LESSONS LEARNED AT AG-1 MRS REMEDIAL ACTION AT CAMP BLANDING, CLAY COUNTY, FL

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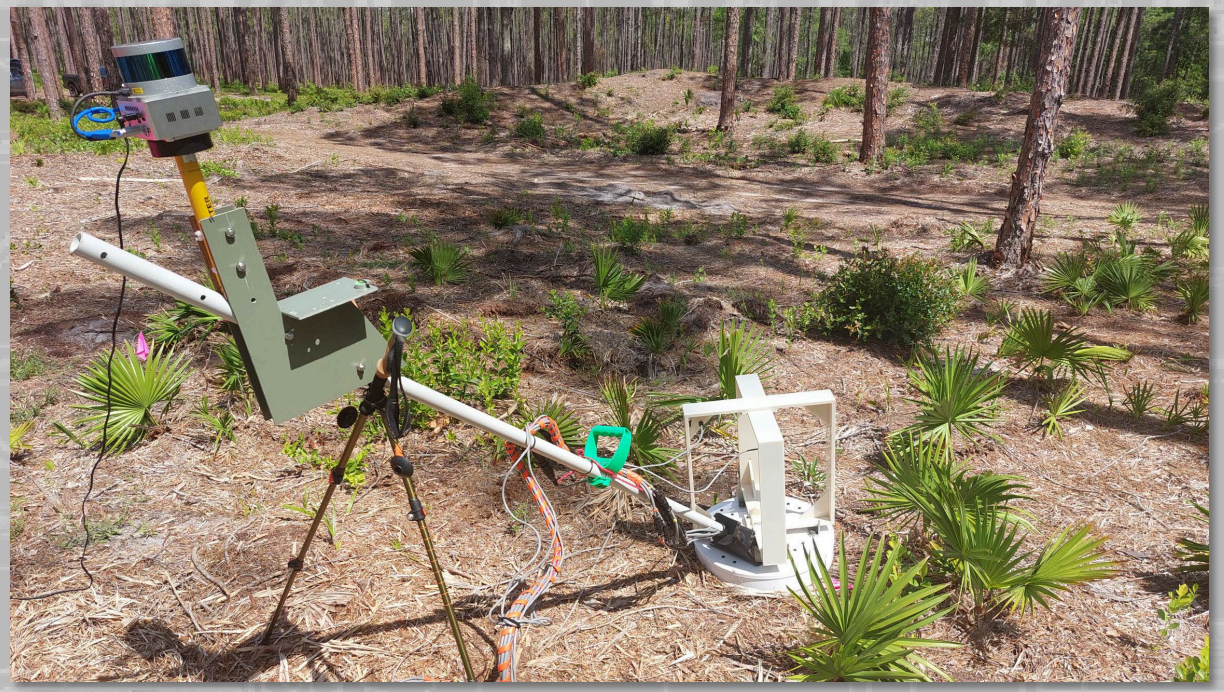
Date: 04 April 2023



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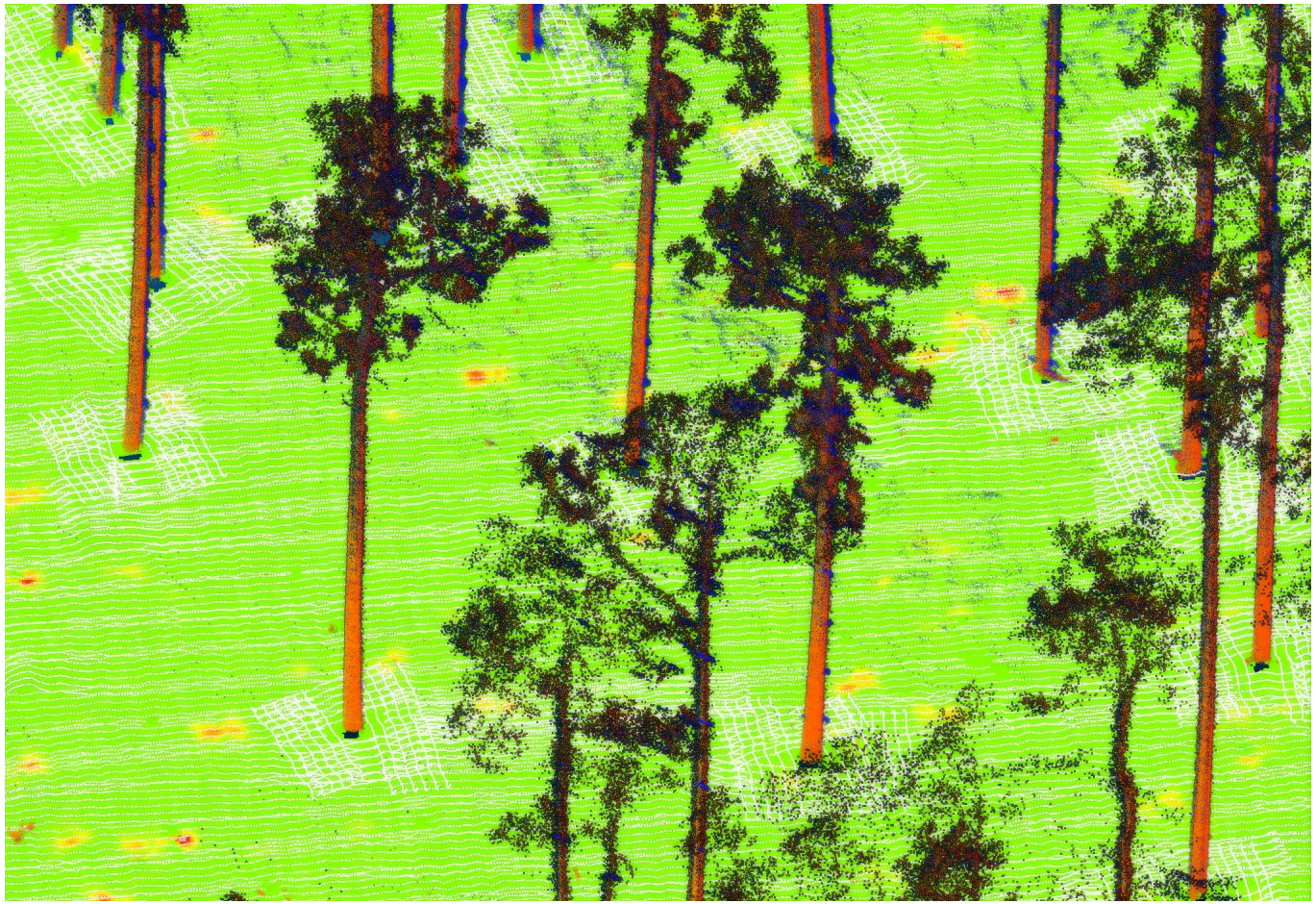
OVERVIEW

- Challenges integrating the Stencil 2 with the UltraTEM Screener
- Issues using SLAM at a forest/clearing interface
- Lack of Confidence
- Other beneficial uses of SLAM data



INTEGRATING THE STENCIL WITH THE SCREENER

Poor Inversion Results at the IVS
– Recurring failures over a medium ISO at 0.15m
– Primary polarizability (L1) match less than the 0.9 MQO
– Significant underestimation of the ISO's size

Several Root Causes identified with the help of
– Black Tusk Geophysics (BTG)
– Gap EOD
– Kaarta

