PARSONS

Drones:

Using Drones to Evaluate Munitions Disposal Features

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delivering a better world

Agenda

- Project Description
- Capabilities Implemented
- Output
- Issues
- Considerations for your projects

Tooele Army Depot - South

1,800 acre site located approximately 35 miles southwest of Salt Lake City, Utah

Before demilitarization, TEAD-S stored close to 45% of the entire US chemical weapon arsenal

Utilized photogrammetry to produce volume estimates for use during the CMS

Photogrammetry

Photogrammetry is the science of making measurements from photographs and it is based on having multiple views of the same object.

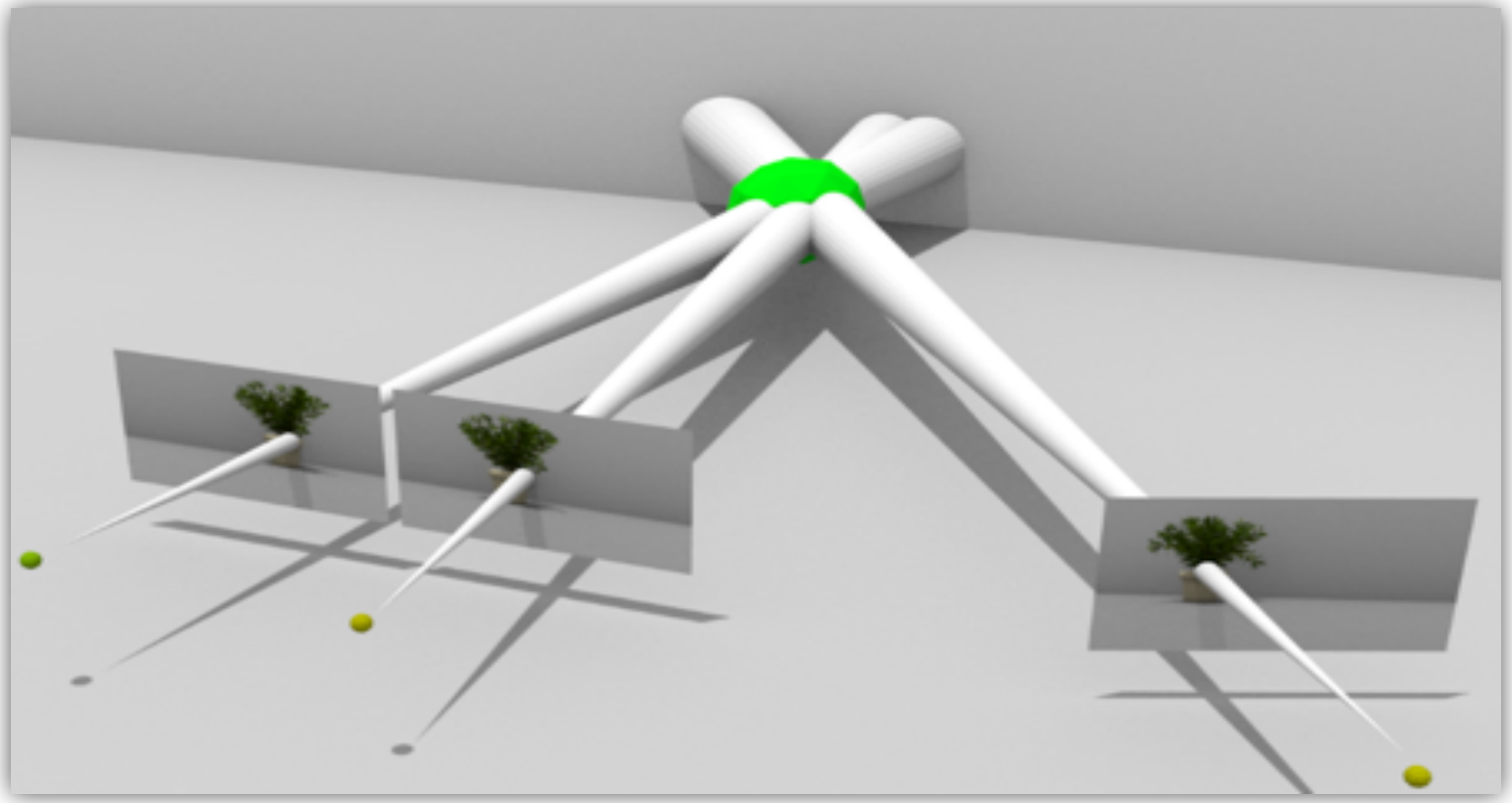
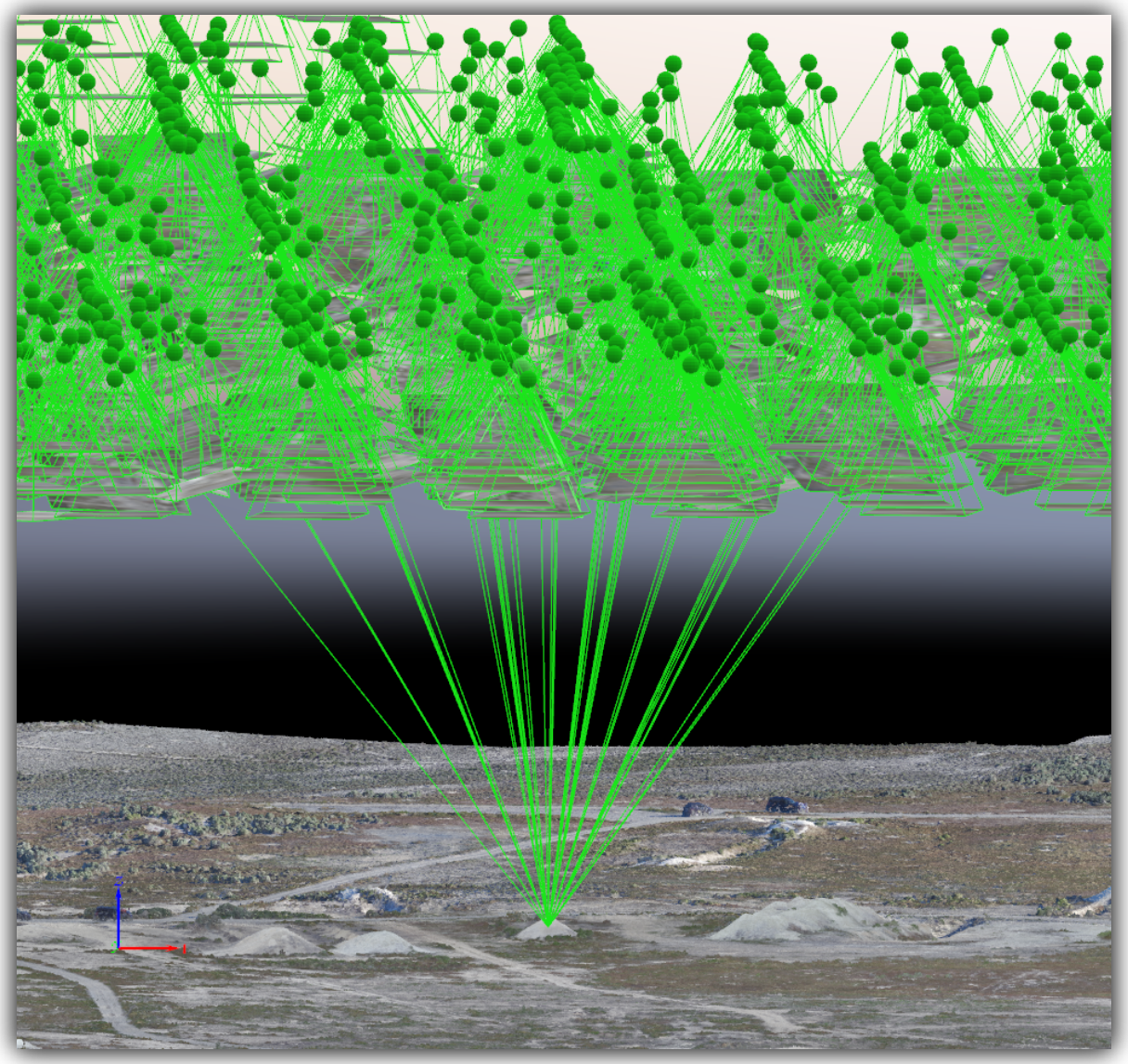


