Malcolm Hughes

Advances in Subsurface Mapping

Presenter: Chris Rooney, MCInstCES

Agenda

1. Company Overview
2. RICS and TSA
3. NUAR & PUMA
4. PAS128:2022 Utility Mapping
5. GPR & Geophysical Surveys
1. Questions

MALCOLM HUGHES

Offices – England, Scotland & Wales

£8 + million turnover

Over 100 employees offering nationwide coverage

Chartered Land Surveyors

Major projects including Mersey Gateway, Belfast Transport Hub, and Piccadilly Circus.

Part of the Ogilvie Group

Operational throughout UK and beyond


MALCOLM
HUGHES

RICS and TSA Membership

Resources and help available:

- The Survey Association (TSA)
- The Royal Institution of Chartered Surveyors (RICS)
- *Surveys of Land, Buildings and Utility Services at Scales of 1:500 and larger – Client Specification Guidelines*
- The Chartered Institution of Civil Engineering Surveyors
- A professional Surveyor

MALCOLM HUGHES

THE SURVEY ASSOCIATION
FULL MEMBER

RICS®
Regulated by RICS

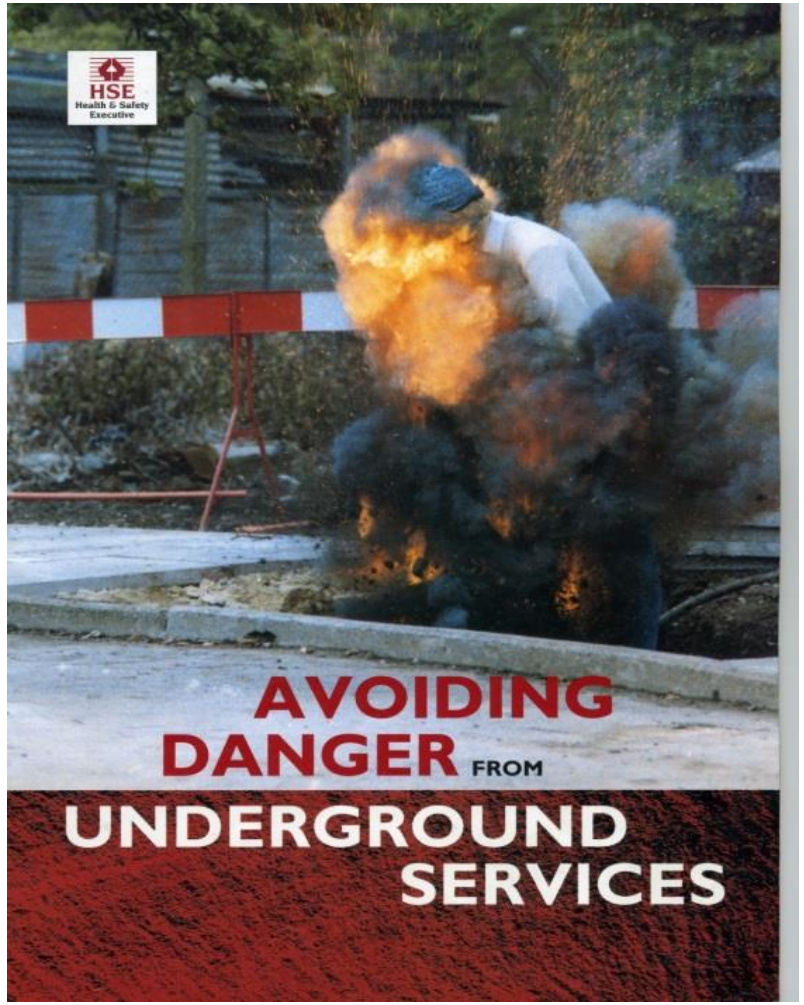
Underground Utility Surveys

Why located Buried pipes?

UK Requirements:

- Factory Act 1961 : S :176(1)
- CDM Regulation 2015
- Health and Safety at Work: S 2, 3 & 7
- Gas Safety Regulation 1972: Pt. II & VII
- Electricity Supply Regulation 1988 : R10
- New Roads and Streeworks Act
- Management of Health & Safety at Work Regulations (Reg 3)
- Pipeline Safety Regulations 1966

The HSE's Publication
HSG47 "Avoiding danger from Underground Services"



National Underground Asset Register

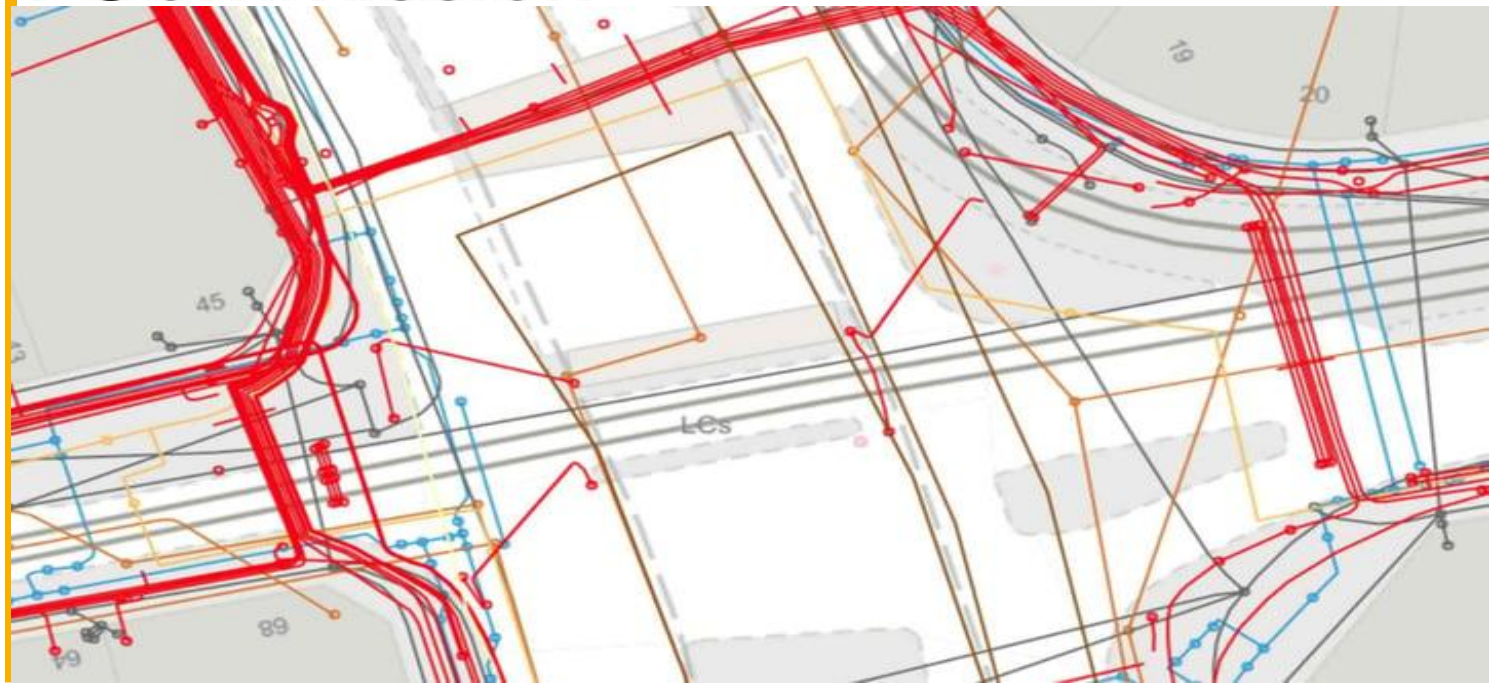
NUAR

www.nuar.uk

- 2019 Concept – 2025 Reality
- 650+ Asset Owners
- Hosted By O.S.

- Standardised Formats
- Secure Information
- Streamlined Process
- Support Improvements