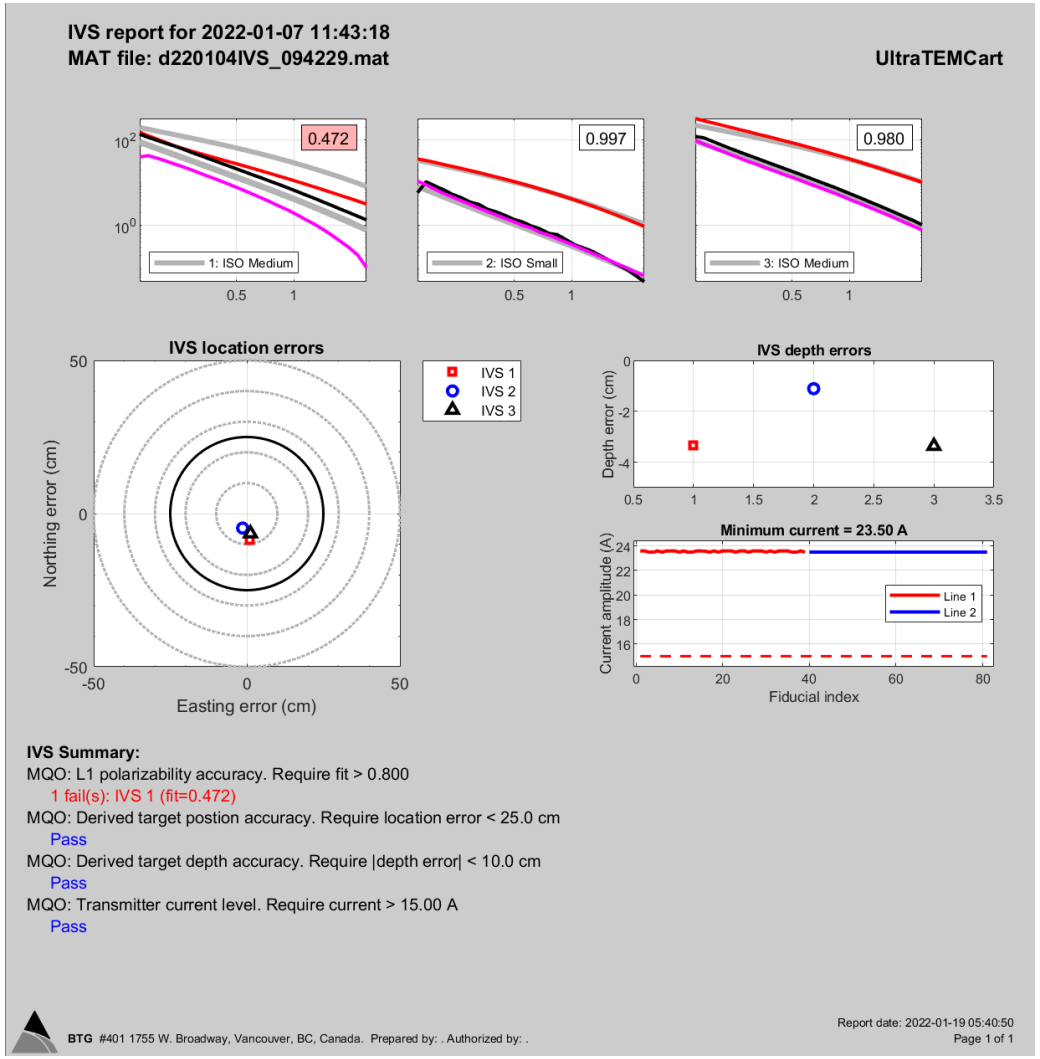
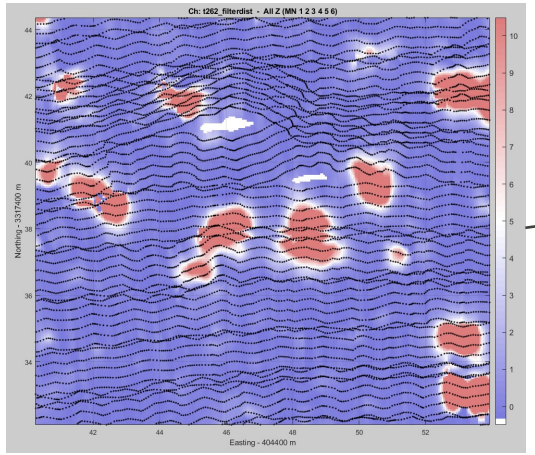
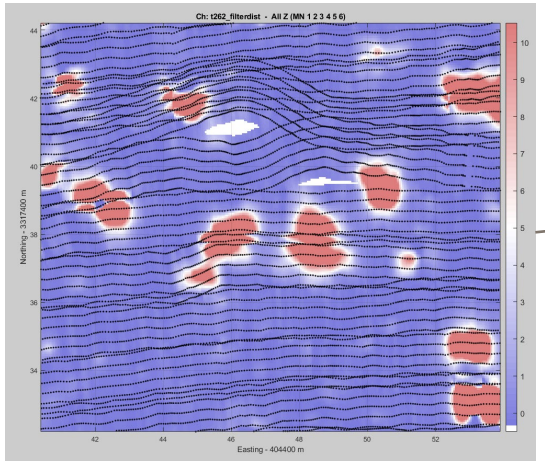


Figure courtesy of BTG/Gap EOD

INTEGRATING THE STENCIL WITH THE SCREENER

Attitude data from the Stencil
- No on-board filtering of the attitude data with the Stencil
- These sudden movements were amplified when mapped to the Rx cube positions and degraded polarizability estimates
- Applied an 11-point rolling average filter to the Stencil attitude data
- **Still not resolved…**





Raw

5pt

11pt

Figure courtesy of BTG

INTEGRATING THE STENCIL WITH THE SCREENER

Inconsistent Lag

– Shift between the time bases for the Screener and the Stencil resulted in an apparent lag in the merged Screener data that affected the accurate recovery of polarizabilities even after a lag correction was applied.

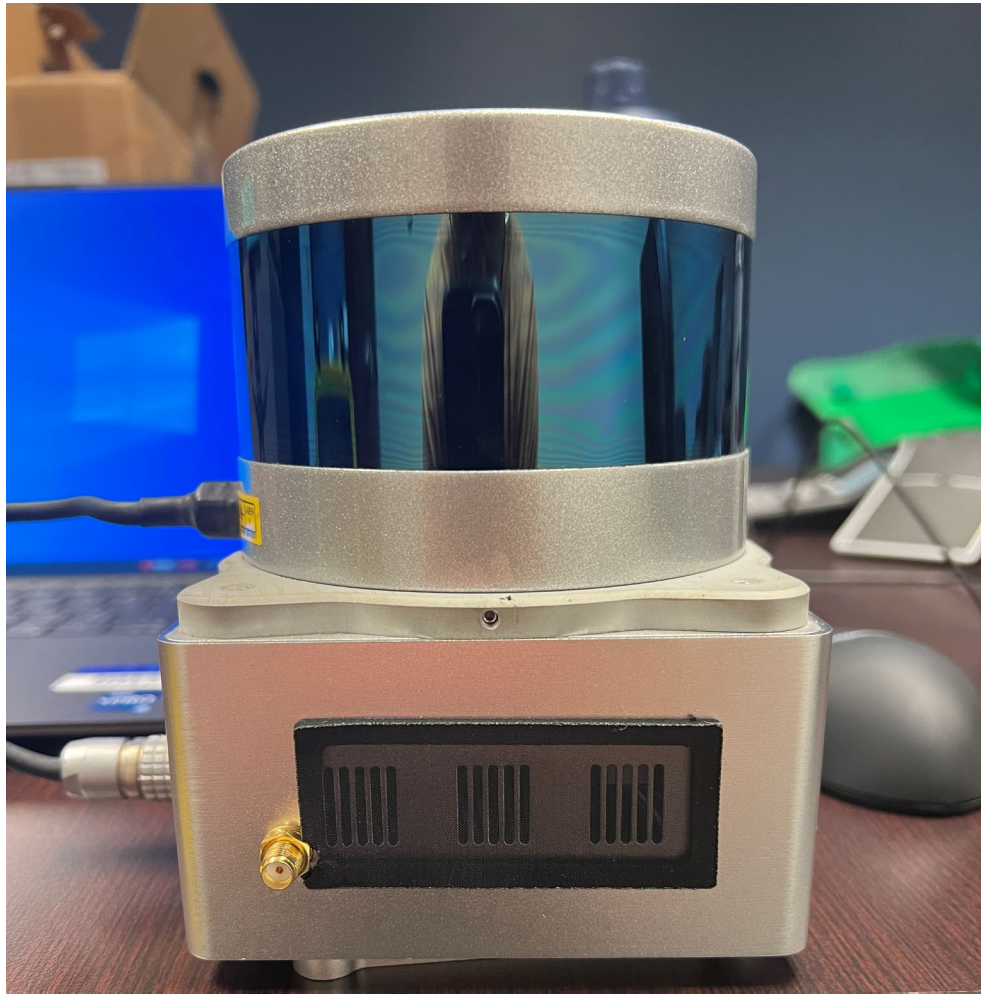
– The lag between the Stencil and the Screener was inconsistent between survey events
  - Outputs from the Stencil to the Screener would drift every time the Stencil was powered up.
  - The data analyst had to assess the appropriate lag value for each survey event by matching anomalies from adjacent sensor passes.
    – This led to a QC seed failure in a highly cluttered grid because the analyst couldn't accurately match anomalies.
  - With the inconsistent lag, we would have benefited from data processing seeds

