SOIL CONTAMINATION SAMPLING INTENSITY: DETERMINING ACCURACY AND CONFIDENCE USING A MONTE CARLO SIMULATION

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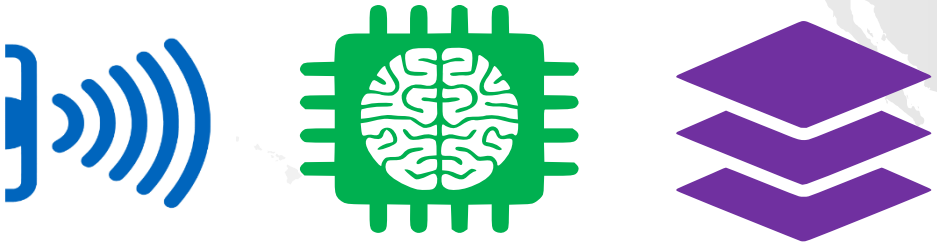

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INTRODUCTION

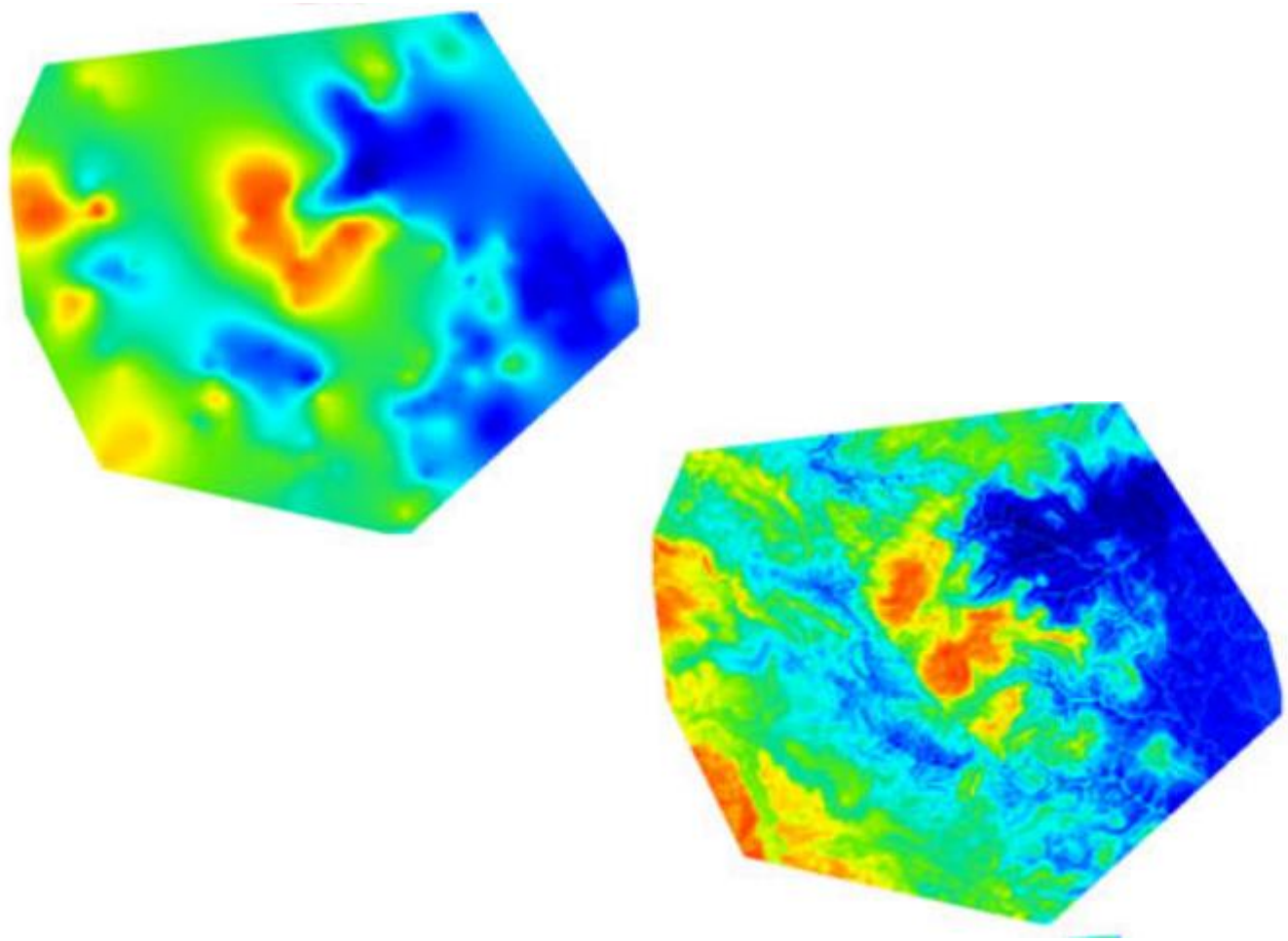
Table 1 Failure Rate of AESRD Surface and Contamination Audits (GoA, 2010)

Alberta Environment/SRD Surface Audits	2003 to 2011	9%
Alberta Environment/SRD Contamination Audits	2003 to 2011	28%

Source: Polet M., Powter, C. 2012. Phase II Assessments and Phase III Remediation: A Brief History. RemTech Presentation.

