



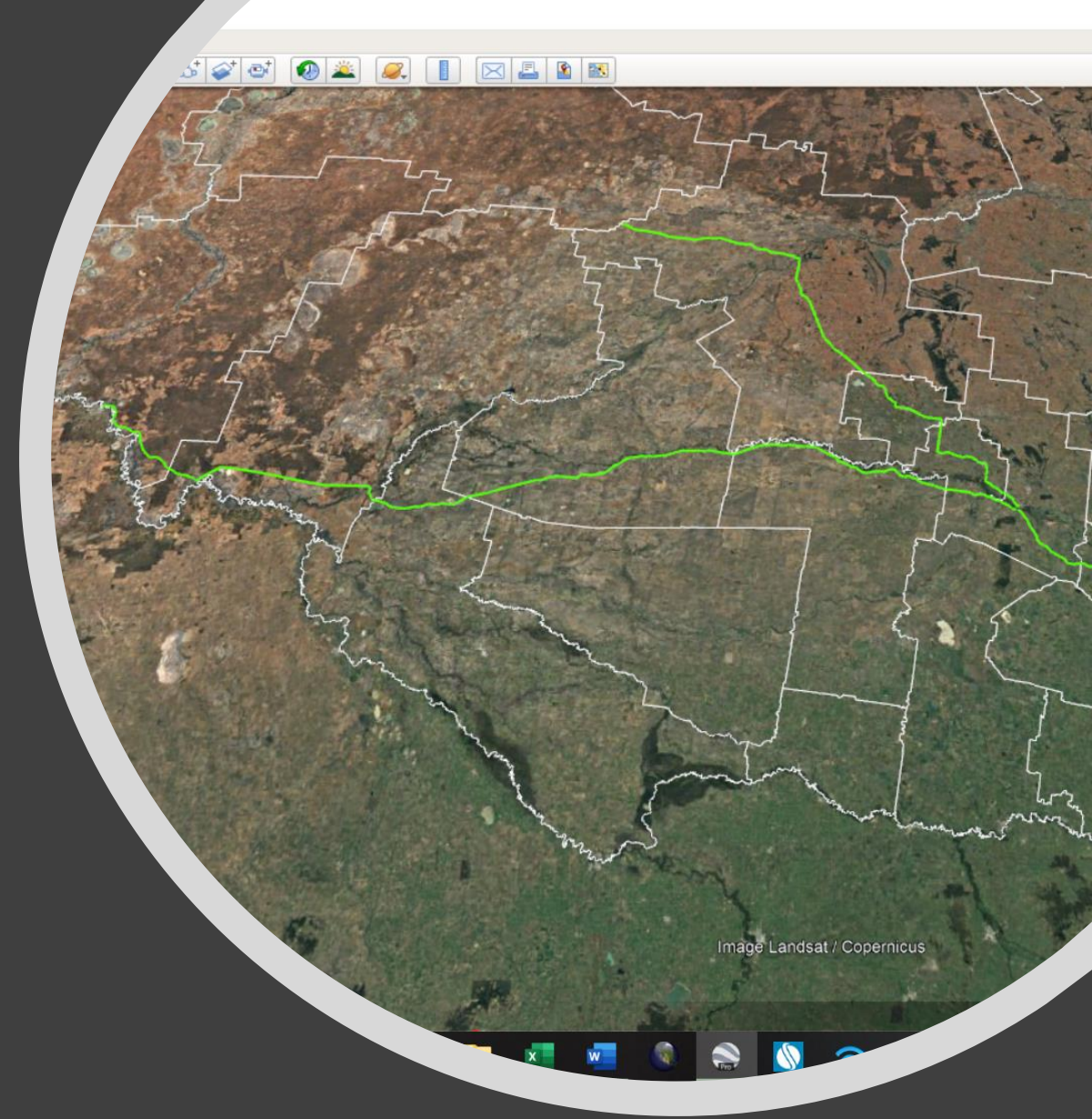
Of course
size matters
darling...

Let's Begin...

Setting the scene

- 1200km road
- Fairly remote
- Vertical accuracy $<0.3\text{m}$ @ 2 sigma
- Control point every 20km

UAV or Manned Aircraft?



Horses for Courses

ID
media



So, what kind of a survey are you looking for?

So, what sort of a survey are you looking for?

Provide the right information

- Location
- Accuracy
- Turnaround
- Deliverables
- Access
- Purpose





Then, the Provider has a chance of offering the correct solution

- Orthophoto – 3 band, 4 band or NIR
- Digital Terrain Model
- Digital Surface Model
- Contours
- 3D model
- Canopy Height Model



There's
more than
one way to
skin a cat!