Photo credit: Pix4D

Photogrammetry (cont.)

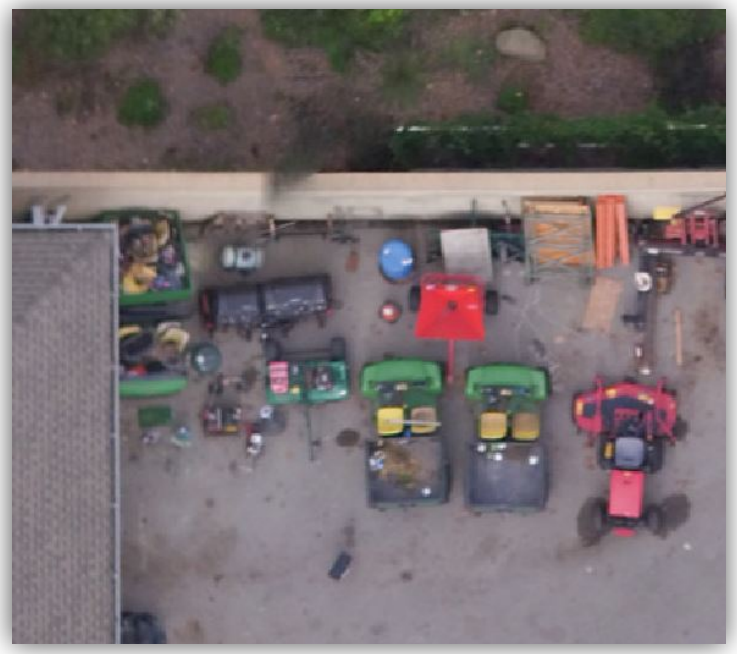


- Because all angles are top down, photogrammetry can only see the topmost surface (e.g. trees).
- Best suited to low vegetation, urban, industrial, or cleared environments
- Can provide maps, models, and meshes accurate to less than a centimeter

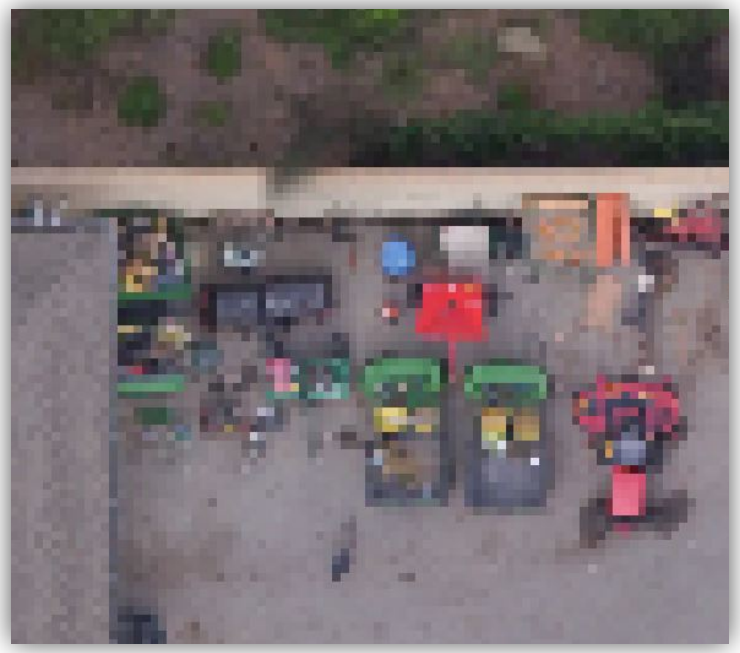
Photogrammetry (cont.)