METHODS

- Monte Carlo Simulation
  - Run thousands of simulations to estimate error with different sampling intensities
- Randomly generate a contaminate plume using spatial interpolation
  - IDW
  - Kriging
  - Machine learning with a Euclidean Distance Matrix
- Map the plume with machine learning model (Behrens et al. 2018)
- 9 sampling grid intensities ranging from 10% to 50% of the max distance
- 90,000 simulations run in total



Behrens, T., Schmidt, K., Viscarra Rossel, R. A., Gries, P., Scholten, T., and MacMillan, R. A. 2018. Spatial modelling with Euclidean distance fields and machine learning. Eur. J. Soil Sci. **69**: 757–770. doi:10.1111/ejss.12687.

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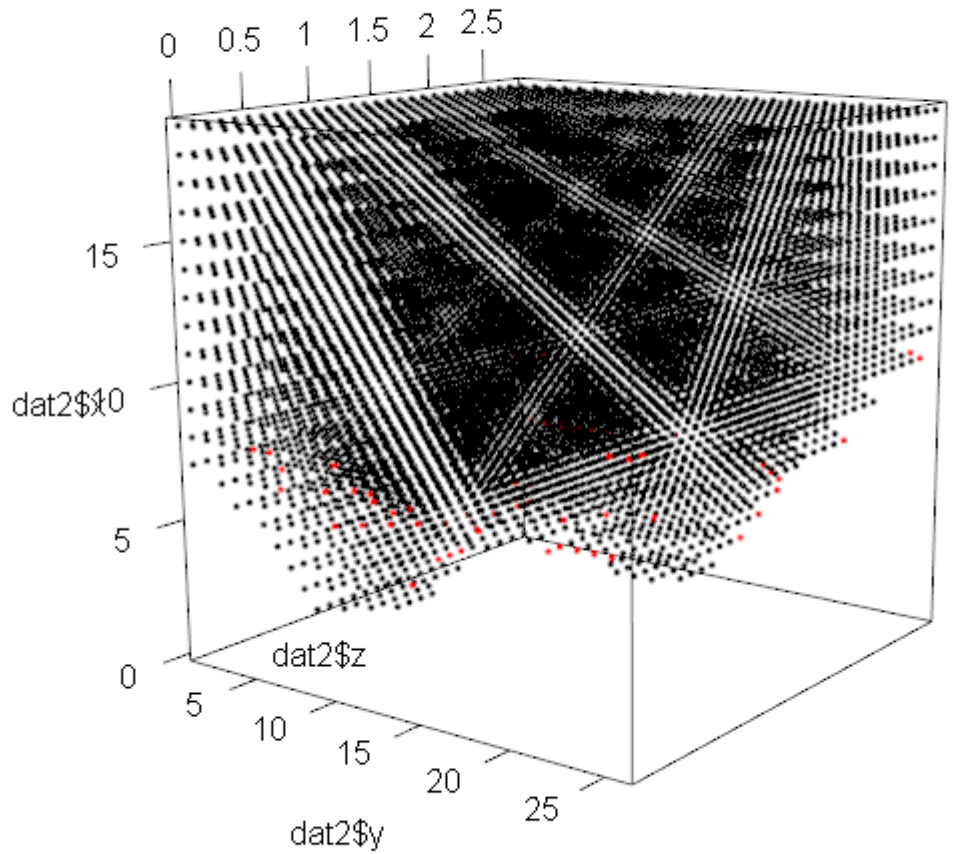
RESULTS



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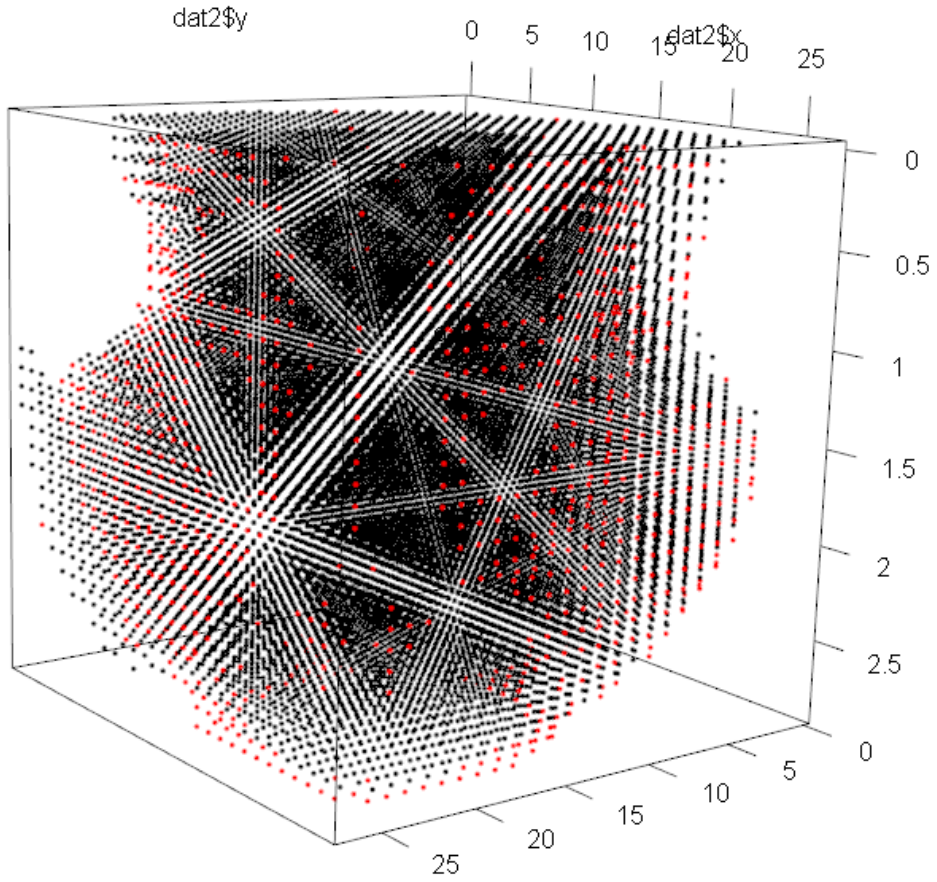
RESULTS



