GPS World
The Business and Technology of Global Navigation and Positioning

Geospatial solutions
APPLYING THE POWER OF PLACE

UAS Technology

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UAS FAA Regulatory Environment

UAS Regulations

1. Hobby use

1. Government use

1. Commercial use

- The same UAS can be used by all three. It's mostly about intent, not about technology.

Hobby/Recreational UAS Rules

Hobby

AC 91-57a Circular(2015)

-Flown for hobby/rec use.

-Less than 55 lbs

-400' AGL

-Coordinate with airport when within 5 miles.

-Give right-of-way to manned aircraft.

Hobby

Public/Government UAS Rules

Decision Flowchart for Government Ops

-CoA issued for particular purpose in a particular area. Typical government CoA is issued in 60 business days.

-Agency to provide the FAA with a "declaration letter" from the city, county, or state attorney's office assuring the FAA that the proponent is recognized as a political subdivision of the government of the State under Title 49 USC

Government/Public

-Government ops by government for government.

-Includes public universities.

-Examples of government/public CoAs issued.

Commercial UAS Rules

Commercial

-The only way to fly UAS commercially today in the US is via a FAA 333 Exemption and Certificate of Waiver or Authorization (CoA).

-Current approval process is about six months.

-My 333 Exemption request was ~14 pages and took just under three months to be approved (April 3 – June 26, 2015) . It's valid for two years unless “sooner superseded, rescinded or canceled.”

Commercial

The 333 Exemption carries the following requirements (highlighted list):

-PIC must be a FAA licensed pilot w/current FAA medical certificate.

-There must be a Visual Observer.

-PIC and VO must maintain visual line of sight (VLOS) while stationary and without aid (eg. binoculars).

-Daytime-only operations.

Commercial

-Fly at least 500 ft vertically and 2,000 ft horizontally from clouds.

-Return-to-Home feature on UAS if comms lost.

-Give way to all manned aircraft.

-500 ft from all non-participating people, vessels, vehicles, structures unless granted permission by said owner.

-Permission from property owner.

Commercial

The CoA.

-A CoA is required in addition to 333 Exemption.

-The FAA has been issuing standard, nationwide CoAs along with 333 Exemptions. If you want to operate outside of the CoA limitations, a separate CoA must be applied for.

-The standard, nationwide CoA includes the following limitations:

Commercial

-Visual Flight Rules (500 ft vertical, 2,000 ft hor)

-UAV weighing 55 lbs or less.

-At or below 400 ft AGL

-5 nautical miles from airport with tower

-3 nautical miles from airport with published instrument procedure, no tower.

-2 nautical miles from airport with neither.

-2 nautical miles from heliport.

Commercial

*****New FAA UAS Rules as of Aug. 29, 2016*****

-Remote (drone) pilot certificate obtained at FAA facility. At least 16 yrs old. Valid for two yrs.

-TSA background check.

-No observer (second person) required.

-Operator not required to have a Remote Pilot Cert, but certificated pilot must be present.

-Max 400 ft AGL.

-VLOS only, airspace limitations.

Commercial

New FAA UAS Rules as of Aug. 29, 2016

-Can't fly over non-participants.

-Can't fly from a moving vehicle unless rural.

-Less than 55 lbs.

-Rules begin August 29, 2016.

-FAA “How to Use the Rule”

https://www.faa.gov/uas/media/AC_107-2_AFS-1_Signed.pdf

Commercial

New FAA UAS Rules as of Aug. 29, 2016

-Oregon FAA Knowledge Test Centers:

Aurora, Bend, Corvallis, Creswell, Hillsboro, Independence, McMinnville, Newberg, Roseburg, Troutdale.

-60 questions, two hour limit. Passing is 70%.

-$150 fee.

Sample Questions

-What effect does density altitude have on the efficiency of a UA propeller?

A – Propeller efficiency is increased.

B – Propeller efficiency is decreased.

C – Density altitude does not affect propeller efficiency.

Sample Questions

-To avoid a possible collision with a manned airplane, you estimate that your small UA climbed to an altitude greater than 600 feet AGL. To whom must you report the deviation??

A – Air Traffic Control.

B – The National Transportation Safety Board.

C – Upon request of the FAA.

UAS Websites

-FAA UAS Getting Started

https://www.faa.gov/uas/getting_started/

-www.airmap.io

UAV Technology

Airframes, Sensors, and Software

UAS Airframe

Rotorcraft vs. Fixed wing vs. Hybrids

Rotorcraft

-Easier to learn to fly.

-Easier to launch and land.

-Easier to comply with VLOS requirement.

-More suitable for inspection tasks.

-Limited flight time (20 minutes) due to battery.

-Limited coverage area per mission due to battery.

Fixed-Wing

-Longer flight times.

-Can cover a much greater area.

-Easier to accommodate multiple sensors.

-More difficult to land.

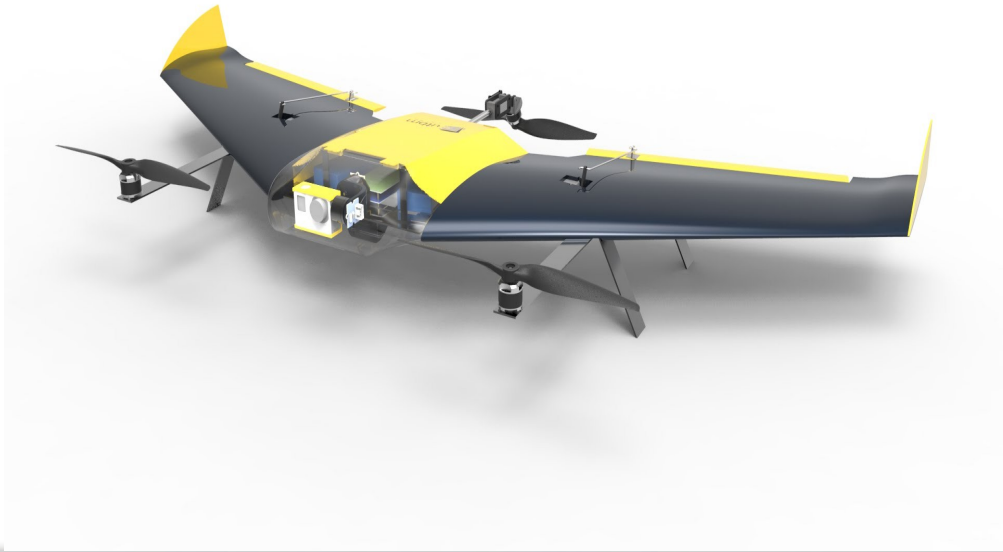
-VLOS requirement more difficult to manage.

-Greater expertise required to operate.

Hybrid

-Combines the advantages of rotorcraft and fixed-wing UAS.

-Limited airframe availabilitv.



Flight Controller

-iPads and other tablets.

-Comms link (Wifi frequencies are common).

Mission Software

-Manufacturer-supplied. Typically generic functionality (as opposed to mapping/surveying).

-Third-party. Dronedeploy, Mapsmadeeasy, etc. Support for specific make/model UAS is important.

-Open source. https://conservationdrones.org/

Mission Software

-Video of sample mission.

https://www.mapsmadeeasy.com/drone_mapping

-Photo overlap. 60/70/80/90% overlap.

-Homogeneous surfaces (water, trees) confused the image processing software.

-Battery management.

Sensors

-RGB digital camera. Phantom has a 12MP Sony. Orthophotos and Phodar (3D and volumes).

