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PRIVATE AND CONFIDENTIAL

THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOPHYSICS LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.

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1. EXECUTIVE SUMMARY

APEX Geophysics Limited was requested by Breedon Group to carry out a geophysical investigation at Mounthall Camross, Co. Laois. The site has potential for sand and gravel deposits. The objective of the investigation was to provide information on sand and gravel thickness, overburden thickness, depth to bedrock and volume of available resource.

The site is at Mounthall, Co. Laois, approximately 20 km west of Portlaoise and covers an area of approximately 32 ha of open agricultural fields and forestry. There is an existing sand/gravel pit in the northeastern part of the site. Site topography ranges from 176.6 to 232.3 m OD. The Geological Survey of Ireland (GSI) Bedrock Geology map shows pale & red sandstone, grit & claystone of the Cadamstown Formation. The Quaternary Sediments map shows gravels in the northern and eastern part of the site, and till and alluvium in the southern and western part. The bedrock is classified as a 'Locally important aquifer – Bedrock which is moderately productive only in local zones'. The sand/gravel deposits are not classified as an aquifer.

The survey was carried out on the 7th, 8th and 14th July 2022 with the collection of EM conductivity readings, 10 ERT profiles and 3 seismic refraction profiles. No readings were obtained within the forested areas in the west of the site. The following zones have been outlined based on the geophysical interpretation:

Zone A in the east of the site is mainly 'clean' SAND/GRAVEL underlain by some silty SAND/GRAVEL and extends to approximately 9.1 ha in total with interpreted sand/gravel thickness from 7 to 15 m (average 11 m). This zone may have economic potential. Allowing for standoffs the potential resource in **Zone A is c. 1.0 m.t of 'clean' SAND/GRAVEL and silty SAND/GRAVEL over 5.4 ha.**

Zone B in the west of the site is mainly silty SAND/GRAVEL with some 'clean' SAND/GRAVEL and extends to approximately 12.3 ha. Interpreted sand/gravel thickness is thin ranging from 3 m to 8 m (average 5 m) and may be discontinuous in places. Topsoil/overburden thickness appears to be around 1m. Allowing for standoffs the potential resource in **Zone B is c. 0.7 m.t. of mainly silty SAND/GRAVEL over 8.1 ha** (including forested area). This zone may have economic potential but the variable thickness and quality may limit development.

Zone C is a smaller area of 'clean' SAND/GRAVEL surrounded by silty SAND/GRAVEL that forms the rising ground in the north of the site. It extends to approximately 5.3 ha and interpreted sand/gravel thickness ranges from 5 to 8 m (average 6 m). Allowing for standoffs the potential resource is **c. 0.1 m.t in Zone C of mainly 'clean' SAND/GRAVEL.** This zone may have some economic potential but is quite small.

Estimated topsoil/overburden thickness in the above areas is around 1m. There is a further area of around 5.2 ha in the northwest consisting of the excavated area referred to in Zone C above and an area to the southwest of this to the southwest where sand/gravel is very thin or absent.

Bedrock has been indicated by the seismic data at depths ranging from 3 to 25 m bgl depending on location and topography and generally corresponds to between 170 and 225 mOD being deepest in the southeast. The electrical resistivity and seismic velocities are typical of thinly bedded sandstone, shale and mudstone.

Confirmatory direct investigation by trial pitting is recommended with samples taken for Particle Size Distribution (PSD) analysis and chemical, physical, mechanical and laboratory tests. A topographic survey is also recommended. Economic potential is subject to laboratory testing, planning and development cost.

The geophysical report and volume estimates should be reviewed after any direct investigation.

2. INTRODUCTION

APEX Geophysics Limited was requested by the Breedon Group to carry out a geophysical investigation at Mounthall, Camross, Co. Laois. The site has potential for sand and gravel deposits.

2.1 Survey Objectives

The objective of the investigation was to provide information on the following:

- sand and gravel thickness,
- overburden thickness,
- depth to bedrock,
- volume of available resource.

2.2 Site Background

The site is located in the south eastern foothills of the Slieve Bloom Mountains at Mounthall, Co. Laois, approximately 20 km west of Portlaoise, (Fig. 2.1). The site covers an area of approximately 32 ha and comprises of open agricultural fields and forestry. There is an existing sand and gravel pit in the northern part of the site with possible backfilled areas to the west of the pit. Site topography is variable and ranges from 176.6 to 232.3 m OD generally rising to the northwest with low ground in the centre and a small hill or kame type feature in the east. There are houses in the northwest and to the southeast of the site and a new house is currently being constructed in the northeast of the site.



Fig 2.1A: Site location.



Fig 2.1B: Site looking northwest at centre of site in foreground and rising ground behind.



Fig 2.1C: Looking southeast at the previously excavated area.



Fig 2.1D: Looking west at the small hill in the east of the site.

2.2.1 Geology

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area (GSI 2019a) indicates that the site is underlain by pale & red sandstone, grit & claystone of the Cadamstown Formation (Figure 2.2). A SW-NE running structural unconformity line is mapped c. 500 m north of the survey area.

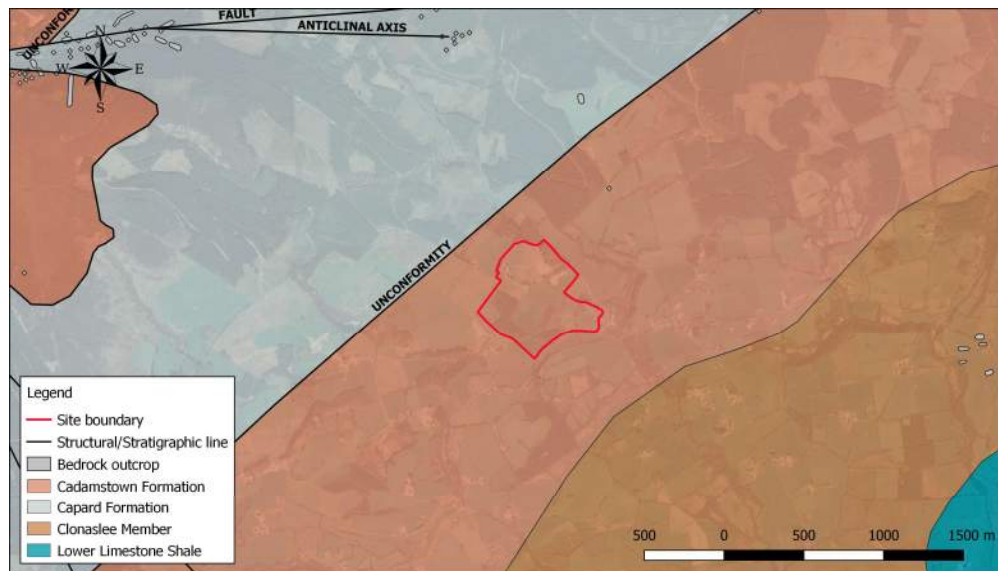


Fig 2.2: Bedrock geology.

2.2.2 Soils

The GSI Quaternary Sediments map for the area (GSI 2019b) indicates that the site is underlain by gravels derived from Devonian sandstones in the northern and eastern part, and till derived from Devonian sandstones and alluvium in the southern and western part of the site (Fig. 2.3).



Fig 2.3: Quaternary sediments.



2.2.3 Vulnerability

The groundwater vulnerability rating for the survey area (GSI 2019c) is 'high' in the northern and eastern part and 'moderate' in the southern and western part (Fig. 2.4).

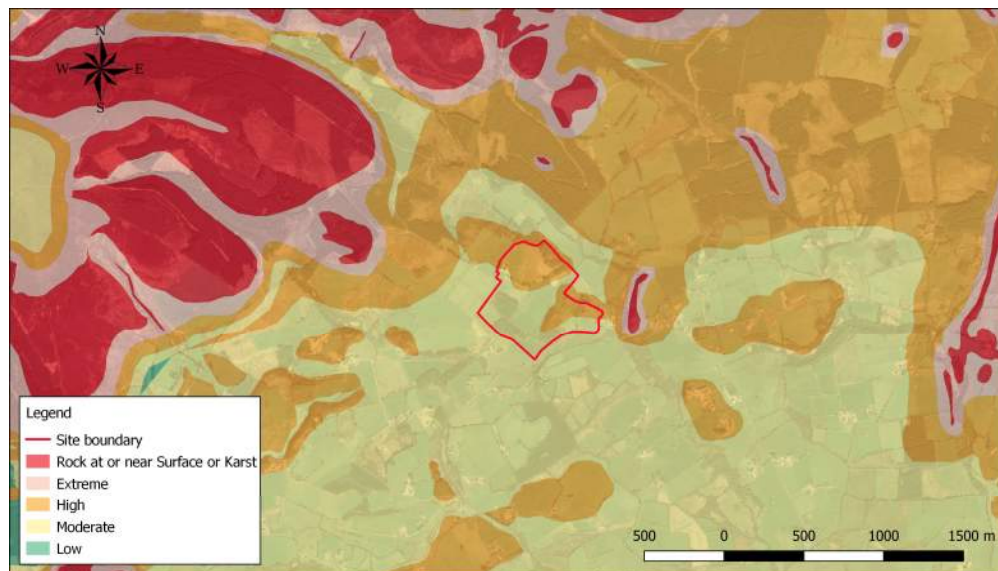


Fig 2.4: Groundwater vulnerability.

2.2.4 Aquifer Classification

The bedrock under the site is classified as a 'Locally important aquifer – Bedrock which is moderately productive only in local zones' (Fig. 2.5). The sand and gravel deposits are not classified as an aquifer.

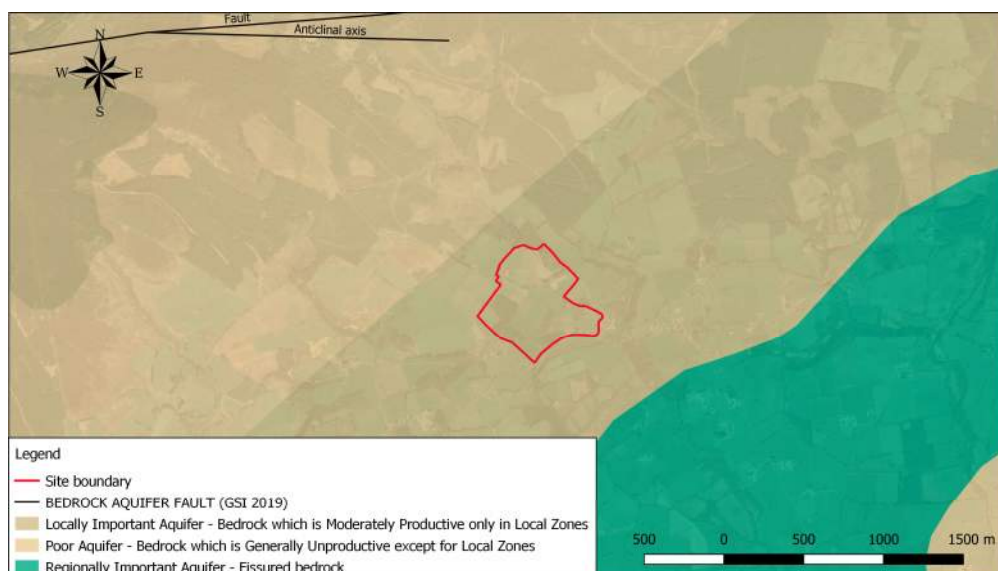


Fig 2.5: Bedrock aquifer.



2.2.5 Historical Data

The historical 6-inch sheet (Fig. 2.6) shows the site is on an area of limestone drift and reddish drift with some limestone pebbles. Sandstone and conglomerate outcrops are mapped c. 200 m east of the survey area.

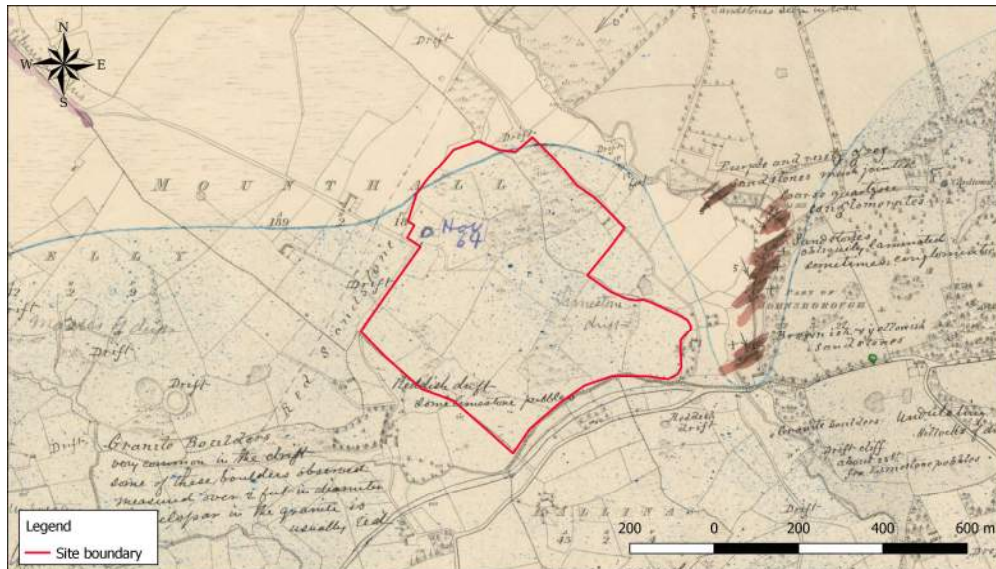


Fig 2.6: The historical 6-inch map.

2.3 Survey Rationale

The investigation consisted of reconnaissance EM ground conductivity mapping with follow-up 2D ERT and Seismic Refraction profiling:

EM ground conductivity mapping operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). This technique will provide information on the shallow (0-6m below ground level) variation of the superficial deposits and outline shallow bedrock.

ERT images the electrical resistivity of the materials in the subsurface along a profile to produce a cross-section showing the variation in resistivity with depth. Each cross-section will be interpreted to determine the material type along the profile based on typical resistivities returned for Irish ground materials.

Seismic Refraction profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

As with all geophysical methods the results are based on indirect readings of the subsurface properties. The effectiveness of the proposed approach will be affected by variations in the ground properties. By combining a number of techniques it is possible to provide a higher quality interpretation and reduce any ambiguities which may otherwise exist. Further information on the detailed methodology of each geophysical method employed in this investigation is given in **APPENDIX A: DETAILED GEOPHYSICAL METHODOLOGY**.

3. RESULTS

The survey was carried out on the 7th, 8th and 14th July 2022 with the collection of EM conductivity readings, 10 ERT profiles and 3 seismic refraction profiles. The geophysical survey locations are indicated on Drawing AGP21228_01 (Appendix B). No readings were obtained within the forested areas in the west of the site.

3.1 EM Ground Conductivity Mapping

The EM ground conductivity results (Drawing AGP21228_02, Appendix B) show the bulk conductivity of the ground materials from 0 - 6.0 m bgl. The recorded conductivity values ranged from 0.5 to 10 mS/m and have been generally interpreted in conjunction with the ERT and seismic data as follows:

Conductivity (mS/m)	Interpretation
0.5 – 3.0	Topsoil over SAND/GRAVEL and silty SAND/GRAVEL
3.0 – 5.0	Topsoil over silty SAND/GRAVEL
5.0 – 8.0	Topsoil over gravelly CLAY
8.0 – 10.0	Alluvium.