Geospatial Commission



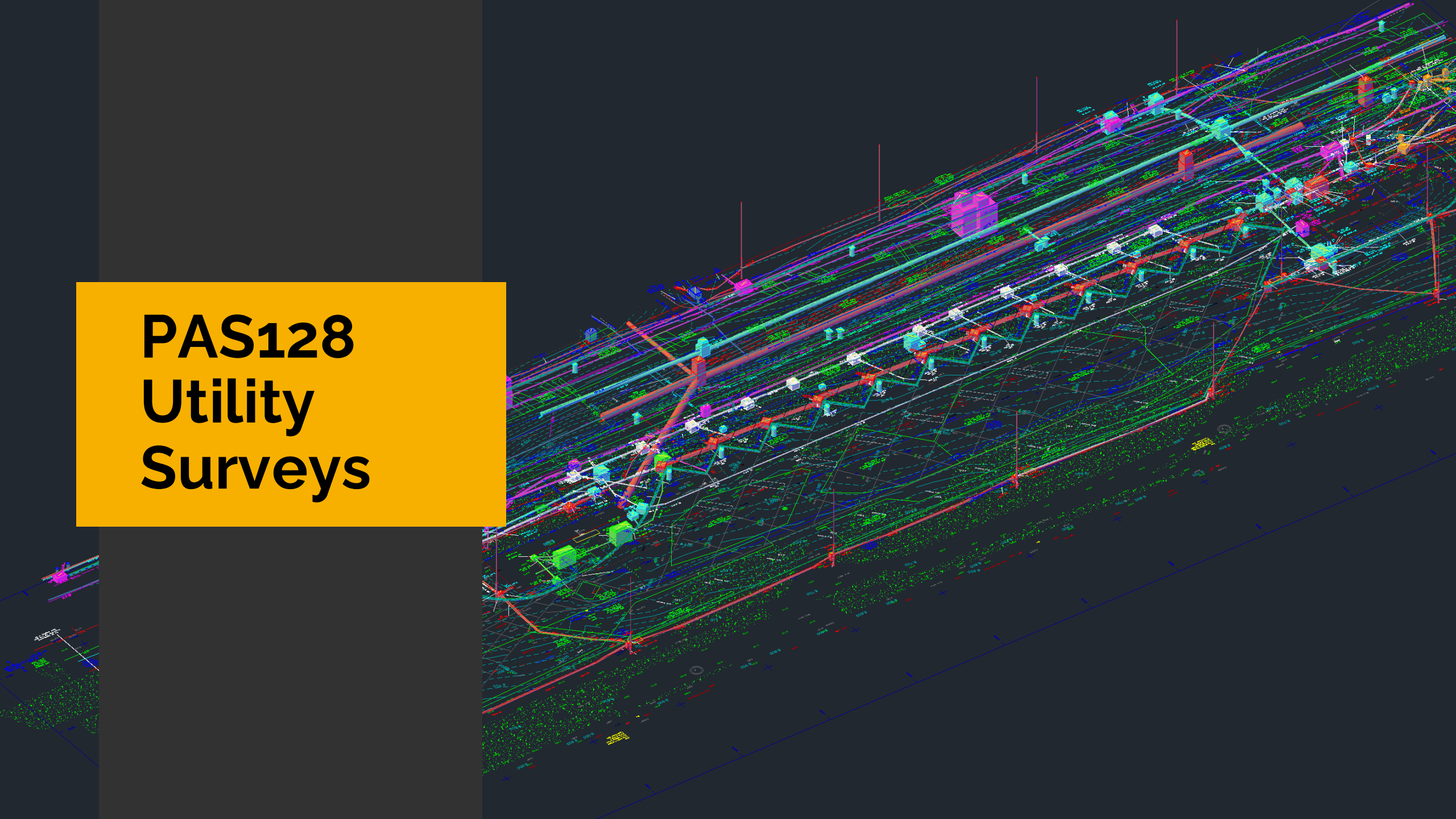
PAS128 Utility Mapping Accreditation

PUMA

www.tsa-uk.org.uk/puma

- Independently Audited – both field works and office works.
- Conformity to specification requirements.
- Qualified practitioners.
- Verified Processes & Procedures
- Better bid evaluation.
- High level of service.
- Reduced Risk.
- Reduced construction costs.

PAS128 Utility Surveys



How to: PAS128 Utility Surveys

Desktop Utility Record Search
Type D

Site Reconnaissance
Type C

Detection Survey
Type B

Verification Survey
Type A

Survey Le

Table 2 – Detection methods

Method [A]	Survey grid/search resolution [B]				Quality levels achievable	Typical application (informative)
	EML [C]	GPR		Other techniques [D]		
		General	Post-processing			
M1	Orthogonal search transect at ≤10 m intervals and when following a utility trace, search transects at ≤5 m intervals	Either: a) boundary survey incorporating a minimum of 5 survey transects around perimeter of site, spaced not more than 3 m apart: or b) ≤5 m orthogonal grid; or c) multiple antenna array [E]	No	≤5 m survey grid	B1, B2, B3, B4	Used where the density of services is typical of an undeveloped area
M1P			Yes		B1P, B2P, B3P	
M2	Orthogonal search transect at ≤5 m intervals and when following a utility trace, search transects at ≤2 m intervals	Either: a) ≤2 m orthogonal; or b) multiple antenna array [E]	No	≤2 m survey grid	B1, B2, B3, B4	Used where the density of services is typical of a suburban area or where the utility services cross a boundary of a survey area
M2P			Yes		B1P, B2P, B3P	
M3P	Orthogonal search transect at ≤2 m intervals and when following a utility trace, search transects at ≤1 m intervals [F]	Either: a) a) ≤1 m orthogonal; or b) multiple antenna array [E]	Yes	≤1 m survey grid	B1P, B2P, B3P, B4	Used where the density of services is typical of a busy urban area or for clearance surveys prior to operations such as borehole/ drilling/ fencing/tree planting
M4P	Orthogonal search transect at ≤2 m intervals and when following a utility trace, search transects at ≤0.5 m intervals [F]	Either: a) ≤0.5 m orthogonal; or b) multichannel GPR array with swathes collected in both directions, and gaps between swathes limited to ≤0.5 m; or c) a dual polarized multichannel array with swathes collected in one direction, but ensuring full area coverage is achieved with no gaps between swathes	Yes	≤0.5 m survey grid	B1P, B2P, B3P, B4	Used where the density of services is typical of a congested city area

NOTE 1 *In general the effort increases from M1 to M4 and the addition of post-processing. For areas with a greater density of utilities or areas considered high risk by the client, a detection method that has a higher level of effort should be selected.*

NOTE 2 *"P" indicates post-processing has been included. Post-processing should be used for any method above an M2.*

[A] It is a requirement that a minimum of GPR and EML techniques are used (see **9.2.1.1.2**).

[B] The tolerance for orthogonal transect centres and survey grids shall be ±0.1 m.

[C] It is a requirement that passive EML is deployed over the whole survey area and that where an active EML method can be used, it is used (see **9.2.1.2**).

[D] The transect centre depends on technique used.

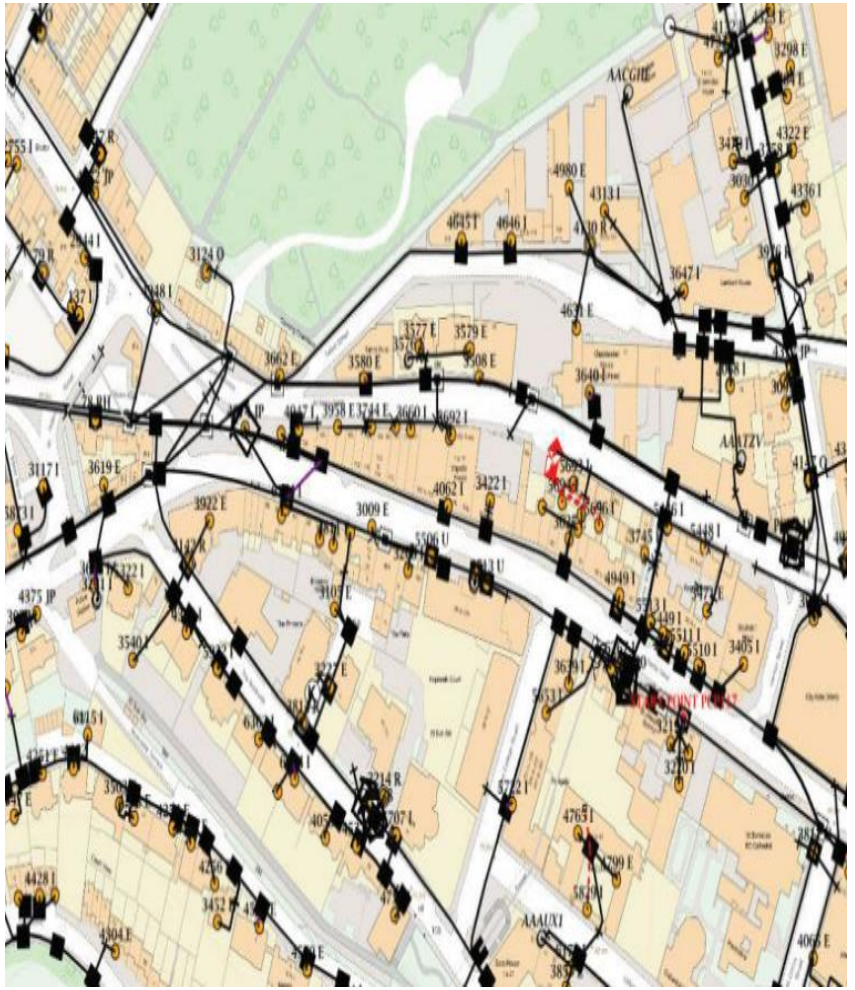
[E] A multiple antenna array radar with antenna separation <100 mm, deployed in accordance with **9.2.1.3.2**.

[F] To achieve a B1 or B1P there might be significant additional effort required to manipulate the electromagnetic field to enable a symmetrical field to establish accurate readings.

PAS128 Utility Surveys

Desktop Utility Searches

- MHLS have our own in-house team
- Approx. 5,000 searches per year
- PAS128 Type D Compliant
- Deliverables include AutoCAD and Report format
- Forms part of an initial assessment.
- Prerequisite to any PAS128 C, B, or A Survey



PAS128 Utility Surveys

Effective Techniques to undertake Utility Mapping

Common Techniques

- EML – CAT & Genny / Precision Locators
- GPR – Ground Penetrating Radar
- CCTV Cameras
- Radio Sondes

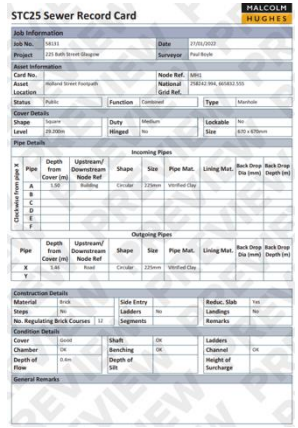
Less Common Techniques

- Acoustic Vibration
- Earth Resistance
- Magnetometry
- Gyroscopic Mapping

Metadata

Additional Data to supplement your survey

- Manhole & Asset Chamber Record Cards
- GPR Radargrams
- Proof of Compliance
- Site Photography
- Calibration Statements and Certification
- Surveyor Qualifications