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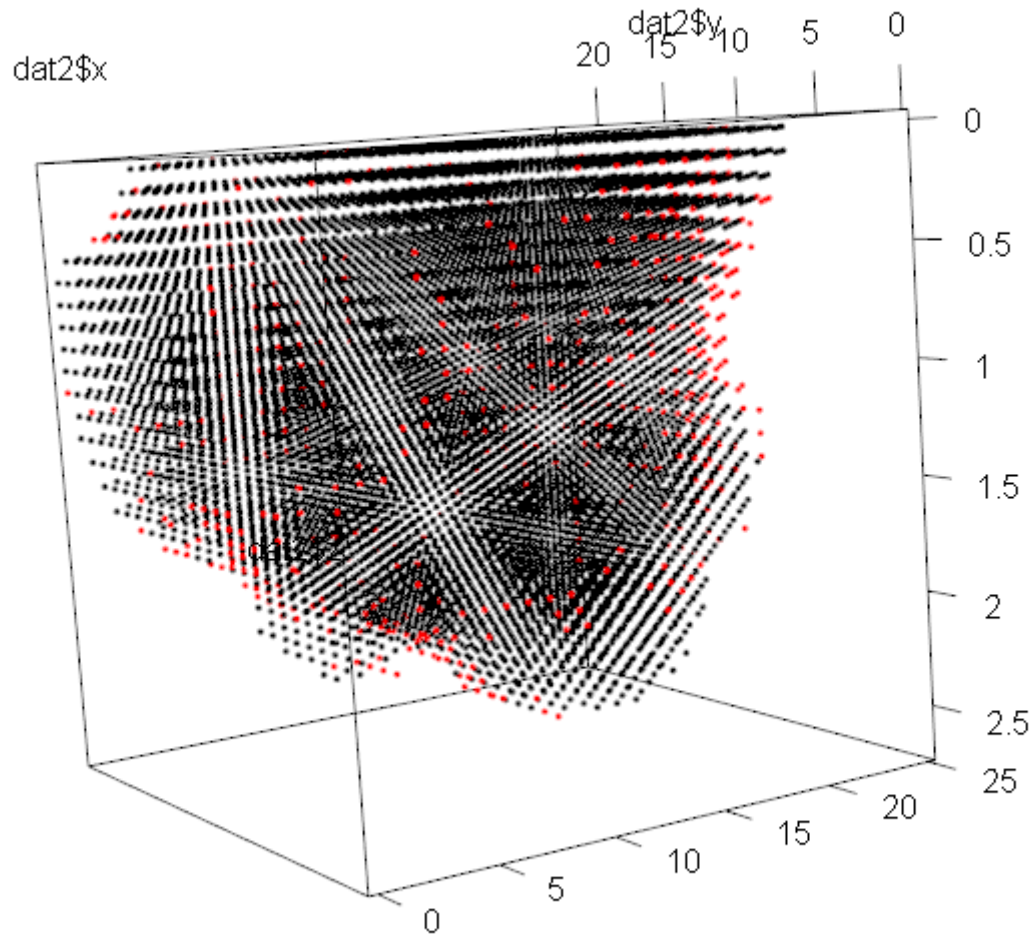

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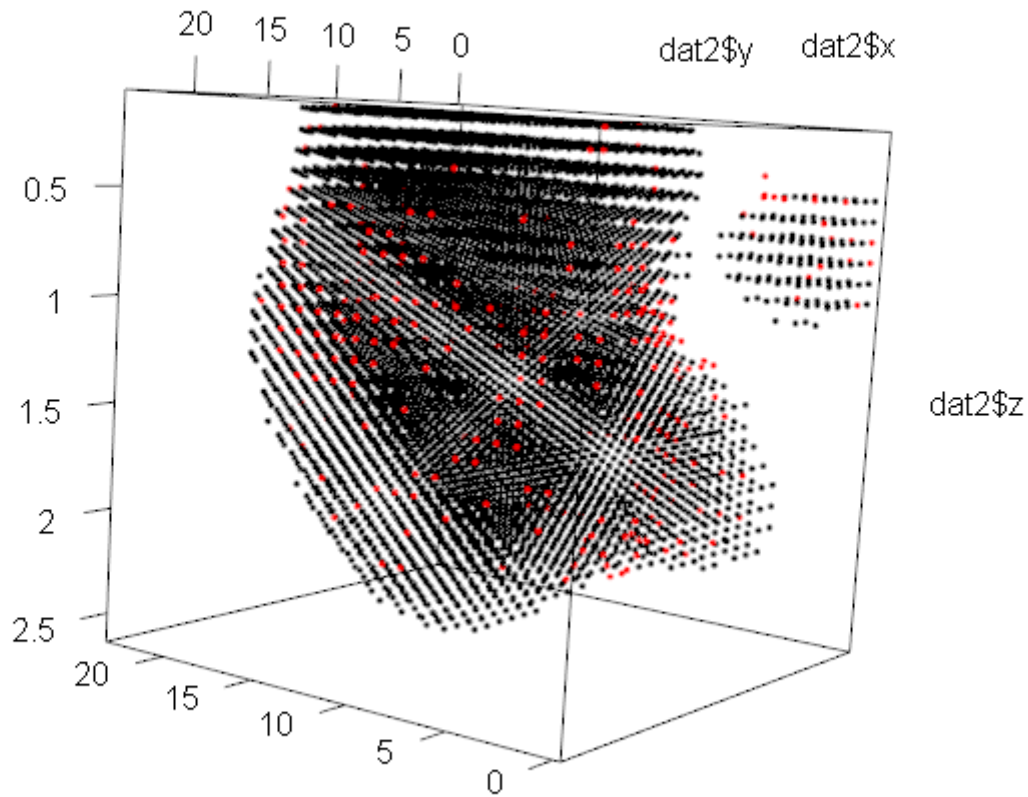