INTEGRATING THE STENCIL WITH THE SCREENER

Inconsistent Lag

– This was diagnosed through the application of Independent Model Location Inversion (IMLI) algorithm.
  - Allows for a separate estimate of extrinsic source parameters (location and orientation) for each line of dynamic AGC data acquired over an anomaly.
– Applied IMLI and standard inversions to all IVS and production data

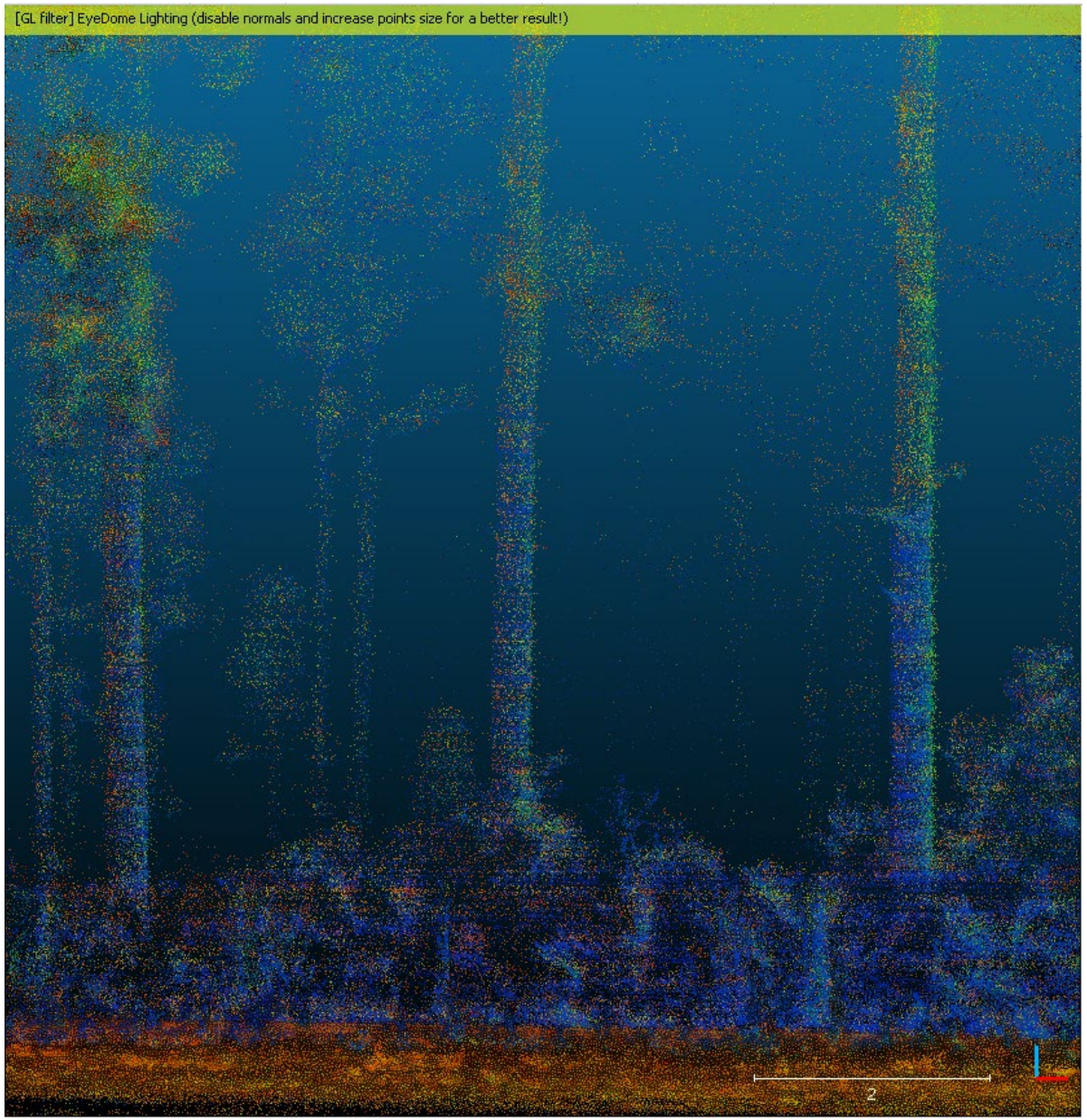
– To improve the timing between the Stencil and the Screener, Gap EOD and Kaarta worked together to get a 1PPS output added to the Stencil.
  - This will be tested for the first time in the coming weeks.
– **Still not resolved…**



INTEGRATING THE STENCIL WITH THE SCREENER

IVS Point Cloud Accuracy

– The quality of the position data was still not great from the Stencil at the IVS.
  - Kaarta ran their sharpening tool on our IVS Point Cloud
    – Offsets improved to 2cm from 4cm (Kaarta's UXO QC tool for GCPs).