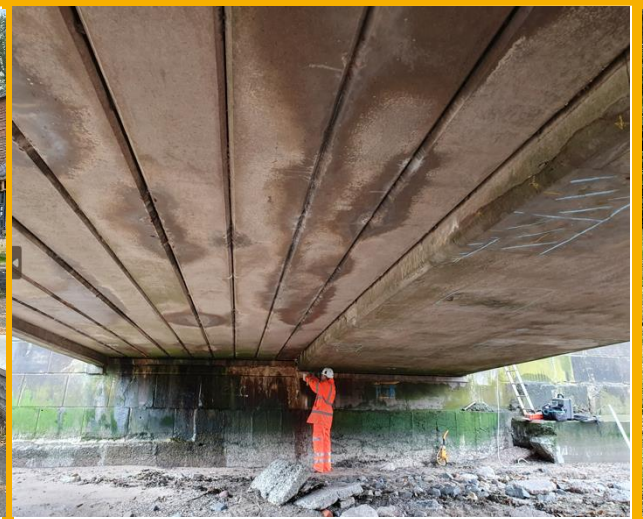
Ground Penetrating Radar

Many Uses – Many Limitations









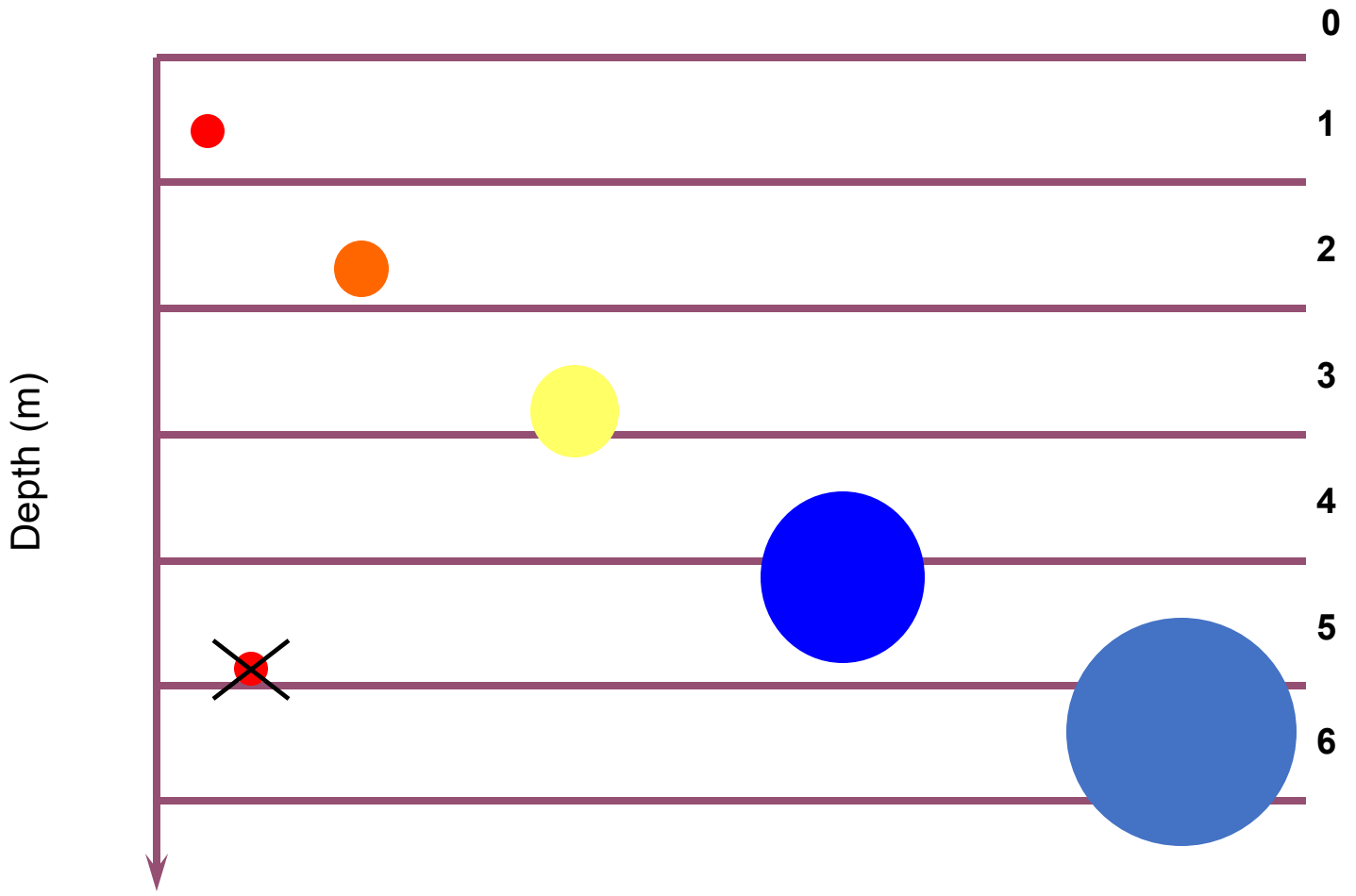

GPR Principles

Electromagnetic Wave Propagation

GPR Limitations

Best Geophysical Method = Most Limitations

- Penetration depth and ability to locate services is strongly dependant on ground conditions
- Relies on contrast between materials for detection.
- Dielectric Spectrum
- Wet ground? Bad results.
- Deeper target must be larger in diameter than shallow objects in order to be detected by GPR



Common GPR Systems

Many Configurations – Same Limitations

Vehicle Mounted GPR

- Featuring multi-channel, multi-frequency and dual polarisation options.
- Collect large quantities of high quality data on our subsurface mapping projects very quickly at driving speed, without disruption to the traffic flow.
- If used in conjunction with our compact multi-channel high-density radar array system, we can now offer our Clients up to 100% GPR coverage.

Ground Penetrating Radar

Effective GPR as part of a PAS128 Utility Mapping Survey

- Specified use as per detection methodology. Bi-Directional Data Collection Required.
- Use effectively to assign Quality Levels.
- All transects must be geolocated.
- Boundaries – minimum 5 transects <3m apart
- Anything above M2 spec – now must be post processed.
- We will try and deploy MC-GPR where possible to assist with data collection. Cost saving.

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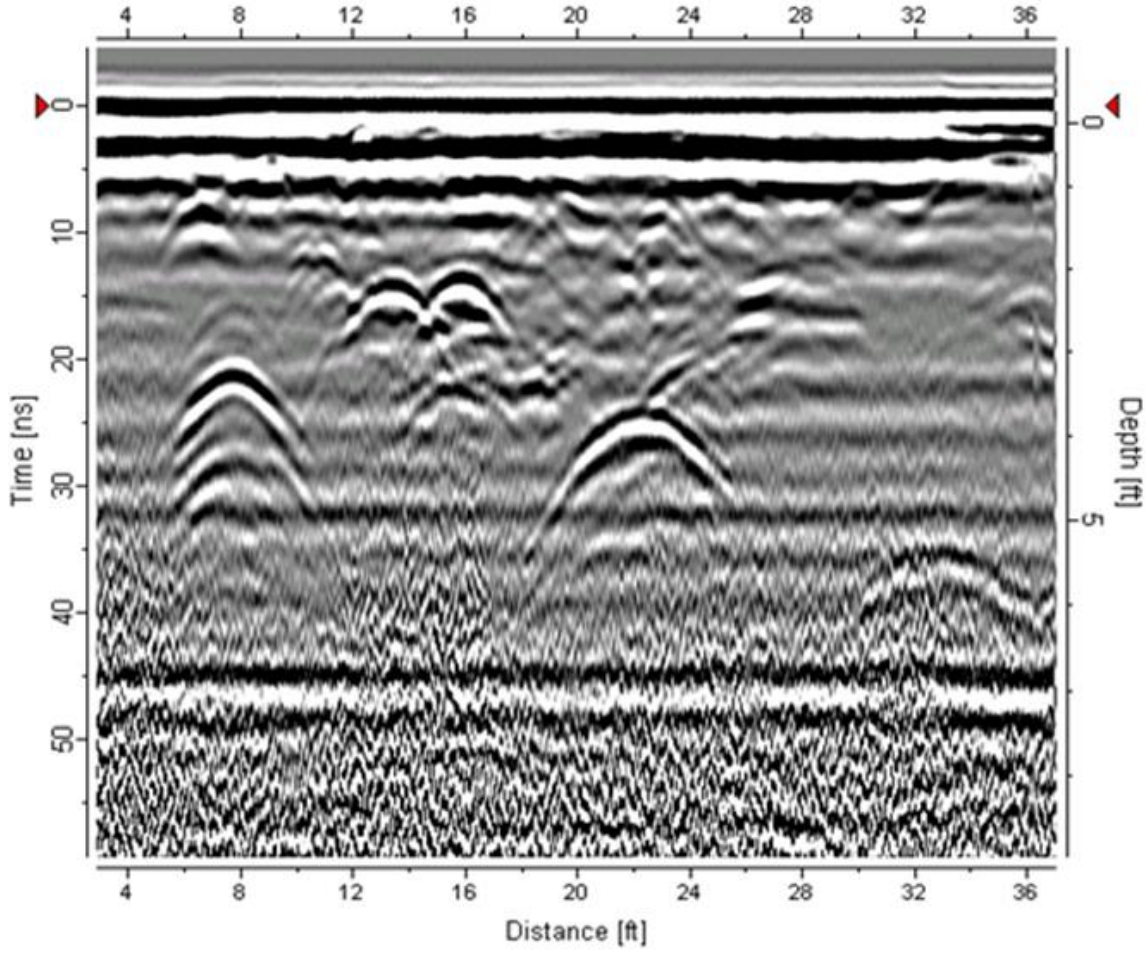
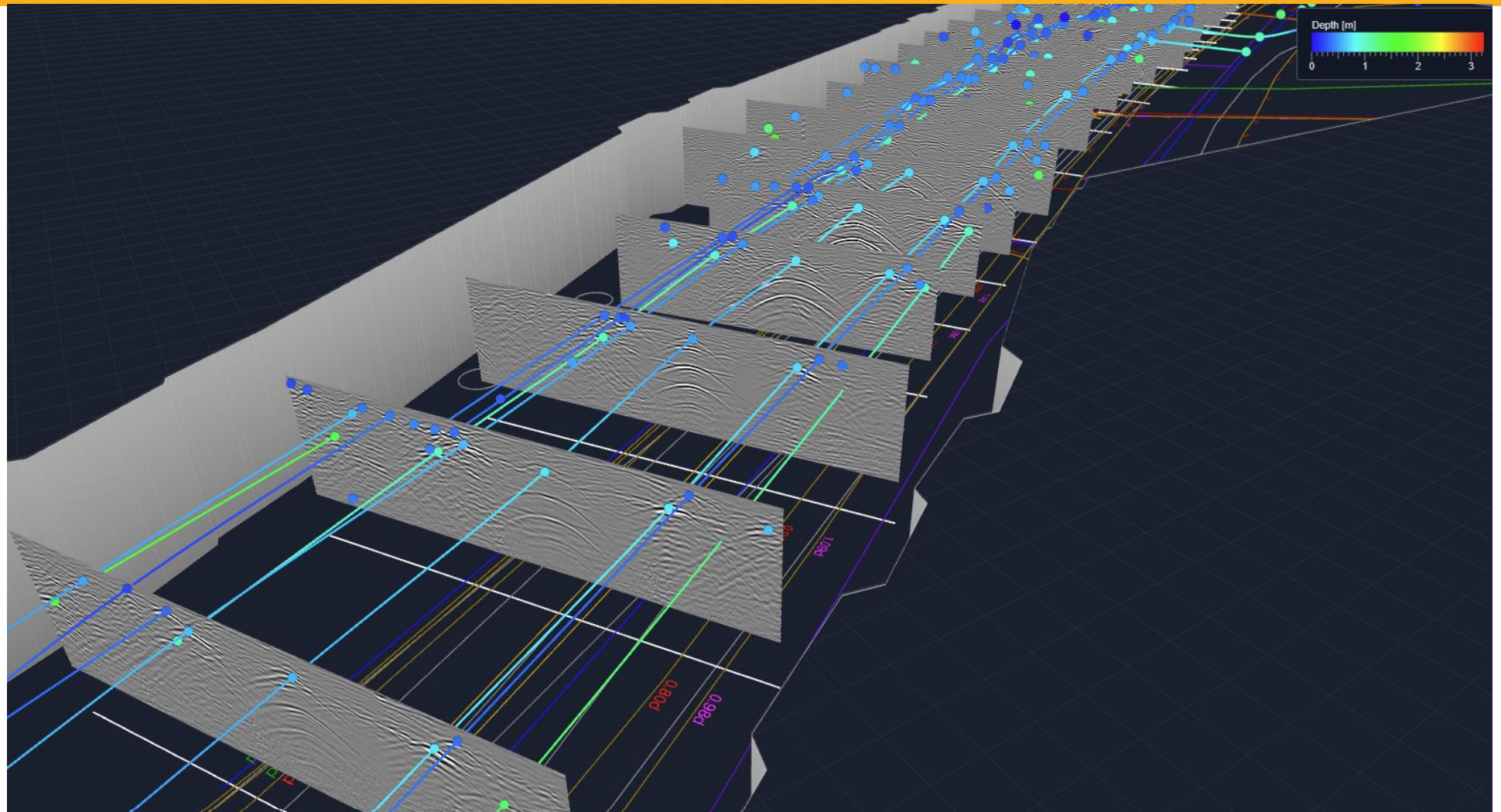
Ground Penetrating Radar