-Thermal. Heat-sensing.

-Lidar. Surface mapping.

-NDVI. Characterizing vegetation.

-Industry-specific sensors.

Image Processing

-Standard photogrammetry toolset optimized for UAS.

-Pix4D or Agisoft PhotoScan Pro. QGIS.

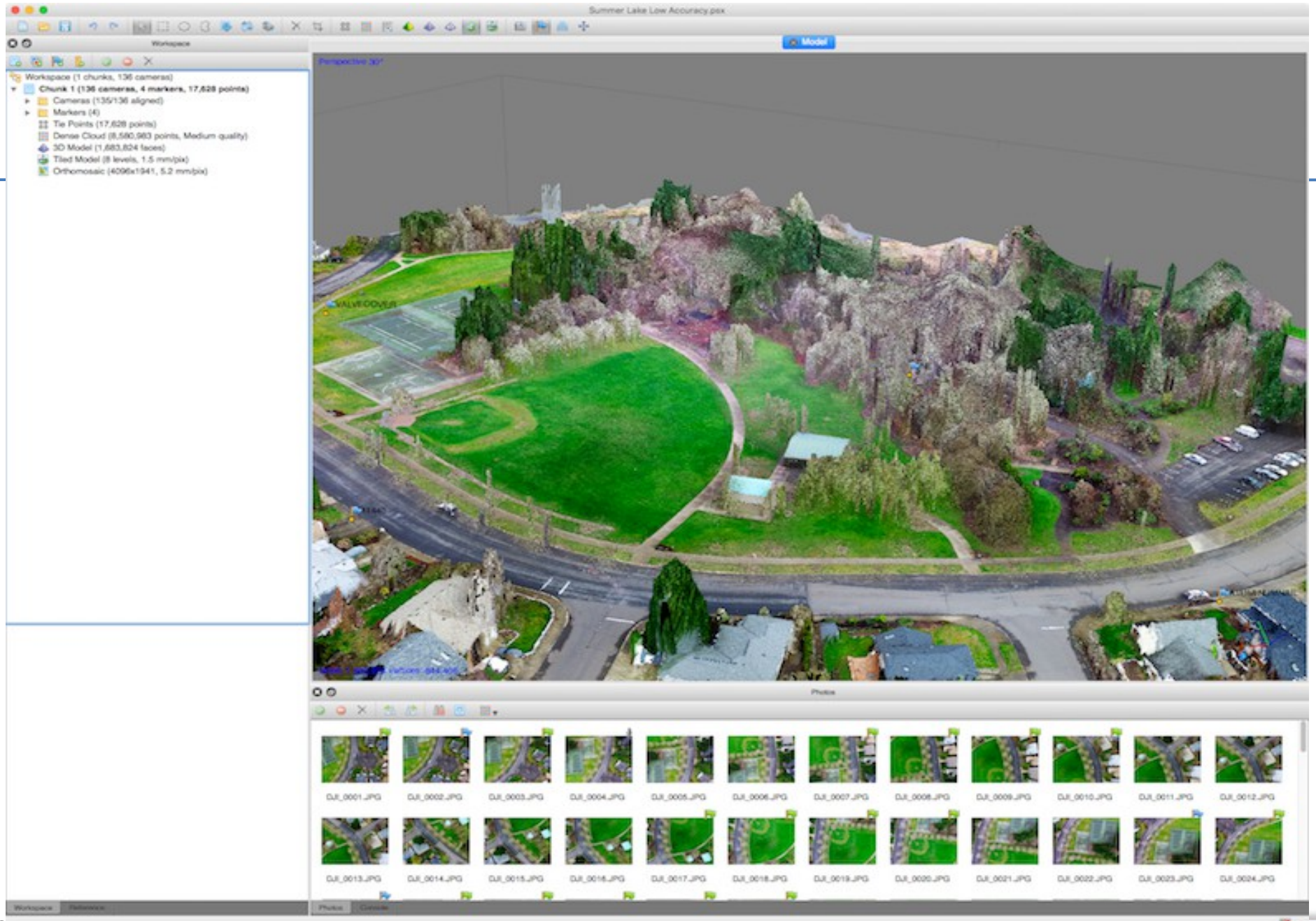
-Match images efficiently and accurately.

-Incorporates ground control.

-Produce DEMs/DSMs.

-Produce orthophotos, 3D models, volumes and elevation contours.

-Processing computer (CPU/Memory/Video)



Project Examples:
What's Possible with a Consumer UAS?

What quality of data can I squeeze from a $1,000 consumer drone?

Parts List

-DJI Phantom UAV quadcopter.

-Mission planning software.

-iPad Mini tablet computer w/ArcGIS Collector.

-RTK GNSS receiver.

-Pix4D (Drone2Map) or Agisoft PhotoScan Pro image processing software.

Sample Projects

First Mission

-Project YF. 30 acres.

-Goal: produce orthophoto and 4K video of a stream tributary.

-Challenges: limited batteries (2), rental car didn't support charger, tried to do too much.

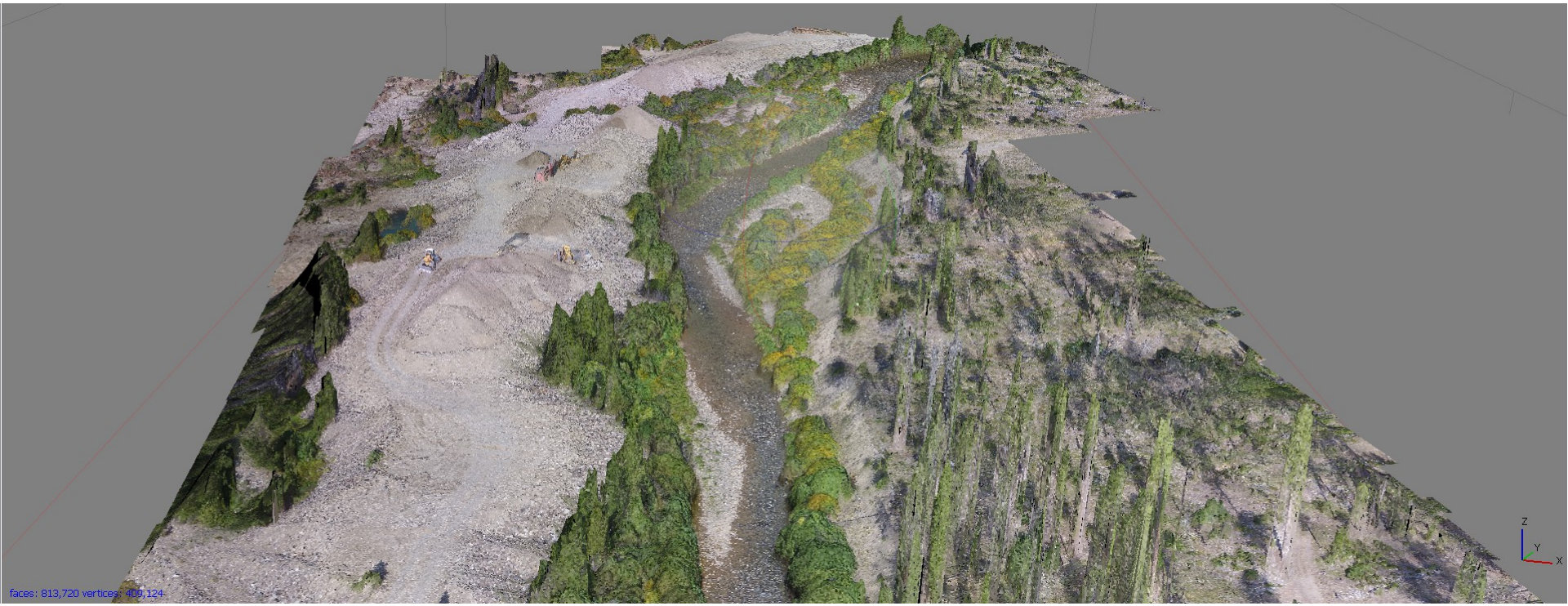
-Result: Success, with exception.