LiDAR or Photogrammetry

Remotely Piloted Aircraft System (RPAS)

Typical RPAS aerial surveying services include:

- Periodic volumetric surveying, such as monthly aerial surveying of stockpiles, open pits, tailings storage facilities.
- Aerial topographic surveying
- High resolution 3D modelling of open pit mines
- Environmental monitoring, including vegetation health from multispectral imagery, landform stability analysis, measurement of rehabilitation performance.
- Infrastructure Inspection

Manned Aircraft

Typical Manned Aircraft aerial services include:

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So are we saying there is no difference?

	Remotely Piloted Aircraft System	Manned Aircraft
LiDAR	Yes	Yes
3 Band Imagery	Yes	Yes
4 Band Imagery	Yes	Yes
Oblique imagery	Yes	Yes
NIR/Thermal/Multi-Spectral	Yes	Yes
Crew	At least 2	2
Controlled by CASA	Yes	Yes
Visual line of site required	Yes	No
Accuracy	Yes	Yes
Timeliness of data delivery	Hours	Days
Flight Time	Up to 1 hour	As long as there is fuel
Area covered in a day	10-15km ²	Up to 5000km ²



SIZE

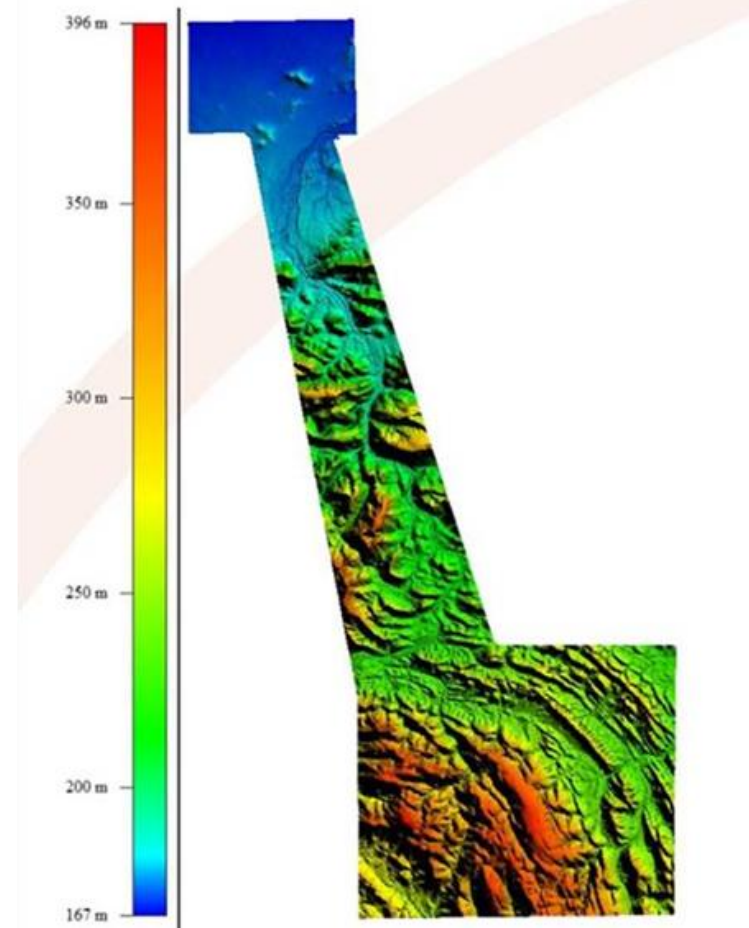


The next question – “Go big” or “Stay small”?

- Size?
- Location?
- Access?
- Problem?
- Frequency required?