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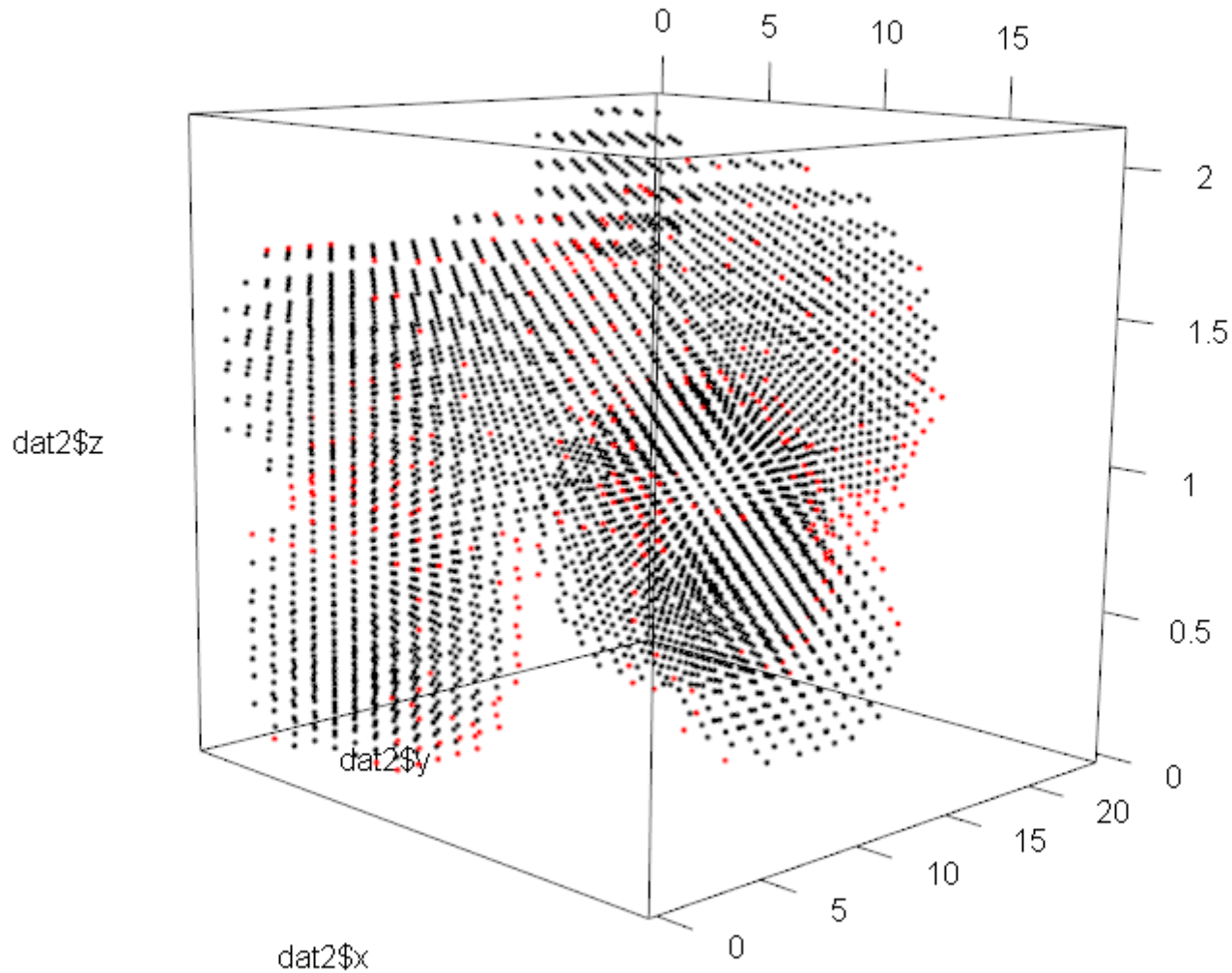