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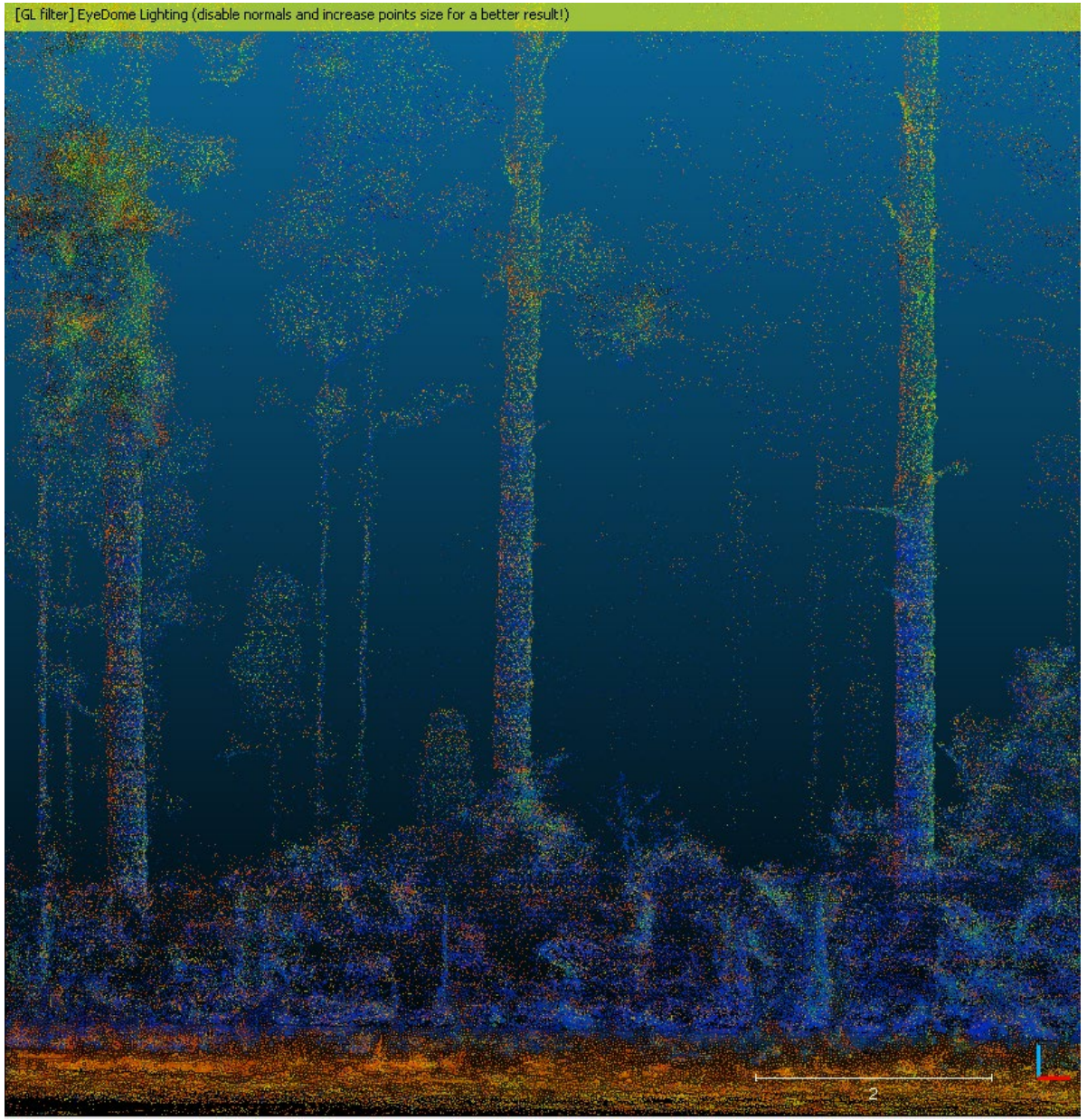
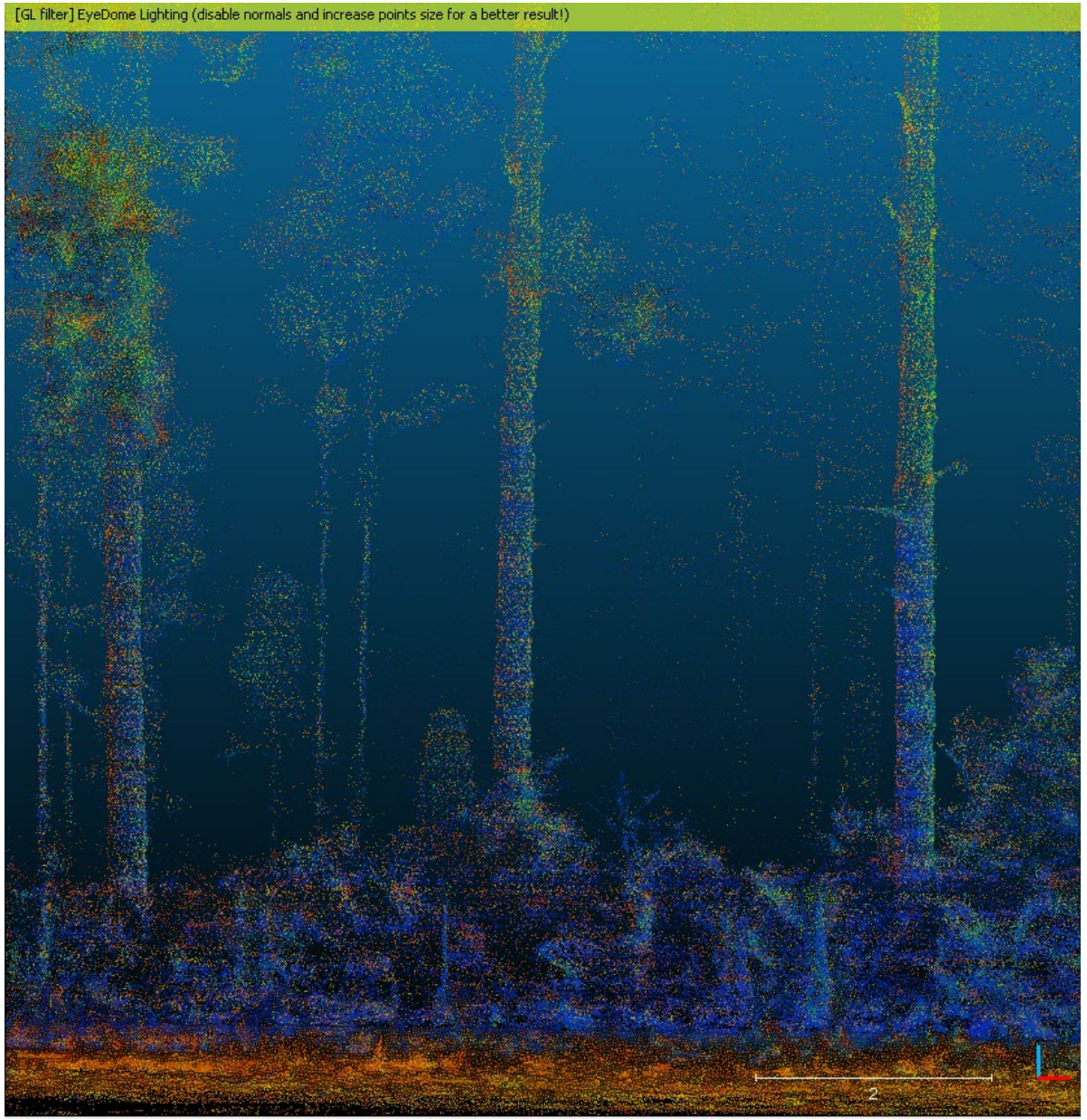


INTEGRATING THE STENCIL WITH THE SCREENER

IVS Point Cloud Accuracy

– The quality of the position data was still not great from the Stencil at the IVS.
  - Kaarta replayed our IVS scan data to the sharpened point cloud.
  - Replaying the data resulted in consistent position data at 10Hz
  - Gap EOD/BTG reprocessed the data with the replayed positioning data and the library match to the ISOs improved.