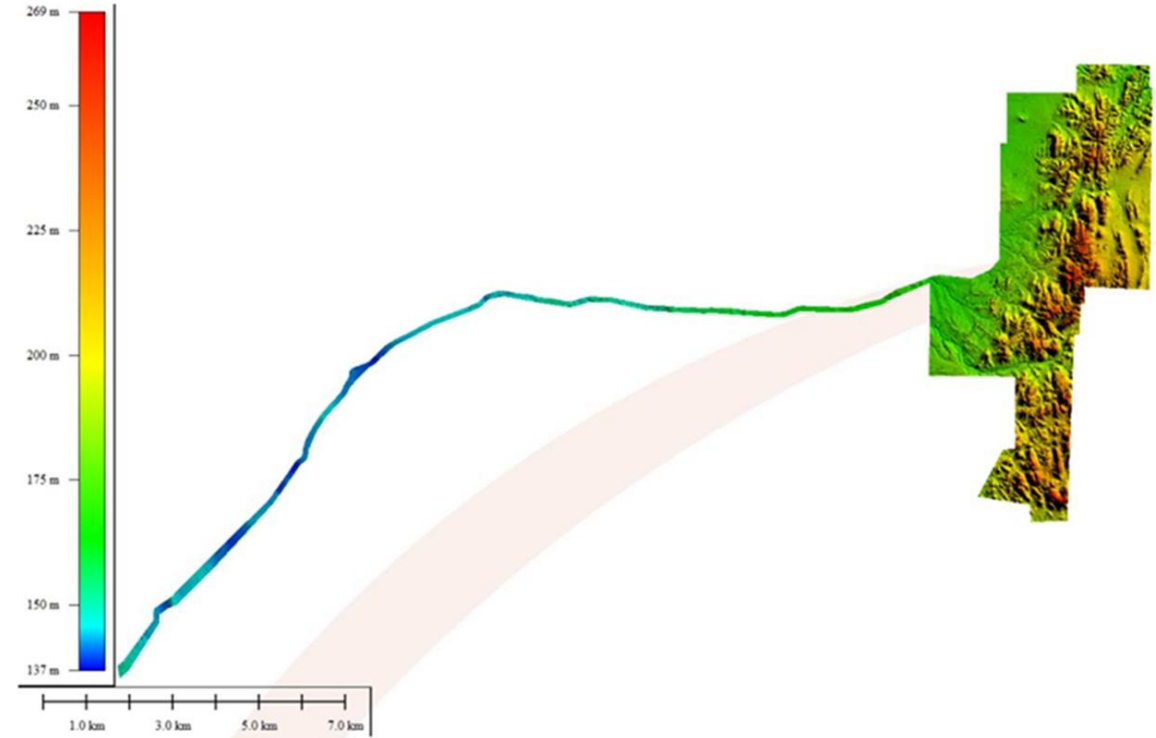


- **Some examples**



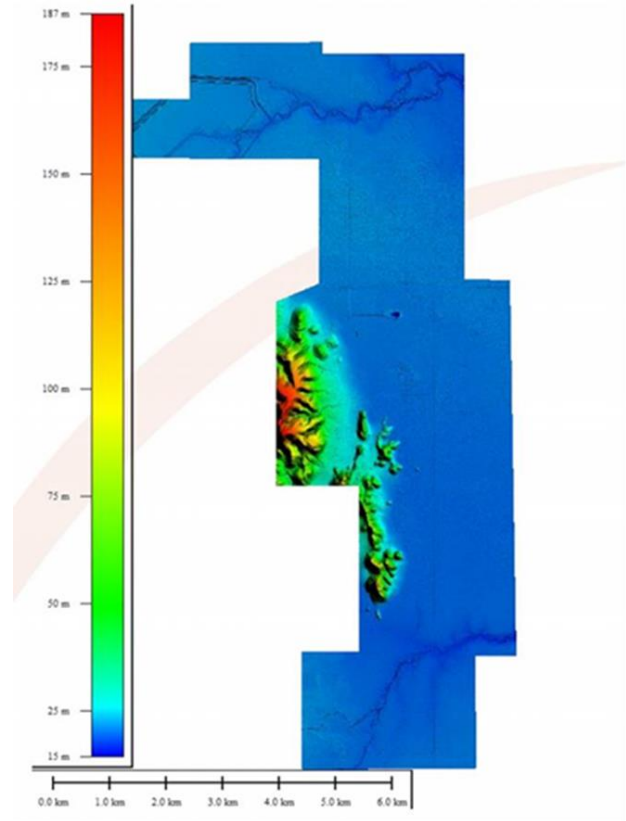
Sulphur Springs

Aerial Survey 8 May 2019_UltracamX_5cm GSD_20km²_144km south of Port Hedland



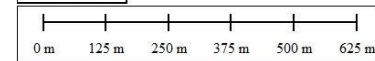
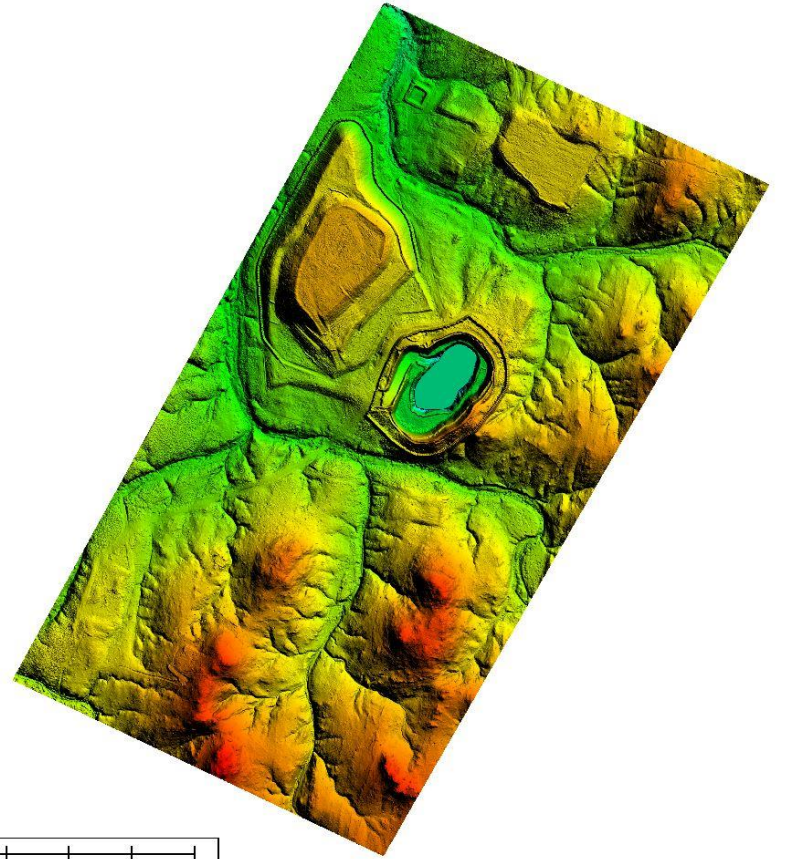
