# Electrical Resistivity Imaging (ERI) of a DNAPL Site: What Happens When Results Don't Equal Success?

**Group 2**

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## Background & Approach

Former Naval Ordnance Plant with a partially delineated trichloroethylene (TCE) plume in a sandy surficial aquifer and absorbed into the underlying clay confining unit. Ordnance manufacturing and metal plating were conducted at the site. Explosives blending (former) and on-site storm drains lie within the area of interest (red square, Fig. 1). Currently operates as an industrial park.

- **Some site characterization** has been performed via monitoring wells and soil borings,
- Main **source area** is near a historic wastewater sewer outfall at the western edge of the site,
- **DNAPL** found near the base of the previous depth of investigation,
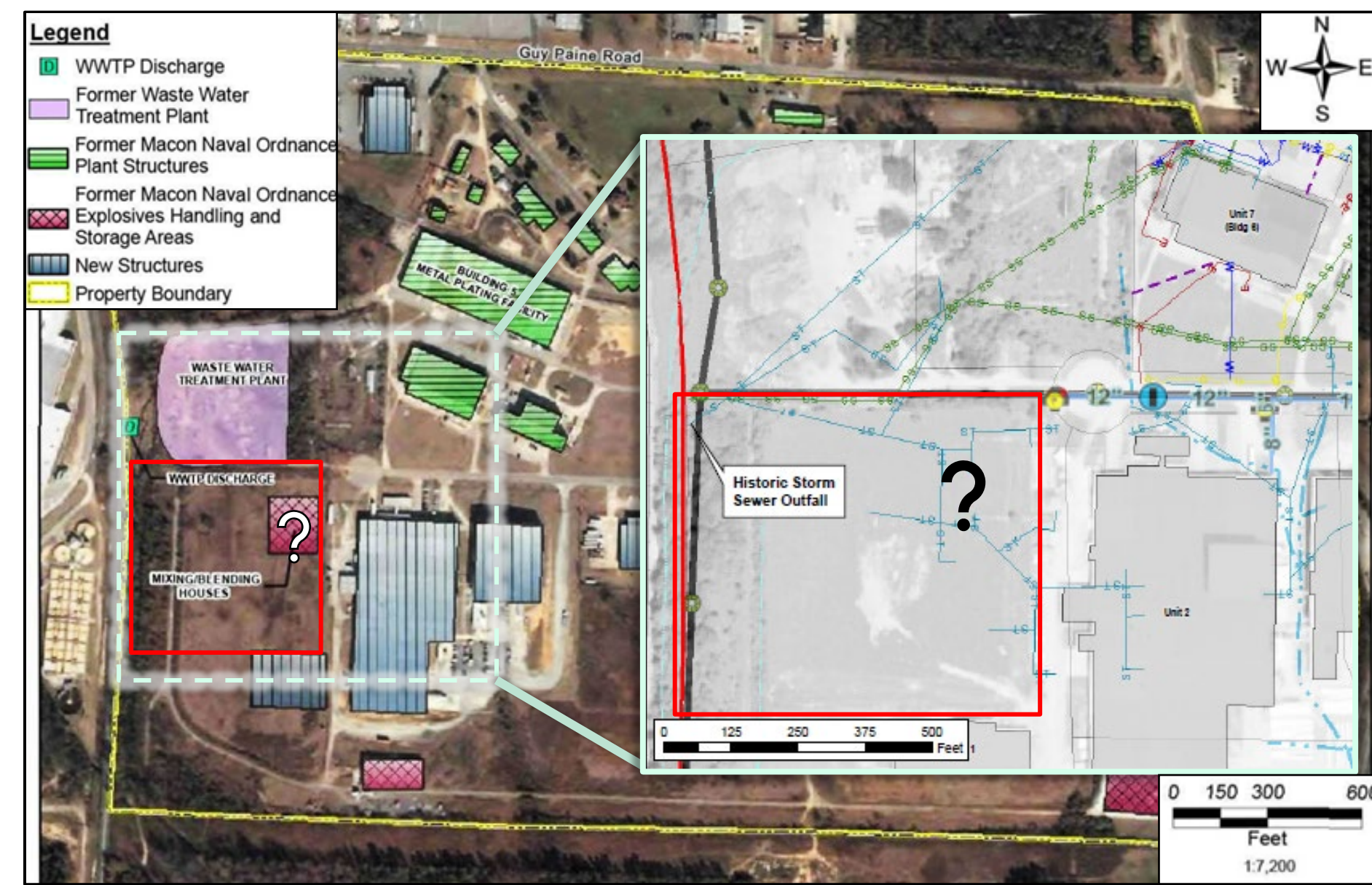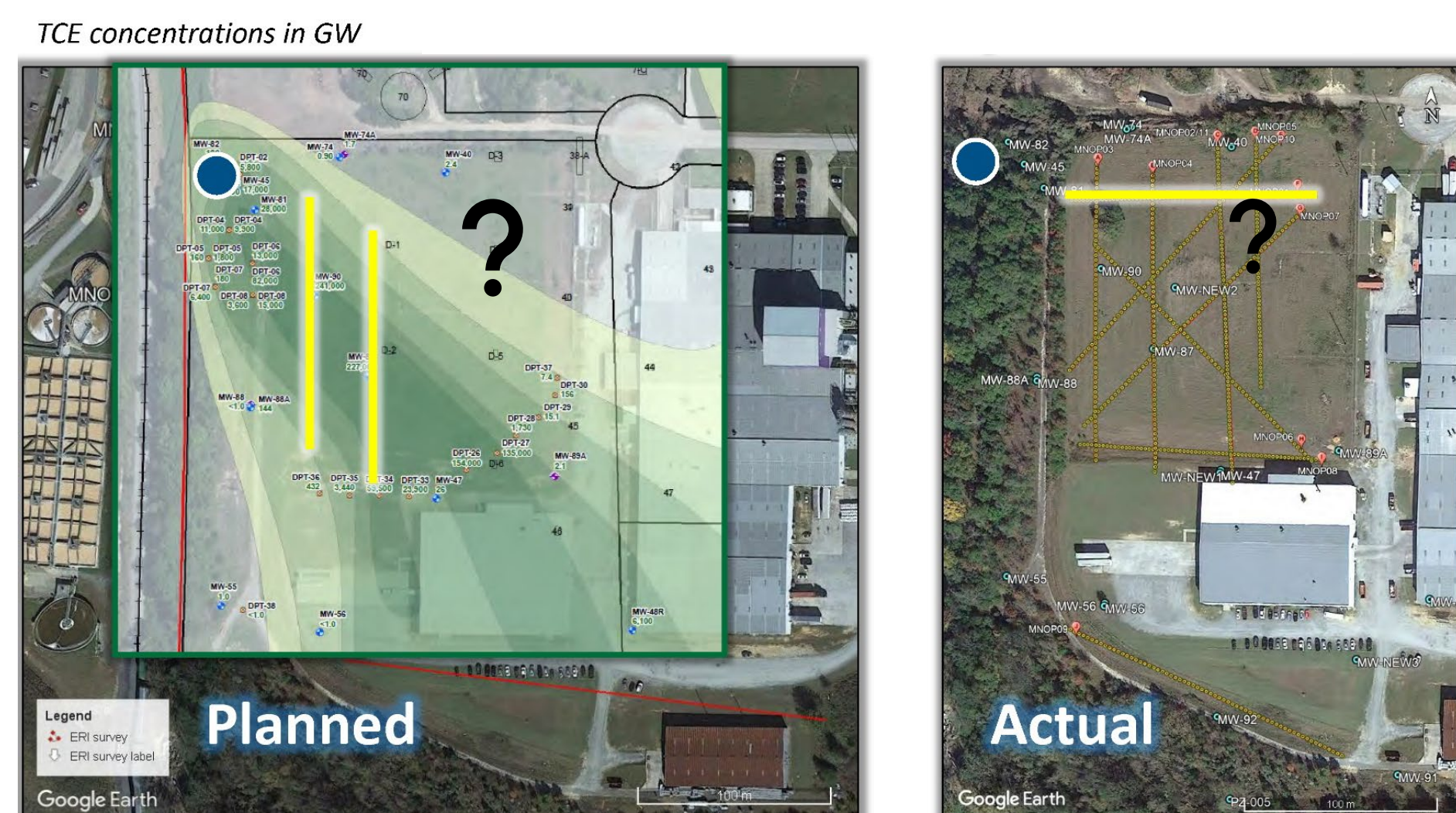- Groundwater concentrations indicative of **NAPL found at center of the area of interest**,
  - **Vertical and horizontal extent** into and across the clay confining unit was unknown,
  - Geology consists of **stacked sand and clay beds** gentling sloping to the S-SE,
  - **Confining clay** = ~50ft below ground surface (bgs).
  - **Depth to water** (DTW) = ~36ft bgs.

Objective was to perform ERI surveys, providing thousands of data points in 2D space, and cross reference the results with previous high res. lithological and chemical analysis of soil cores and groundwater. ERI survey verification by drilling, logging, and analytical analysis of soils and water.