First Mission

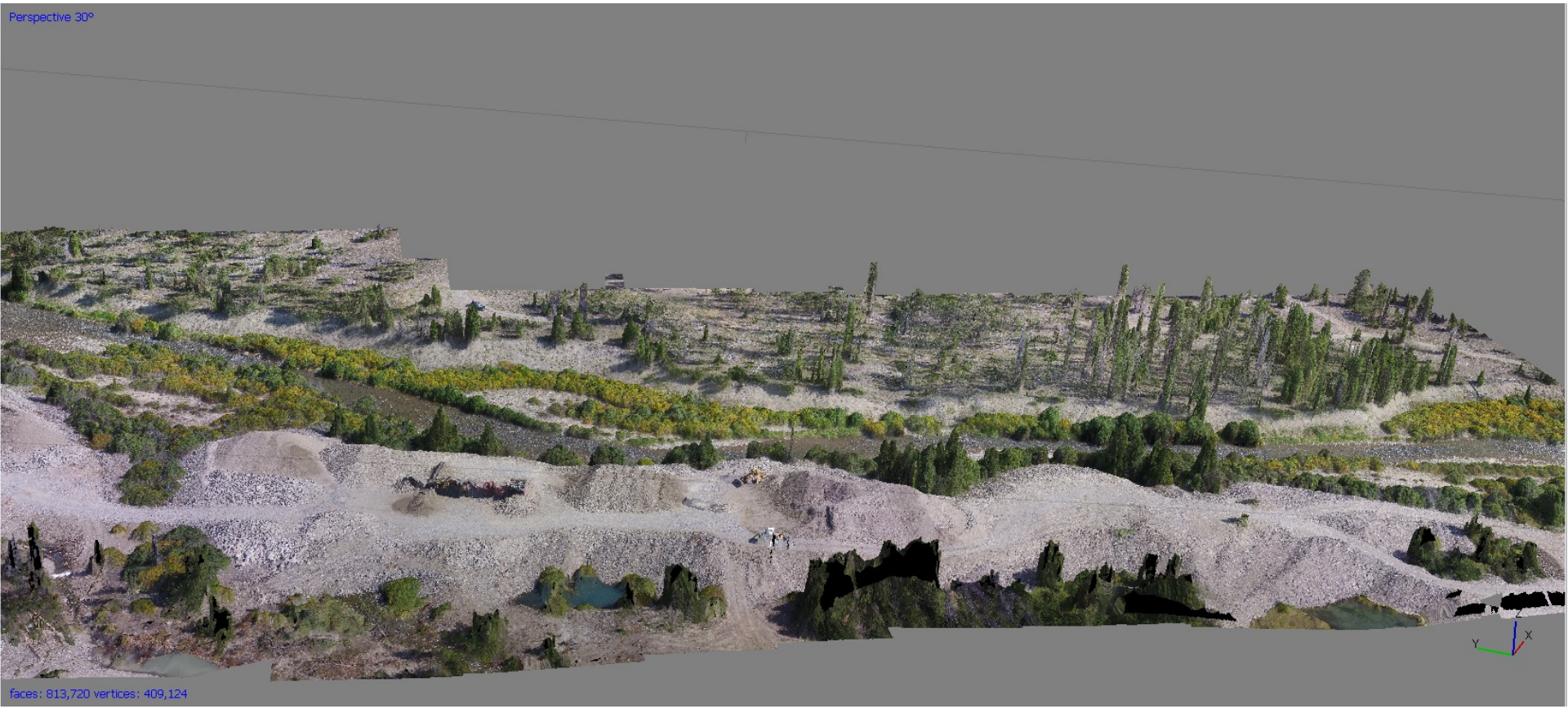
Google Earth

2cm/Pixel UAS

First Mission



First Mission



Second Mission

-Project RR. 5 acres.

-Goal: produce orthophoto and elevation contours. Integrate with Google Earth.

-Challenges: Weather, people.

-Result: Success.