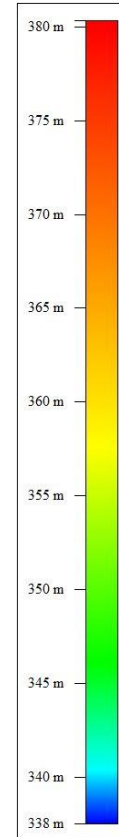
Pilgangoora

30 June 2018_UltracamX_12cm GSD_32km²_120km from Port Hedland



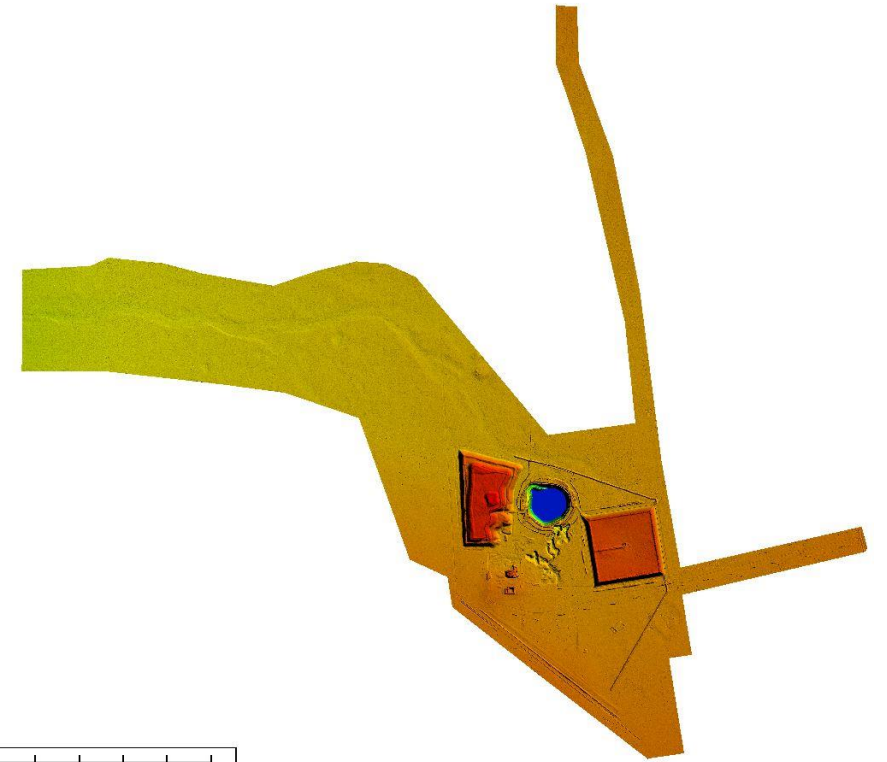
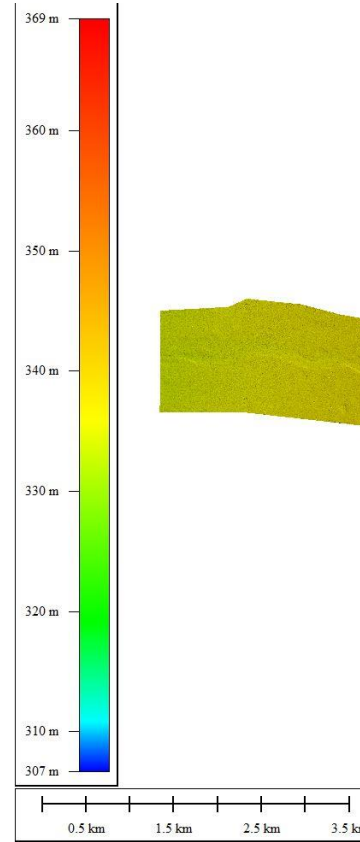
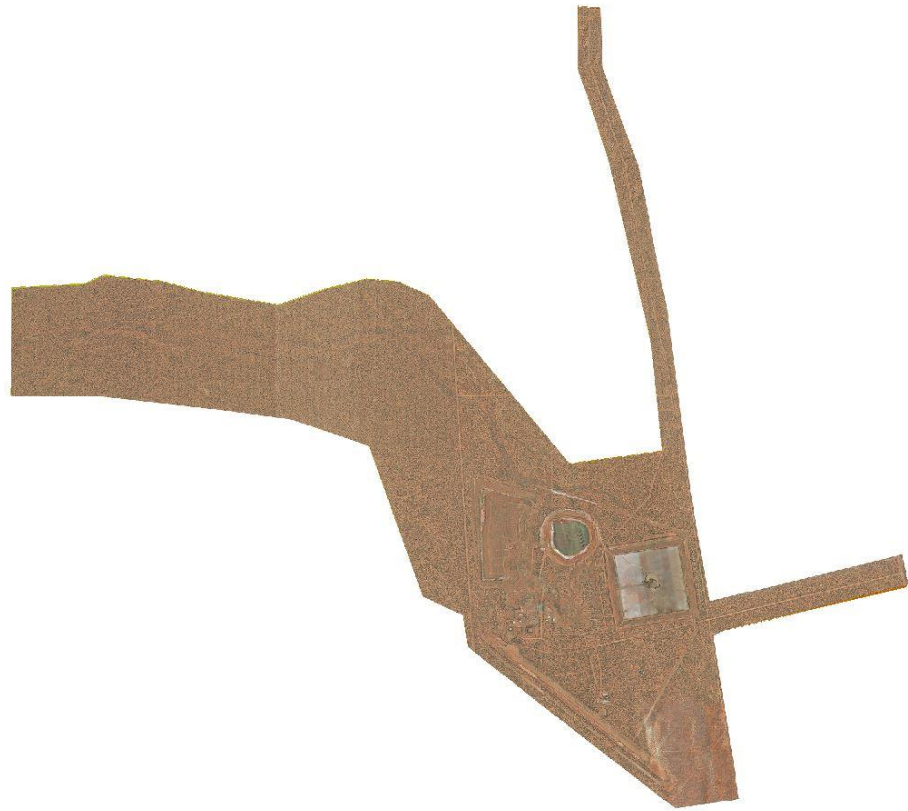
Sorby Hills