– **Resolved!**
  - All three steps were needed to get the ISOs to consistently pass
    – Attitude data filtering
    – IMLI and standard inversions
    – Using the sharpened Point Cloud



TREE LINE INTERFACE SLAM PROBLEM

IVS Location

– Our initial IVSs were located in an open field along the tree line because we wanted to also use RTK GPS while were performing our initial tests.
  - IVS1 (green) was too far (~35m) from the tree line on foggy mornings
  - Set up IVS3 in north, closer to the tree line

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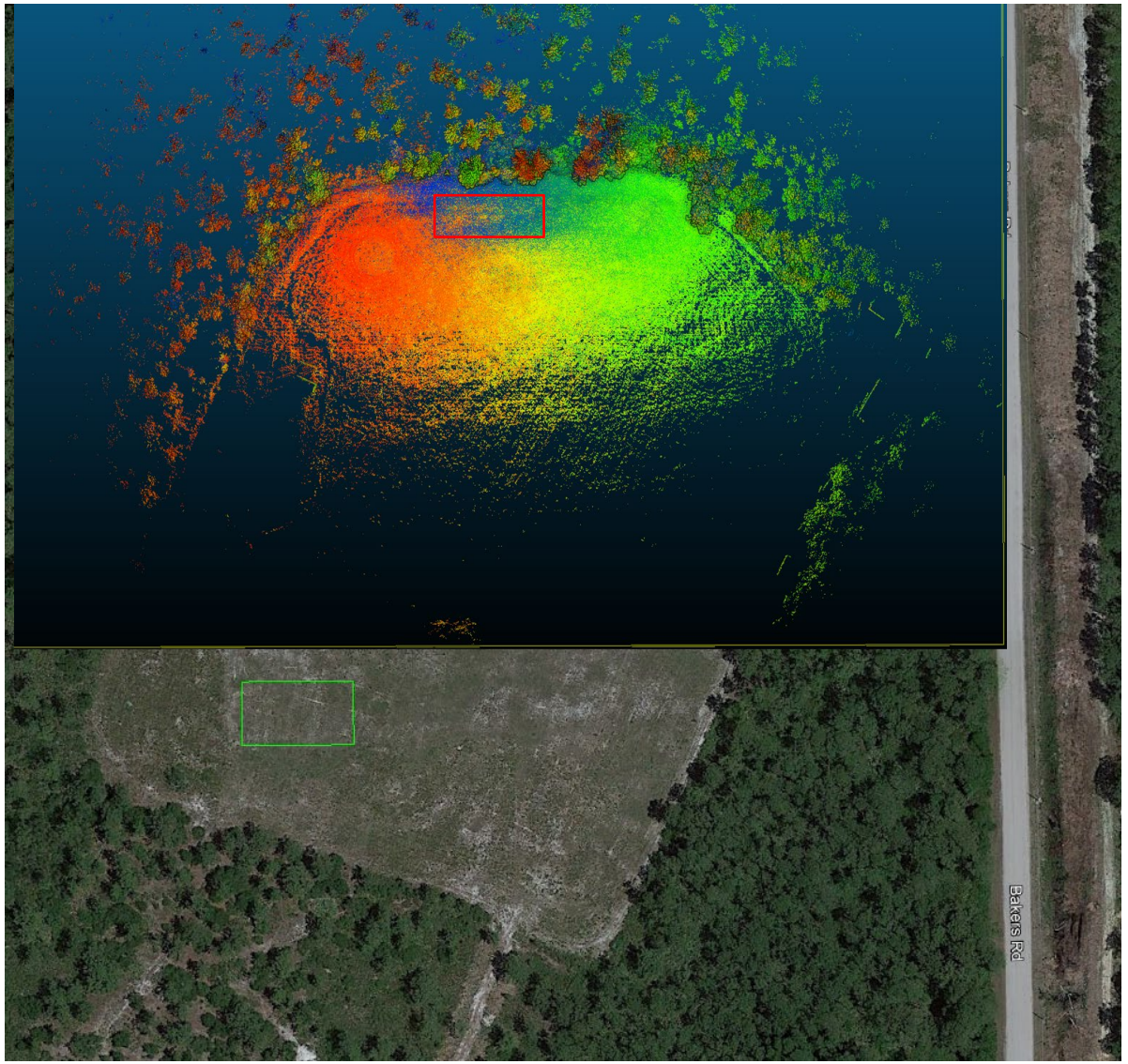
  - IVS1 (green) was too far (~35m) from the tree line on foggy mornings
  - Set up IVS3 in north, closer to the tree line
– Both locations had a “void” in the point cloud.
  - For IVS3, this was to the south.
– This caused a bias in measurements towards the void as the Stencil tries to match the furthest blur in the point cloud to the closest blur in the scan

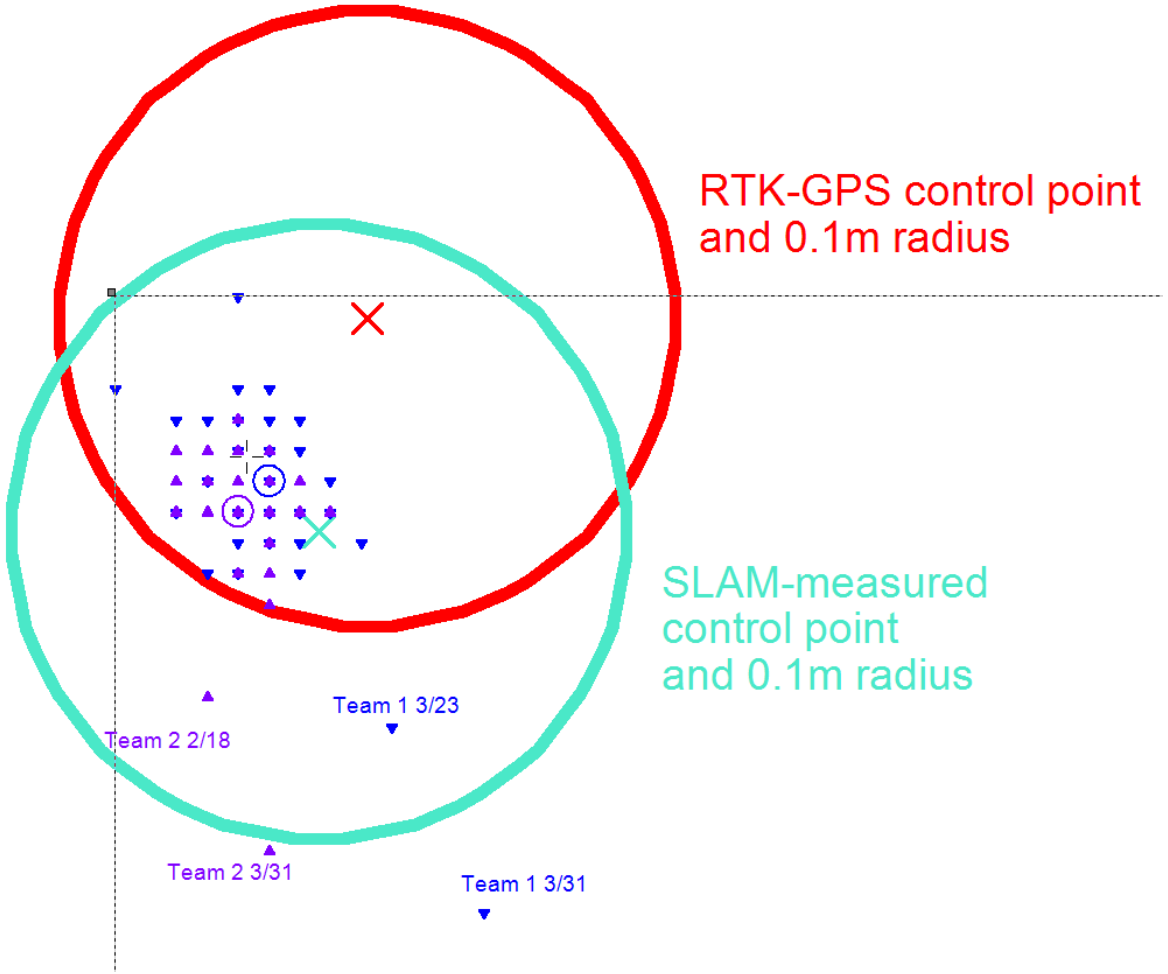


TREE LINE INTERFACE SLAM PROBLEM

Bias in the Stencil Data

– With a void to the south, our measured points were all biased towards the void at around 7cm.

– The bias was manageable until we experienced sustained winds at 35kph from the south on March 31st
  - Failures of 11 and 14cm for static Stencil measurements.
  - Failure of 28cm for an ISO at the IVS.
  - All offsets were towards the void.