UAV-GE1
Legend
Google earth
© 2015 Google
N
100 ft


UAV-GE-CloseUP2
Legend
Google earth
© 2015 Google
N
20 ft


UAV-CloseUP2
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BUS
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© 2015 Google
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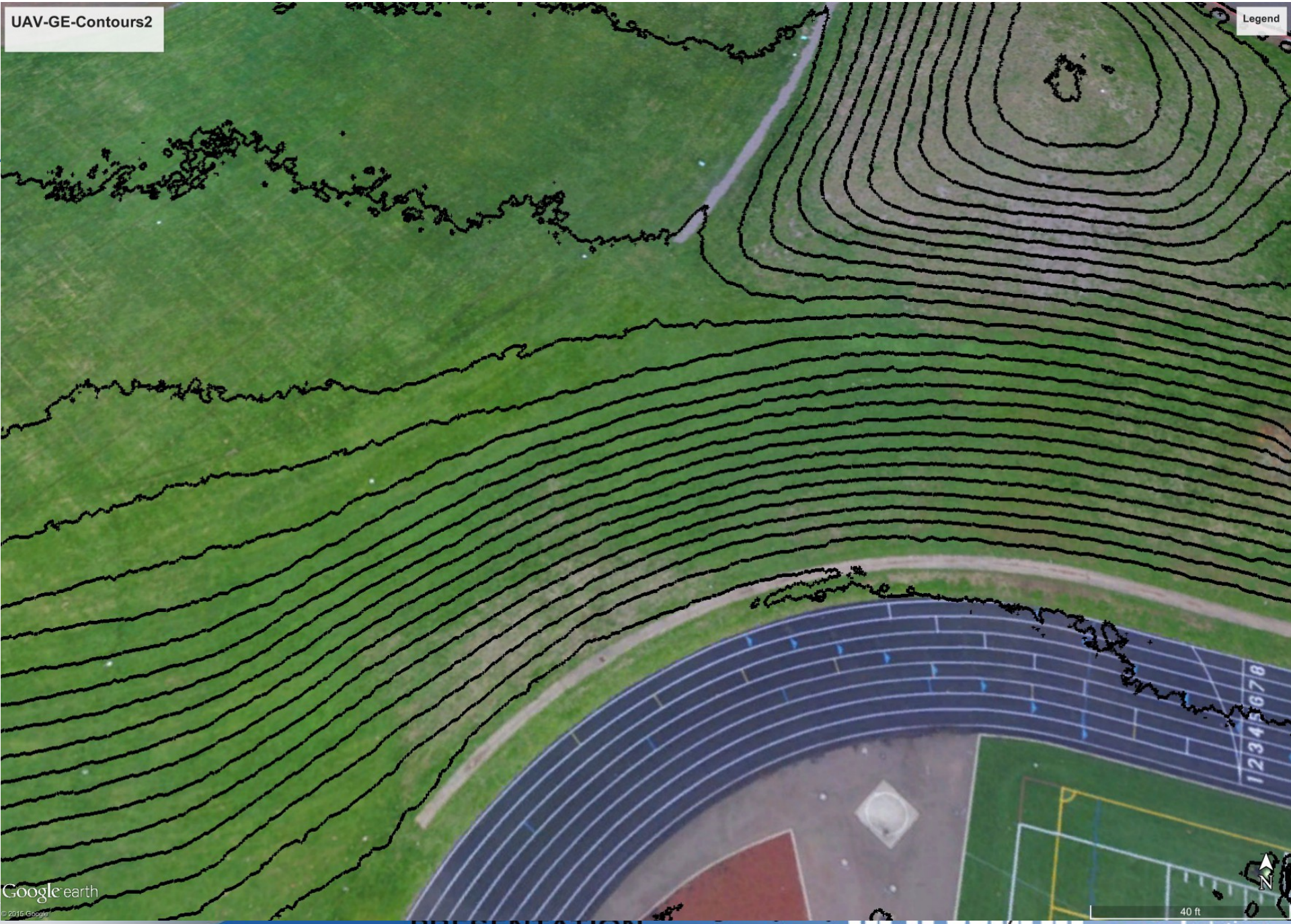
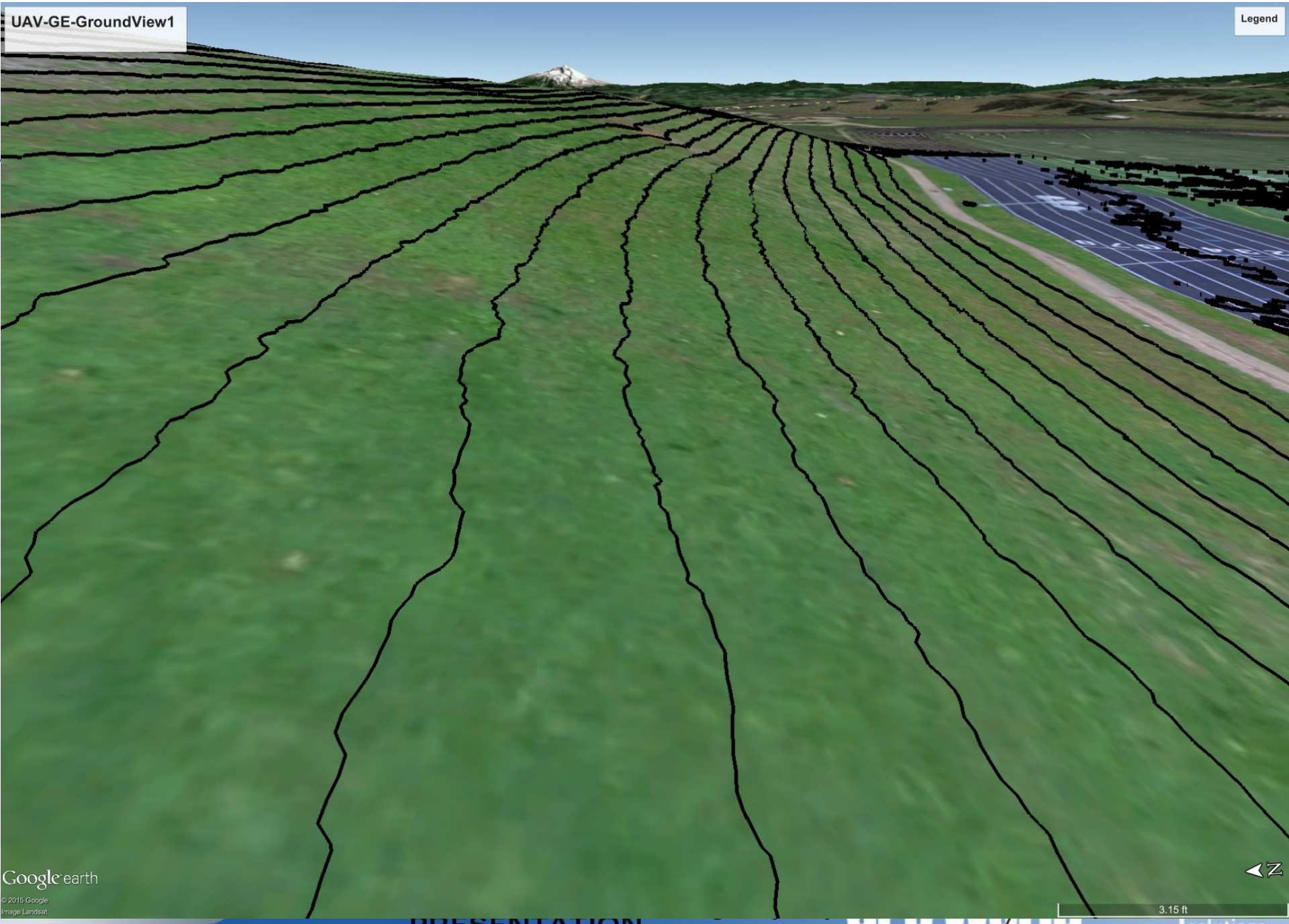
20 ft


UAV-GE-Contours2
Legend
Google earth
© 2015 Google
40 ft
N


UAV-GE-GroundView1
Legend
Google earth
© 2015 Google
Image Landsat
3.15 ft

Third Mission

-Project WASCO. 160 acres.

-Goal: Produce orthophoto and one foot elevation contours.

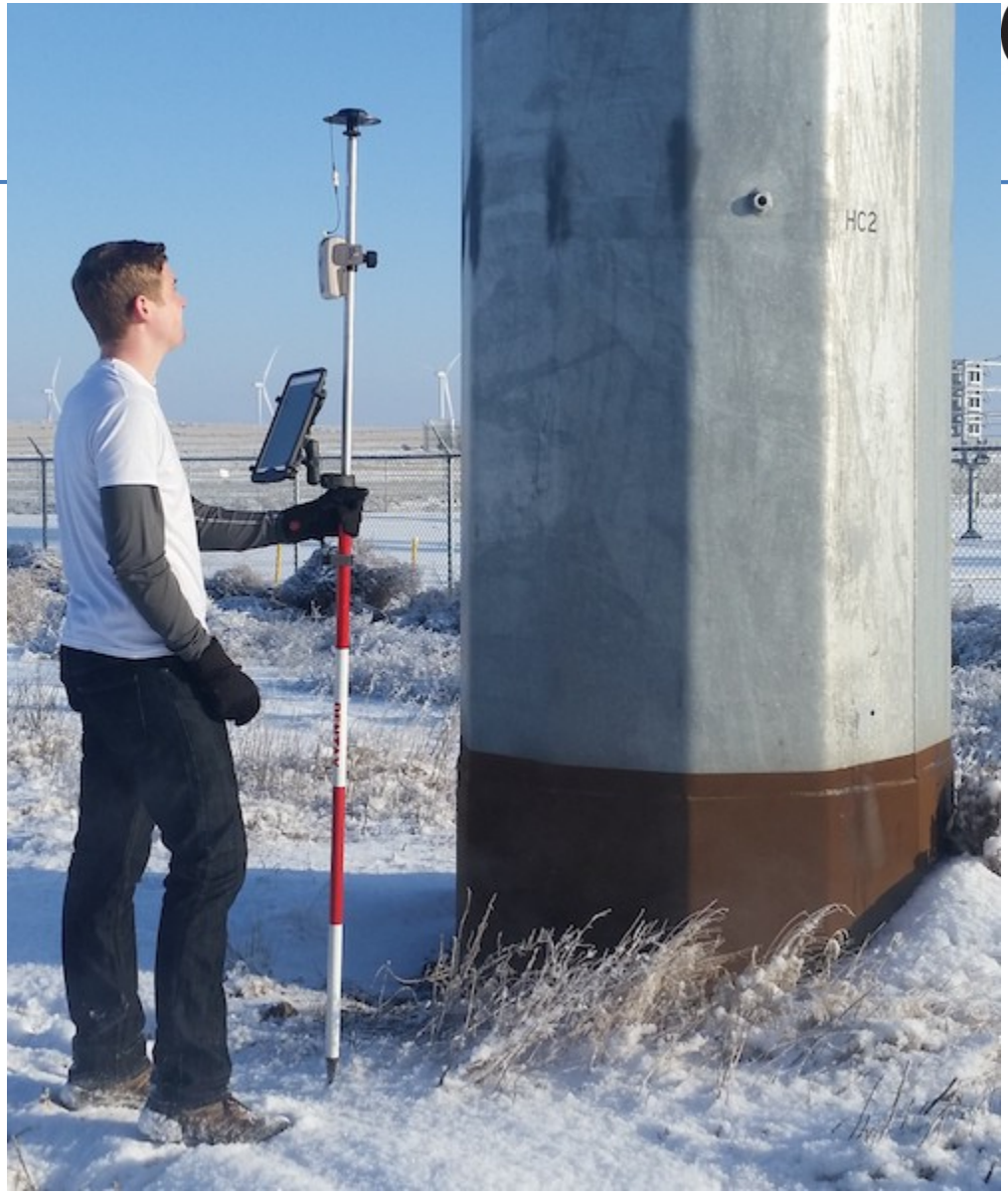
-Challenges: Weather (rain, snow, temp, wind), homogeneous ground cover, batteries.