Aerial Survey 13 May 2019_UltracamX_12cm GSD_46km²_50km north-east of Kununurra

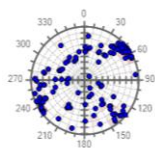
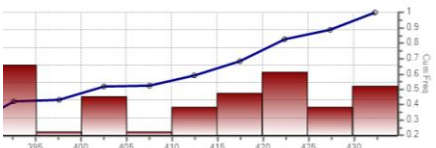
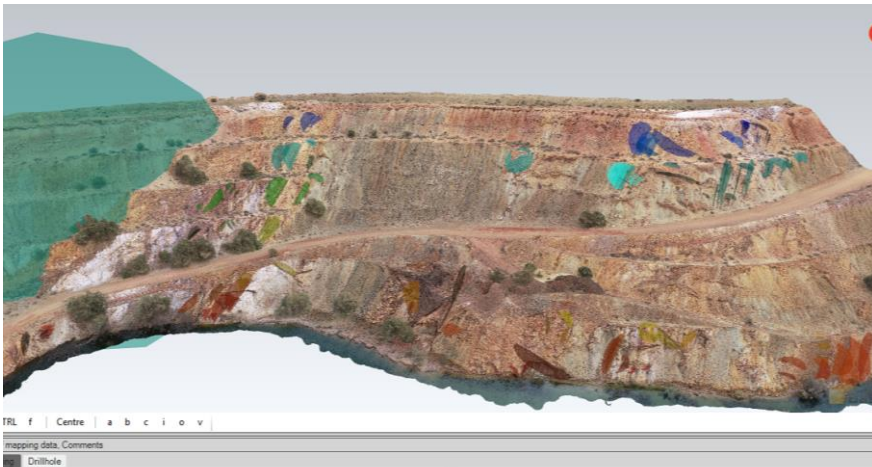
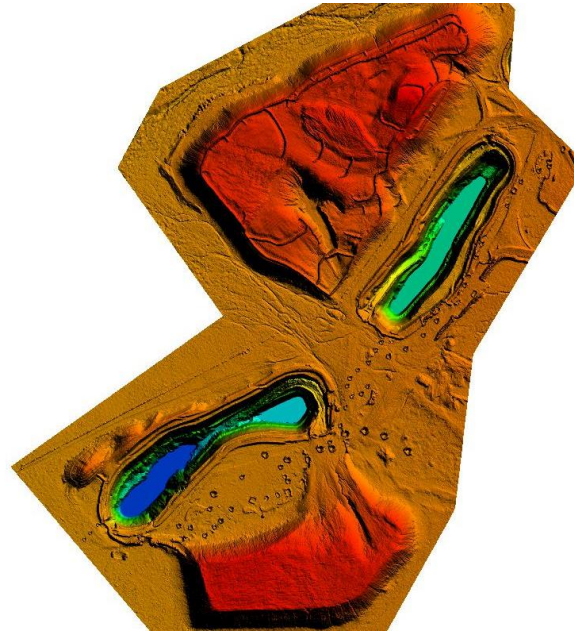
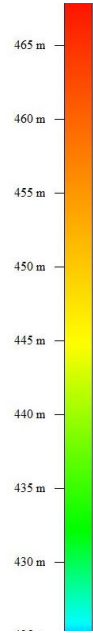