3.2 ERT

Ten ERT Profiles (R1-R10) have been acquired across the site. The resistivity values have been interpreted on the following basis.

Resistivity (Ohm-m)	Interpretation
100-250	Topsoil and sandy gravelly CLAY
250-500	Clayey silty SAND/GRAVEL
500-1,000	Silty SAND/GRAVEL
1,000-3,000	'Clean' SAND/GRAVEL
100-315	MUDSTONE/SHALE
315-3,175	SANDSTONE

3.3 Seismic refraction profiling

Three seismic refraction spreads were recorded across the site (S1, S2 and S3, Appendix C). The seismic velocities indicated 3 seismic velocity layers that have been interpreted on the following basis:

P-Wave Seismic Velocity (m/s)	Interpretation	Estimated Stiffness/ Rock Quality
250-300	Topsoil, SAND/GRAVEL, silty SAND/GRAVEL	Soft/Loose
800-950	SAND/GRAVEL, silty SAND/GRAVEL, clayey SAND/GRAVEL	Medium Dense
2,500-3,400	MUDSTONE/SHALE/SANDSTONE	Fair - Good

4. DISCUSSION

The geophysical results are presented on Drawings AGP22128_R1 to AGP22128_R10, Appendix B and summarised on Drawing AGP22128_03.

Electrical resistivity values for Irish sand and gravel deposits are generally within the following ranges:

Material	*Fines Content %	Resistivity (Ohm-m)	Economic Potential
'Clean' SAND/GRAVEL	< 5	> 1000	Yes
Silty SAND/GRAVEL	5 - 15	500-1000	<u>may</u> have, subject to screening/washing.
Clayey SAND/GRAVEL	> 15%	250-500	<u>unlikely</u> , due to fines content

**Fines refer to the clay and silt content of the sand/gravel material. The higher the fines content the poorer the material and use is restricted and screening/or washing required. These estimates should be confirmed by subsequent sampling and testing.*

The geophysical survey has outlined the following zones across the site (Drawing AGP22128_03):

- Zone A is a zone of mainly **'clean' SAND/GRAVEL** underlain by some **silty SAND/GRAVEL** that includes the kame type small hill in the east of the site. It extends to approximately 9.1 ha and interpreted sand/gravel thickness ranges from 7 to 15 m. Topsoil/overburden thickness appears to be around 1m. This zone may have economic potential and direct investigation by trial pitting is recommended.
- Zone B is a larger zone of mainly **silty SAND/GRAVEL** with some **'clean' SAND/GRAVEL** that covers the lower ground in the west of the site and flanks the partially forested slopes rising to the southeast and northwest. It extends to approximately 12.3 ha and interpreted sand/gravel thickness is thinner than Zone A ranging from 3 m to 8 m and may be discontinuous in places. Topsoil/overburden thickness appears to be around 1m. This zone may have some economic potential but the thickness and quality may not be sufficient to merit development. Some direct investigation by trial pitting is recommended.
- Zone C is a smaller area of **'clean' SAND/GRAVEL** surrounded by **silty SAND/GRAVEL** that forms the rising ground in the north of the site. It extends to approximately 5.3 ha and interpreted sand/gravel thickness ranges from 5 to 8 m. The area immediately to the southeast has been previously excavated and topsoil/overburden thickness appears to be around 1m. This zone may have some economic potential and direct investigation by trial pitting is recommended.
- There is a further area of around 5.2 ha consisting of the excavated area referred to above and an area to the southwest of it where sand/gravel is very thin or absent (See red dashed area on Drawing AGP22128_03).

Bedrock has been indicated by the seismic data at depths ranging from 3 to 25 m bgl depending on location and topography and generally corresponding to between 170 and 225 mOD with the deepest bedrock in the southeast of the site and shallowest in the northwest. The electrical resistivity of the rock (100 – 3,175 Ohm-m) and seismic velocities (2,500-3,400 m/s) are typical of thinly bedded sandstone, shale and mudstone.

4.1 RESOURCE ESTIMATE

The geophysical data have outlined a potential resource of 'clean' SAND/GRAVEL underlain by silty SAND/GRAVEL in **Zone A** with an average interpreted thickness of 11 m. **Zone B** has an average interpreted thickness of 5m of main silty SAND/GRAVEL and Zone C an average interpreted thickness of 6 m of mainly 'clean' SAND/GRAVEL.

The potential resource areas and estimated volumes allowing for a stand-off from boundaries of 30 m, from dwellings of 50 m and with a deduction of 5 % for fines are shown in Table 4.1 below. Potential resource areas are outlined in yellow on Drawing AGP22128_03.

Zone	Material	Extent	Average Thickness (0.7 correction applied) **	Computed Sand/Gravel Volume	Sand/Gravel Resource Tonnes ***
		(ha)	(m)	(cu.m)	(@1.8 t/cu.m. - 5% fines)
A	sand/gravel and silty sand/gravel	5.40	11.0	594,000	1,015,740
B	silty sand/gravel	8.10	5.0	405,000	692,550
C	sand/gravel and silty sand/gravel	1.00	6.0	60,000	102,600
Total					1,810,890

Table 4.1 Preliminary resource estimate.

** The estimated thicknesses shown on the ERT profiles have been multiplied by a calibration factor of 0.7, (this is due to the overestimation of the thickness of high resistivity materials, which is an artifact of resistivity data processing software.

*** A conversion density of 1.8 tonnes/cu.m. for SAND/GRAVEL has been used.

The main potential resource is located in Zone A (c. 1.0 m.t of 'clean' SAND/GRAVEL and silty SAND/GRAVEL) with a possible additional c. 0.7 m.t. of mainly silty SAND/GRAVEL in Zone B and c. 0.1 m.t in Zone C.

The above estimates are based on interpreted geophysical data and average heights from the topographic data acquired as part of the geophysical investigation. It is also assumed that the forested area in Zone B will be available for development. Confirmatory direct investigation by trial pitting is recommended.

Economic potential is subject to satisfactory laboratory testing, planning and development cost considerations.

5. RECOMMENDATIONS

Trial pits to confirm the findings of the geophysical survey are recommended at the following locations:

No.	Easting (ITM)	Northing (ITM)
TP1	626860.1	698102.7
TP2	626705.6	698119.0
TP3	626698.0	698214.2
TP4	626584.0	698091.4
TP5	626515.8	698006.1
TP6	626408.2	698078.5
TP7	626303.3	698125.5
TP8	626463.3	698176.4
TP9	626379.2	698250.7
TP10	626483.4	698481.9

A machine with a reach of 6 – 7 m should be used to open the pits. Samples should be taken for Particle Size Distribution (PSD) analysis and for chemical, physical, mechanical and laboratory tests to assess suitability for use.

Given the variable topography across the site a topographic survey is also recommended if Trial Pit results are positive. This will allow better estimation of volumes.

The geophysical report and volume estimates should be reviewed after any direct investigation.

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GSI, 2019b;
GSI/Teagasc Subsoils Shapefile. <http://www.gsi.ie/Mapping.htm>

GSI, 2019c;
Groundwater Vulnerability Shapefile. <http://www.gsi.ie/Mapping.htm>

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APPENDIX A: DETAILED GEOPHYSICAL METHODOLOGY

A combination of geophysical techniques was used to provide a high-quality interpretation and reduce any ambiguities, which may otherwise exist.

EM Ground Conductivity Mapping

Principles

This is an electromagnetic technique used to investigate lateral variations in overburden material and to assist with the indication of the depth to bedrock. This method operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). Readings over material such as organic waste and peat give high conductivity values while readings over dry materials with low clay mineral content such as gravels, limestone or quartzite give low readings. The EM31 survey technique determines the apparent conductivity of the different overburden layers from 0-6m bgl depending on the dipole mode used.

Data collection

The EM31 equipment used was a GF CMD-4 conductivity meter equipped with data logger and integrated GPS. This instrument features a real time graphic display of the previous 20 measurement points to monitor data quality and results. Conductivity and in-phase values were recorded across the site. Local conditions and variations were recorded.

Data processing

The conductivity and in-phase field readings were downloaded, contoured and plotted using the SURFER 12 program (Golden Software, 2015). Data which was affected by metallic objects was removed. Assignment of material types and possible anomaly sources was carried out, with cross-reference to other data.

Electrical Resistivity Tomography (ERT)

Electrical Resistivity Tomography was carried out to provide information on lateral variations in the overburden material as well as on the underlying overburden and bedrock.

Principles

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. This method involves the use of electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

Data Collection

Profiles were recorded using an ABEM LS4 resistivity meter, imaging software, four 21 takeout multicore cables and up to 80 stainless steel electrodes. Saline solution was used at the electrode/ground interface in order to gain a good electrical contact required for the technique to work effectively. The recorded data were processed and viewed immediately after surveying.

Data Processing

The field readings were stored in computer files and inverted using the RES2DINV package (Geotomo Software, 2006) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-depth model of the resistivities.

The inverted 2D resistivity models and corresponding interpreted geology are displayed on the accompanying drawings alongside the processed seismic sections. Profiles have been contoured using the same contour intervals and colour codes. Distance is indicated along the horizontal axis of the profiles.

Seismic Refraction Profiling

Principles

This method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities.

Seismic profiling measures the p-wave velocity (V_p) of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher V_p velocities while soft, loose or fractured materials have lower V_p velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

Data Collection

A Geode high resolution 24 channel digital seismograph, 24 10HZ vertical geophones and a 10 kg hammer were used to provide first break information, with a 24 take-out cable. Equipment was carried and operated by a two-person crew.

Readings are taken using geophones connected via multi-core cable to a seismograph. The depth of resolution of soil/bedrock boundaries is determined by the length of the seismic spread, typically the depth of resolution is about one third the length of the profile. (eg. 69m profile ~23m depth, 33m profile ~ 11m depth).

Data Processing

First break picking in digital format was carried out using the FIRSTPIX software program to construct p-wave (V_p) traveltime plots for each spread. Velocity phases were selected from these plots using the GREMIX software program and were used to calculate the thickness of individual velocity units. Topographic data were input. Material types were assigned and estimation made of material properties. The processed seismic data are displayed in Appendix C.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped; one deduced from direct arrivals and three deduced from refractions. Phantomming of all possible travel time pairs can be carried out.

Approximate errors for V_p velocities are estimated to be +/- 10%. Errors for the calculated layer thicknesses are

of the order of +/-20%. Possible errors due to the "hidden layer" and "velocity inversion" effects may also occur (Soske, 1959).

Spatial Relocation

All ERT and Seismic Refraction locations were acquired using a Trimble Geo 7X high-accuracy GNSS handheld system using the settings listed below. This system allows collection of GPS data with c.20mm accuracy.

Projection:	Irish Transverse Mercator
Datum:	Ordnance
Coordinate units:	Metres
Altitude units:	Metres
Survey altitude reference:	MSL
Geoid model:	Republic of Ireland

The EM conductivity locations were acquired using a system integrated GPS receiver to an x,y accuracy of +/- 5m or better and converted to ITM.

APPENDIX B: DRAWINGS

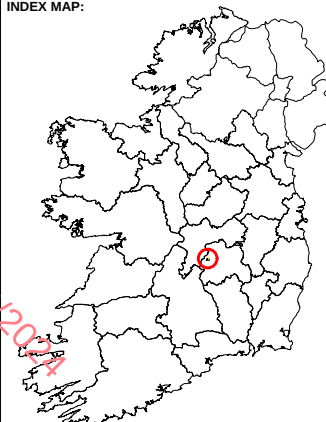
The information derived from the geophysical investigation presented in the following drawings:

AGP21228_01 Geophysical Locations	1:4000	@ A4
AGP21228_02 EM Conductivity Results	1:4000	@ A4
AGP21228_03 Summary Interpretation Map	1:4000	@ A4
AGP21228_R1 ERT Profile R1 & Seismic Profile S2 Results & Interpretation	1:2000	@ A4
AGP21228_R2 ERT Profile R2 Results & Interpretation	1:1000	@ A4
AGP21228_R3 ERT Profile R3 Results & Interpretation	1:1000	@ A4
AGP21228_R4 ERT Profile R4 Results & Interpretation	1:1000	@ A4
AGP21228_R5 ERT Profile R5 Results & Interpretation	1:1000	@ A4
AGP21228_R6 ERT Profile R6 & Seismic Profile S1 Results & Interpretation	1:1000	@ A4
AGP21228_R7 ERT Profile R7 Results & Interpretation	1:1000	@ A4
AGP21228_R8 ERT Profile R8 Results & Interpretation	1:1000	@ A4
AGP21228_R9 ERT Profile R9 & Seismic Profile S3 Results & Interpretation	1:1000	@ A4
AGP21228_R10 ERT Profile R10 Results & Interpretation	1:1000	@ A4

GEOPHYSICAL LOCATIONS
SCALE 1:4000



INDEX MAP:



LEGEND:

- Site
- + EM conductivity reading
- R1 — 2D resistivity profile
- S1 — Seismic refraction profile