Push Cart – Site Mark out



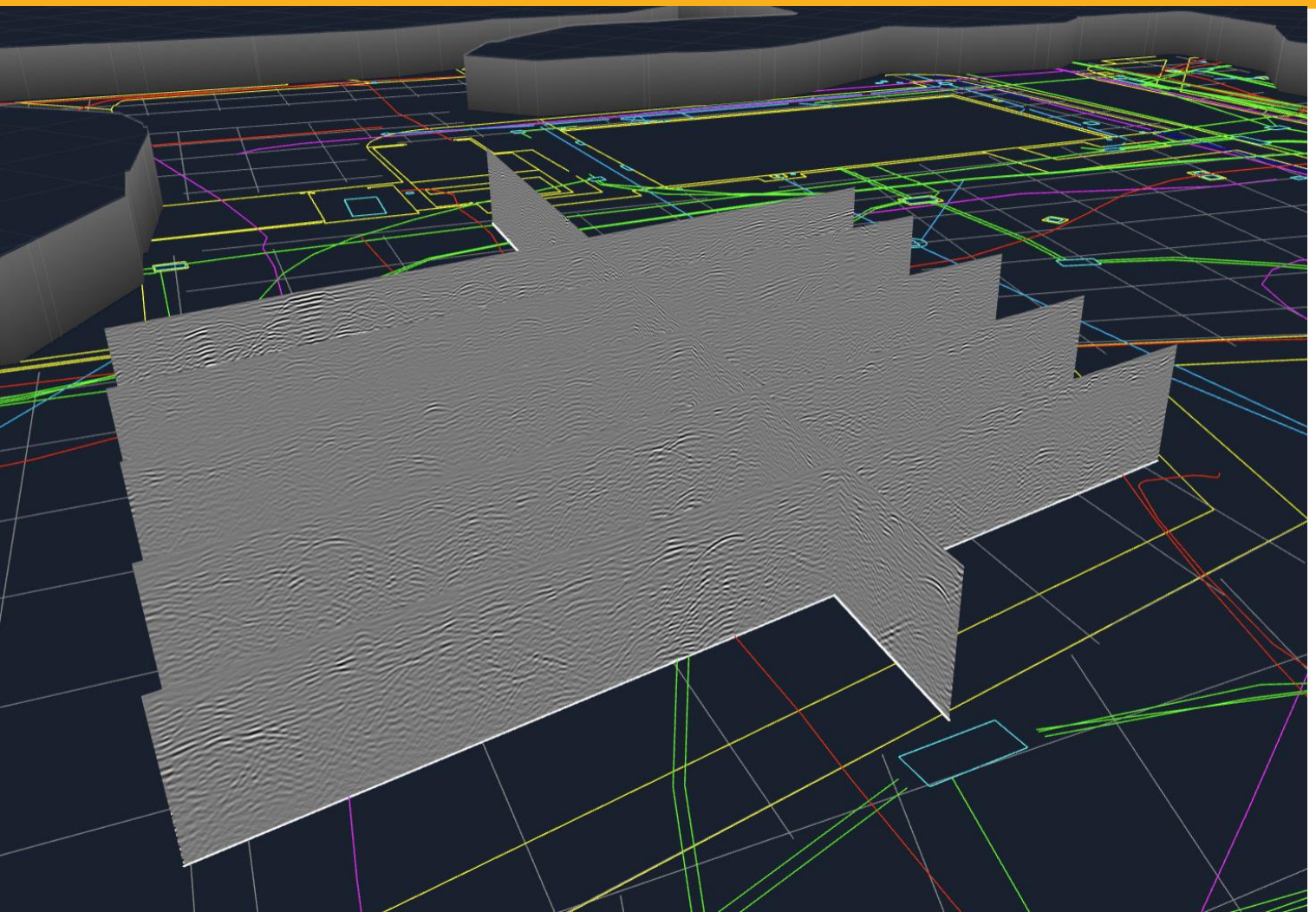
Results!

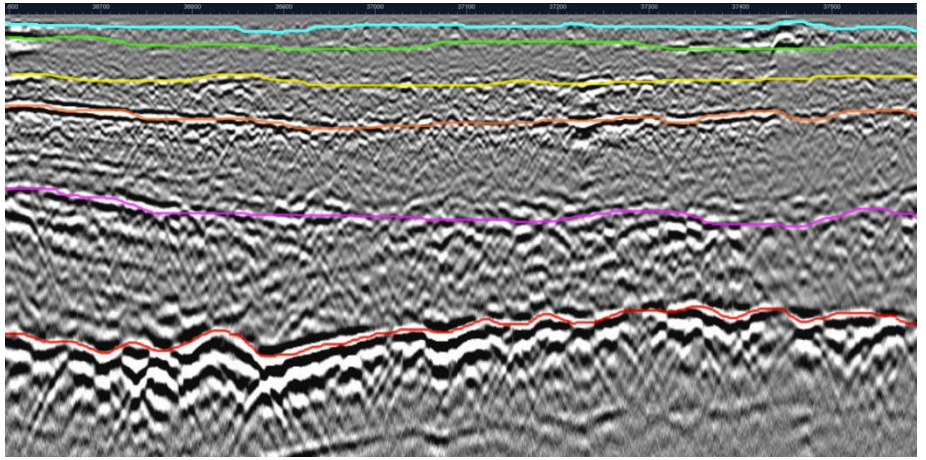
Post Processing

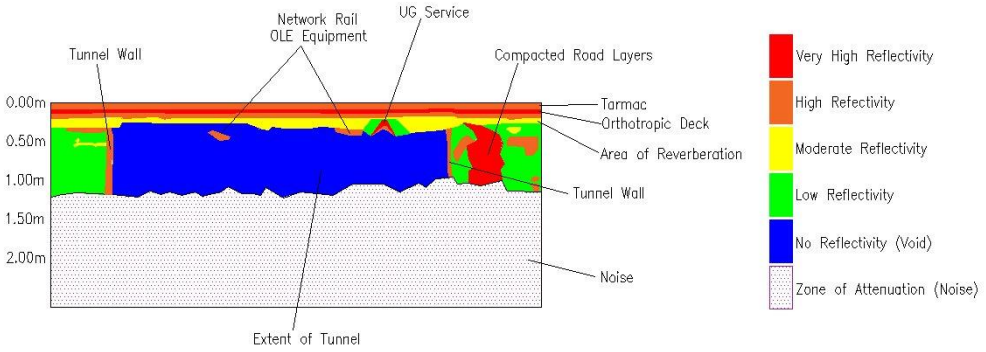


Results!