Ground Sampling Distance vs Resolution

- Ground Sampling Distance (GSD): the distance between two adjacent pixel centers normalized to real world dimensions
- Resolution:



2.5 cm GSD



10 cm GSD

Photo credit: Pix4D

Maps and Contours

3D Models

- Highly accurate 3D models allow for measurements of distance and volume across variations in terrain
- Almost anything can be measured for volume, length, and area:
  - Pipes
  - Pits
  - Trenches
  - Buildings

Photo credit: Pix4D

TEAD-S: Major Considerations

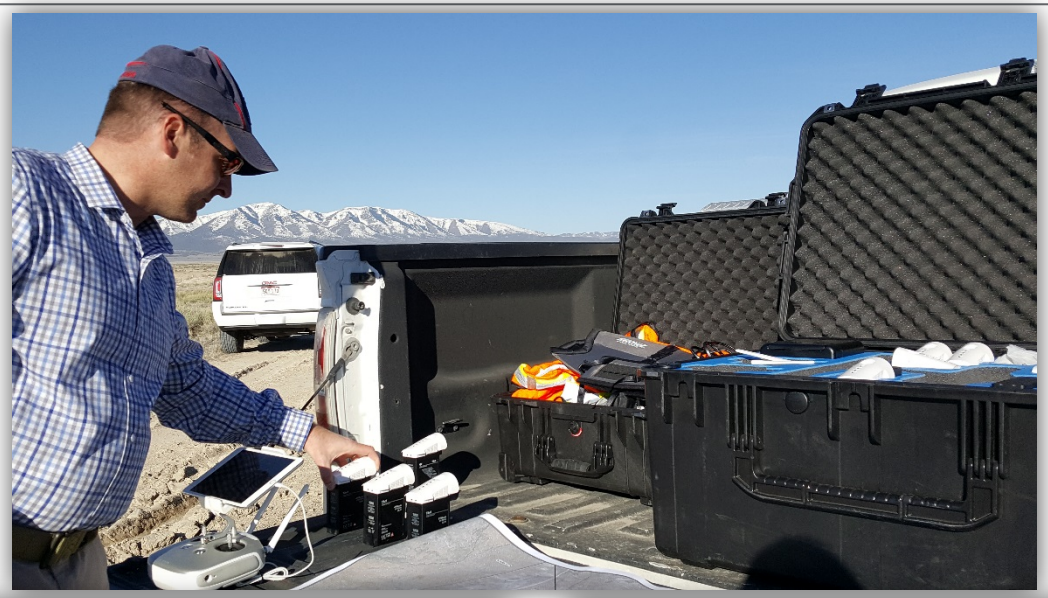
Land Based Survey

- Several teams each with UXO escorts
  - Approximately 5,740 survey points would be required (14 points each)
  - Approximately 10 field personnel
  - Six weeks of surveying
- Air monitoring and medical support required
  - Due to the hazardous nature of CA related waste, significant preparation and training is required to ensure workplace safety
- Enhanced PPE and CRZ
  - Additional PPE and decontamination procedures
- Increased safety risk, schedule, and cost
  - Estimated cost in excess of $320K