TREE LINE INTERFACE SLAM PROBLEM

Bias in the Stencil Data

- According to Kaarta, under normal conditions at our IVS, measured points should cluster around 3cm (yellow points).
- On the high wind day of 3/31, points clustered around 10cm and were offset to the south.
- According to Kaarta, high winds in the production area, which is surrounded by 100's of trees, should not impact positional accuracy. The clustering may increase a little, but there shouldn't be a shift.
- Installed 2 additional IVS location in the production area for follow-on cueing.

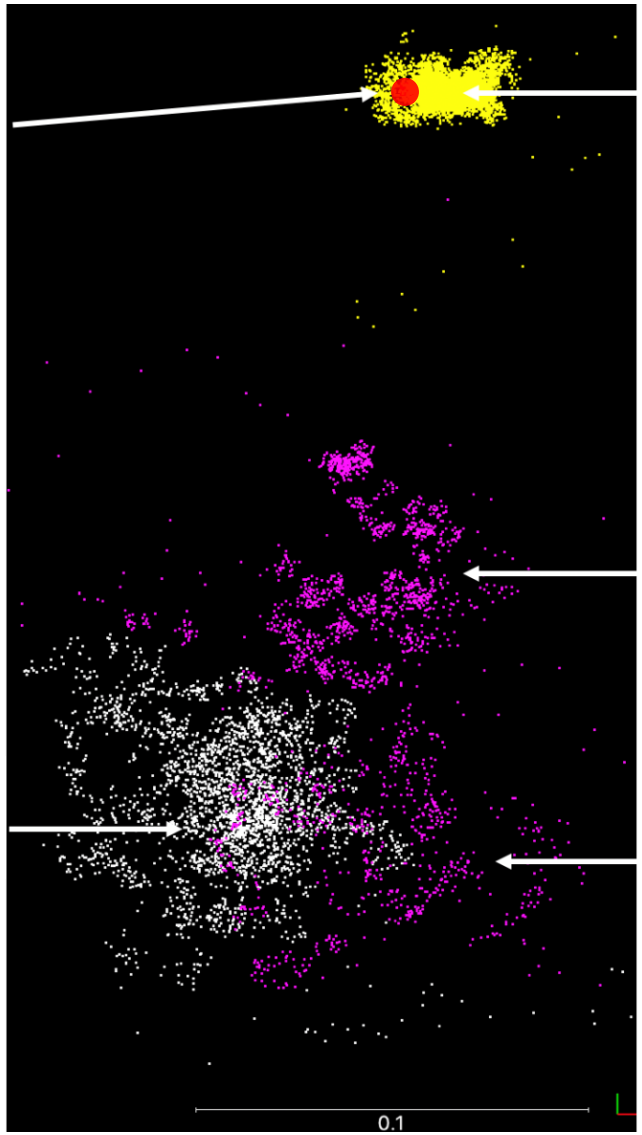
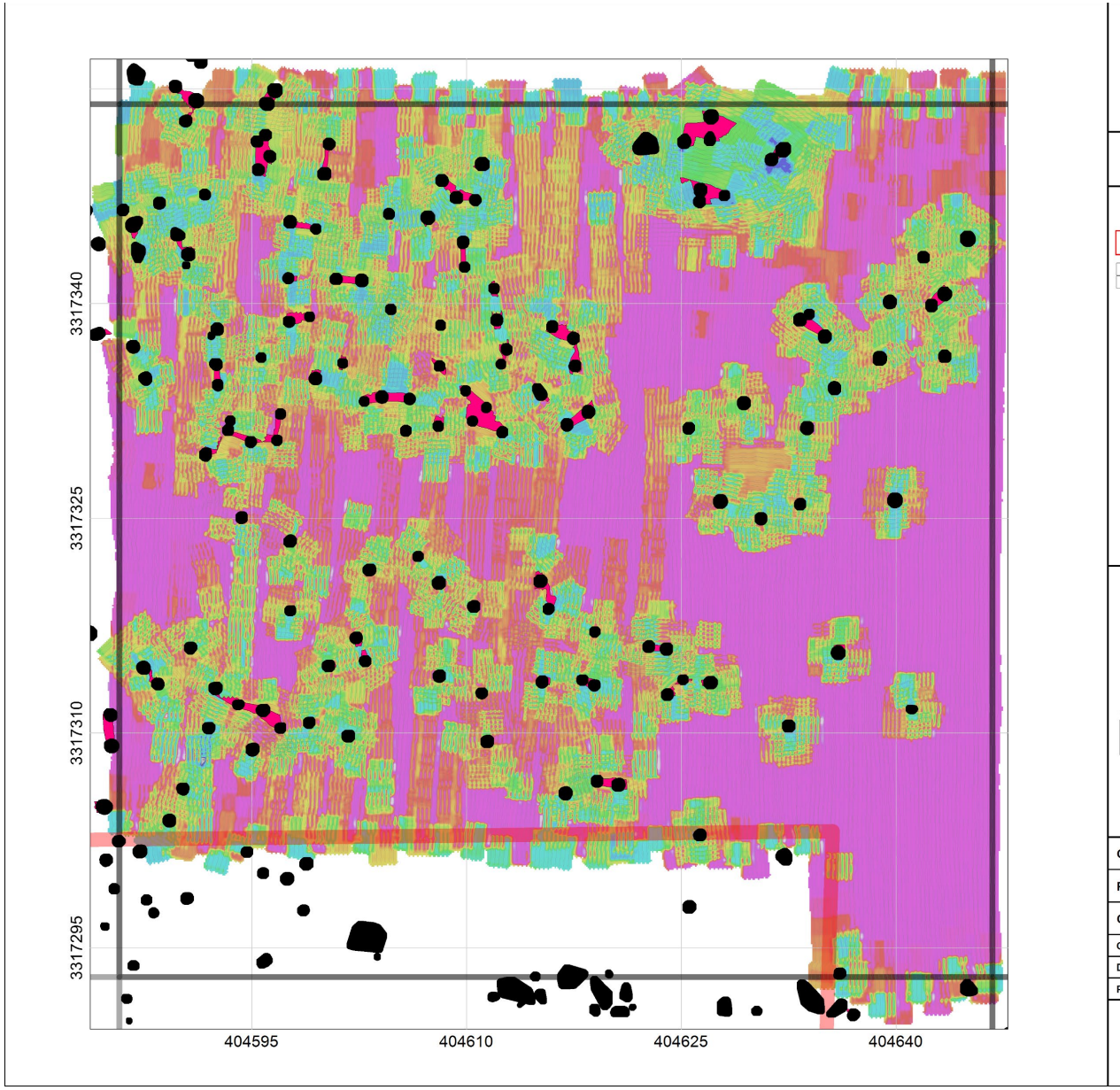