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



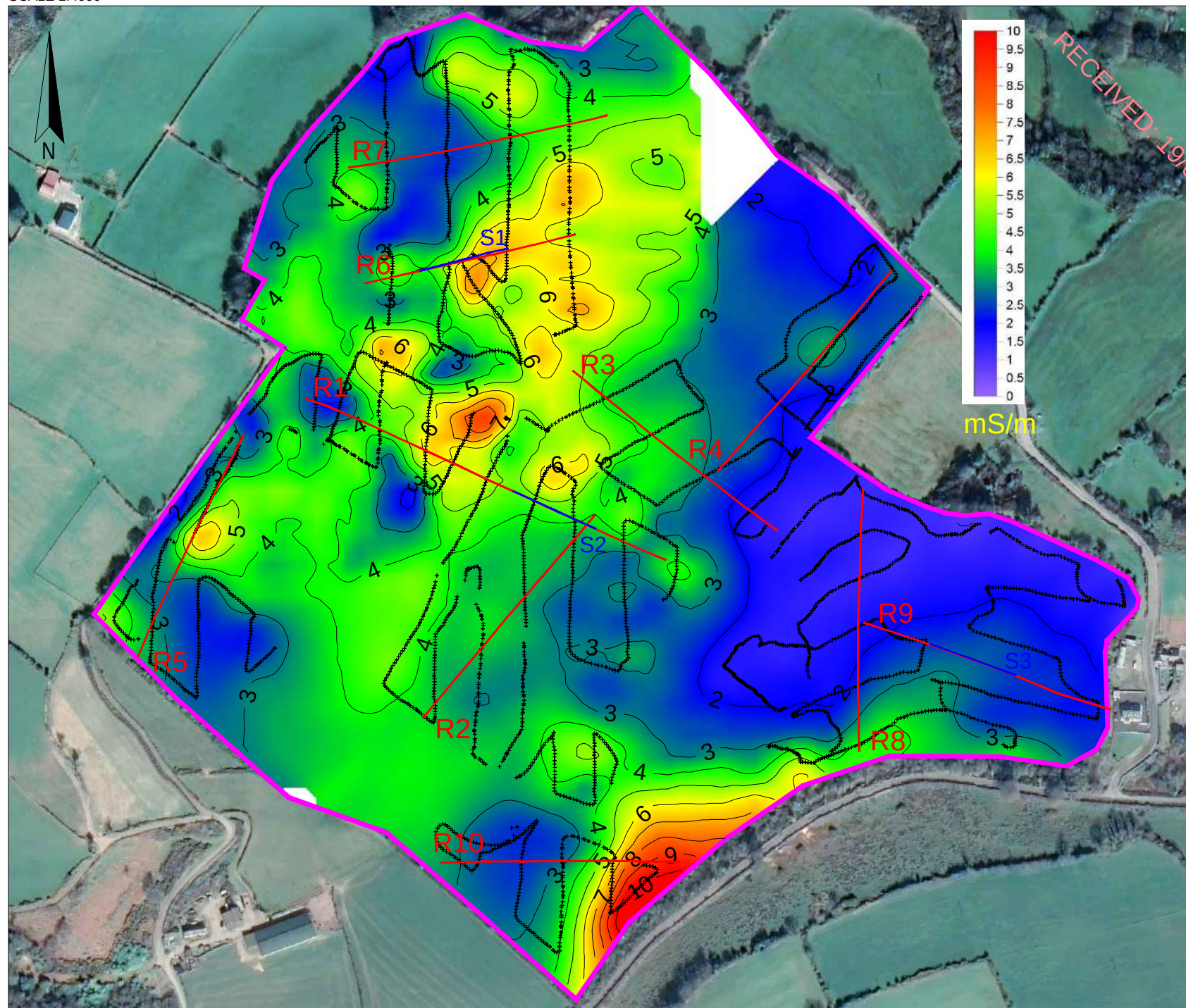
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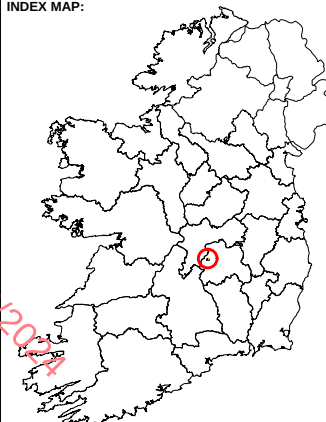
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CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_01		
SCALE:	AS INDICATED @ A4		
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EM CONDUCTIVITY RESULTS

SCALE 1:4000



INDEX MAP:



LEGEND:

- Site
- EM conductivity reading
- R1 2D resistivity profile
- S1 Seismic refraction profile

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_02

SCALE: AS INDICATED @ A4

DATE: 08-08-2022

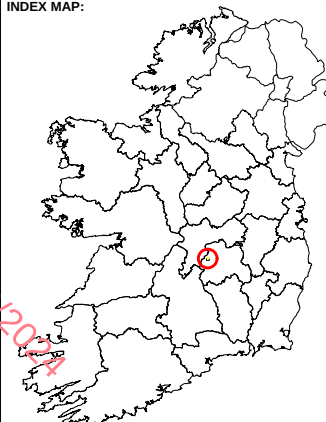
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SUMMARY INTERPRETATION

SCALE 1:4000



INDEX MAP:



LEGEND:

- SAND/GRAVEL and silty SAND/GRAVEL
- Silty SAND/GRAVEL
- Sandy/gravelly Clay
- Alluvium
- Potential Resource Area
- Proposed Trial Pit

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.

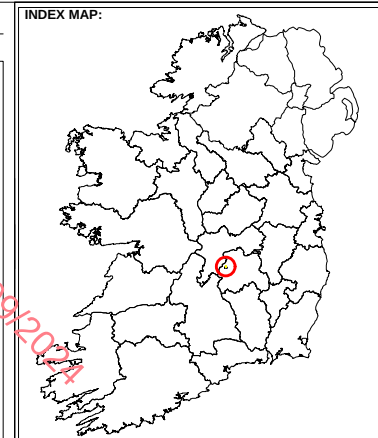
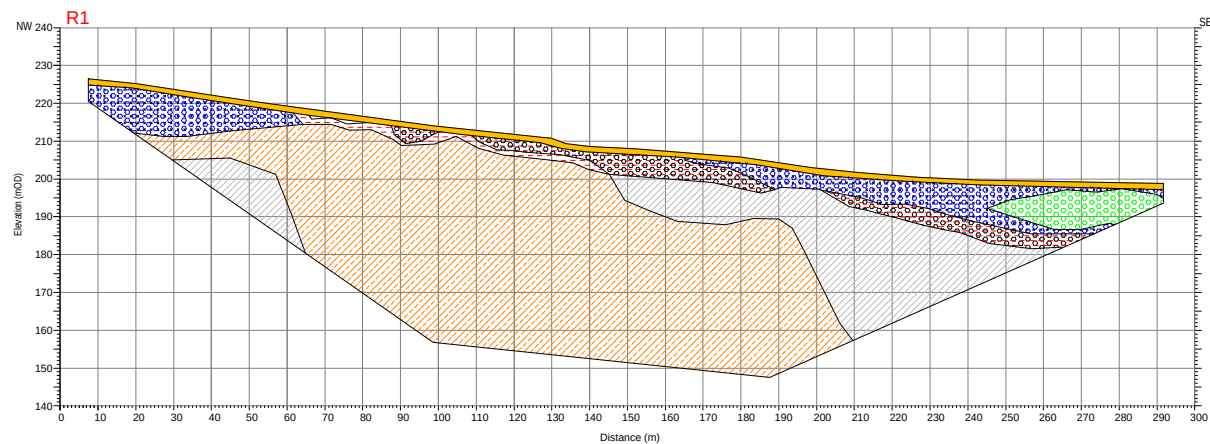
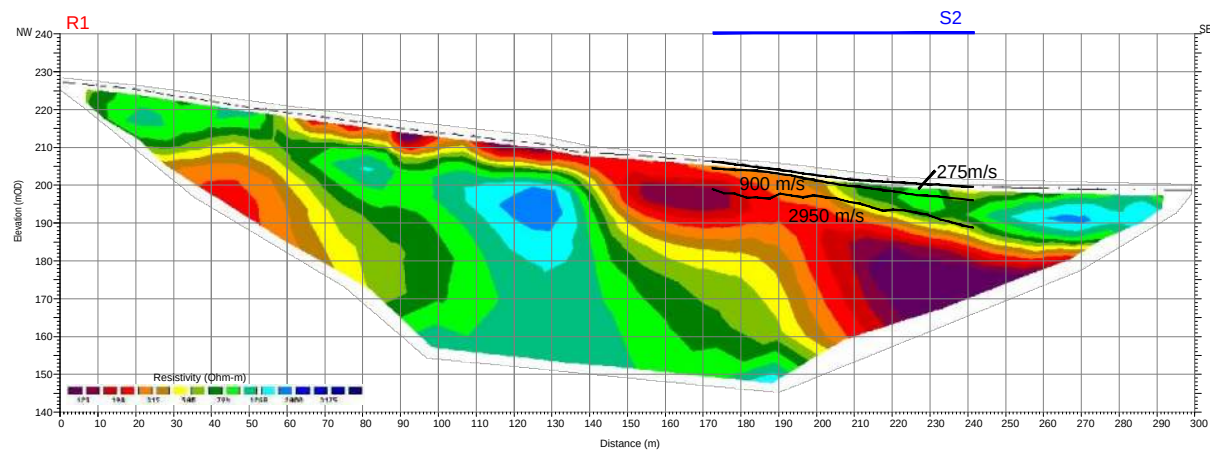


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PROJECT:	MOUNTHALL CAMROSS GEOPHYSICAL SURVEY		
CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_03		
SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
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ERT PROFILE R1 AND SEISMIC PROFILE S2 RESULTS AND INTERPRETATION
SCALE 1:2000



- LEGEND:**
- Topsoil
 - Sandy gravelly CLAY
 - Clayey silty SAND/GRAVEL
 - Silty SAND/GRAVEL
 - SAND/GRAVEL
 - MUDSTONE/SHALE
 - SANDSTONE
 - Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.

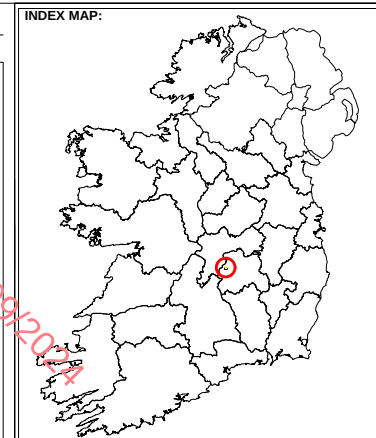
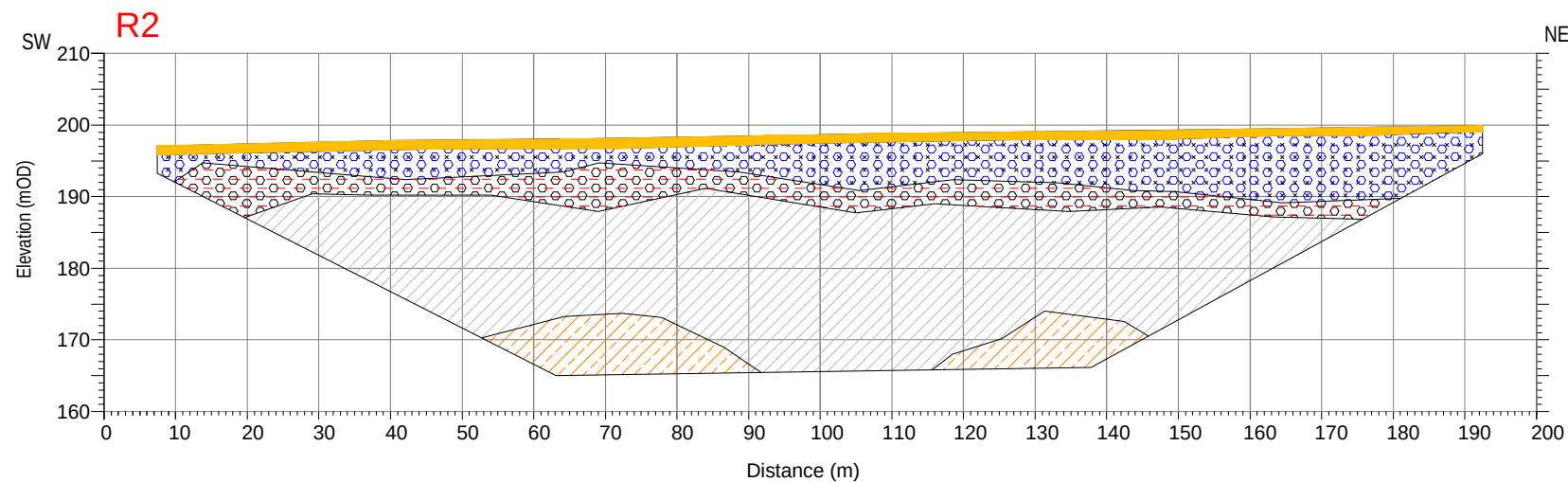
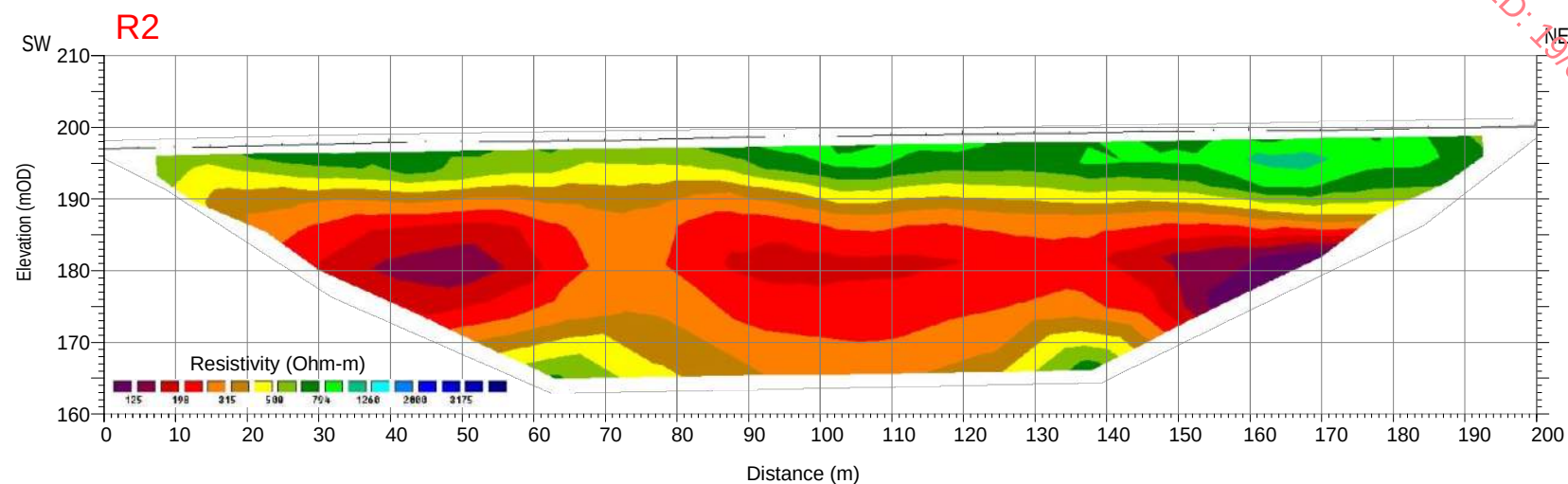
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SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

SCALE 1:1000



LEGEND:

-  Topsoil
 Sandy gravelly CLAY
 Clayey silty SAND/GRAVEL
 Silty SAND/GRAVEL
 SAND/GRAVEL
 MUDSTONE/SHALE
 SANDSTONE
 Seismic refraction layer
 1254-1288 m/s with velocity in metres/second