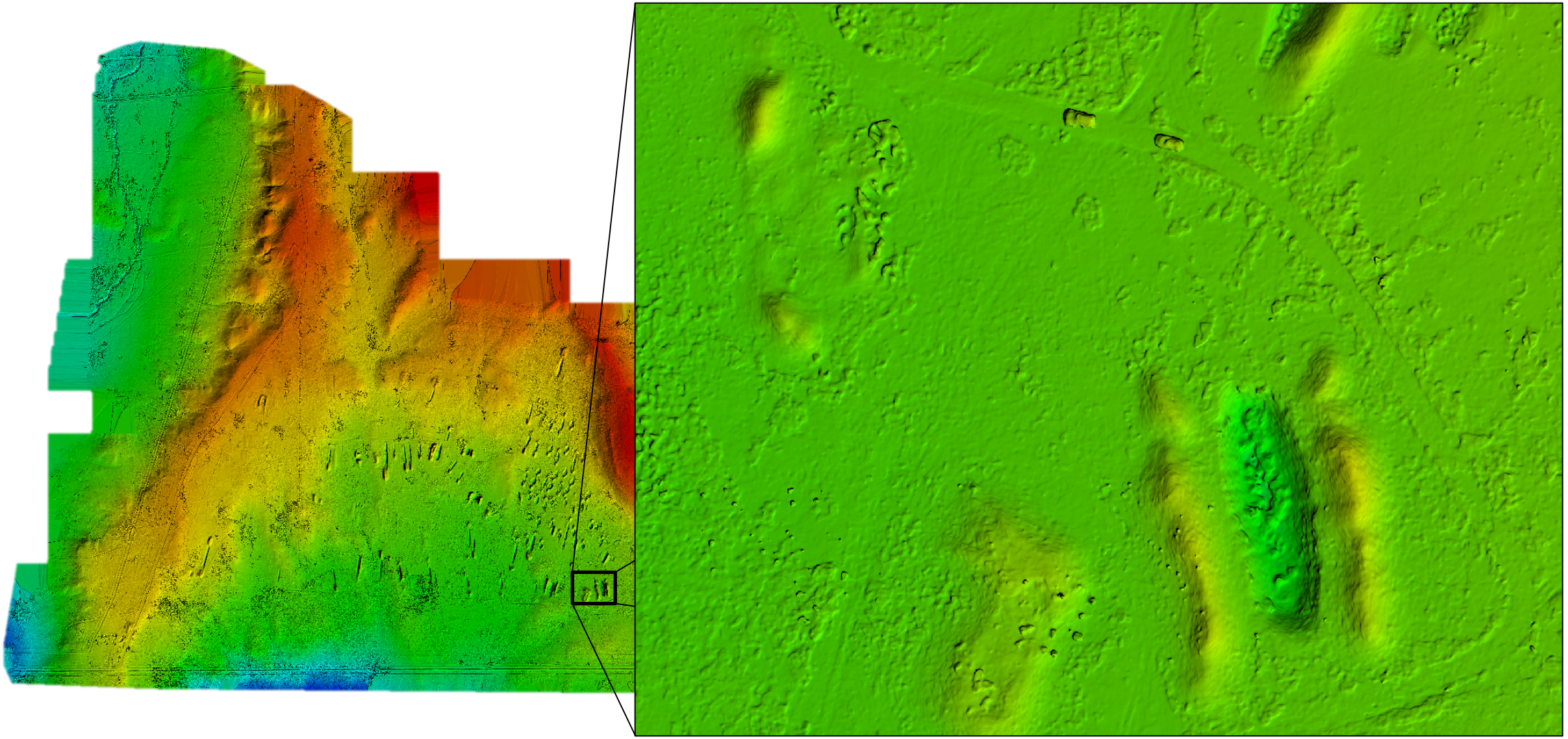
Drone Survey

- One small team
  - Pilot, visual observer, and safety oversight
  - 7 days for data collection
- No air monitoring or medical support
  - The entire survey was collected from areas known to be safe (i.e., established roads)
- No PPE or CRZ
- Significant reduction in safety risk, schedule, and cost
  - Actual cost $24K