Post Processing

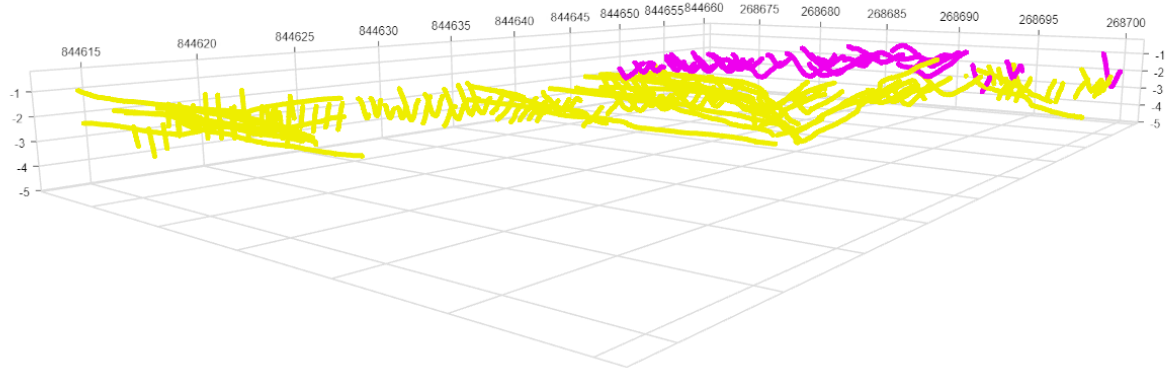




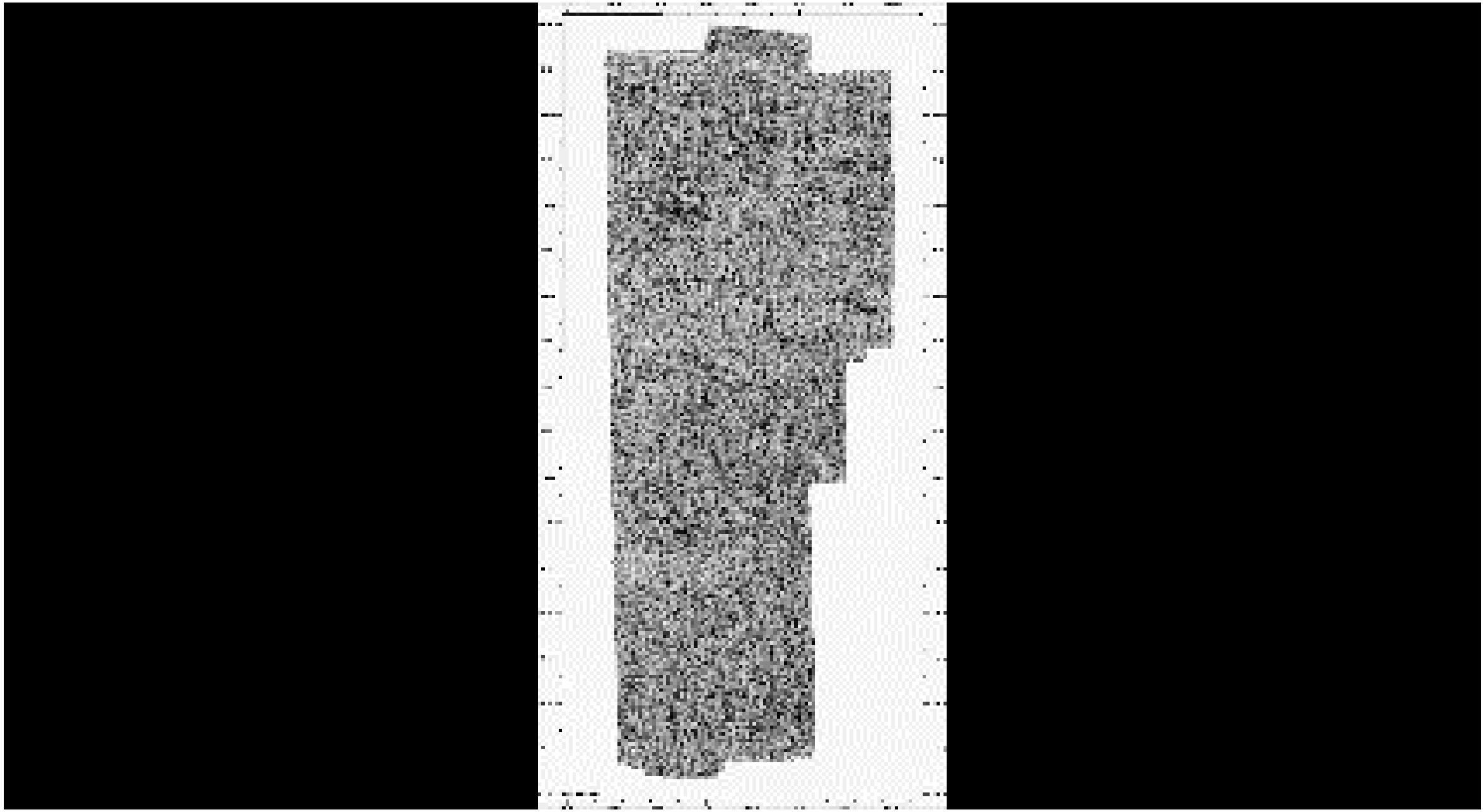


Results!

Post Processing – Other outputs



- 3D Analysis
- Layer Thickness / Depth Variations
- Infilled / Density of Backfill
- Buried Objects (Tanks, Foundations, Basements, Obstructions)



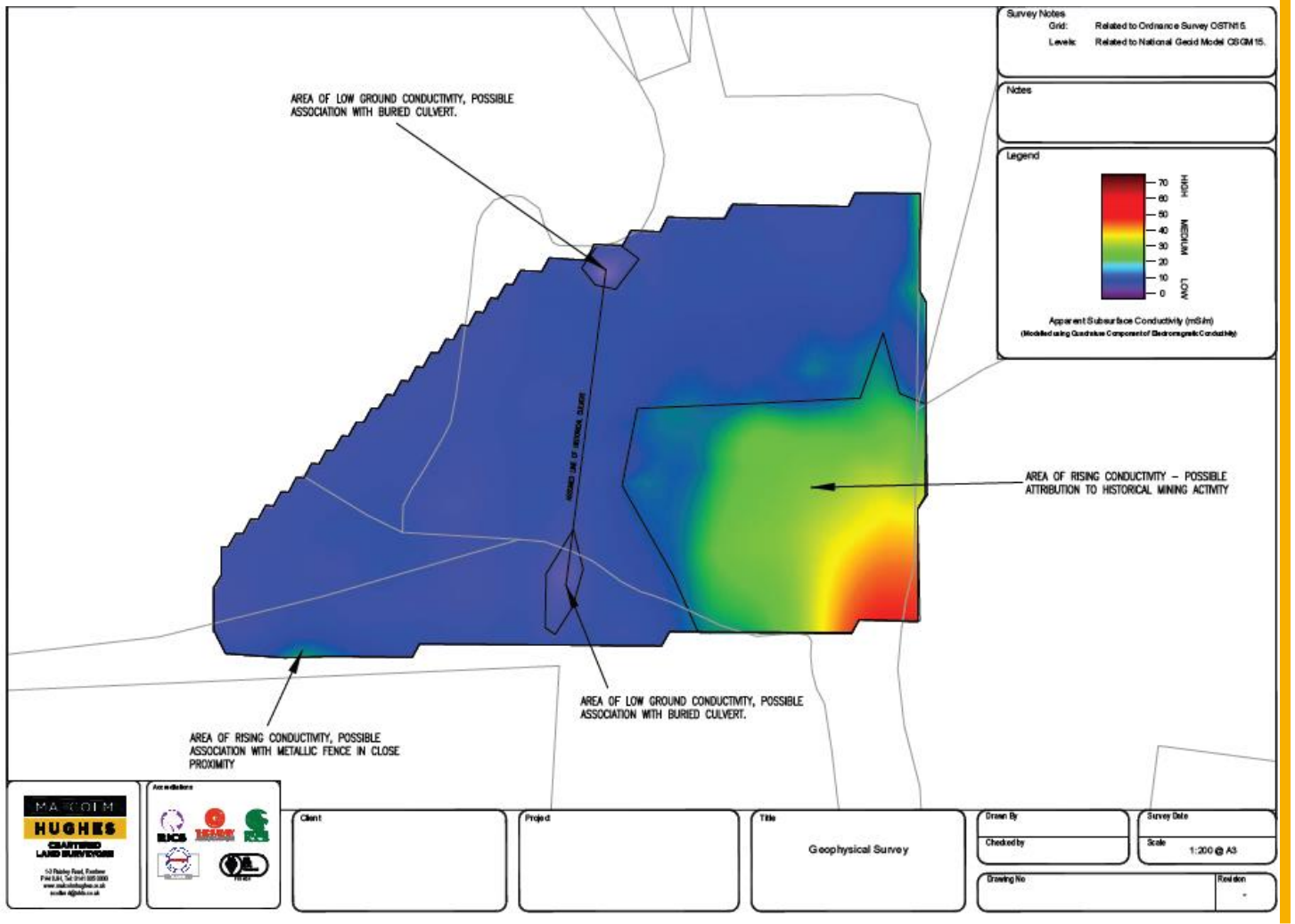
Other GPR Applications

Many Uses – Many Limitations

- Utility and Buried Feature Locating
- Non-Destructive Testing
- Post-Construction Quality Assessments
- Mapping Voids and Sink Holes
- Environmental Applications
- Layer Thickness and Density Assessments
- Bathymetry
- Archaeology
- Forensics