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CLIENT.:	BREEDON GROUP
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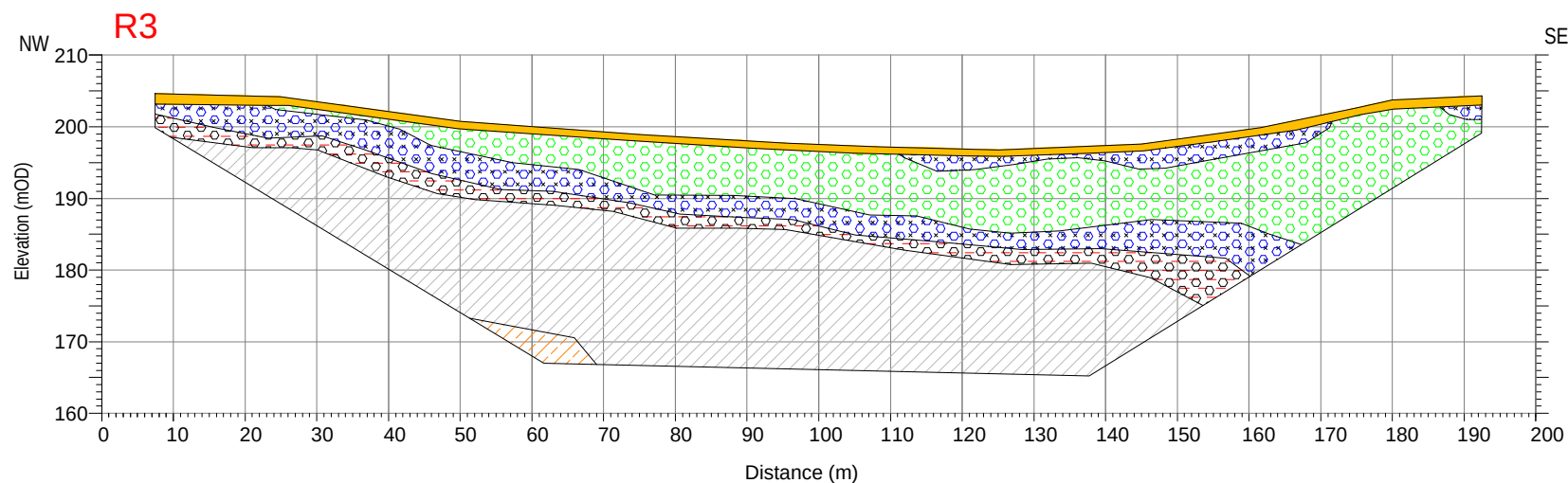
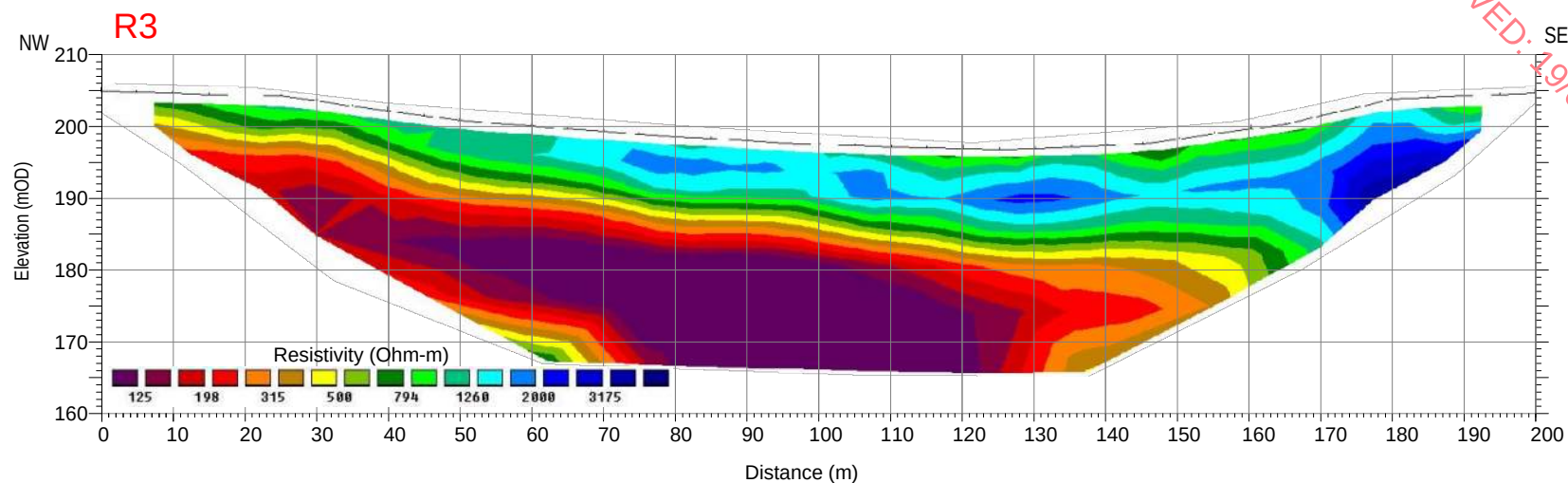
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DATE: 08-08-2022

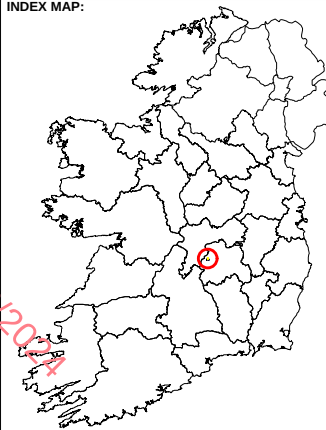
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001	08-08-2022	POC	TL

ERT PROFILE R3 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_R3

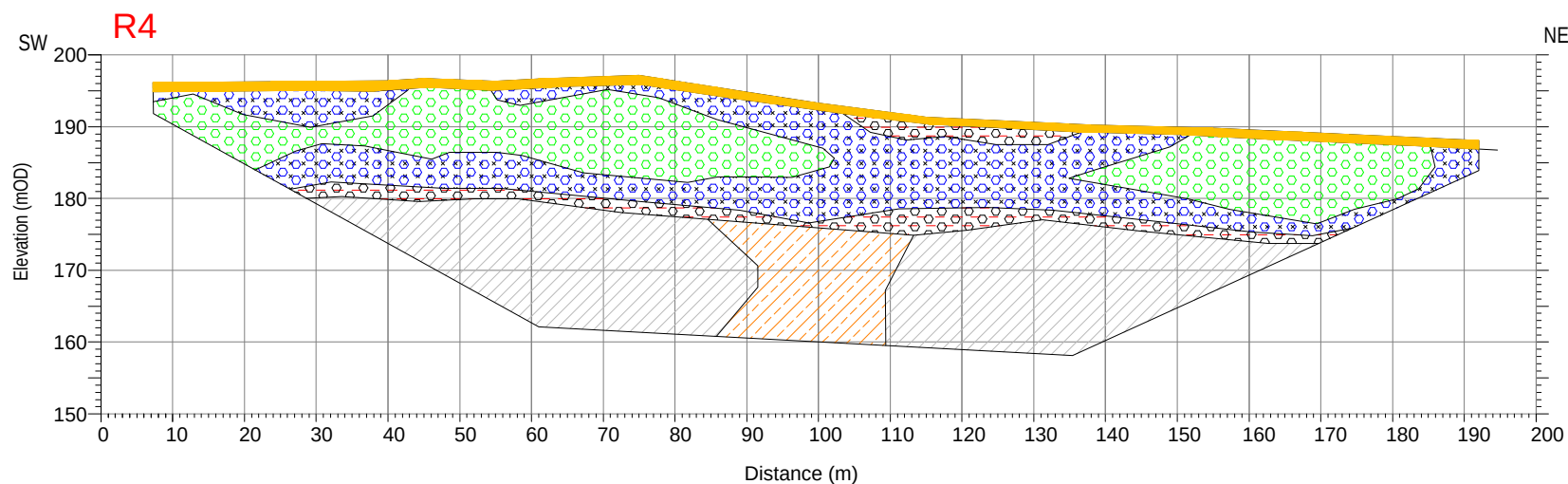
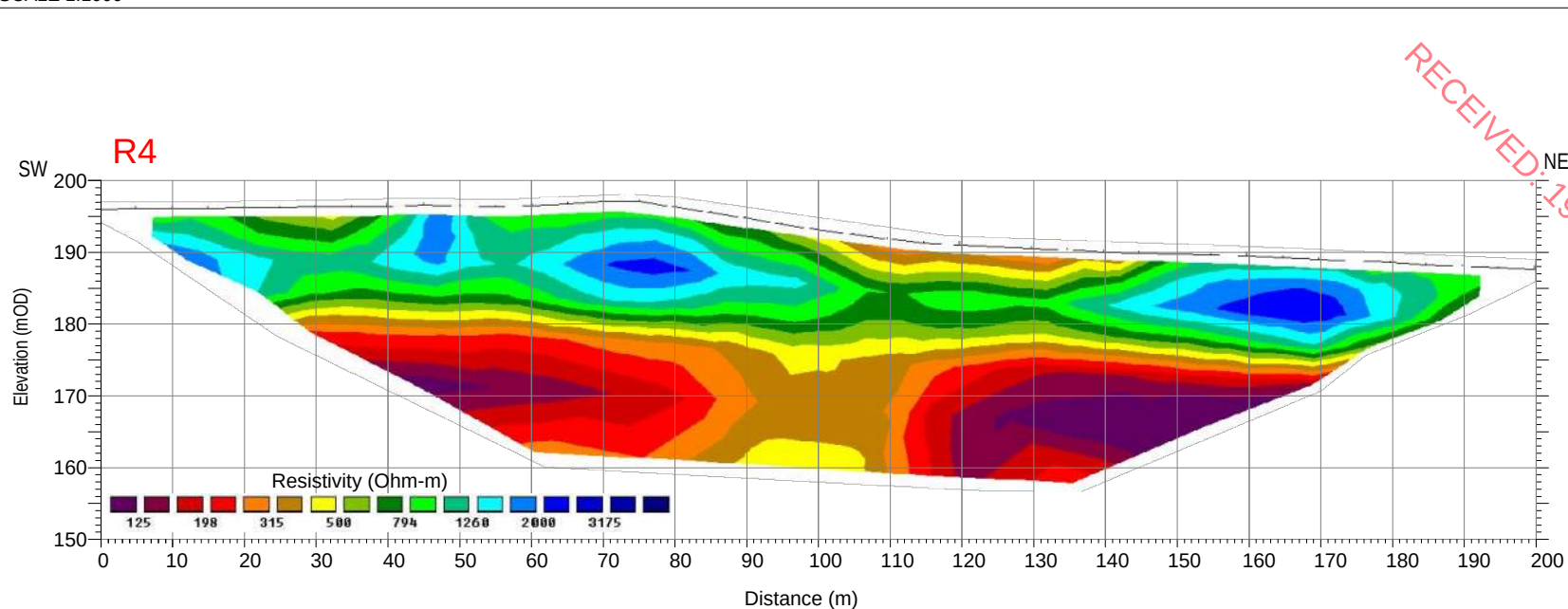
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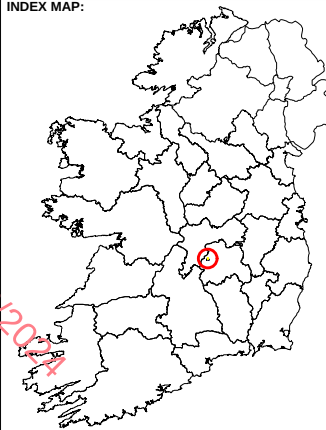
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001	08-08-2022	POC	TL

ERT PROFILE R4 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_R4

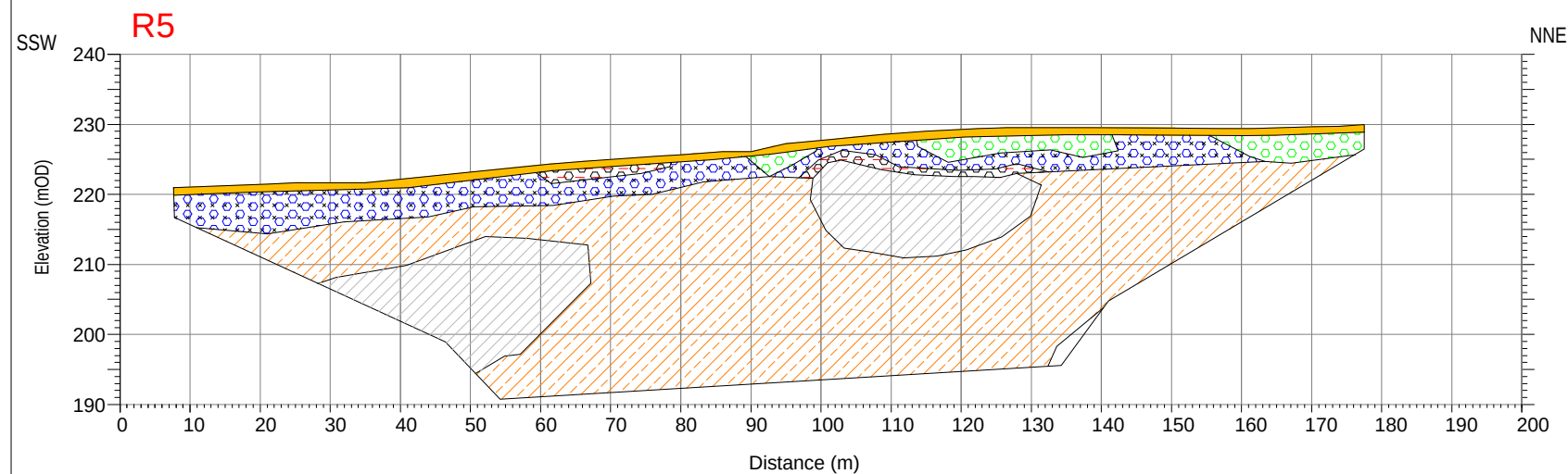
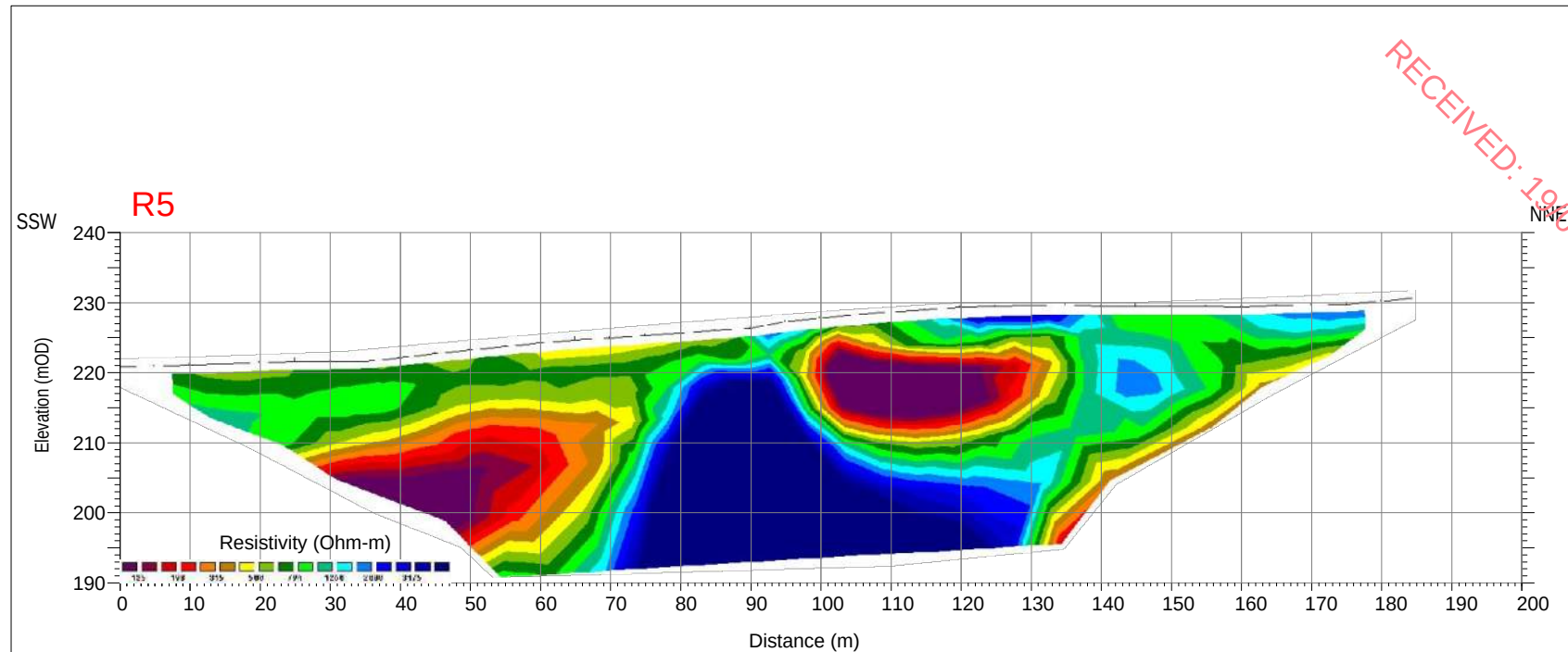
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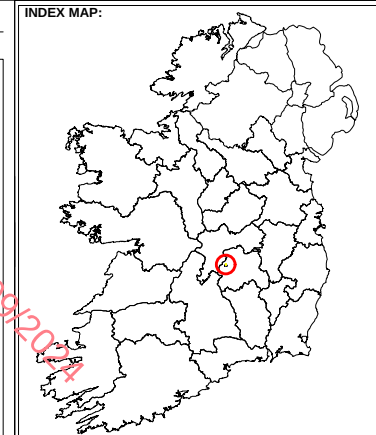
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001	08-08-2022	POC	TL