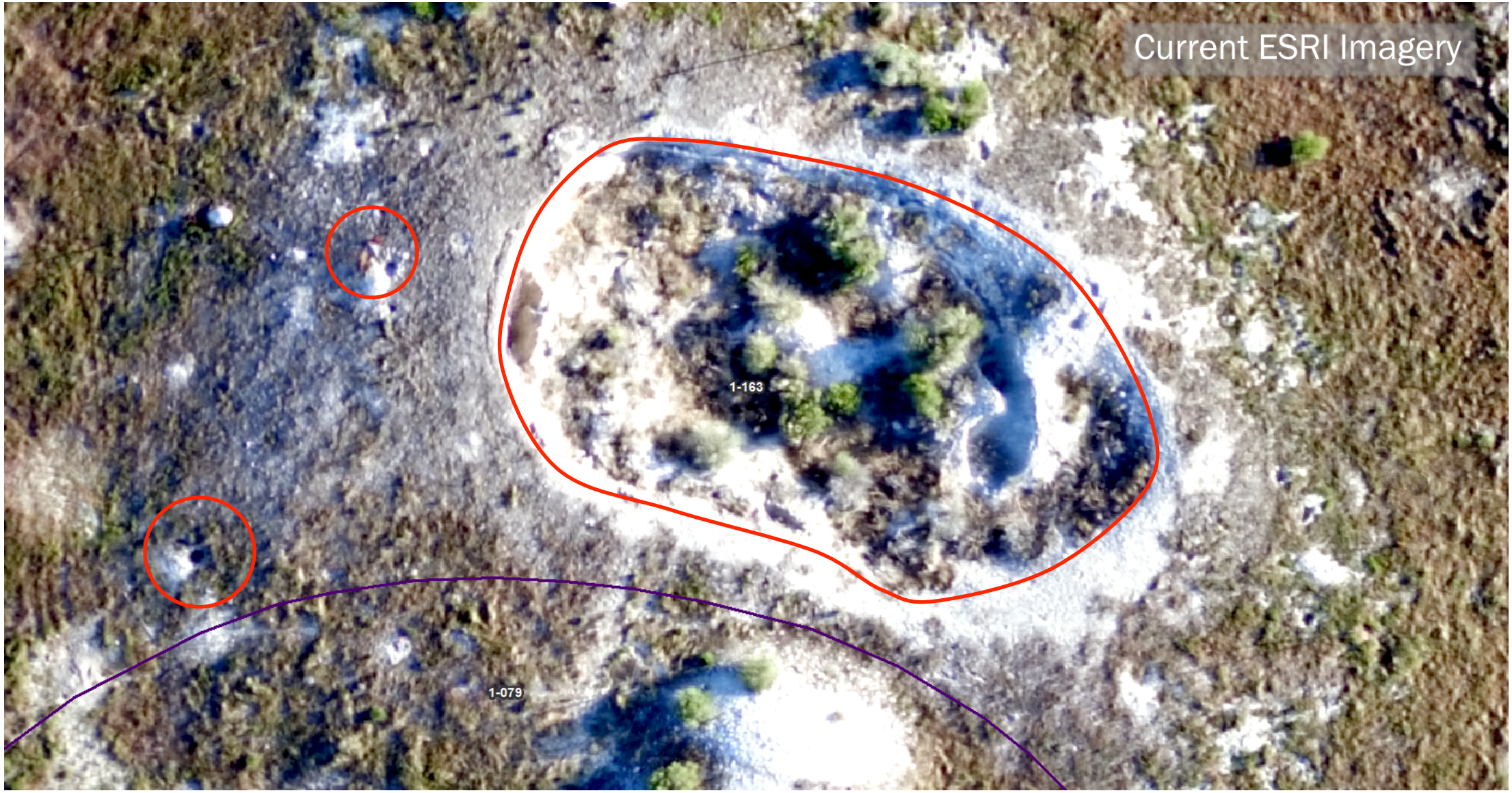
TEAD-S: Field Operations



TEAD-S Results: Digital Elevation Model (DEM)