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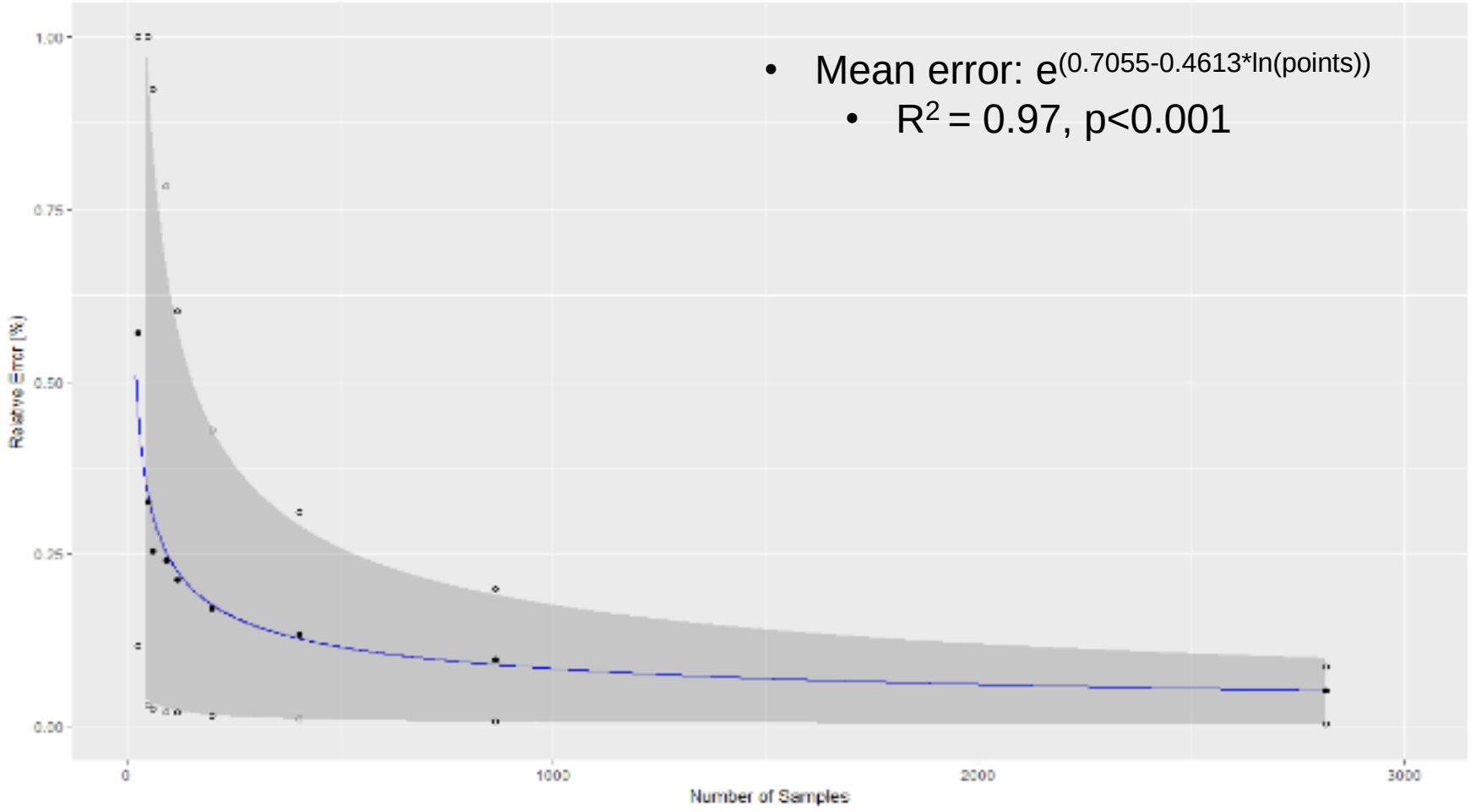
RESULTS



- Mean error: $e^{(0.7055-0.4613*\ln(points))}$
  - $R^2 = 0.97$, $p<0.001$

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RESULTS

- How can we use these results to determine how many data points to collect?
  - Mean error: $e^{(0.7055-0.4613*\ln(points))}$
    - $R^2 = 0.97$, $p<0.001$
  - Remediation cost of \$120 per m^3
    - 2014-2017 OWA Average
  - Conventional laboratory analytical costs
    - \$50, \$75, \$100
  - Quantitative field data with reflectance spectroscopy
    - \$5, \$7.50, \$10