-Result: Mostly success.

-Lesson learned: Adjust camera settings to deal with low-light conditions.

Third Mission

Third Mission



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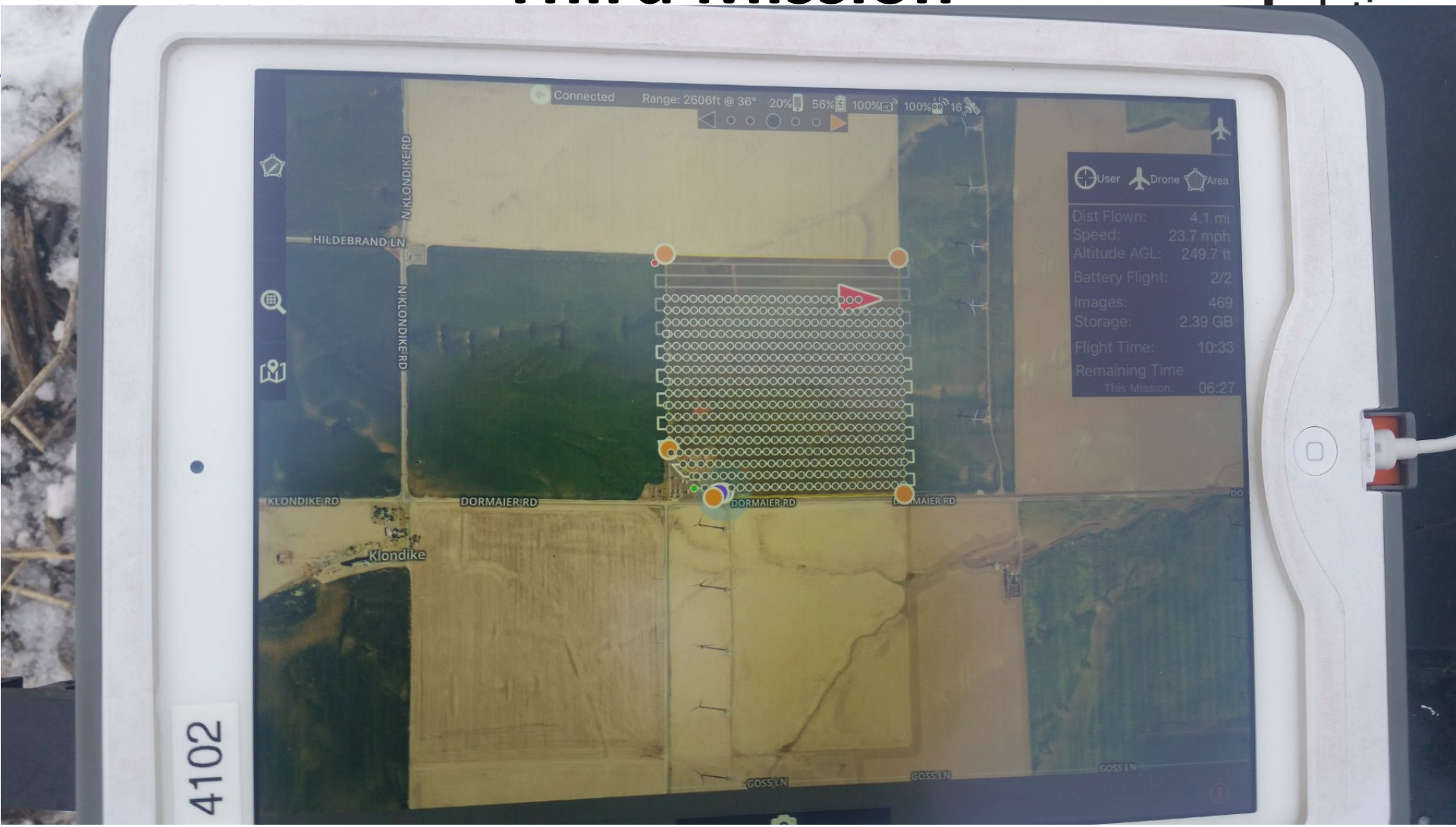