TEAD-S Results: Orthomosaic



TEAD-S Results: Volume Calculations for Trench and Mound Features

SWMU 1 and Buffer Zone Volumes Finished (Updated).xlsm - Excel

I10: Trench and mound

	A	B	C	D	E	F	G	H	
1	Name	Terrain 3D Area (m^2)	Fill Volume (m^3)	Fill Volume Error ($\pm m^3$)	Cut Volume (m^3)	Cut Volume Error ($\pm m^3$)	Total Volume (m^3)	Total Volume Error ($\pm m^3$)	Comment
3	IDF 1-033.f1	780.342	-1128.99	24.0938	0.881902	0.820058	-1128.11	24.9139	
4	IDF 1-033.c1	895.805	-9.8522	4.57978	615.268	26.6427	605.415	31.2225	
5	IDF 1-033.c2	843.668	-6.12783	3.89401	600.772	25.4391	594.644	29.3332	
6									
7									
8									
9									
10	**Total:**		**-1128.99**	**24.0938**	**1216.04**	**52.0818**			Trench and mound

Accuracy of Measurements - Vegetation

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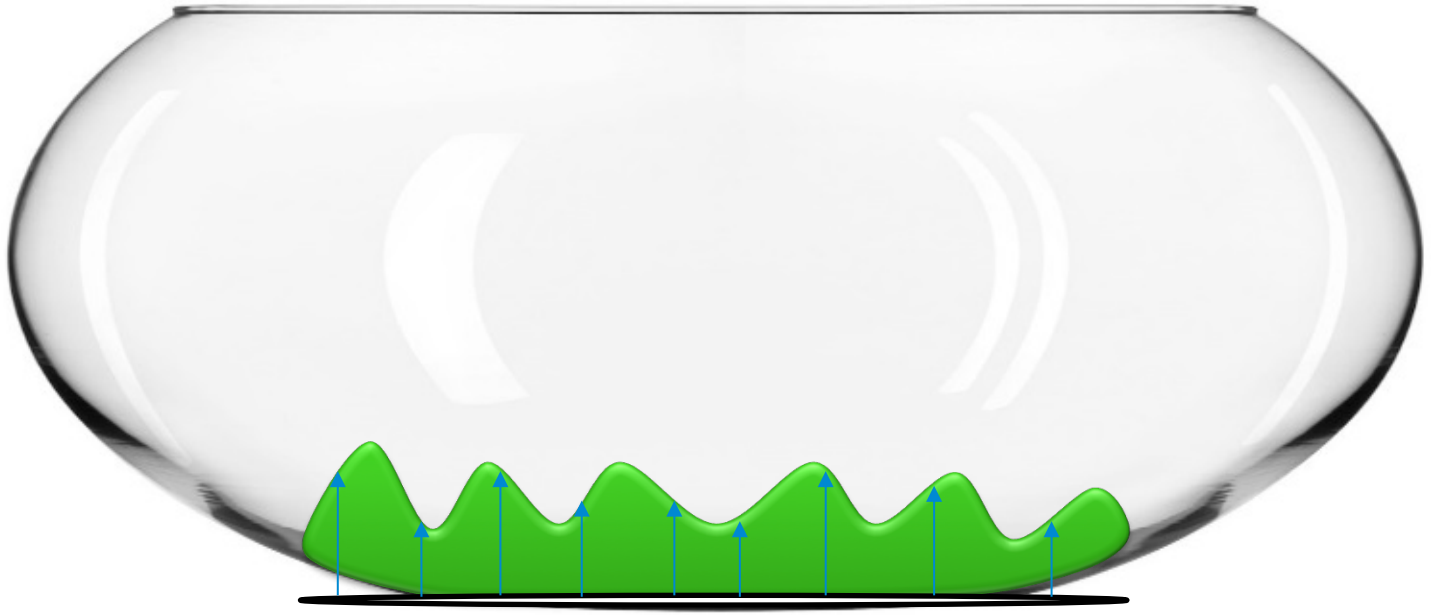


Accuracy of Measurements - Vegetation

Brush Volume 2

Terrain 3D Area:	91.01 m^2
Cut Volume:	34.60 ± 3.39 m^3
Fill Volume:	0.00 ± 0.00 m^3
Total Volume:	34.60 ± 3.39 m^3