Figure courtesy of Kaarta

CONSIDERATIONS FOR SLAM DATA MQOs

Low Confidence on short survey lines

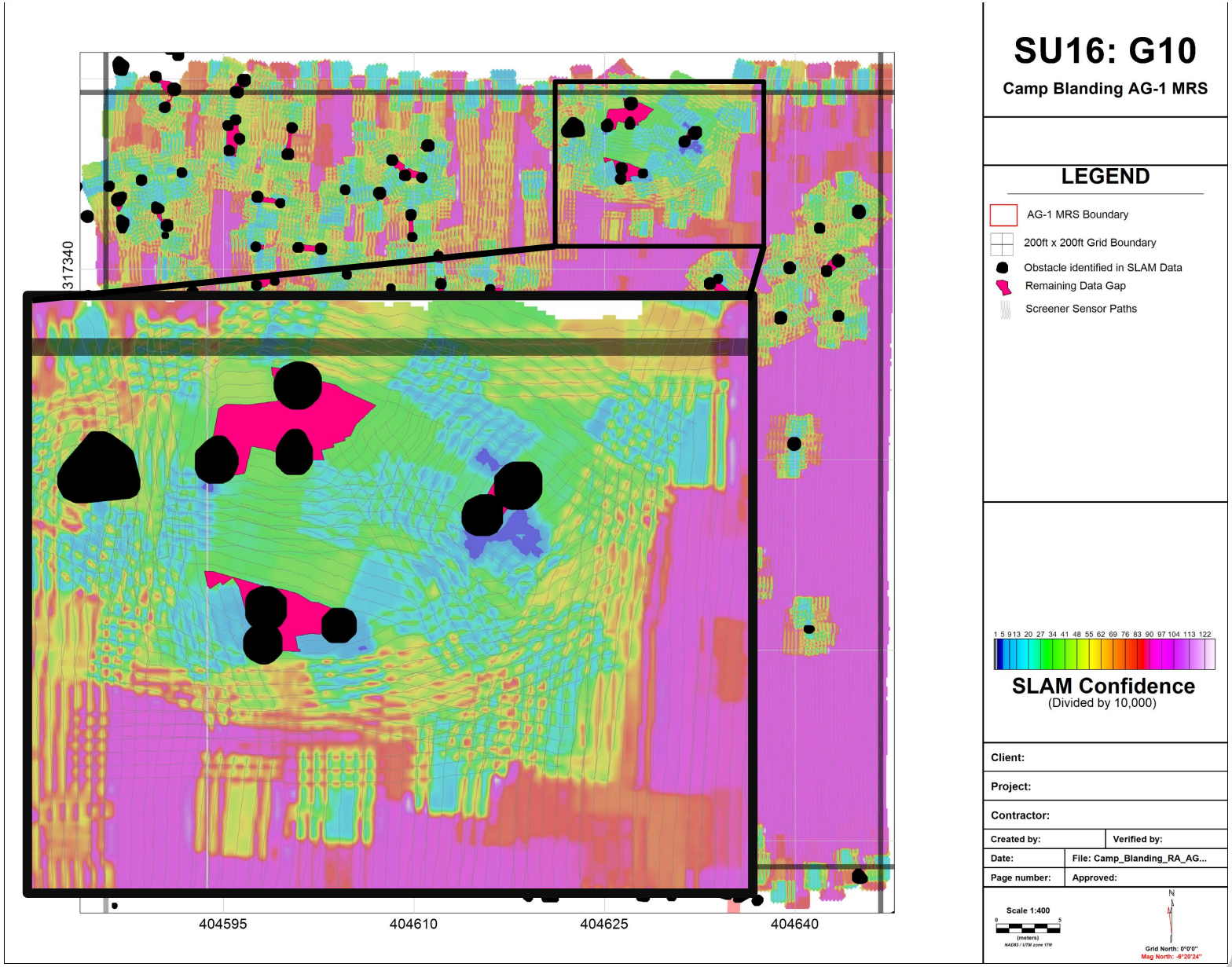
– Confidence drops when stationary and increases after moving for several meters



CONSIDERATIONS FOR SLAM DATA MQOs

Low Confidence on short survey lines

- Confidence drops when stationary and increases after moving for several meters
- Led to low confidence values during data gap collection around obstacles
- Draft Final MR-QAPP Module 2 Confidence MQO >5.



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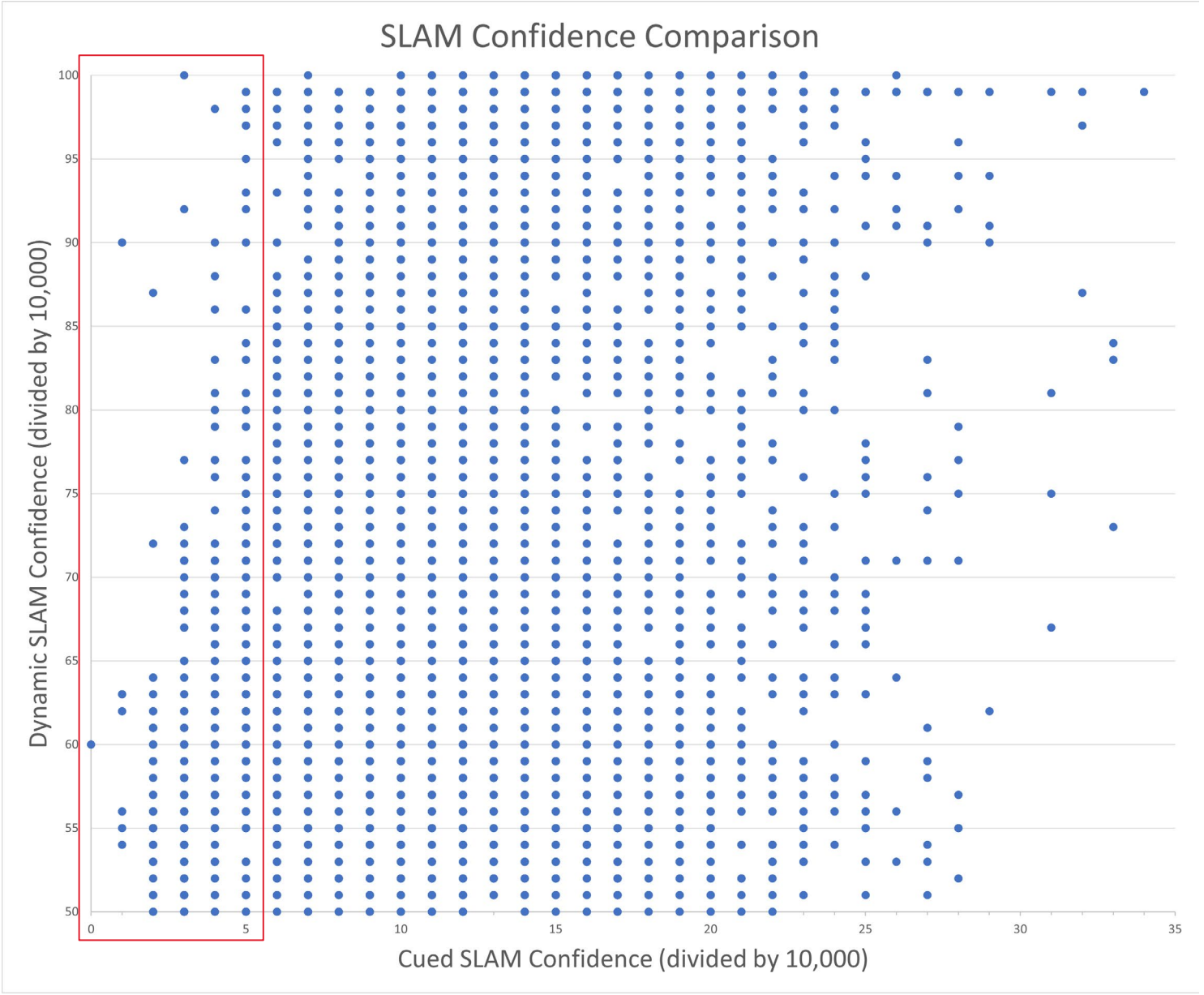
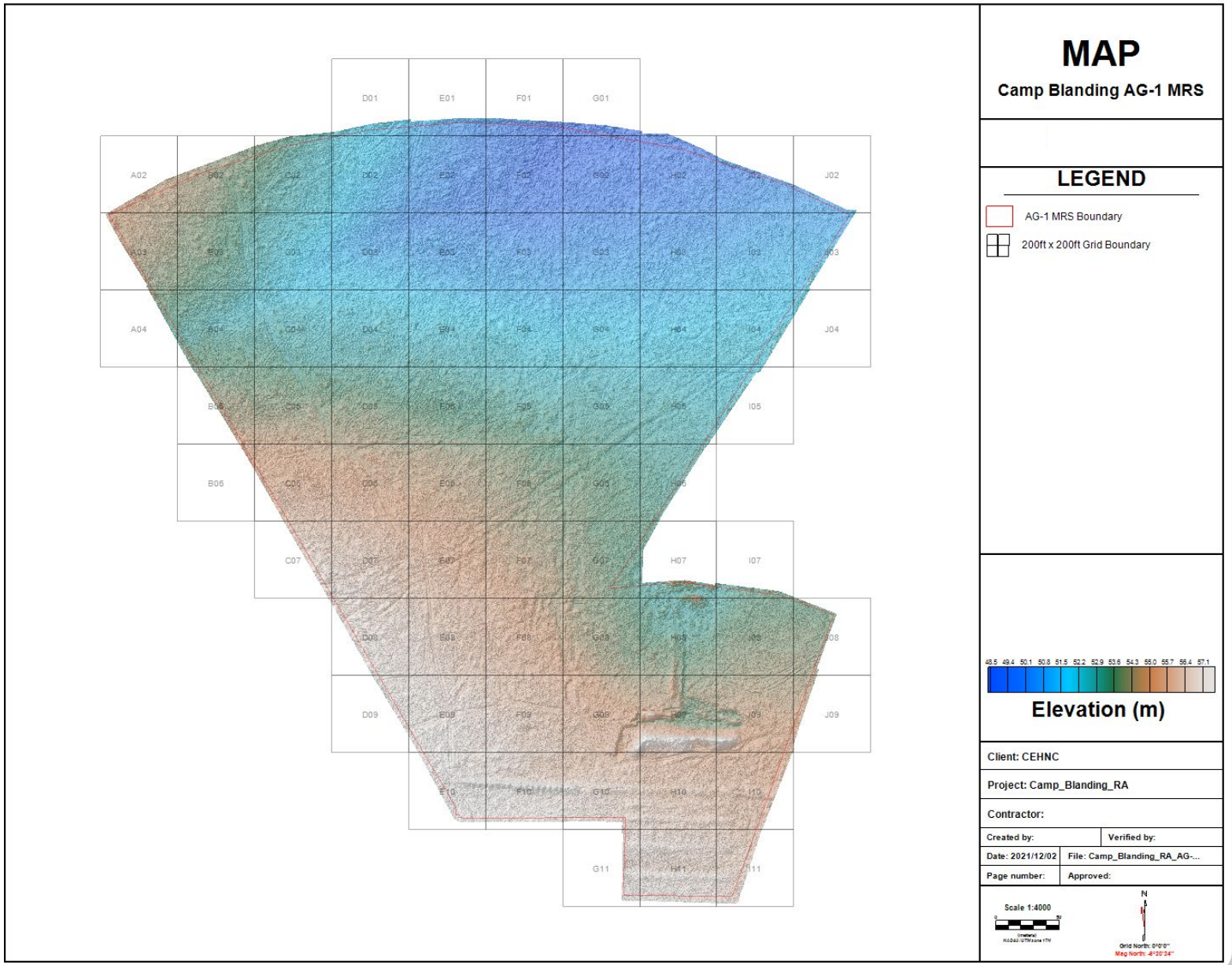
Even Lower Confidence for Cued data