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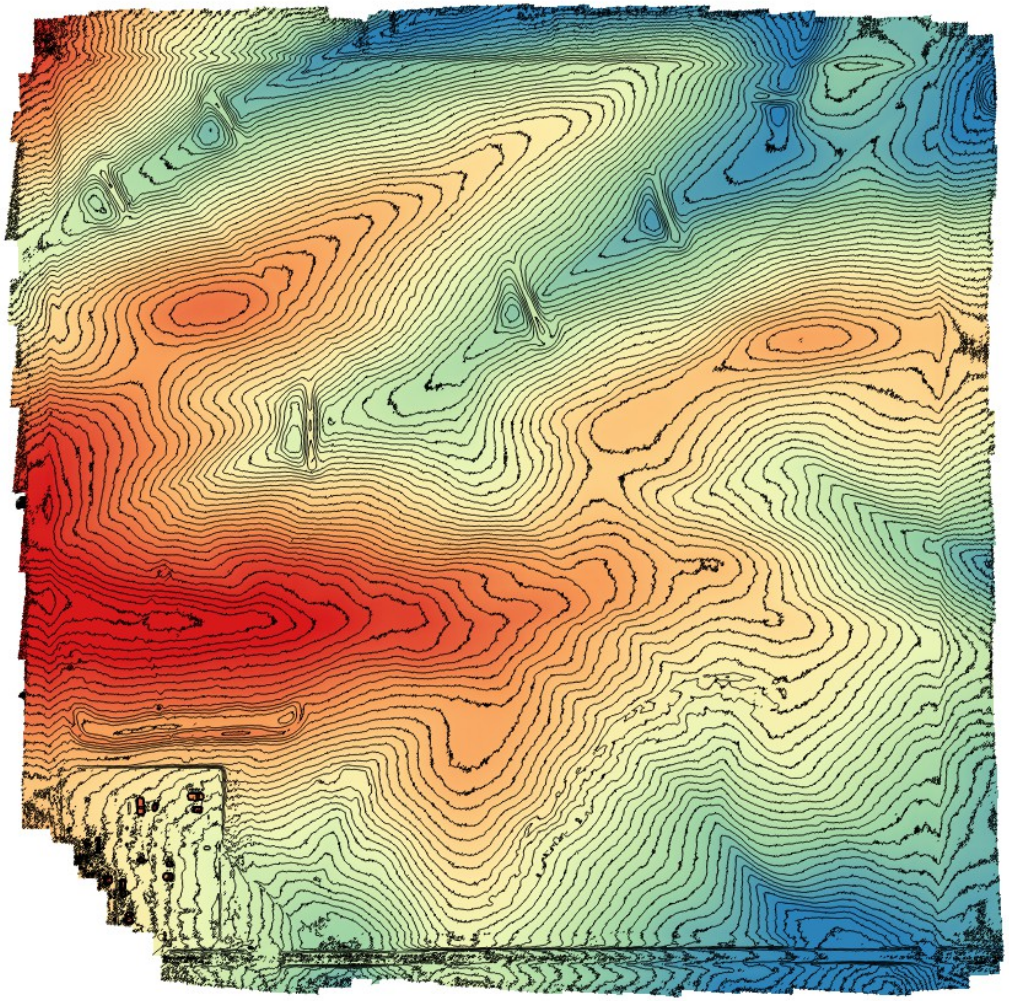

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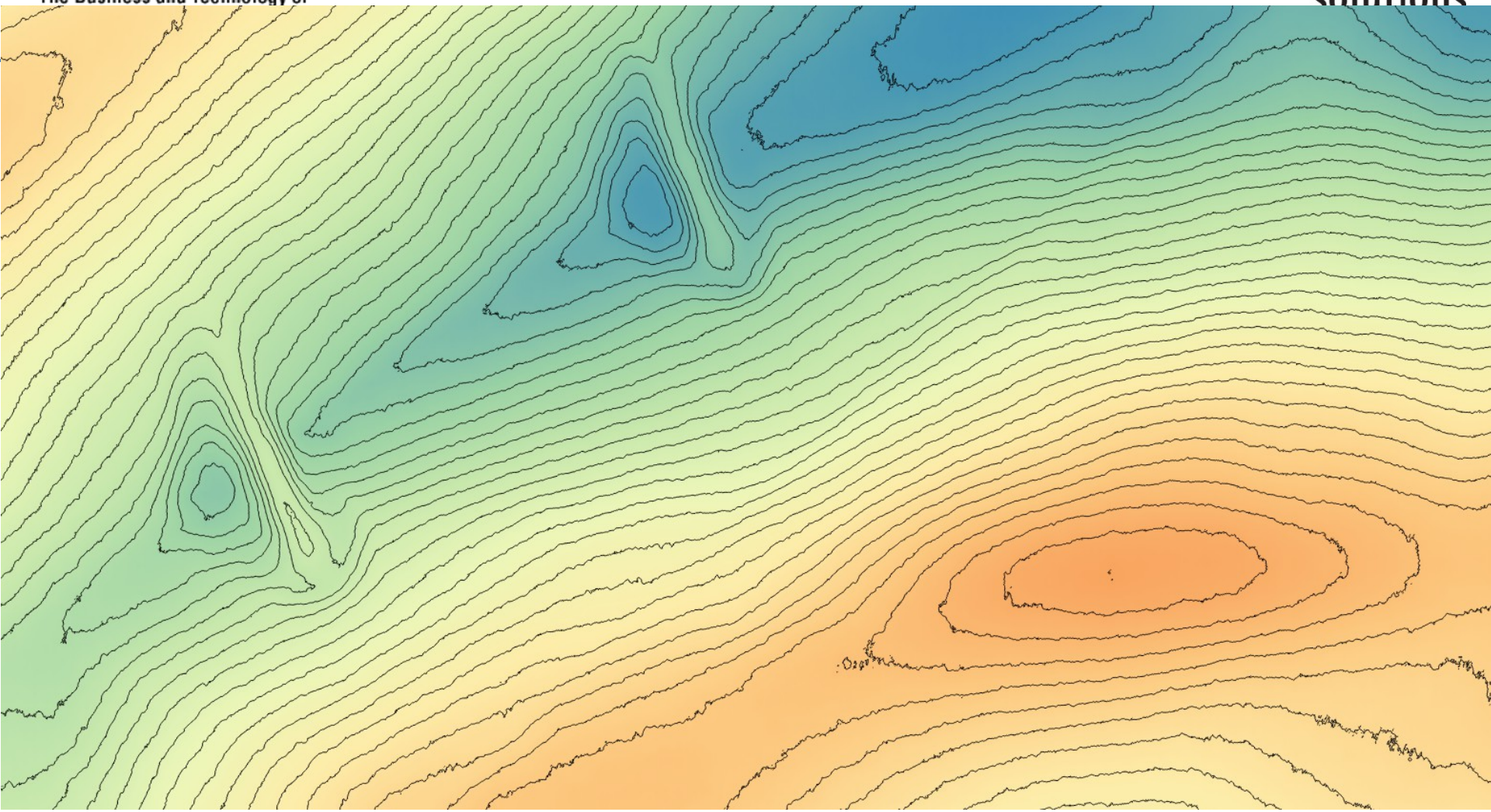