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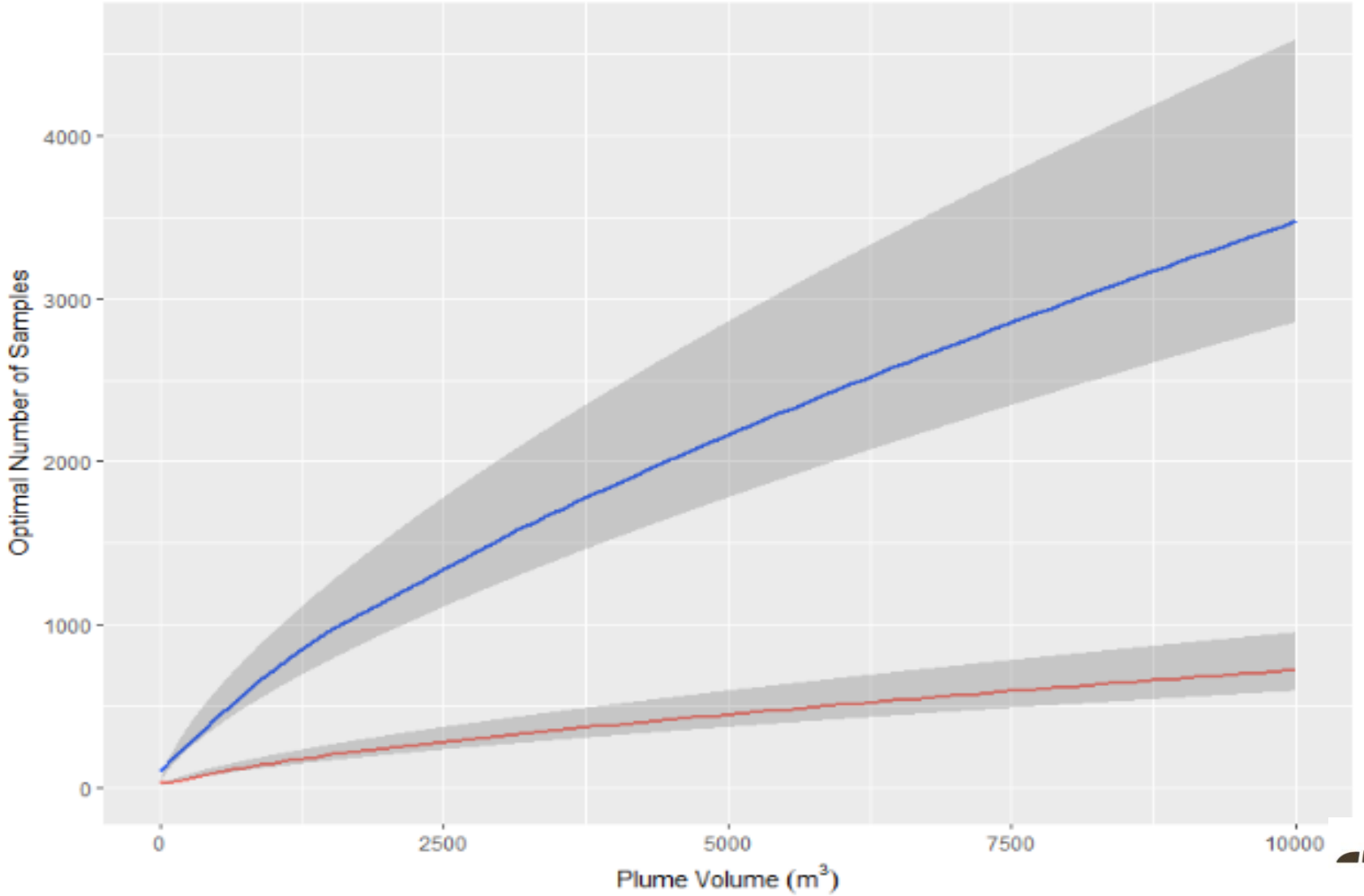
RESULTS



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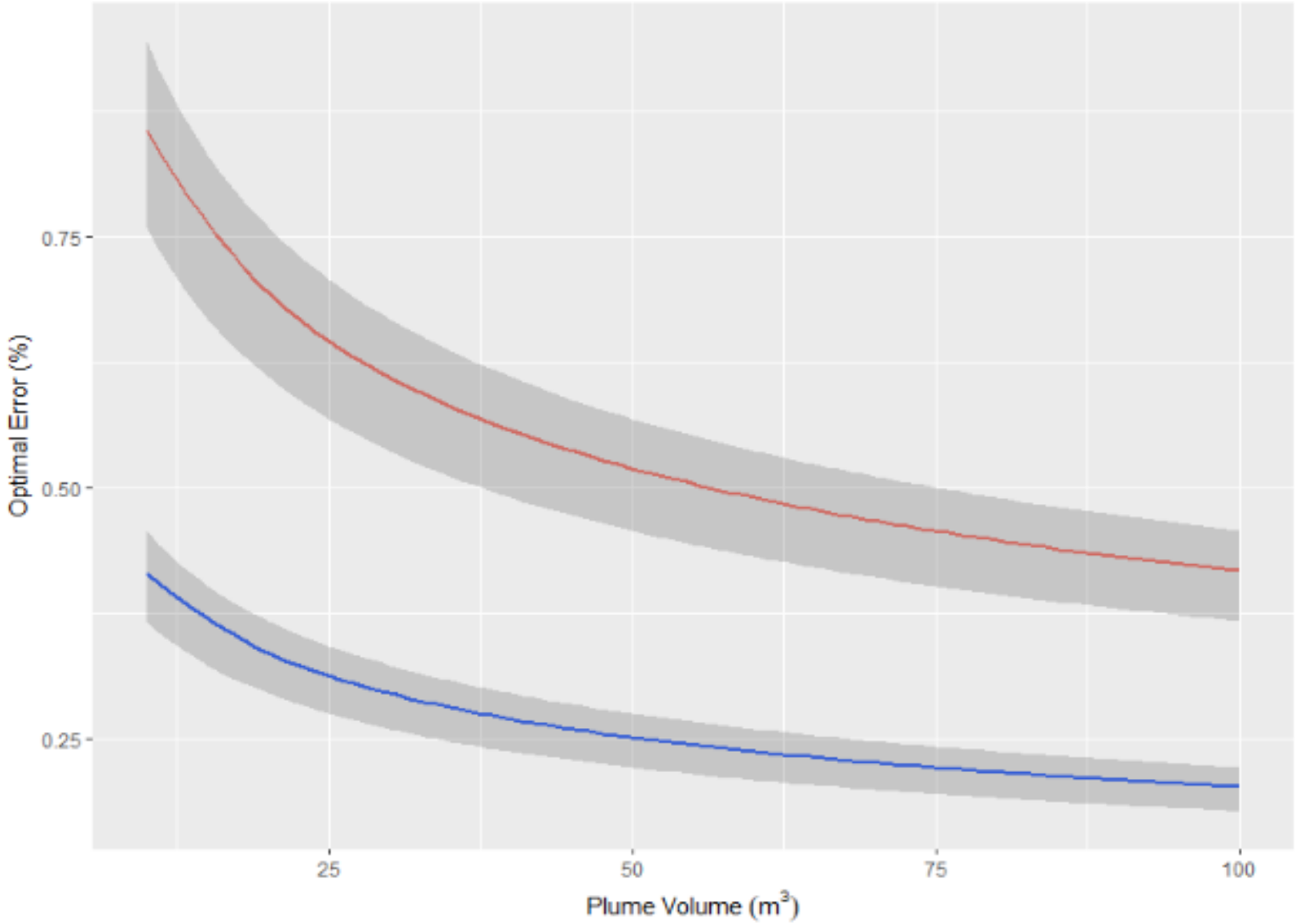