Kimberley Mine Closure

June 2019_UAV photogrammetry_3cm GSD_1.3 km²



Mt Magnet UAV Photogrammetry
Nov 2018_Res: 4cm GSD_Area: 18 km²



Goldfields Pits

May 2019_ near Leonora, WA
Method UAV photogrammetry
4cm GSD (for nadir survey), 1-2cm GSD (for pit models)
5 x small mine sites (each approx 1-2 km²)

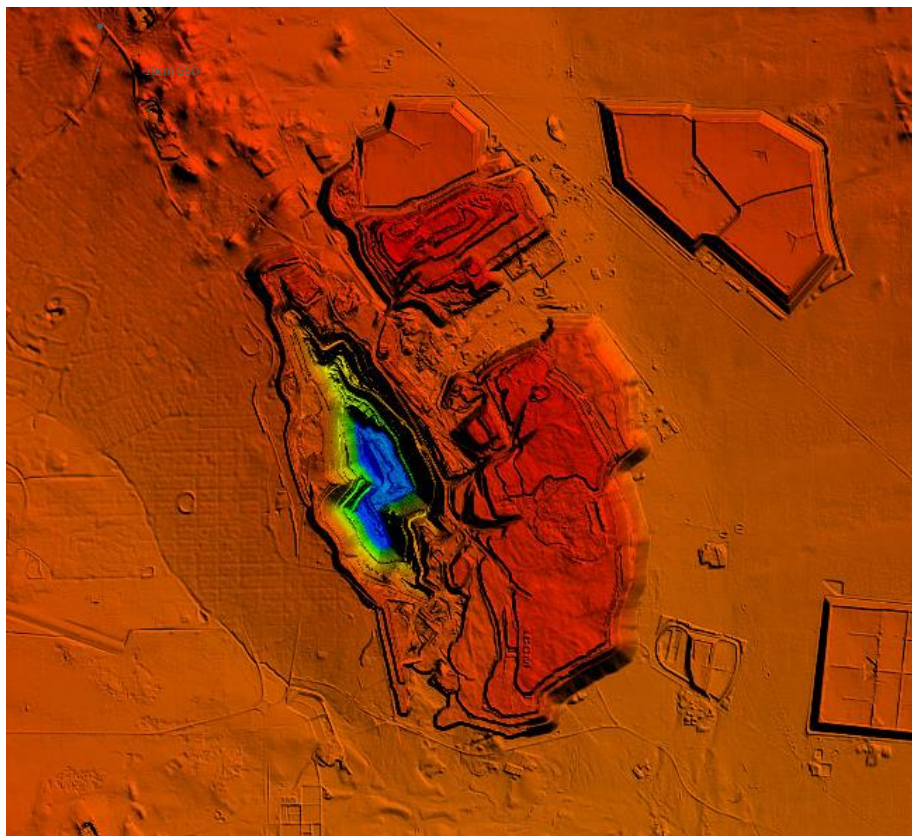