ERT PROFILE R5 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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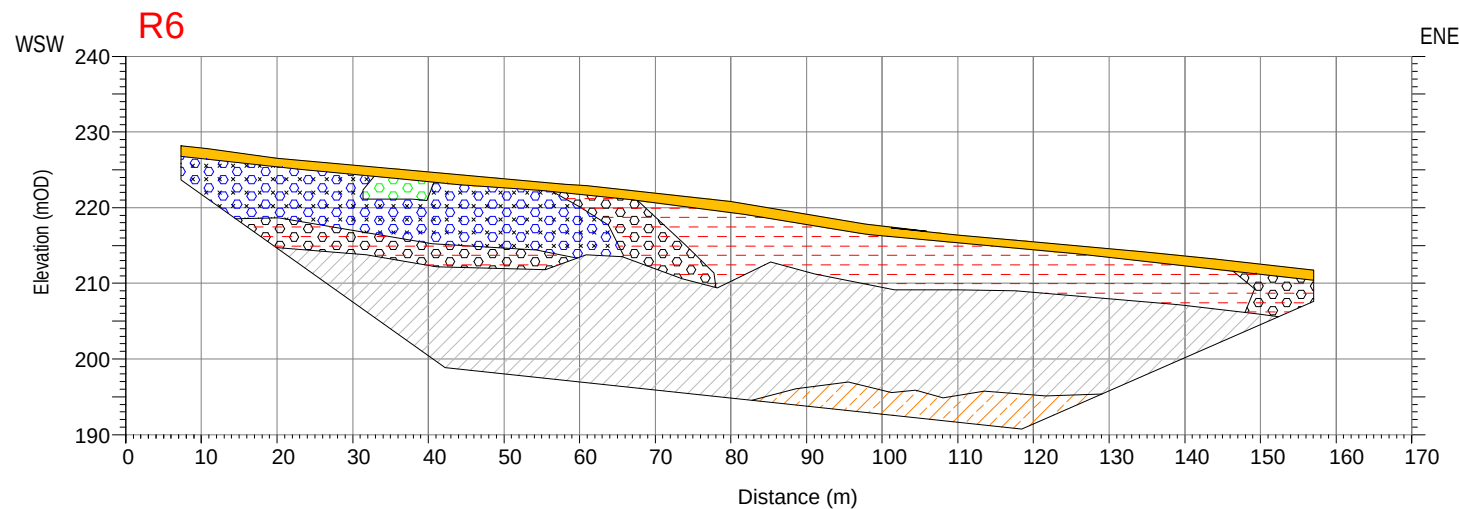
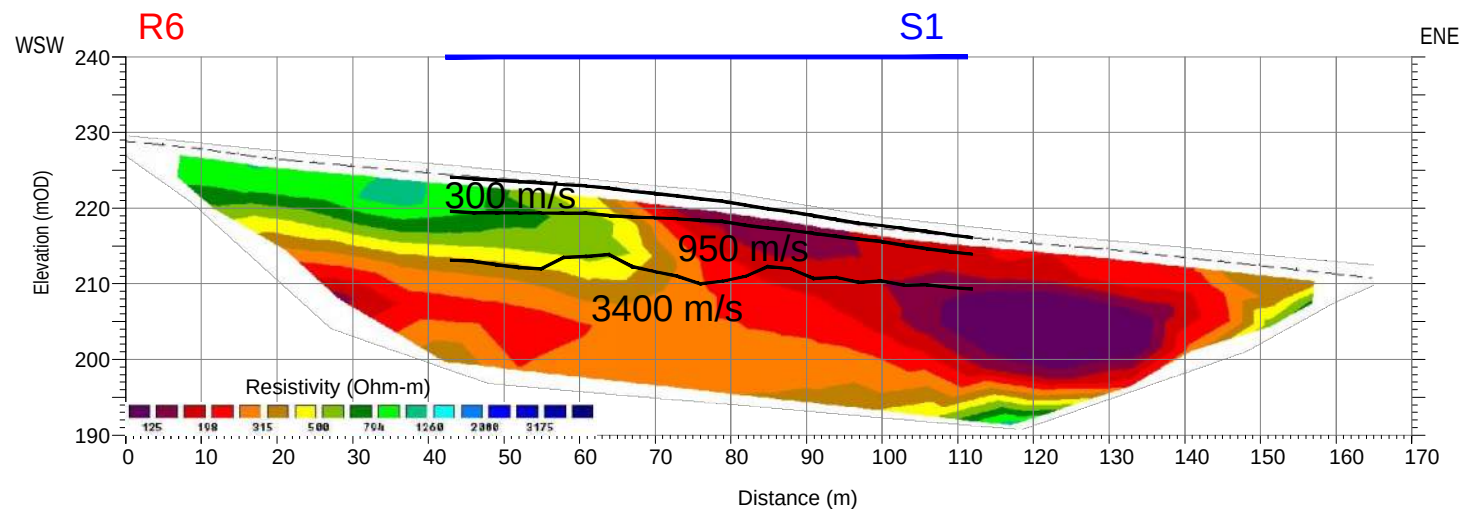
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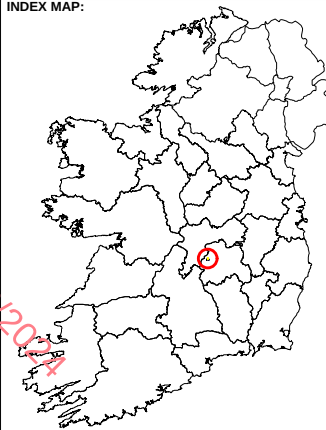
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R6 AND SEISMIC PROFILE S1 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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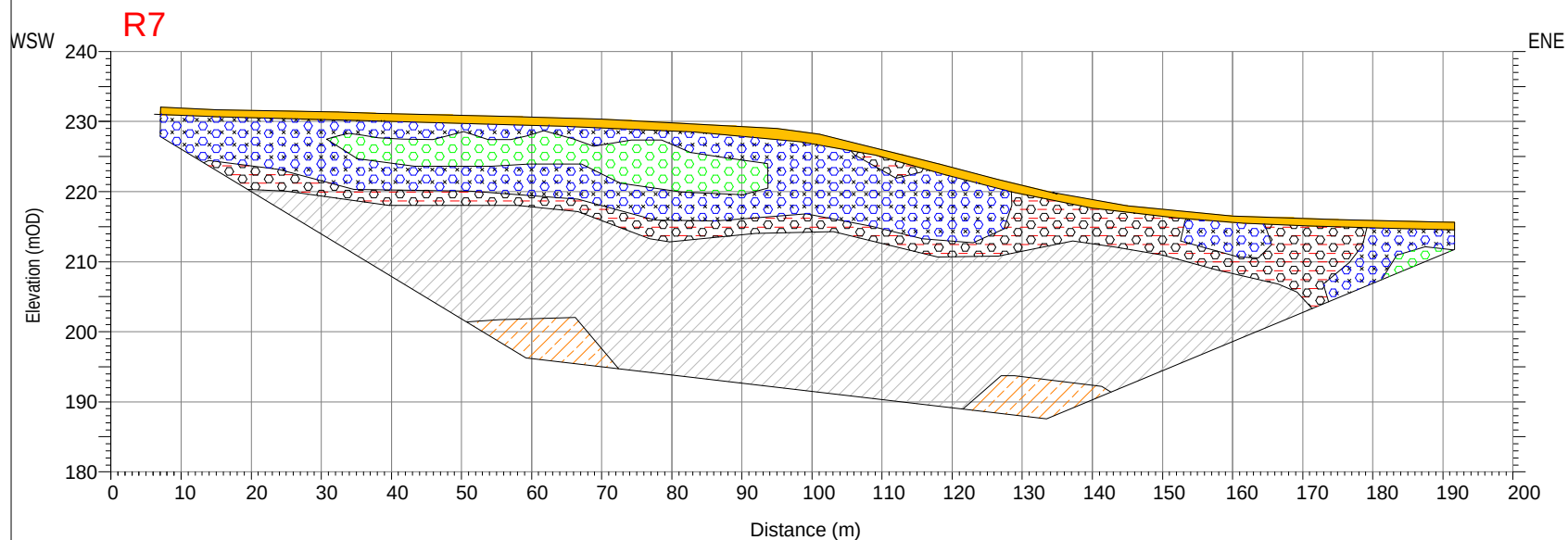
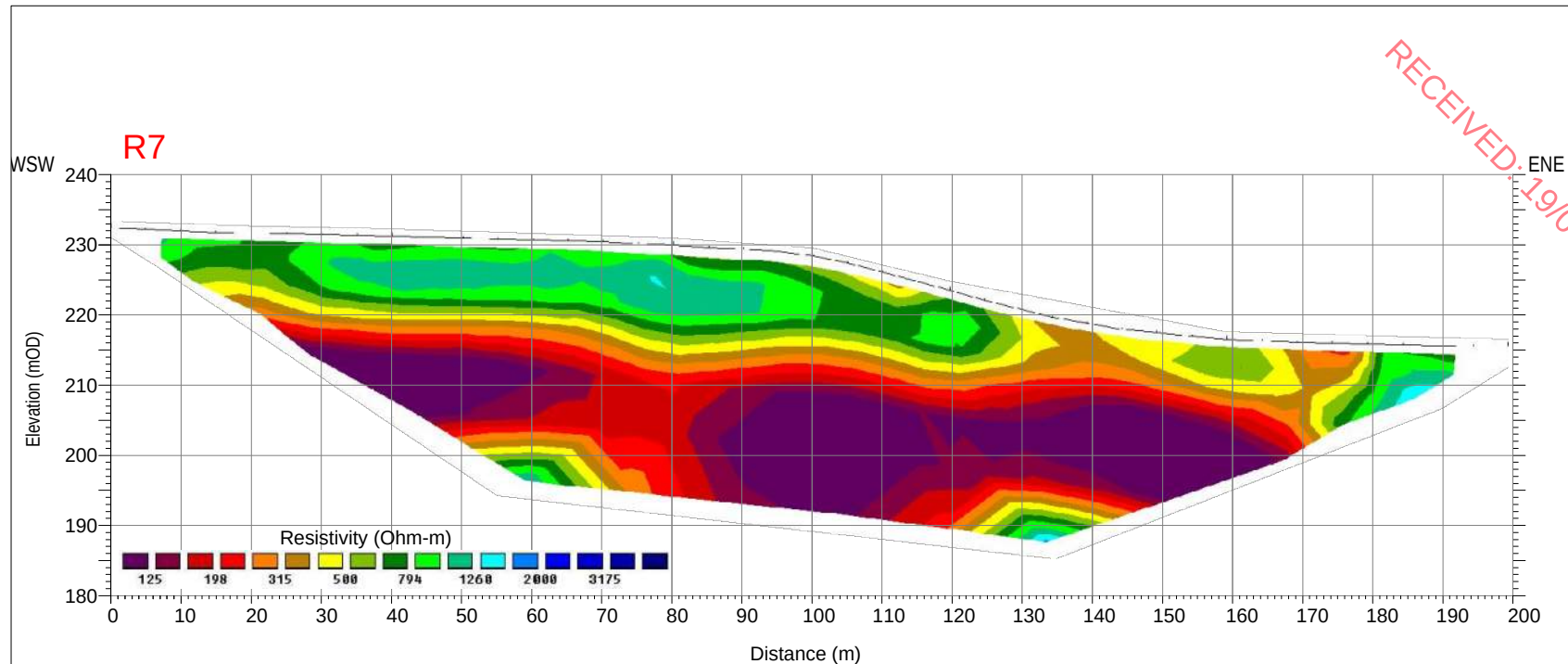
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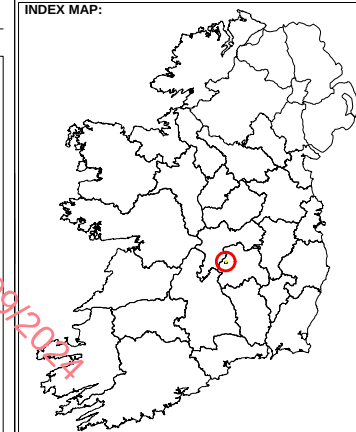
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R7 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