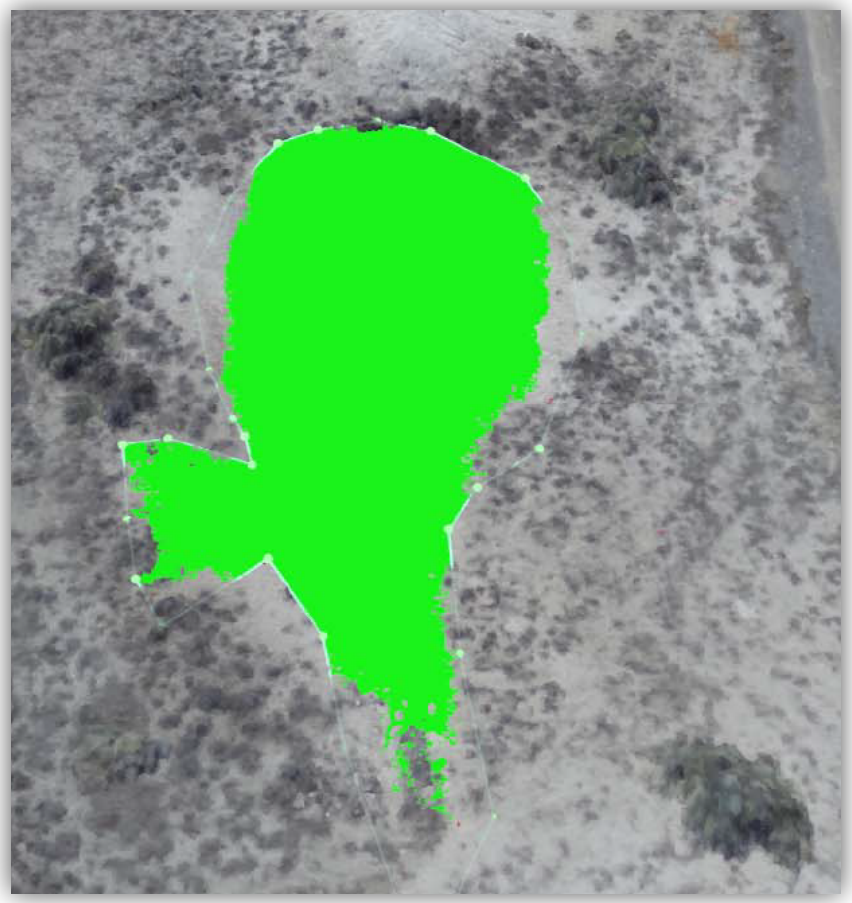
Help

Approximately 25% of the volume of the trench is vegetation!

Detailed Trace Volume

Terrain 3D Area:	243.65 m^2
Cut Volume:	1.68 ± 0.74 m^3
Fill Volume:	-114.14 ± 5.70 m^3
Total Volume:	-112.46 ± 6.44 m^3

Help



Accuracy of Measurements - Vegetation

To verify our method, we cleared the vegetation from the trench and then recollected the data, and compared the results:

Volume of Trench Prior to Brush Removal			
Trial Number	Volume of Brush in Trench (m^3)	Volume of Trench Above Brush (m^3)	Total Volume of Trench (m^3)
1	30	94	124.03
2	35	82	116.10
Volume of Trench with Brush Removed			
Trial Number	-	-	Result (m^3)
1	-	-	128.03
2	-	-	116.81

Summary			
Trial Number	Volume Prior	Volume After	Percent Error
1	124	128	3.2%
2	116	117	0.6%

Important Site Specific Parameters to Consider

Does your project need:

- An up-to-date aerial map?
- To inspect or view equipment or structures that may be physically difficult to access?
- Volumes of products, contaminants, or waste?
- A 3D model?
- Elevation contour data?

Considerations:

- Magnitude of site safety hazards
- Vegetative cover
- Time constraints
- One time snapshot vs progress monitoring
- Proximity to airports, military installations, National Parks, etc.
- Time of year and weather
- Terrain
- Resolution/accuracy

Questions?

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Photo credit: WSJ