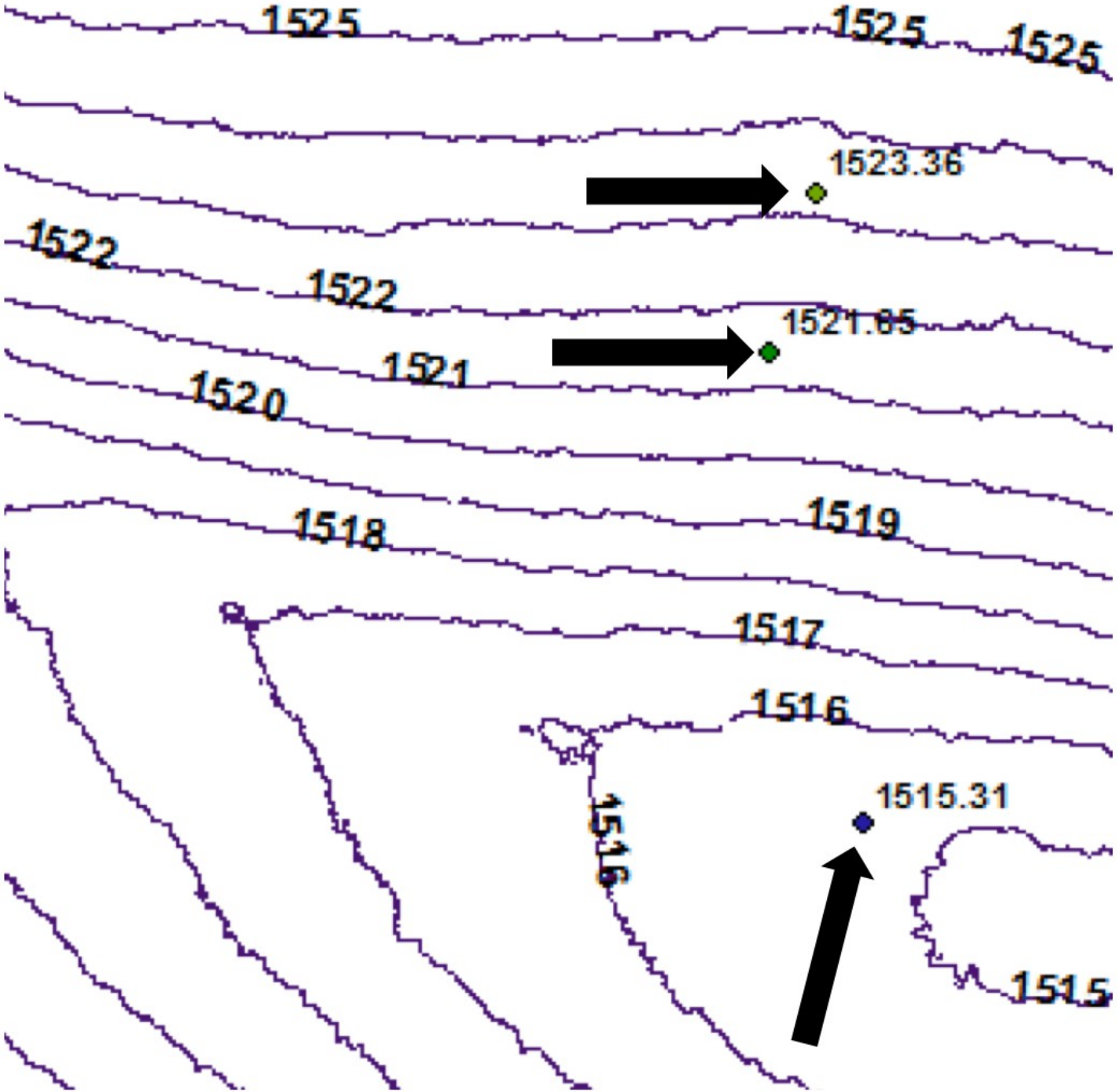
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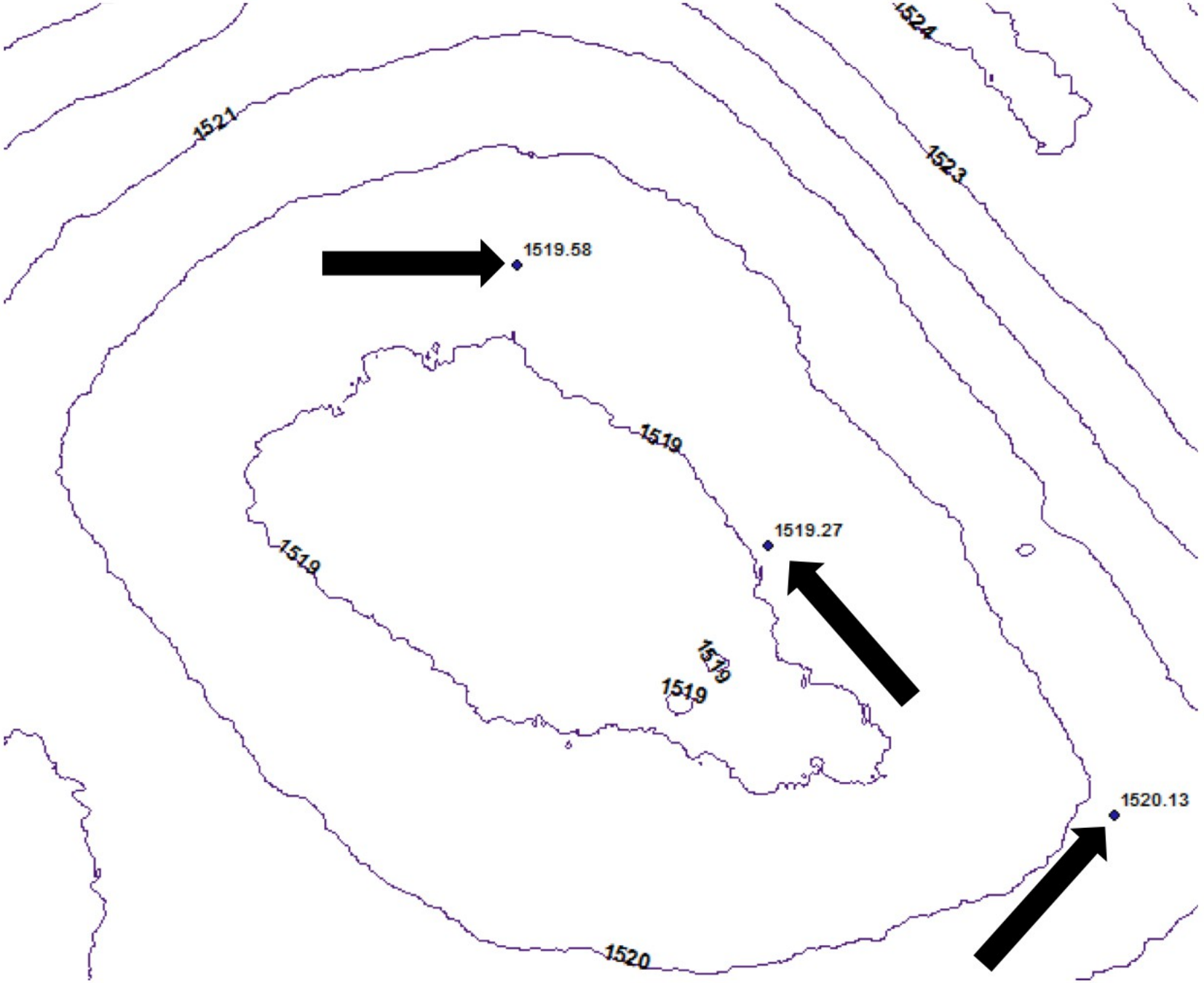
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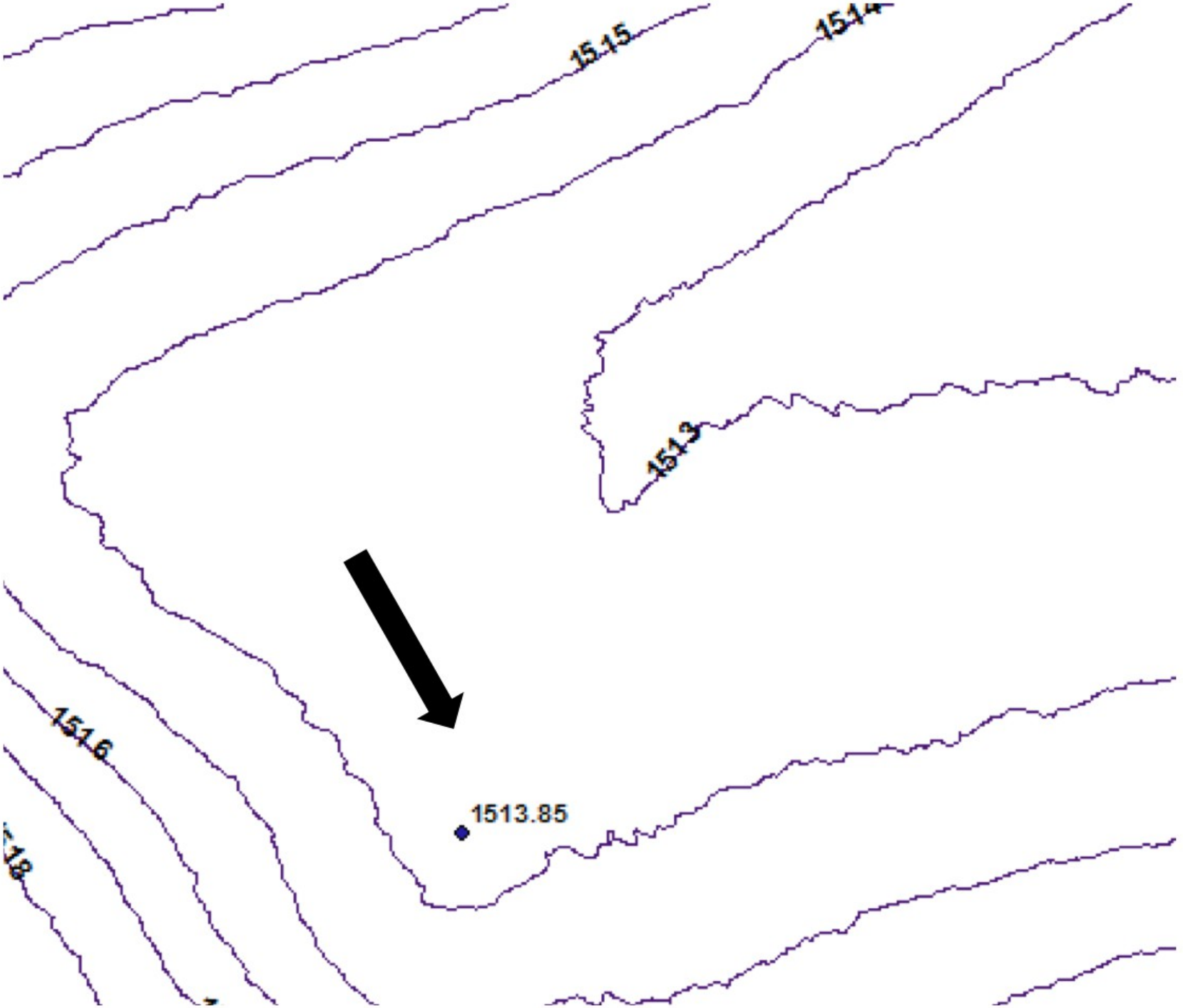
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Fourth Mission