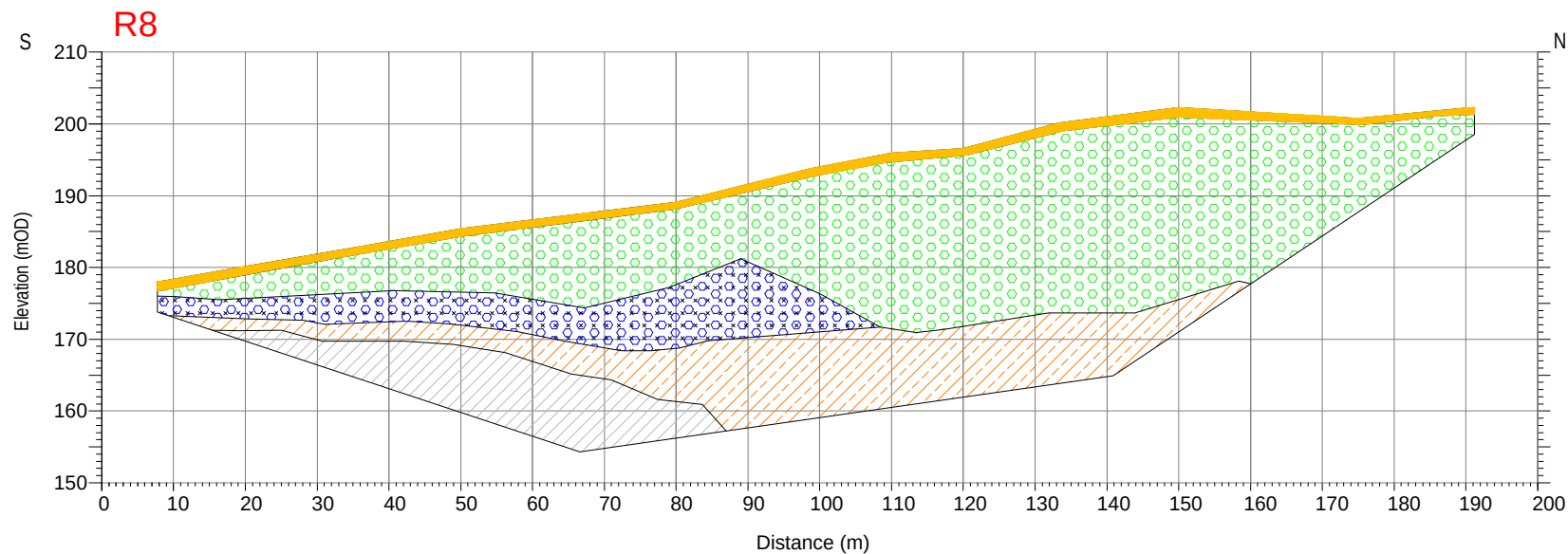
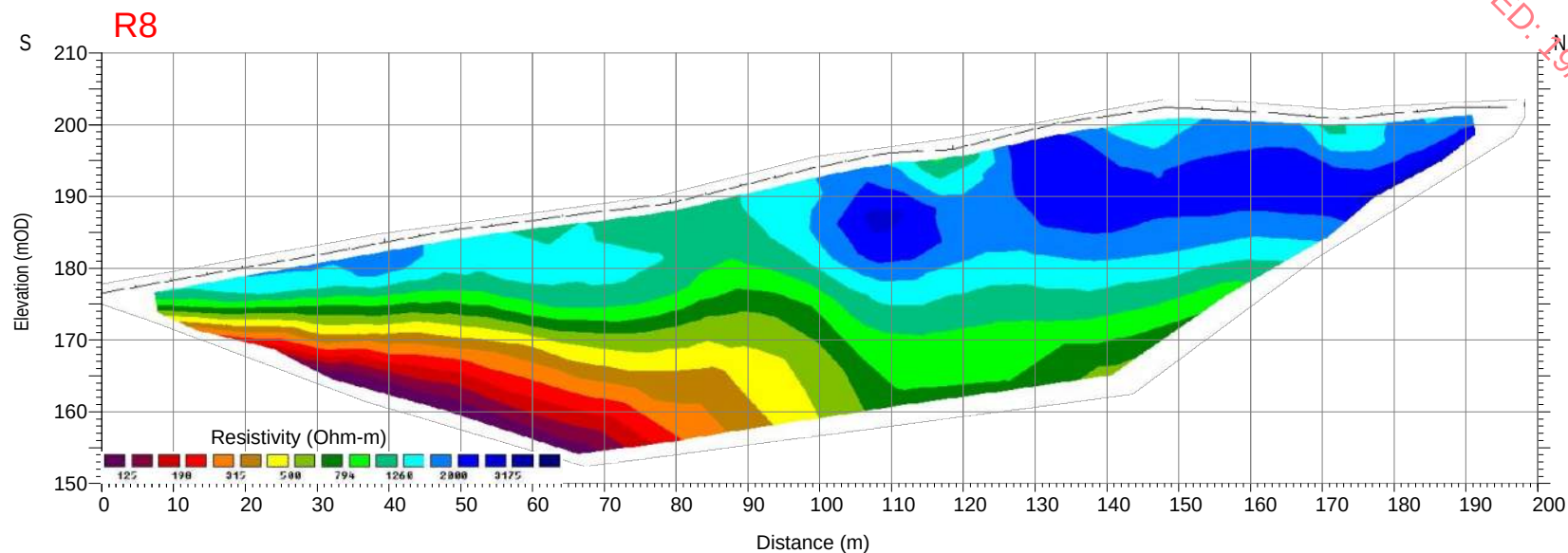
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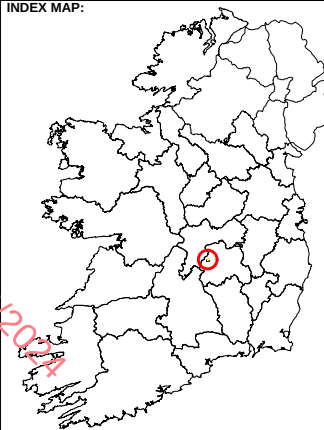
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
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ERT PROFILE R8 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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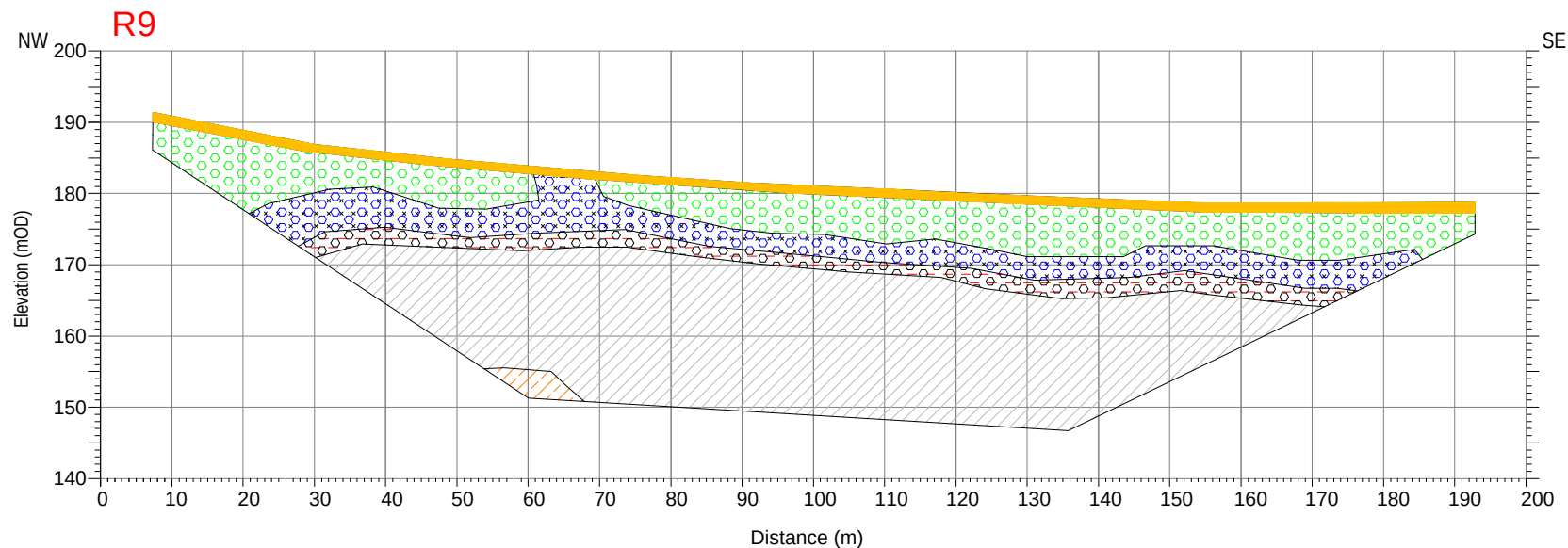
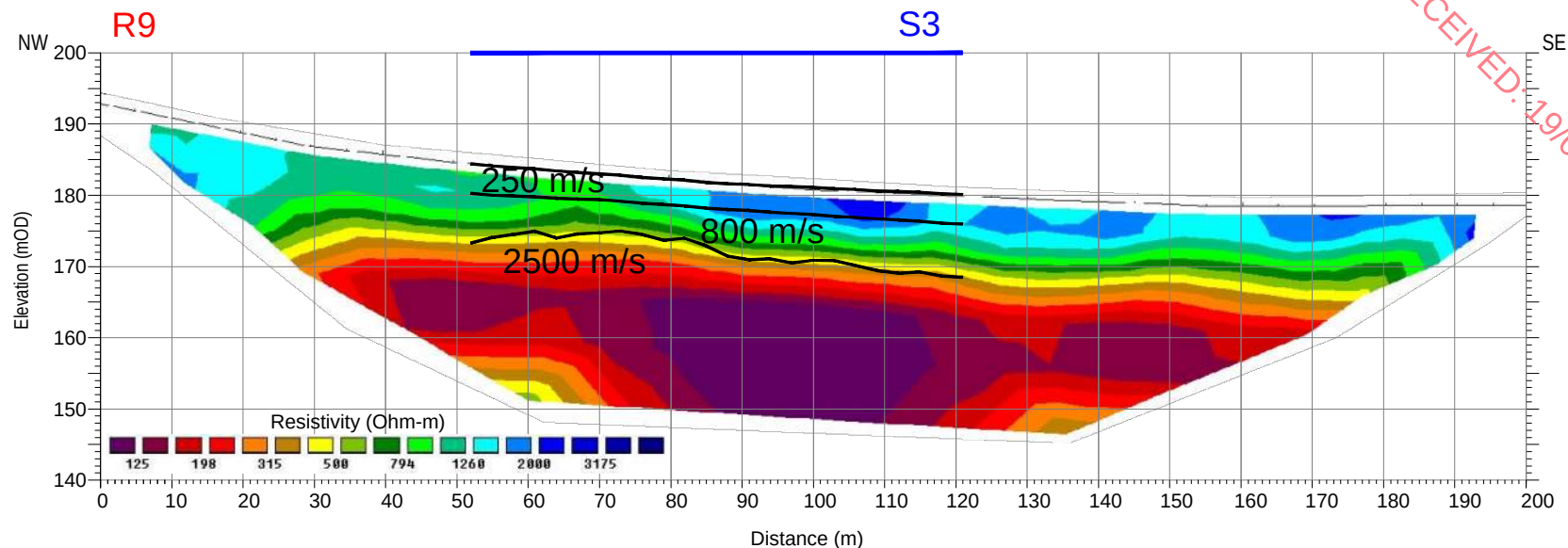
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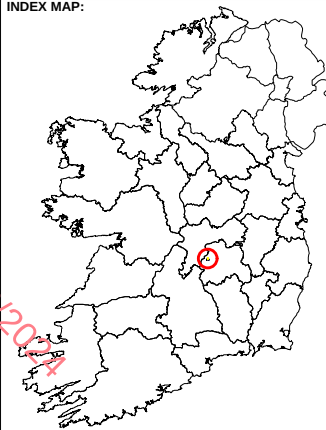
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Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R9 AND SEISMIC PROFILE S3 RESULTS AND INTERPRETATION

SCALE 1:2000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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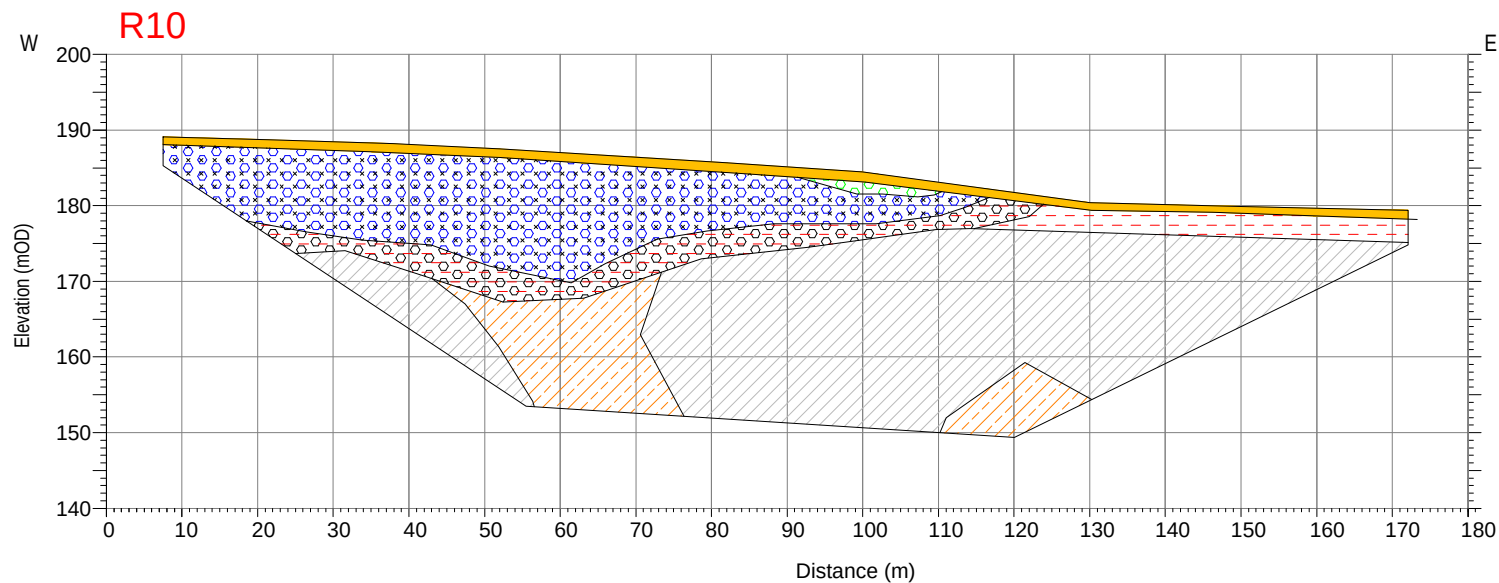
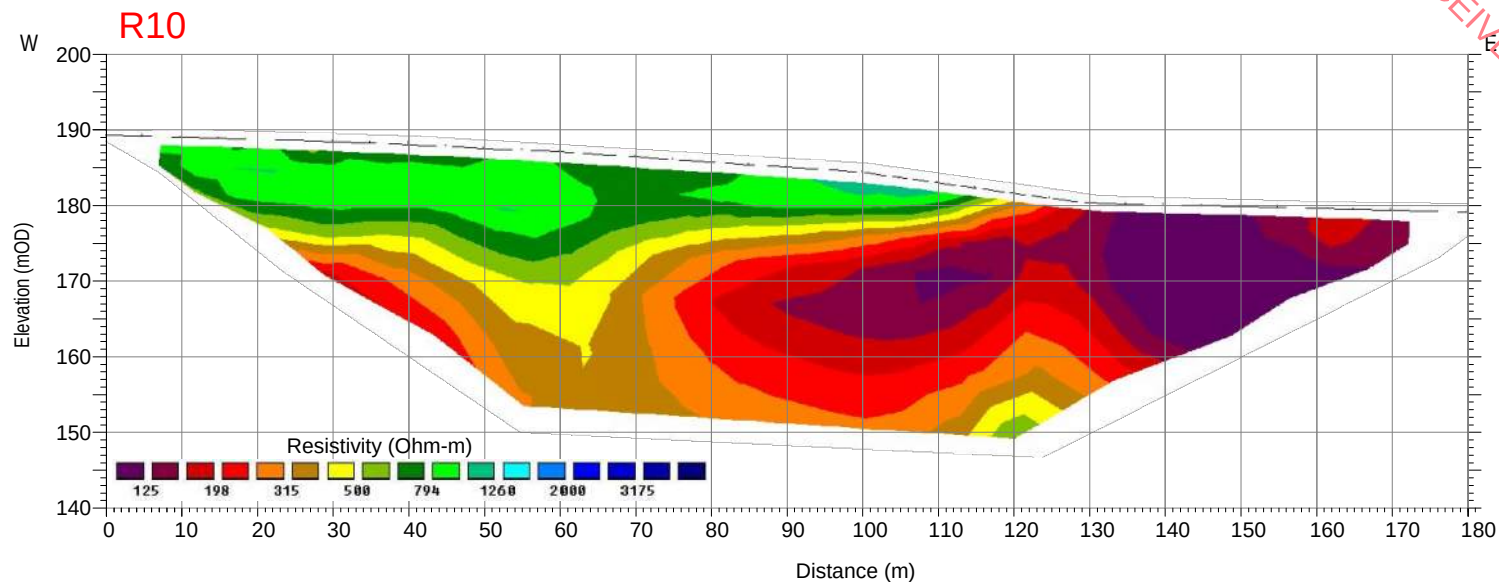
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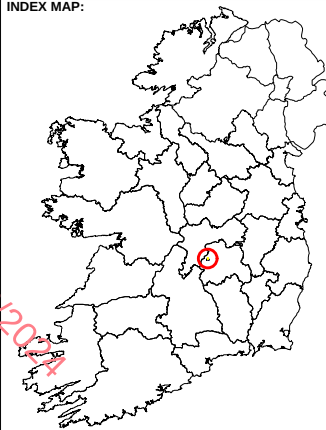
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Version:	Date:	Drawn By:	Checked:
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ERT PROFILE R10 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