- >500 cued targets where confidence was below 5.



OTHER USES FOR SLAM DATA

- Digital elevation model
  - Using the Cloth Simulation Filter plugin in Cloud Compare
    - This process is used to identify obstacles in the point cloud.
    - A by product of this process is a ground level layer.
  - Quickly identify site features
    - Easy identification of berms, trenches and ruts
    - Also identified several smaller berms that were not obvious in the far southeastern portion of the site.
    - Helpful in picking “smooth” locations for IVSs and background locations
    - Could clearly demonstrate to PDT the areas where we had consistent issues with flooding.



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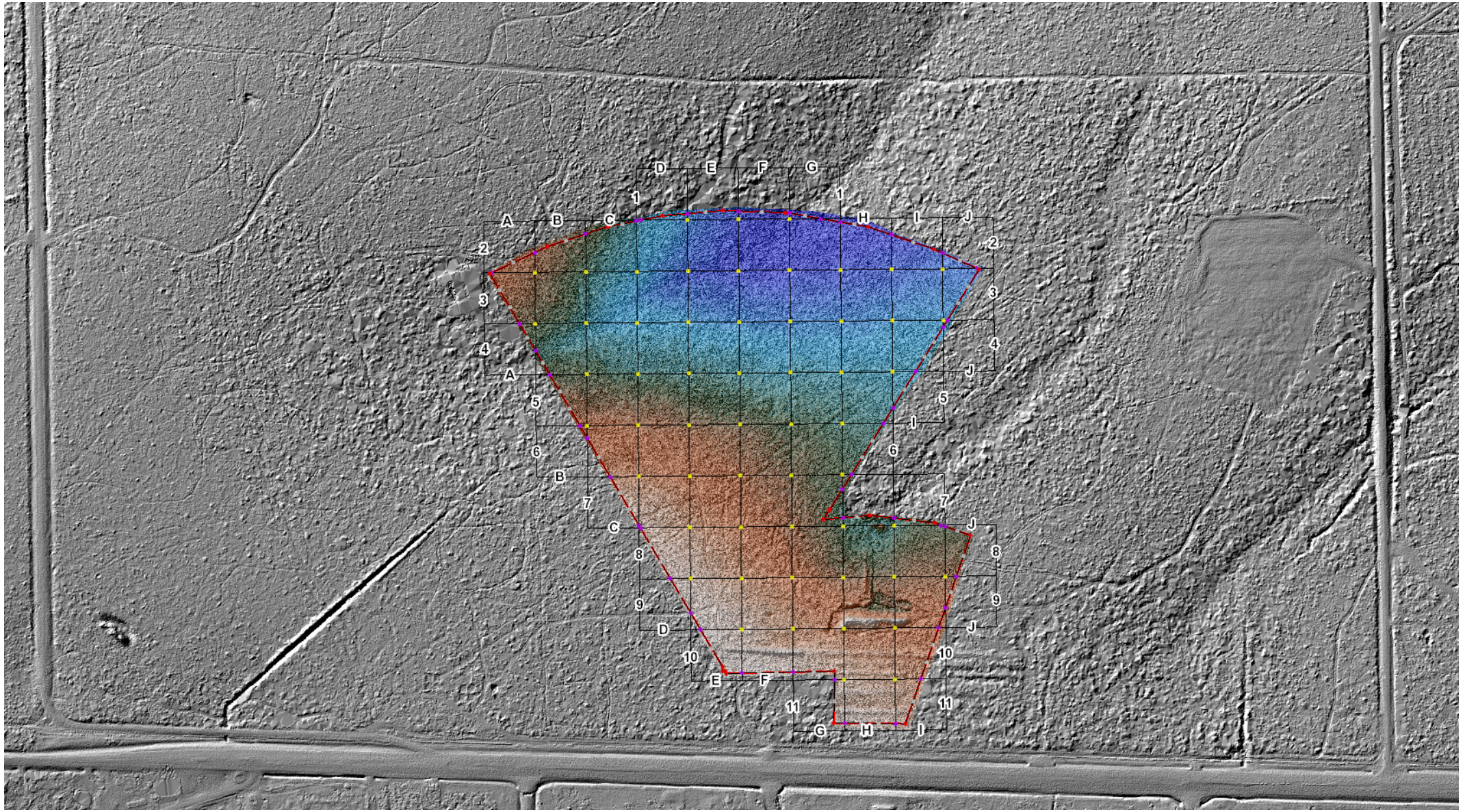

QUESTIONS?