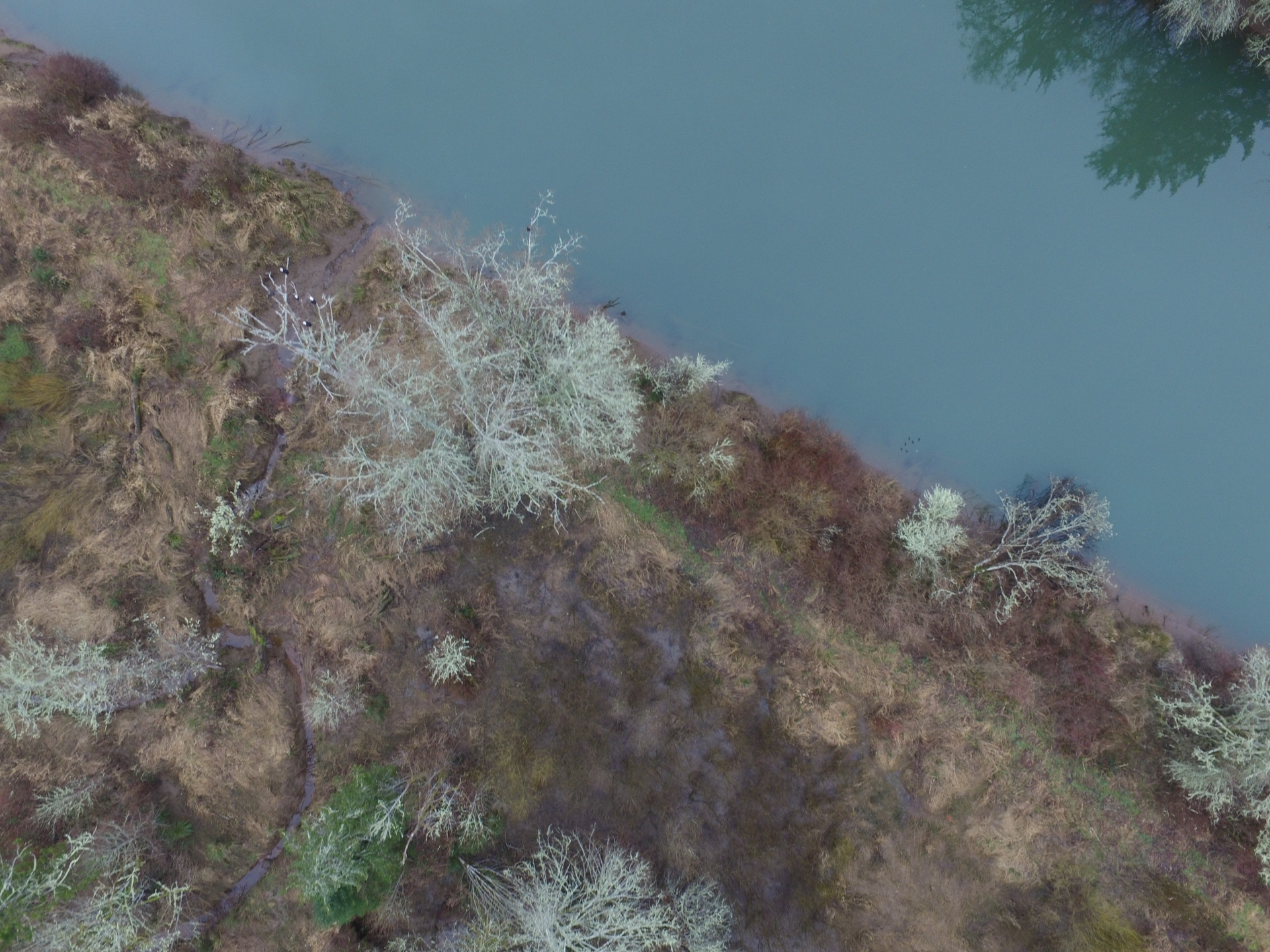
-Project KAN. ~300 acres.

-Goal: Produce orthophoto and one foot elevation contours.

-Challenges: Weather (rain, wind), batteries, timing (low-tide), birds, image processing.

-Result: In progress.

-Lesson learned: Adjust camera settings to deal with variable-light conditions.



Inspection – UAVs aren't all about mapping

UAS GOTCHAS

Gotchas

-Batteries.

-UAS and Controller (tablet computer)

-300 acre project was at least 9 UAS battery swaps. On-site charging takes one hour per pack. Multi-pack charger is valuable.

-Set hard limit on battery time. Battery capacity is 23 minutes. I set to 18 minutes.

Gotchas

-Weather.

-Wind, rain and snow are a problem.

-Ideally wind below 10mph.

-No rain.

-Image processing software has a difficult time when the images are blanketed by snow/dirt/trees. Images may not match up.

-Camera control for varied light conditions.

Gotchas

-Processing a lot of images takes a lot of computer horsepower.

-300 acres produces about 3,000 JPG images @ 5MB each (12MP camera) when flown in one direction at 80% overlap.

-A dedicated high-end “gaming” computer takes several hours to process the data.

Comments?

Questions?

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