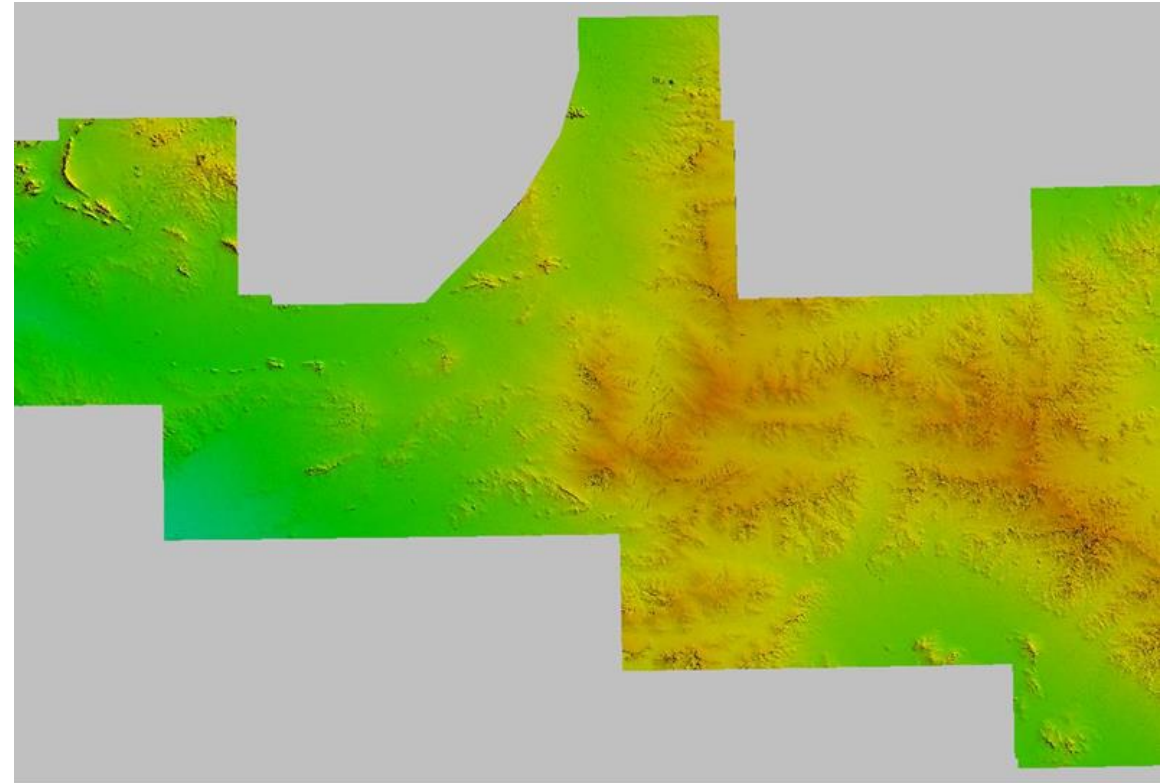
A spade is a great solution, until the hole gets too big!



Kalgoorlie Super pit

- Kalgoorlie_23Mar2011_10cm_MGA51
- 230km²
- 2 hours to fly





Sandfire Doolgunna

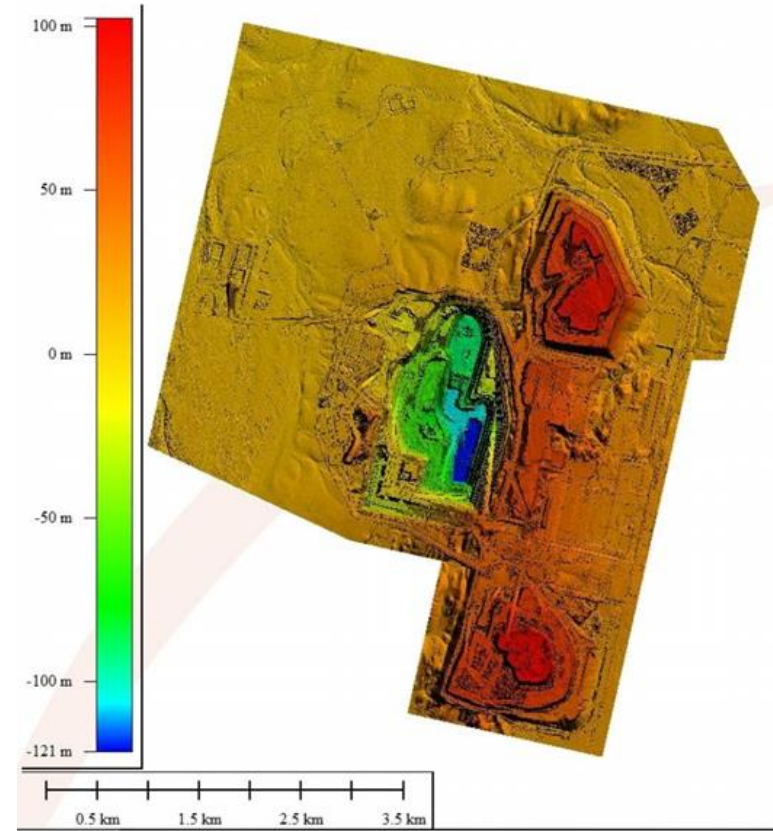
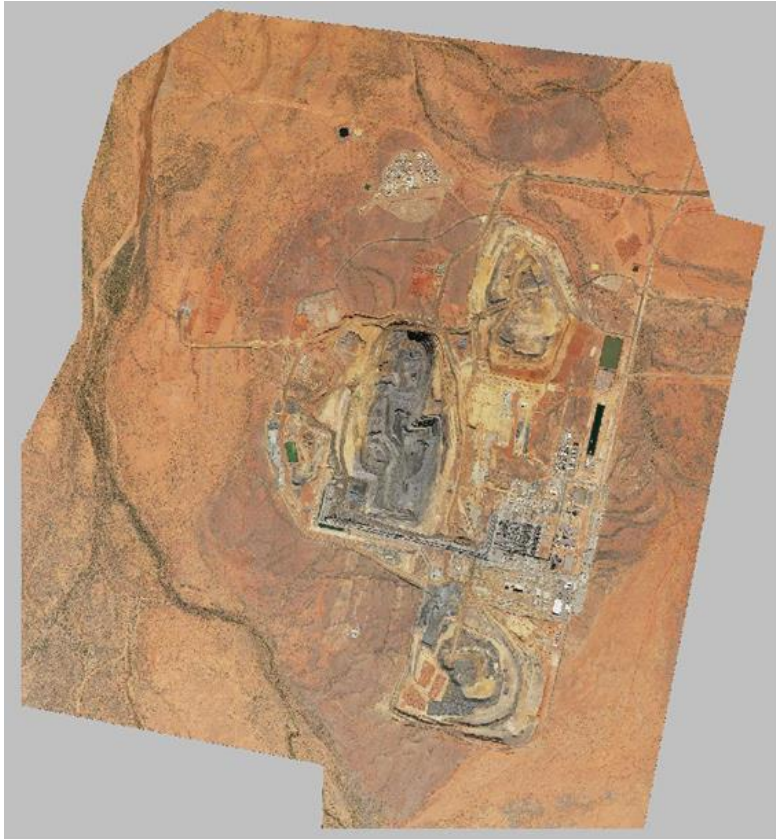
Aerial Survey July 2017, UCEp 15cm GSD, 16384 Frames, 9,000km²!!



