	**Ref No**	**Date**
Laser System	AAM	ALTM-Orion	19647A	05/12-07/12
GPS Base Data	AAM	Static GPS	19647A	05/12-07/12
Base Stn Coords	Quickclose	Total Station	19647A	05/12-07/12
Field Survey Data	Quickclose	RTK & Total Station	19647A	23/07/2012

4.3 Reference Systems

	Horizontal	Vertical
Datum	WGS84	MSL
Projection	UTM Zone 54 & 55	N/A
Geoid Model	N/A	EGM2008
Base Station 1	Nadzab Airport (z55) 470161.94E 9274234.41N	Nadzab Airport 74.08 RL
Base Station 2	Madang Airport (z55) 365385.85E 9423896.92N	Madang Airport 4.43 RL
Base Station 3	Madang Airport 2 (z55) 365530.88E 9423971.95N	Madang Airport 2 4.54 RL
Base Station 4	Vanimo Airport (z54) 533268.96E 9702924.93N	Vanimo Airport 4.52 RL
Base Station 5	Wewak Airport (z54) 796402.27E 9603839.19N	Wewak Airport 1.96 RL

	Horizontal	Vertical
Datum	PNGMG94	MSL
Projection	PNMG Zone 54 & 55	N/A
Geoid Model	N/A	PNG08
Base Station 1	Nadzab Airport (z55) 470161.54E 9274233.51N	Nadzab Airport 73.15 RL
Base Station 2	Madang Airport (z55) 365385.45E 9423896.02N	Madang Airport 3.38 RL
Base Station 3	Madang Airport 2 (z55) 365530.48E 9423971.05N	Madang Airport 2 3.49 RL
Base Station 4	Vanimo Airport (z54) 533268.56E 9702924.03N	Vanimo Airport 3.25 RL
Base Station 5	Wewak Airport (z54) 796401.87E 9603838.29N	Wewak Airport 0.78 RL

4.4 Limitations of Data

The definition of the ground under trees and over wetland areas may be less accurate.

5.0 Extraordinary Issues

There have been no extraordinary issues associated with this project.

6.0 Other Project Information of Note

6.1 ANZLIC Metadata Statement

To be generated from NEDF/ANZLIC metadata tool