Goal of the effort was to expand footprint of previous investgation with non-invasive geophysics.



Figure 1: Property layout (above)

TCE concentrations in GW


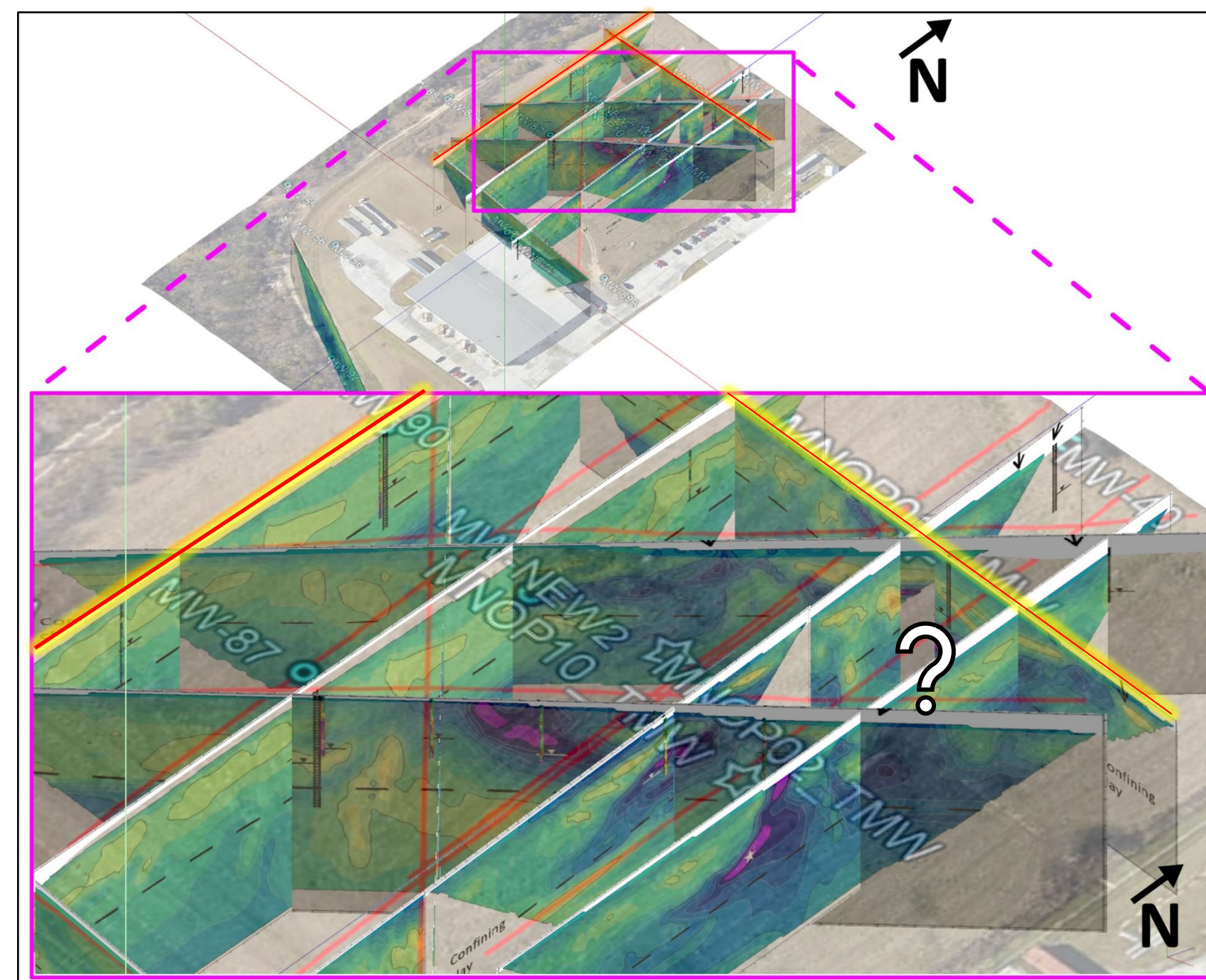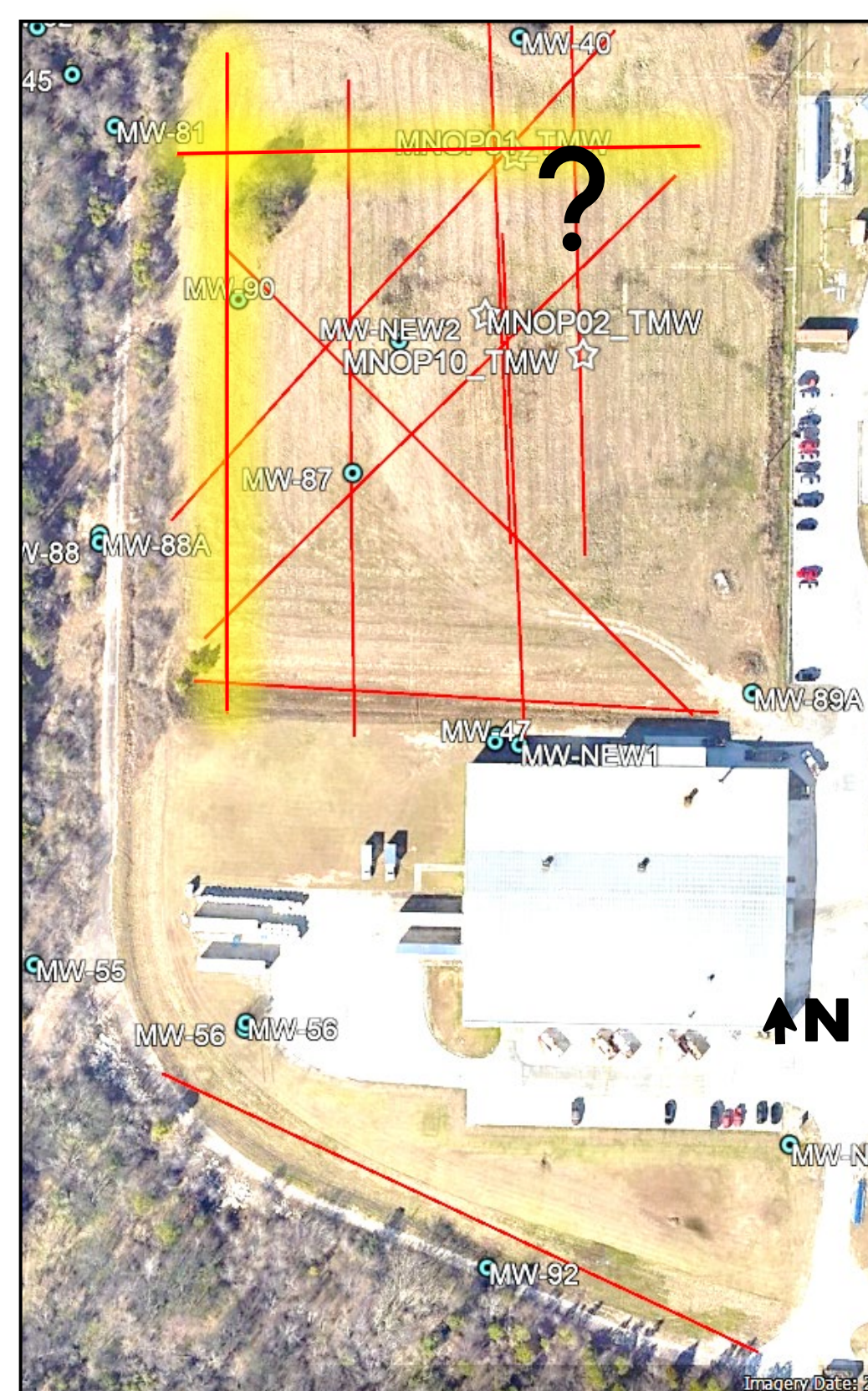
Figure 2: Approach (below)