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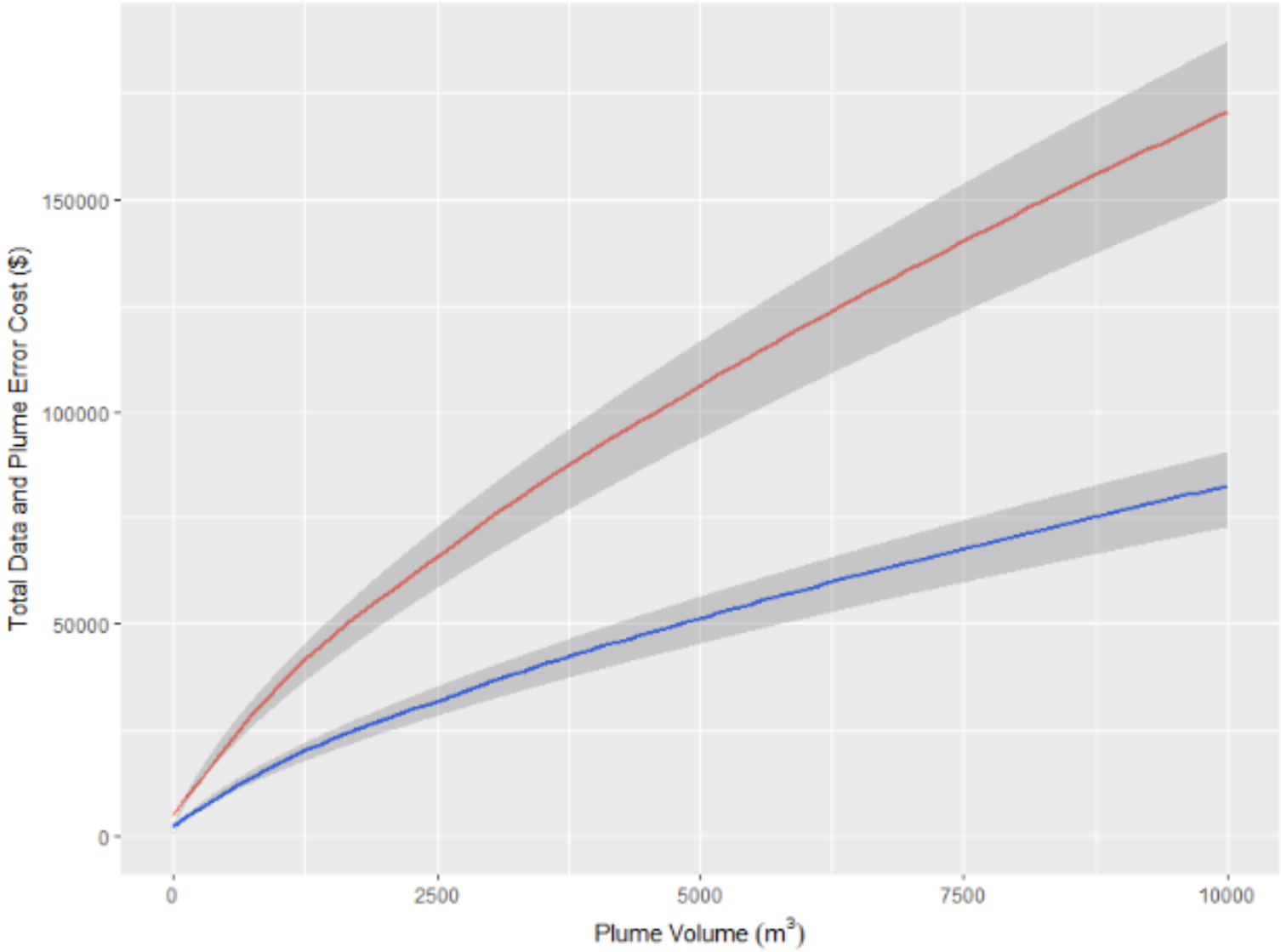
RESULTS