FAST FACTS:

- 1500km north of Perth;
- 115km south of Karratha;
- World's biggest magnetite iron ore mine;
- 24 million tonnes of iron ore per annum;
- 25km slurry pipeline to the port;
- 140,000m³ per day desalination plant;
- Dewatering pit with 5,600m² filtration area;
- 450MW power station;
- 3.1km long breakwater.





CITIC – Cape Preston

6cm GSD_20cm contours_0.05m DEM @1 sigma on clear ground

How RPAS complement existing geospatial data collection

- **Aircraft (manned)**
 - Large single-flight coverage
 - High-resolution (down to 6 cm/pixel)
 - Wide spectral capabilities including LiDAR
 - Typically expensive (not suited to smaller projects)
 - Specific flight approval can be required
 - Operations susceptible to weather
- **RPAS**
 - Cost-effective (suits smaller projects)
 - Imagery can be acquired on demand
 - Very high-resolution (35mm lens 1 cm/pixel)
 - Typically unaffected by cloud cover (due to lower flight altitudes)
 - Excellent positional accuracy with GCPs or RTK
 - Relatively small single-flight coverage
 - Drone regulations or bans can restrict usage e.g. 120m max AGL without area approval
 - Operations susceptible to bad weather



Case study

End of month Tailings Storage Facility (TFS)



Stage 1B

- 8 flights at 120m for 4cm GSD – 1.5 hrs per flight = 2 days
- 1897 photos with 80% overlap
- Processing – 55 hours

Stage 2 extents

- 20-25 flights with 1 pilot and 2 observers
- 4-5 days plus processing
- Must wear fit tested respirators – fibrous ore body



So why are they
going manned
aircraft for end of
month surveys?

The RPAS is NOT the right tool to capture the TSF because:

- **Operating in the vicinity of the TSF Designated area for extended periods is not safe.**

- Operators are out of vehicles for extended periods
- Heat
- Fibrous ore body

- **Competition for equipment**

- **Hard to keep line of site**

- **Loss of RF signal to the pilot from RPAS to GCS**

- **Time for delivery**

- **Wedgetail Eagles**

- **Cost - RPAS**

- 3 people for 3 days \$13,500
 - Flights to site and accommodation \$ 1,000
- \$14,500

Cost – Manned Aircraft

- LiDAR with 10cm orthophoto \$12,500
- 48-hour delivery



Environment

Using high-definition aerial photography to search in 3D for malleefowl mounds is a cost-effective alternative to ground searches

- Mt Gibson Extension Hill
- 7014 ha
- 87% were recorded correctly
- No boots on the ground
- 4cm GSD
- Published in *Pacific Conservation Biology*





The enemy



The enemy strikes..
A UX5HP in good condition and then in pieces a losing the dog fight with a Wedge Tail Eagle

So what have we learnt?

- Horses for Courses
- There's more than one way to skin a cat
- Watch out for Eagles
- Make sure you know what you want
- It is a dynamic space with many innovations to come
- Anything you can do, I can do bigger

AND Size does matter because...





No one wants
a small glass
of wine!