Planned

Actual

## Results



Fig.4: survey layout aerial (below)

Fig.3: pseudo-3D (above)

Fig.5: PID aerial (below)





*Fig.6: Survey MNOP03 (top)* *Fig.7: Survey MNOP01 (bottom)*



Distance (meters)

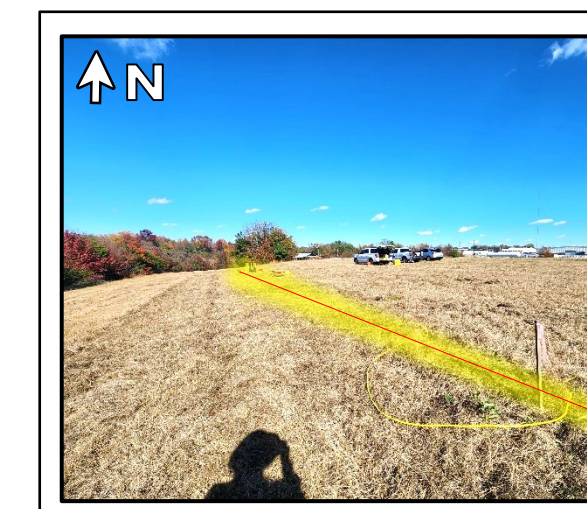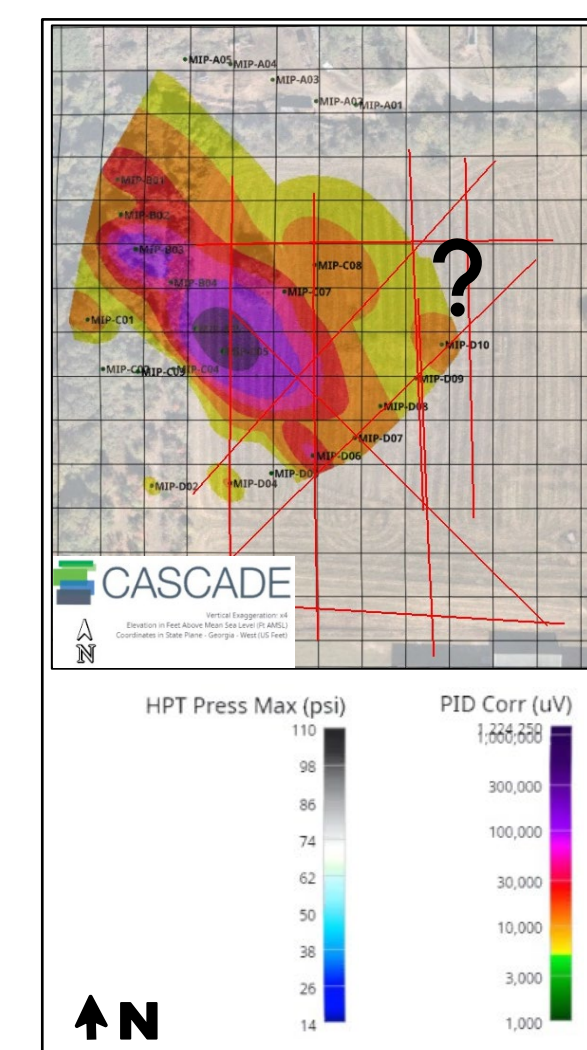A) Resistivity ($Log_{10}$(ohm-m)/m)   B) Resistivity (ohm-m/m)



Distance (meters)

Fig.8: MNOP03 (left; view N)

Fig.9: MNOP05 (mid; view NE)

Fig.10: MNOP01 (right; view E)



## Discussion & What Happened?

What did we see?
- Electrical anomaly amongst background signatures indicative of native geology
- Coarse material overlying fine material
- Water table found where expected
- **Nothing where we know DNAPL exists**

What did verification drilling reveal?
- Very sandy formations; very plastic clay lenses
- Heaving sands; produced sufficient water given limited screen and development
- No PID response, only the bottom 5-ft of MNOP02_TMW was positive; **No DNAPL**
- Only detections in analytical samples was at 30-40 ft bgs
  - TCE < 29 ug/kg in soil, <45 ul/L in GW; both above MCL but only in one sample
  - Only other detection is Cis-1,2-DCE

What can cause extremely low resistivities (<10 ohm-m)?
- Microbial source? Did not sample. No evidence of biofouling at depth
- Metals? Previous efforts did not find metals as a credible COC, therefore did not sample.

## Lessons Learned

- Importance: this is research and ERI is a tool that requires validation
  - **We often operate in the unknown and must test theories using several tools (ERI is just one tool).**
  - **The level of effort involved here is the equivalent of dozens of DPT pushes but at depths greater than DPT could reach and can reduce several monitoring wells to only a few (less poke and hope).**
- While in field, double check amount of erroneous data, location of data, and identify correlations.
  - **Temperature, moisture, lithology, electrode shape and contact with soil, and power source all vary and can introduce error;** poor performance from generator introduced significant error in a couple surveys (did not drill targets along those surveys)
  - **If ~40% of your data points are erroneous, the survey may be unusable.**
  - Are the erroneous data clustered? At depth? At the surface? Some surface errors can be explainable and clustered errors can more easily be removed
  - Reciprocal measurements (vs repeated measurements) can identify potential errors
- Data processing step can tell you a lot.
  - MNOP05 showed bad contact resistance which resulted in erroneous electrodes from 53-64 (remaining 85 ft end of the survey); after erroneous data are removed and reprocessed, highly resistive and highly conductive signatures disappear – totally different image.
- Sample for microbes
  - Microbes are increasingly part of the discussion and considered for ultimate solution.

## Acknowledgements & References

Environmental Resource Management. 2021. *Site Characterization Summary Report*. Macon Naval Ordnance Plant Superfund Site Docket No-CERCLA-04-2018-3760.