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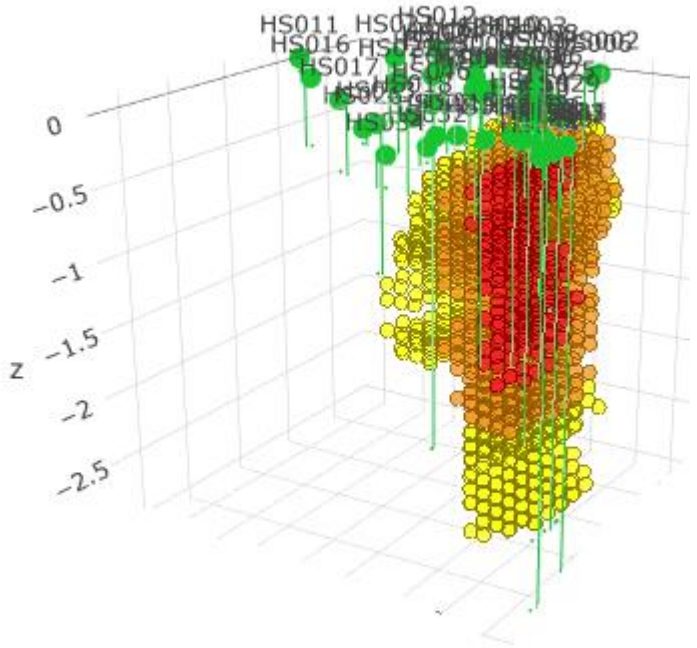
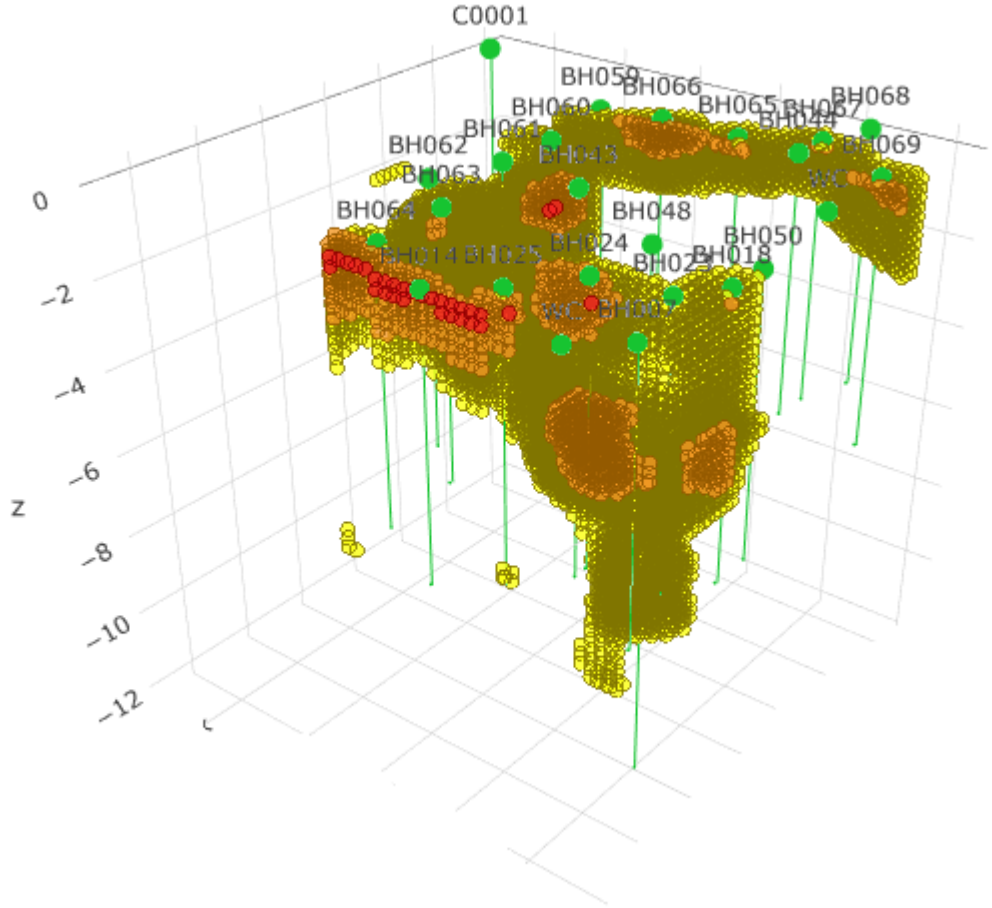
APPLICATION

FEASIBILITY

- Excavation
  - 100 m^3
  - 50 data points

- Phase II ESA
  - 34 three meter boreholes
  - 500 data points
  - 2 days of field work
  - Area – 0.3 ha





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CONCLUSION

- The collection of less than 25 samples for plume characterization leads to low confidence in accurate plume characterization
  - 90th percentile error of 100% observed in this simulation.

- Without *a priori* knowledge of the size and heterogeneity of the plume, professionals engaged in characterizing contaminant plumes should anticipate the collection of hundreds of data points for accurate plume characterization.

- With the availability of lower cost sensor data for a range of soil contaminants, the collection of these volumes of data is now possible.

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QUESTIONS?

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