Subsurface Mapping-Subsurface Excellence:

...More than just pipes & cables



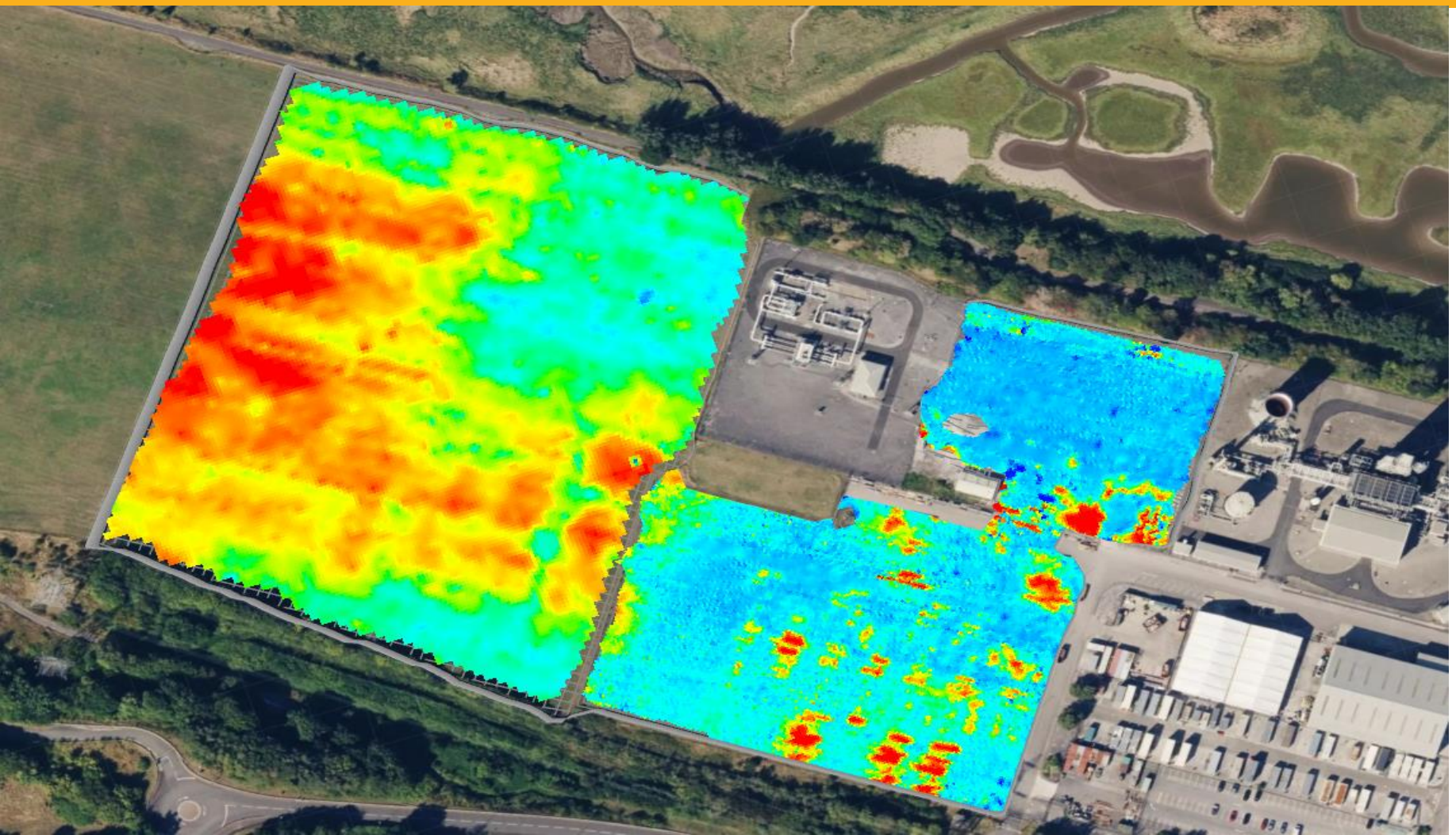
- Former Mining Activities
- Environmental
- Geological
- Ground Investigations
- Rapid Site Characterisation

Variety of techniques available:

- Resistance
- Conductivity
- Magnetics
- Seismology

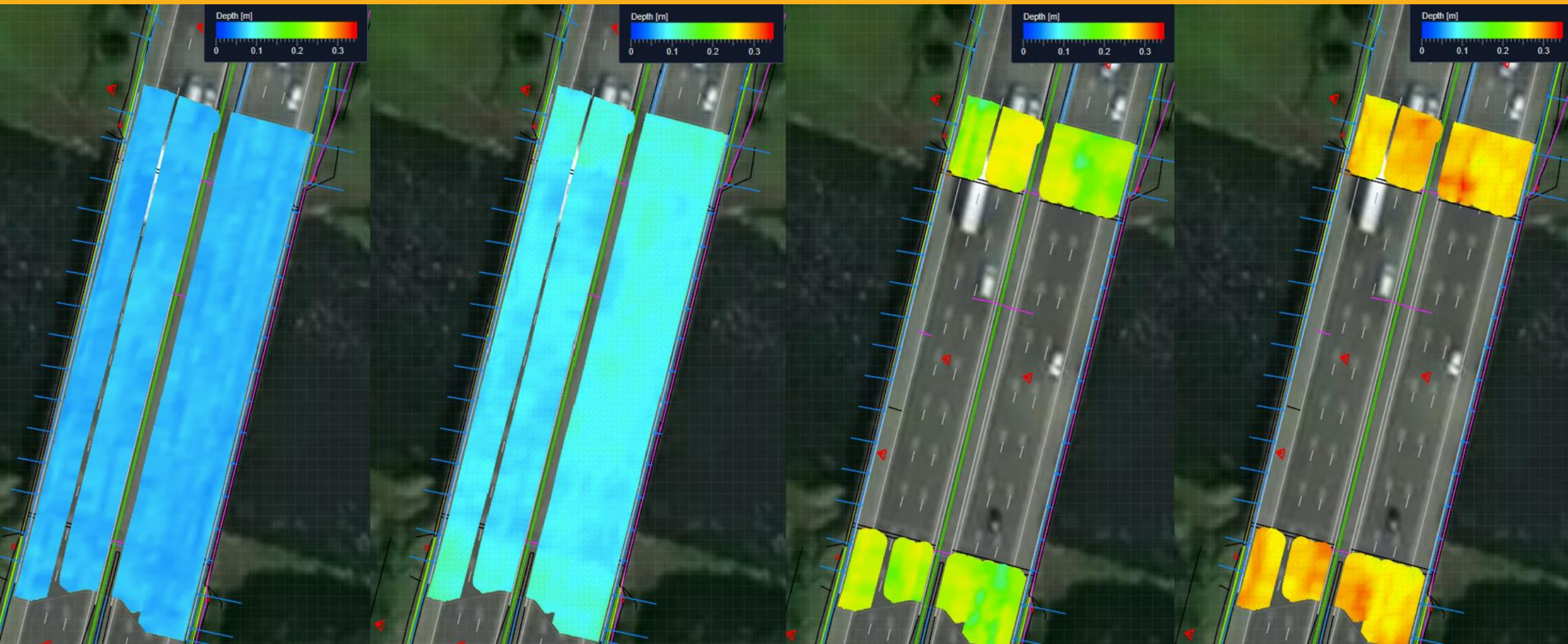
Output Examples:

Geophysical Survey for Buried Foundations



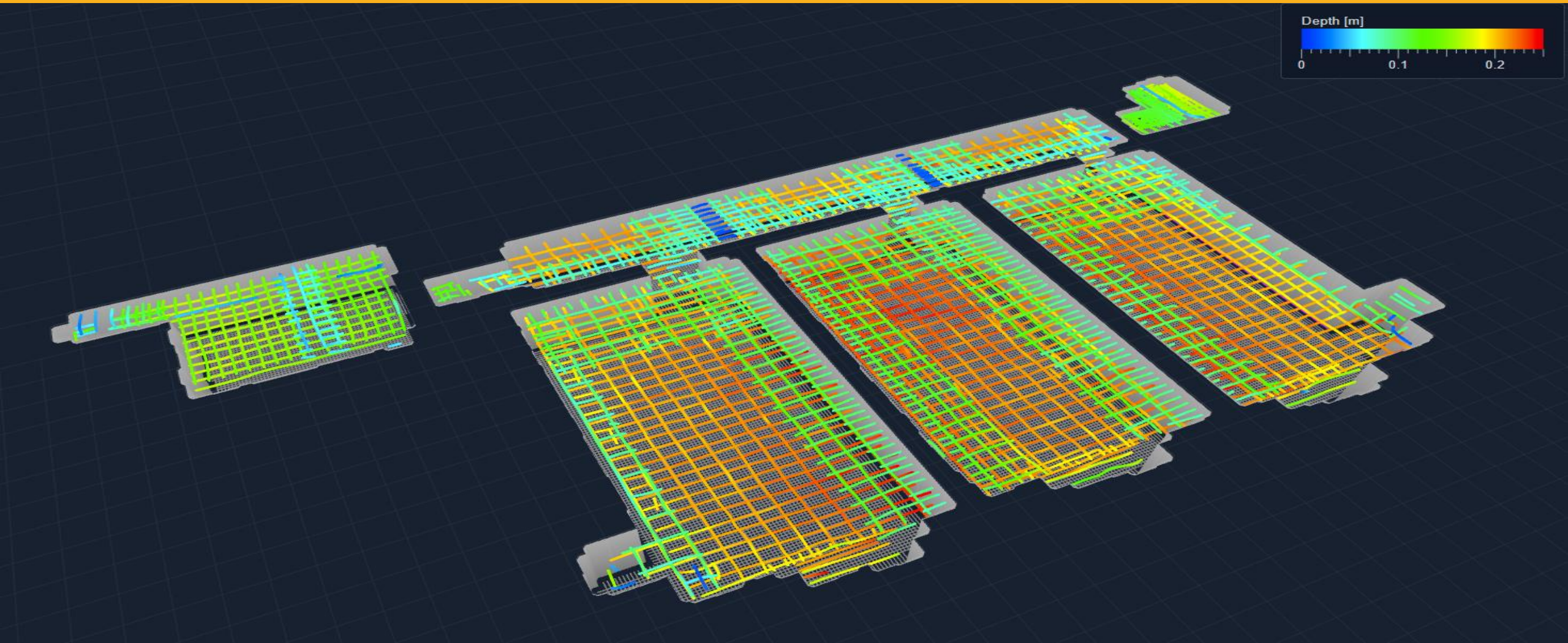
Output Examples:

Construction Layers



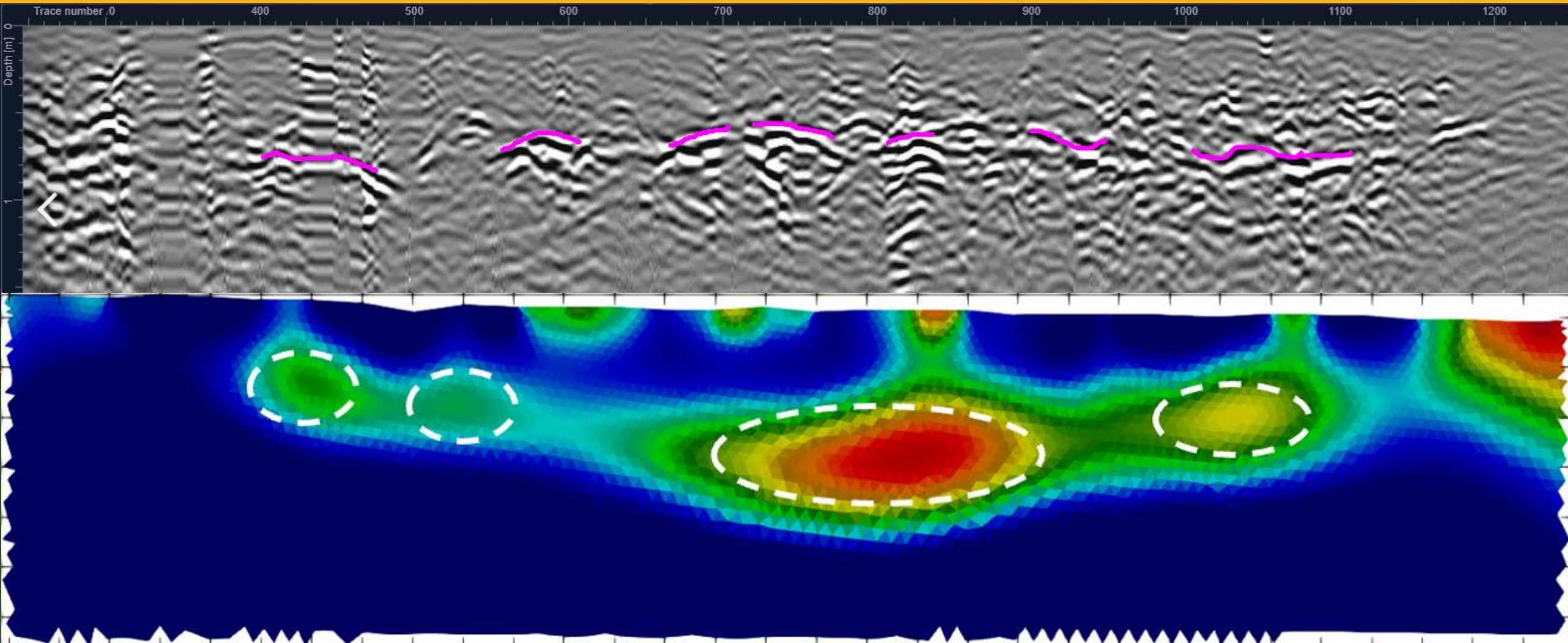
Output Examples:

Rebar Arrangements and Floor Thicknesses



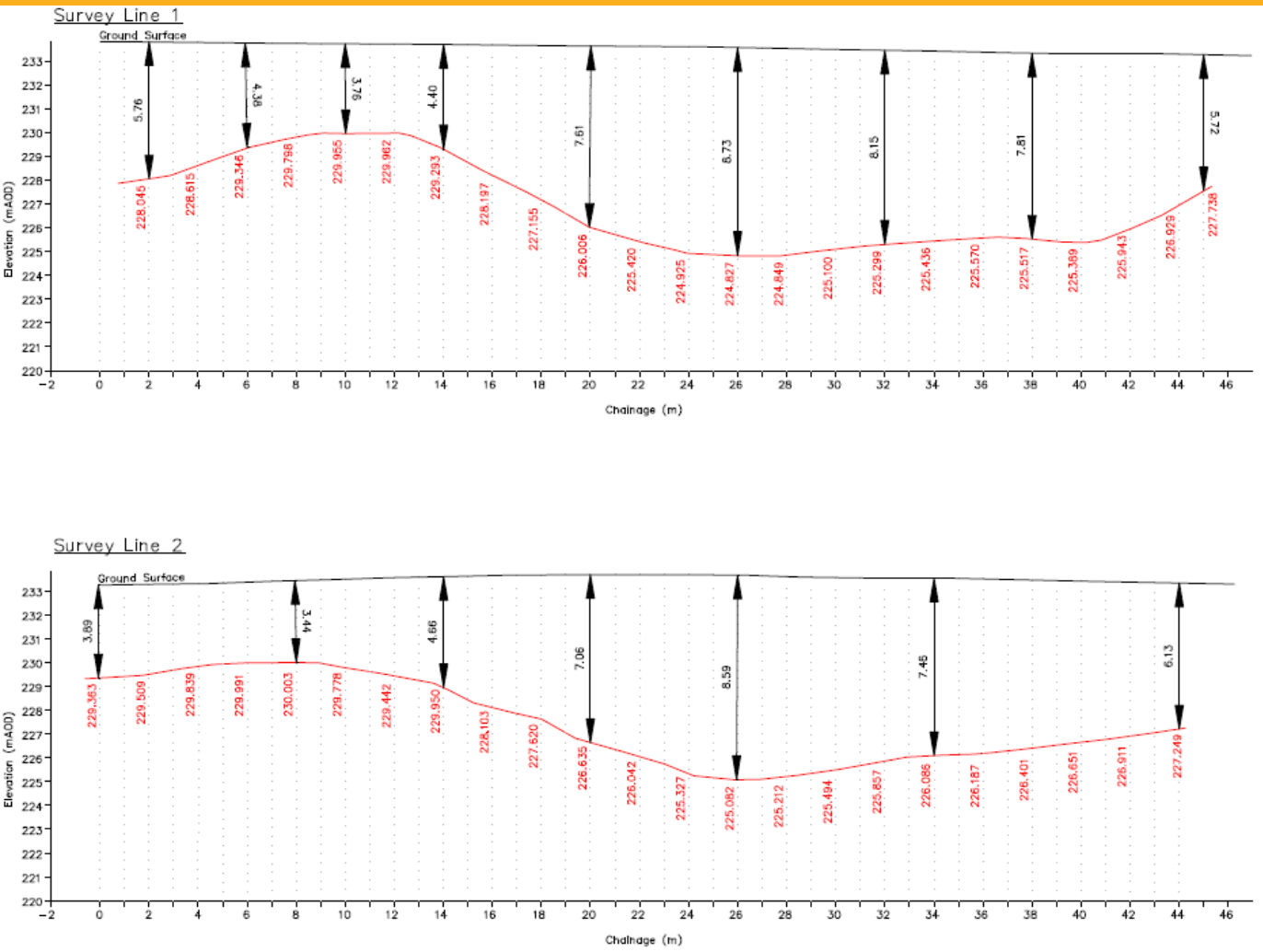
Output Examples:

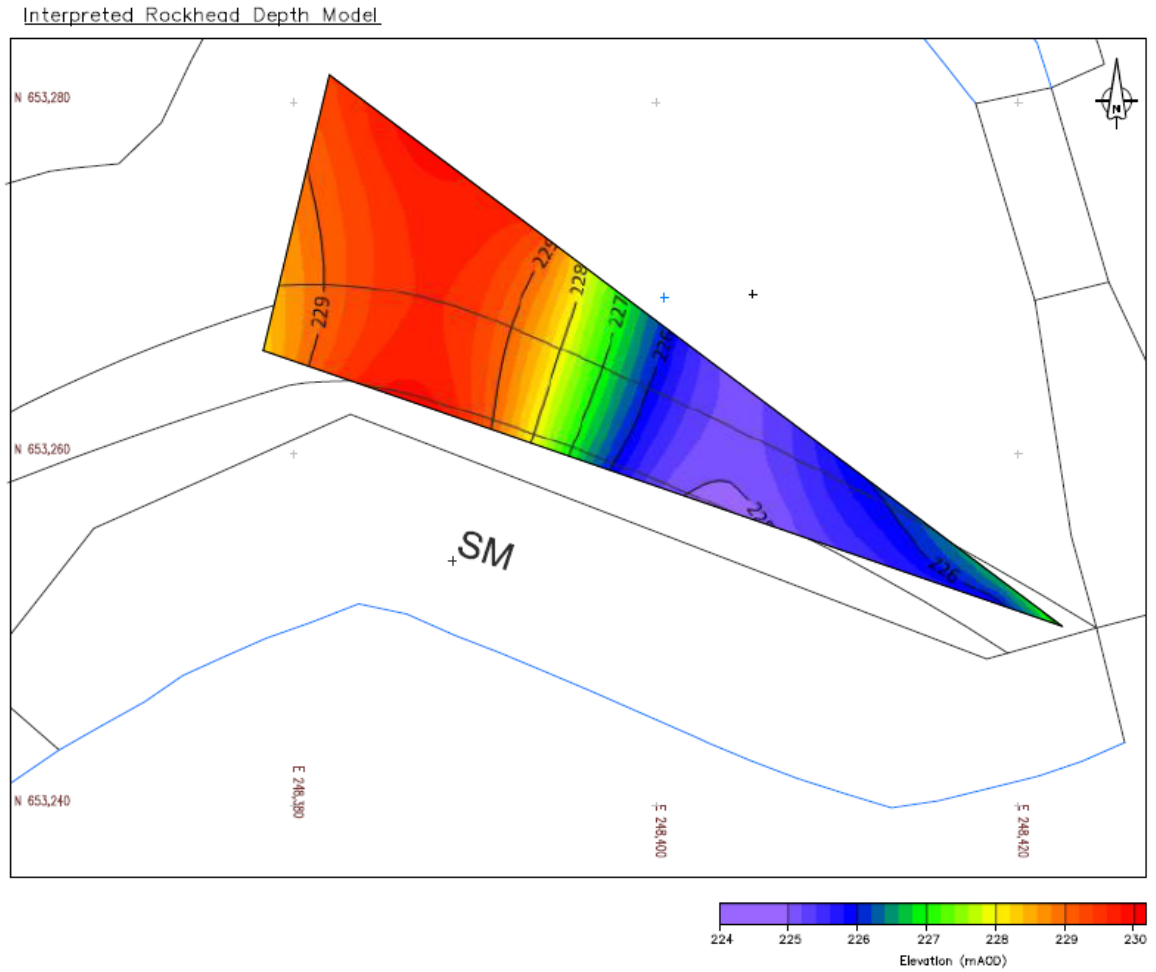
Detection of Badger Setts



Output Examples:

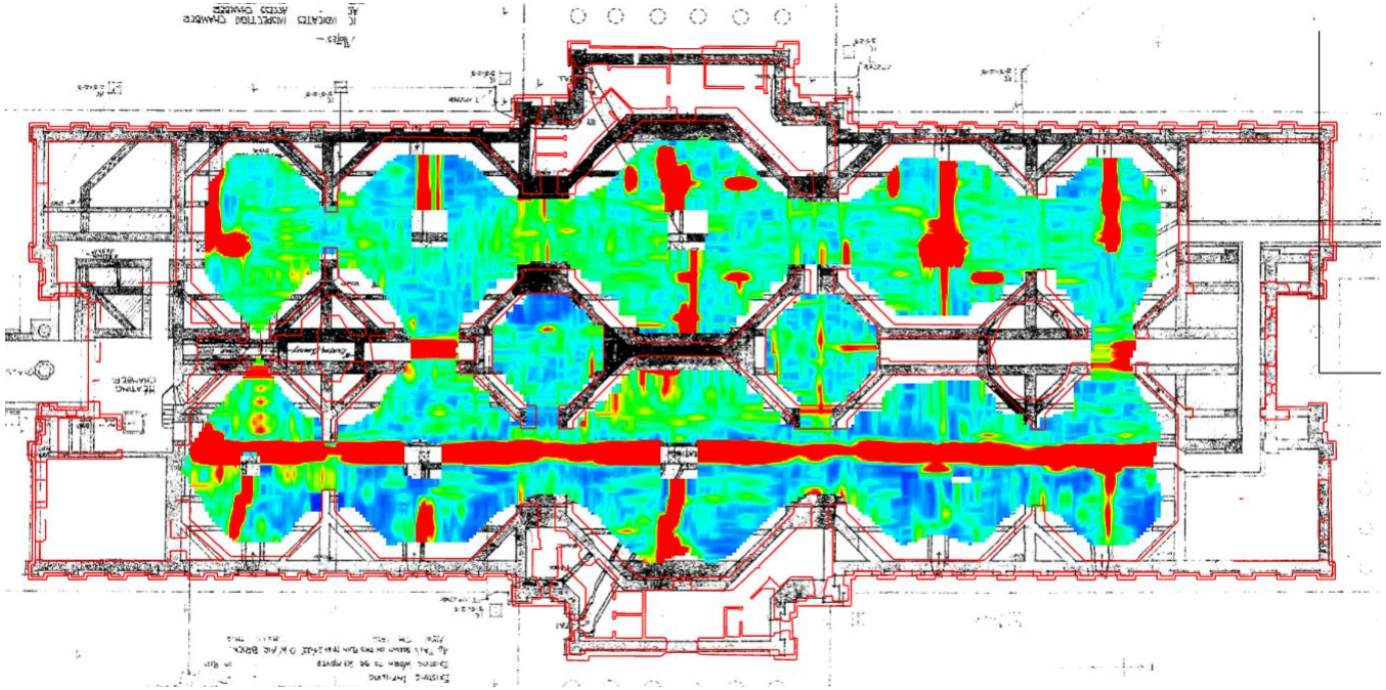
Geophysical Survey for Determination of Bedrock Levels





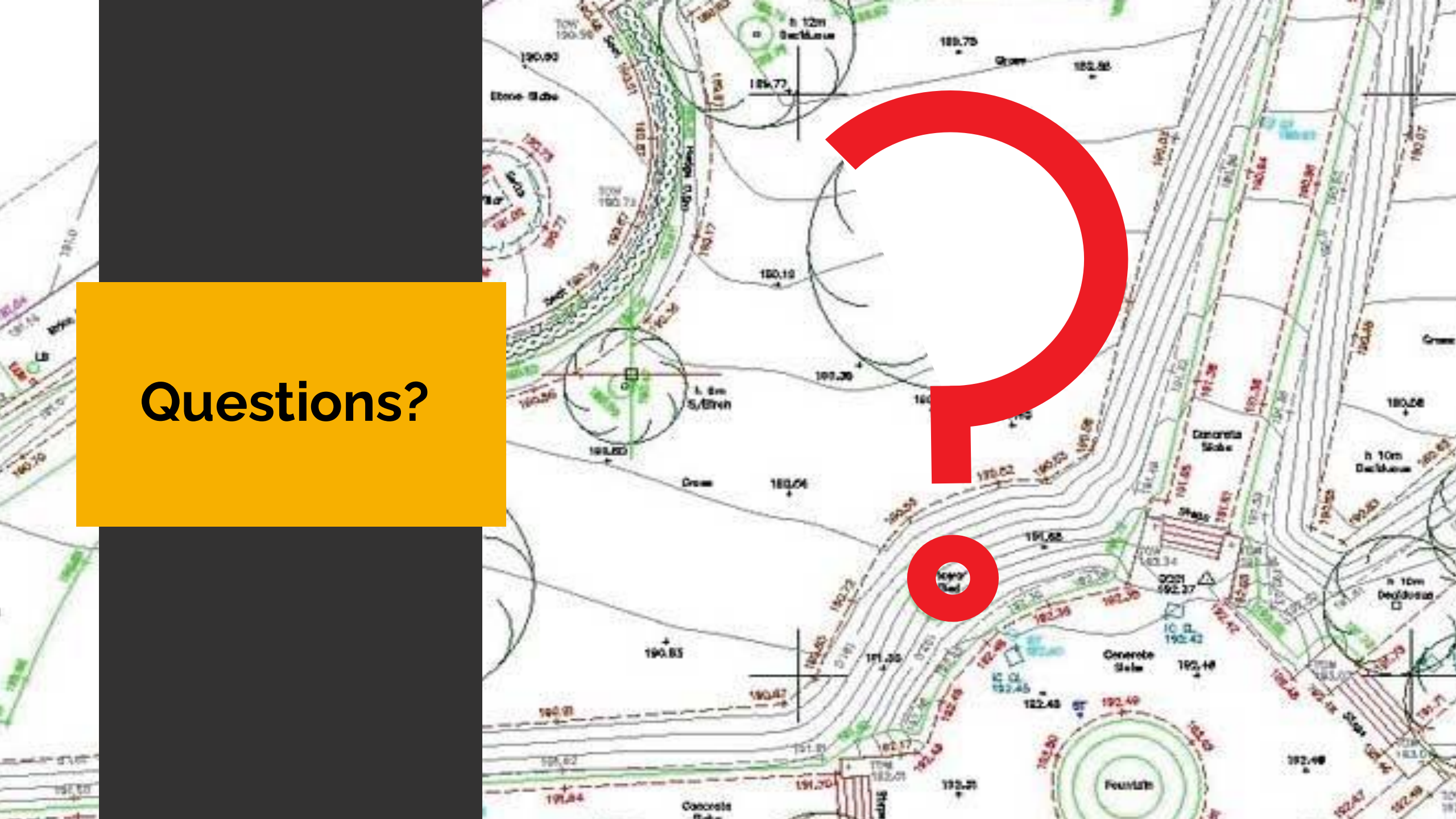
Deliverables Available

We can offer the following outputs:



- 2D and 3D AutoCAD drawings
- Full 3D models
- GPR Timeslice Imagery
- Contour / Amplitude Plots
- Survey Reports (Survey Type D-A)
- Inspection Reports
- Post Survey Handover Meetings
- Need something custom? We can help!

Questions?





Thank you

For more information, visit:
www.malcolmhughes.co.uk

SURVEY/THIS