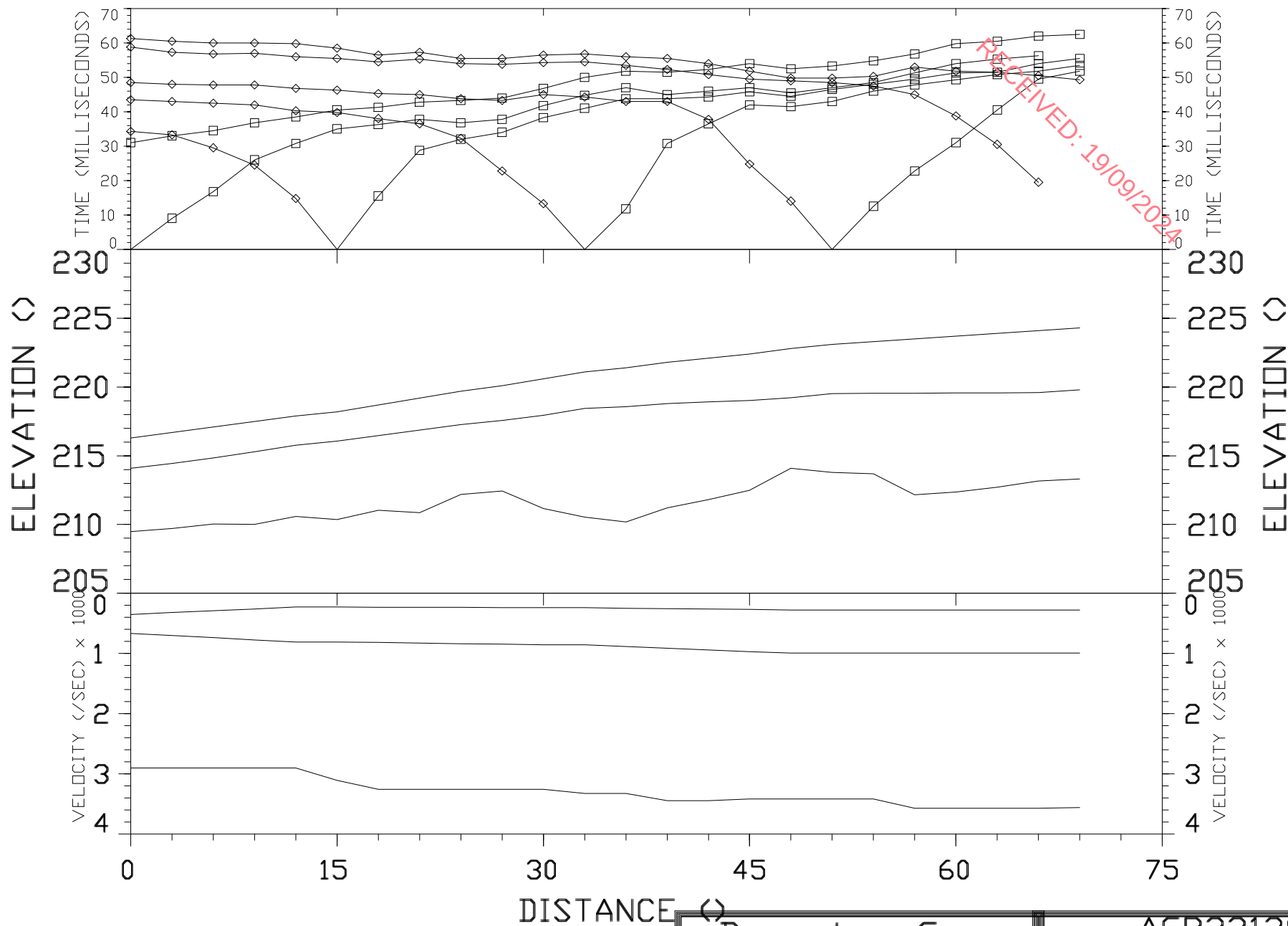
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PROJECT:	MOUNTHALL CAMROSS GEOPHYSICAL SURVEY		
CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_R10		
SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
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APPENDIX C: SEISMIC PLATES

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Breedon Group		AGP22128
by: APEX Geophysics Ltd.		Mounthall Camross
Data SetS1	Date: 08/07/2022	Laois
Equipment: Geode	Spread: S1	Azimuth:

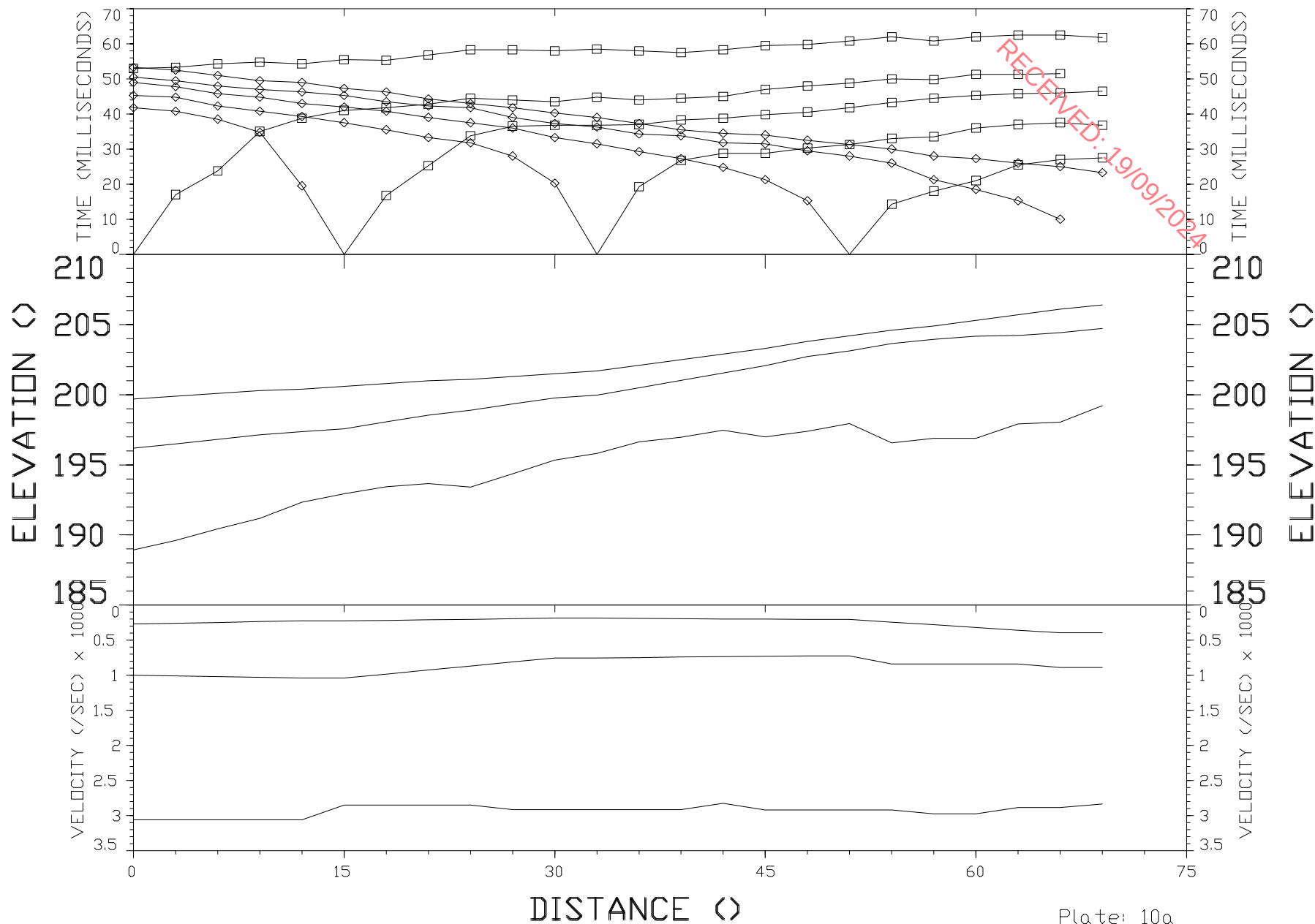
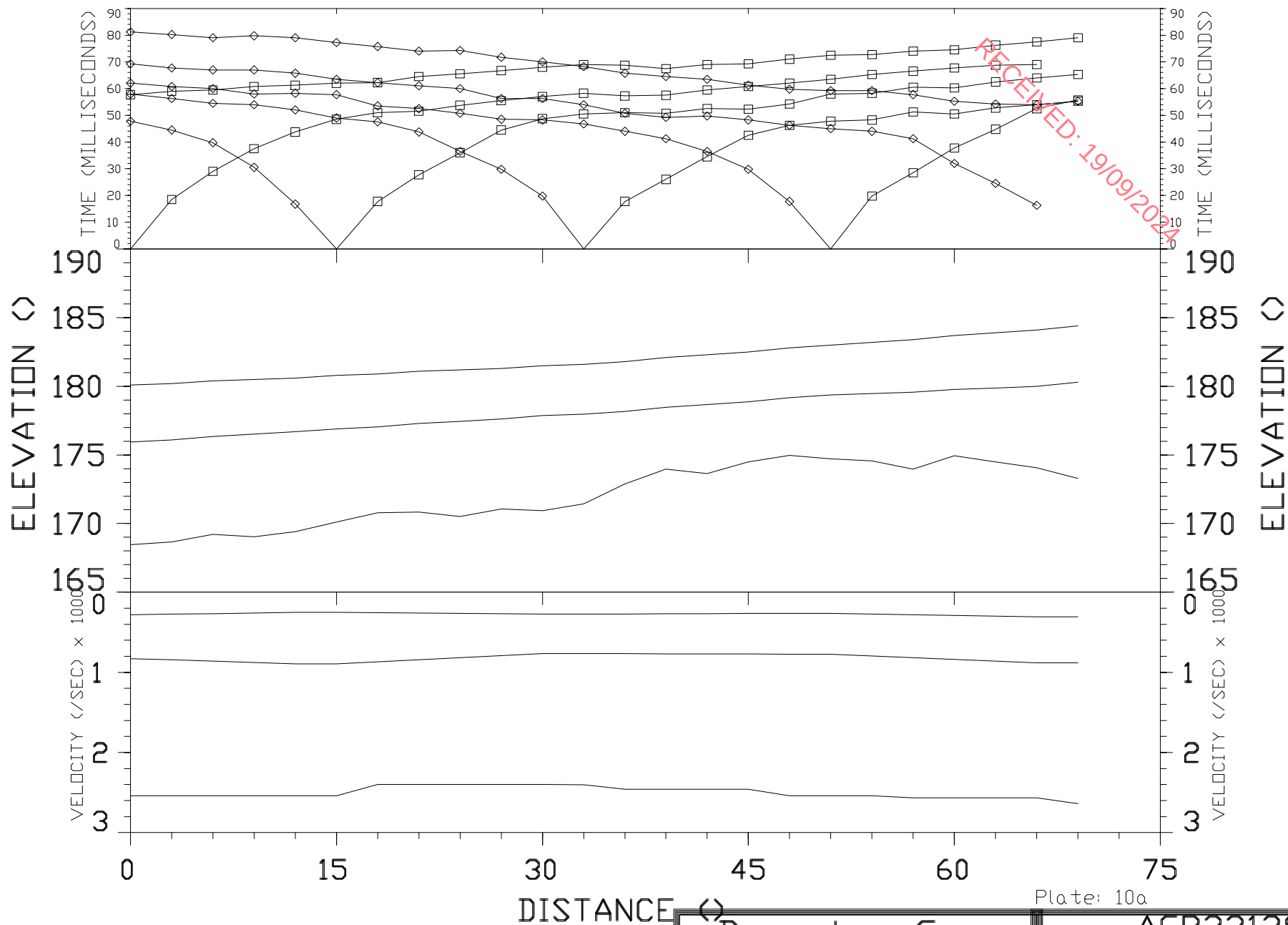


Plate: 10a

Breedon Group		AGP22128	
by: APEX Geophysics Ltd.		Mounthall Camross	
Data SetS2		Date: 08/07/2022	
Equipment: Geode		Spread: S2	
		Azimuth:	



Breedon Group		AGP22128	
by: APEX Geophysics Ltd.		Mounthall Camross	
Data SetS3	Date: 08/07/2022	Laois	
Equipment: Geode	Spread: S3	Azimuth:	

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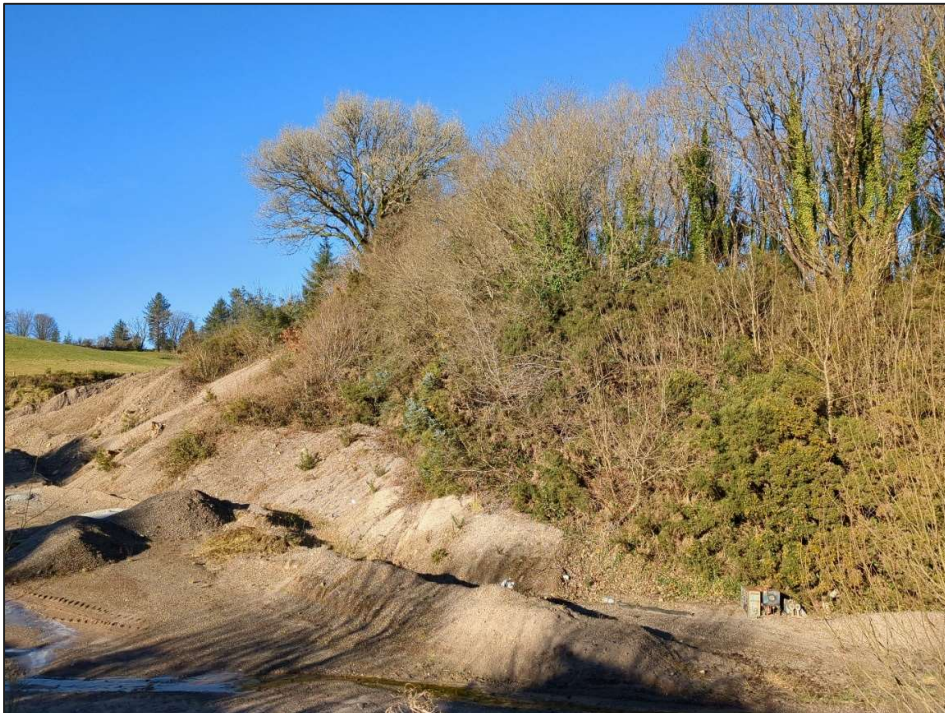
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Appendix 6-C: Exposures at Existing Sand & Gravel Pit

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Appendix 6-D: Geophysical Investigation

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**REPORT
ON THE
GEOPHYSICAL INVESTIGATION
AT
MOUNTHALL, CAMROSS,
Co. LAOIS
FOR
THE BREEDON GROUP.**



**APEX Geophysics Limited
Unit 6, Knockmullen Business Park
Gorey
Co. Wexford**

8TH AUGUST 2022

**T: 0402 21842
E: info@apexgeophysics.ie
W: www.apexgeophysics.com**

RECEIVED: 19/09/2024

PRIVATE AND CONFIDENTIAL

THE FINDINGS OF THIS REPORT ARE THE RESULT OF A GEOPHYSICAL SURVEY USING NON-INVASIVE SURVEY TECHNIQUES CARRIED OUT AT THE GROUND SURFACE. INTERPRETATIONS CONTAINED IN THIS REPORT ARE DERIVED FROM A KNOWLEDGE OF THE GROUND CONDITIONS, THE GEOPHYSICAL RESPONSES OF GROUND MATERIALS AND THE EXPERIENCE OF THE AUTHOR. APEX GEOPHYSICS LTD. HAS PREPARED THIS REPORT IN LINE WITH BEST CURRENT PRACTICE AND WITH ALL REASONABLE SKILL, CARE AND DILIGENCE IN CONSIDERATION OF THE LIMITS IMPOSED BY THE SURVEY TECHNIQUES USED AND THE RESOURCES DEVOTED TO IT BY AGREEMENT WITH THE CLIENT. THE INTERPRETATIVE BASIS OF THE CONCLUSIONS CONTAINED IN THIS REPORT SHOULD BE TAKEN INTO ACCOUNT IN ANY FUTURE USE OF THIS REPORT.

PROJECT NUMBER	AGP22128		
AUTHOR	CHECKED	REPORT STATUS	DATE
EURGEOL. PETER O'CONNOR PGEO., M. SC. (GEOPHYSICS), DIP EIA MGT.	EURGEOL YVONNE O'CONNELL P.GEO., PH.D. (GEOPHYSICS)	V.02	8 TH AUGUST 2022

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1. EXECUTIVE SUMMARY

APEX Geophysics Limited was requested by Breedon Group to carry out a geophysical investigation at Mounthall Camross, Co. Laois. The site has potential for sand and gravel deposits. The objective of the investigation was to provide information on sand and gravel thickness, overburden thickness and depth to bedrock.

The site is at Mounthall, Co. Laois, approximately 20 km west of Portlaoise and covers an area of approximately 32 ha of open agricultural fields and forestry. There is an existing sand/gravel pit in the northeastern part of the site. Site topography ranges from 176.6 to 232.3 m OD. The Geological Survey of Ireland (GSI) Bedrock Geology map shows pale & red sandstone, grit & claystone of the Cadamstown Formation. The Quaternary Sediments map shows gravels in the northern and eastern part of the site, and till and alluvium in the southern and western part. The bedrock is classified as a 'Locally important aquifer – Bedrock which is moderately productive only in local zones'. The sand/gravel deposits are not classified as an aquifer.

The survey was carried out on the 7th, 8th and 14th July 2022 with the collection of EM conductivity readings, 10 ERT profiles and 3 seismic refraction profiles. No readings were obtained within the forested areas in the west of the site. The following zones have been outlined based on the geophysical interpretation:

Zone A in the east of the site is mainly 'clean' SAND/GRAVEL underlain by some silty SAND/GRAVEL and extends to approximately 9.1 ha in total with interpreted sand/gravel thickness from 7 to 15 m (average 11 m). This zone may have economic potential.

Zone B in the west of the site is mainly silty SAND/GRAVEL with some 'clean' SAND/GRAVEL and extends to approximately 12.3 ha. Interpreted sand/gravel thickness is thin ranging from 3 m to 8 m (average 5 m) and may be discontinuous in places. Topsoil/overburden thickness appears to be around 1m. This zone may have economic potential but the variable thickness and quality may limit development.

Zone C is a smaller area of 'clean' SAND/GRAVEL surrounded by silty SAND/GRAVEL that forms the rising ground in the north of the site. It extends to approximately 5.3 ha and interpreted sand/gravel thickness ranges from 5 to 8 m (average 6 m). This zone may have some economic potential but is quite small.

Estimated topsoil/overburden thickness in the above areas is around 1m. There is a further area of around 5.2 ha in the northwest consisting of the excavated area referred to in Zone C above and an area to the southwest of this to the southwest where sand/gravel is very thin or absent.

Bedrock has been indicated by the seismic data at depths ranging from 3 to 25 m bgl depending on location and topography and generally corresponds to between 170 and 225 mOD being deepest in the southeast. The electrical resistivity and seismic velocities are typical of thinly bedded sandstone, shale and mudstone.

Confirmatory direct investigation by trial pitting is recommended with samples taken for Particle Size Distribution (PSD) analysis and chemical, physical, mechanical and laboratory tests. A topographic survey is also recommended. Economic potential is subject to laboratory testing, planning and development cost.

The geophysical report should be reviewed after any direct investigation.

2. INTRODUCTION

APEX Geophysics Limited was requested by the Breedon Group to carry out a geophysical investigation at Mounthall, Camross, Co. Laois. The site has potential for sand and gravel deposits.

2.1 Survey Objectives

The objective of the investigation was to provide information on the following:

- sand and gravel thickness,
- overburden thickness,
- depth to bedrock,

2.2 Site Background

The site is located in the south eastern foothills of the Slieve Bloom Mountains at Mounthall, Co. Laois, approximately 20 km west of Portlaoise, (Fig. 2.1). The site covers an area of approximately 32 ha and comprises of open agricultural fields and forestry. There is an existing sand and gravel pit in the northern part of the site with possible backfilled areas to the west of the pit. Site topography is variable and ranges from 176.6 to 232.3 m OD generally rising to the northwest with low ground in the centre and a small hill or kame type feature in the east. There are houses in the northwest and to the southeast of the site and a new house is currently being constructed in the northeast of the site.



Fig 2.1A: Site location.



Fig 2.1B: Site looking northwest at centre of site in foreground and rising ground behind.



Fig 2.1C: Looking southeast at the previously excavated area.



Fig 2.1D: Looking west at the small hill in the east of the site.

2.2.1 Geology

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area (GSI 2019a) indicates that the site is underlain by pale & red sandstone, grit & claystone of the Cadamstown Formation (Figure 2.2). A SW-NE running structural unconformity line is mapped c. 500 m north of the survey area.

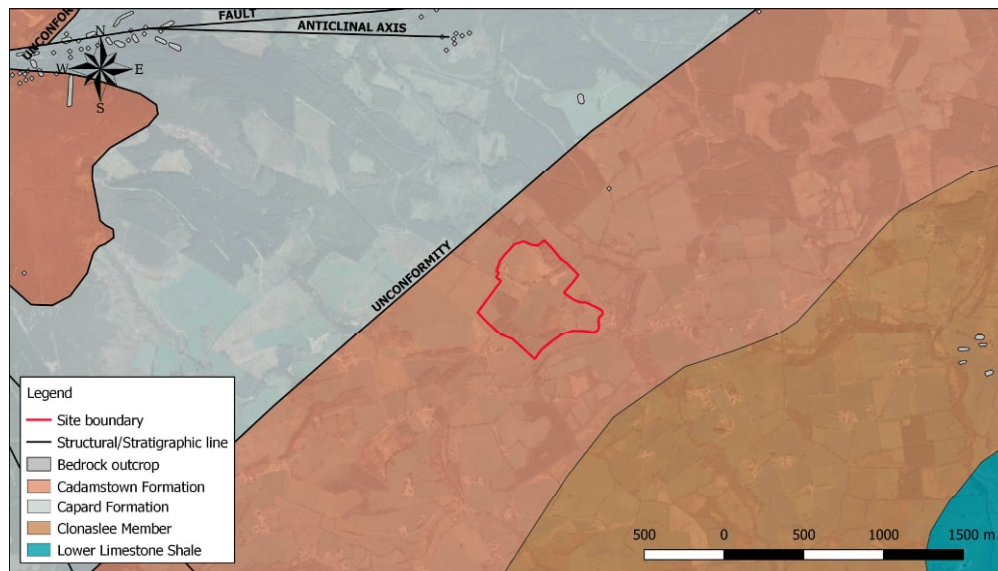


Fig 2.2: Bedrock geology.

2.2.2 Soils

The GSI Quaternary Sediments map for the area (GSI 2019b) indicates that the site is underlain by gravels derived from Devonian sandstones in the northern and eastern part, and till derived from Devonian sandstones and alluvium in the southern and western part of the site (Fig. 2.3).

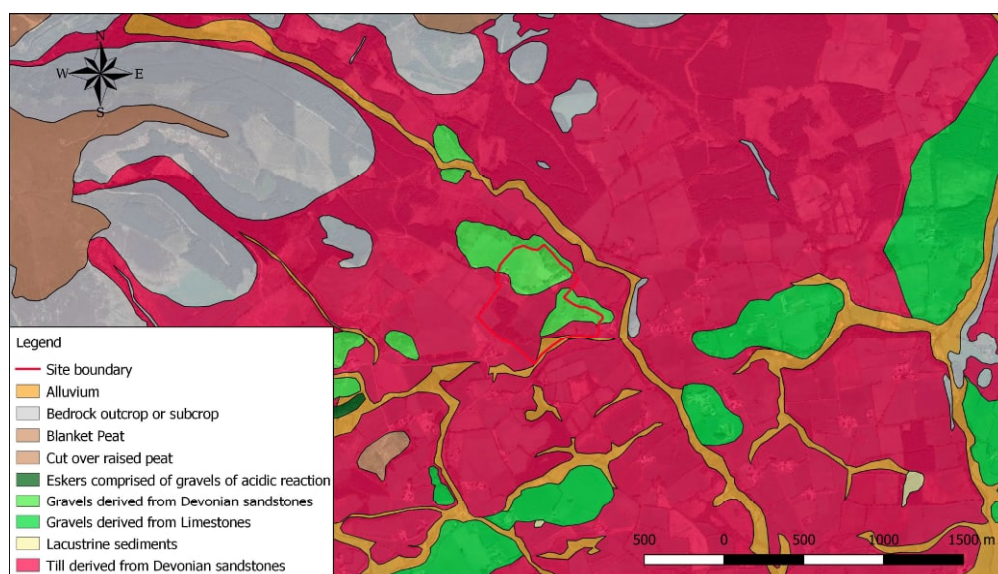


Fig 2.3: Quaternary sediments.

2.2.3 Vulnerability

The groundwater vulnerability rating for the survey area (GSI 2019c) is 'high' in the northern and eastern part and 'moderate' in the southern and western part (Fig. 2.4).

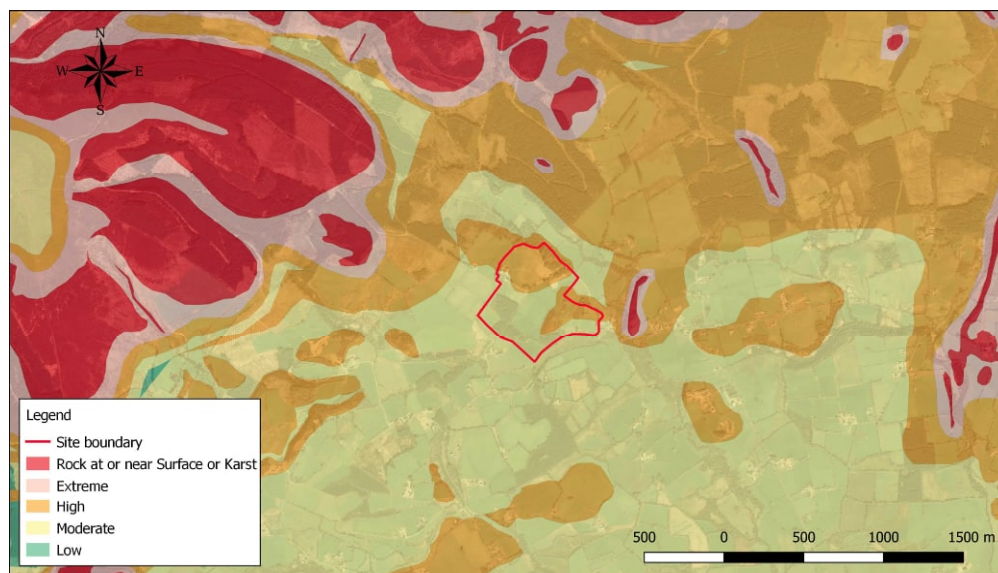


Fig 2.4: Groundwater vulnerability.

2.2.4 Aquifer Classification

The bedrock under the site is classified as a 'Locally important aquifer – Bedrock which is moderately productive only in local zones' (Fig. 2.5). The sand and gravel deposits are not classified as an aquifer.

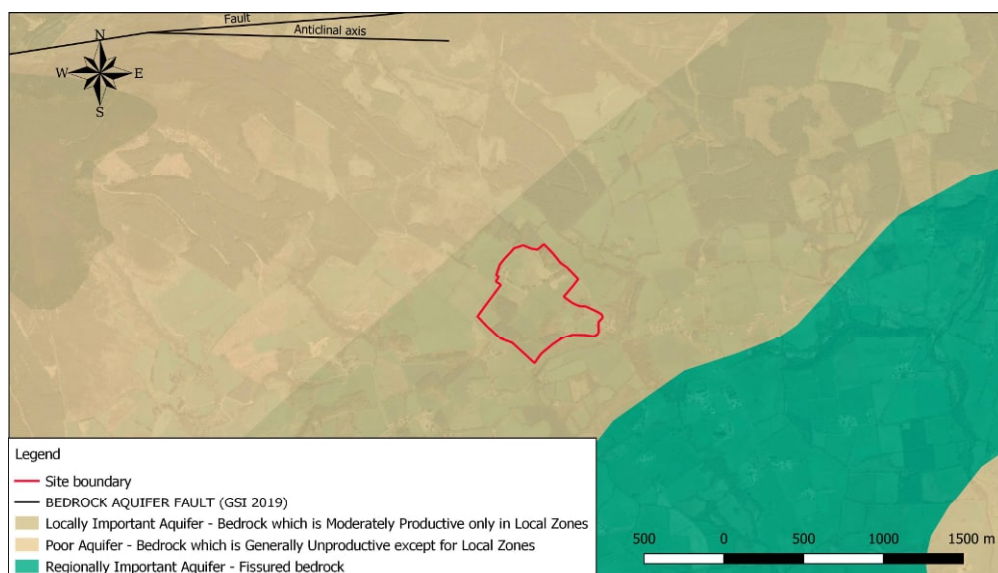


Fig 2.5: Bedrock aquifer.



2.2.5 Historical Data

The historical 6-inch sheet (Fig. 2.6) shows the site is on an area of limestone drift and reddish drift with some limestone pebbles. Sandstone and conglomerate outcrops are mapped c. 200 m east of the survey area.

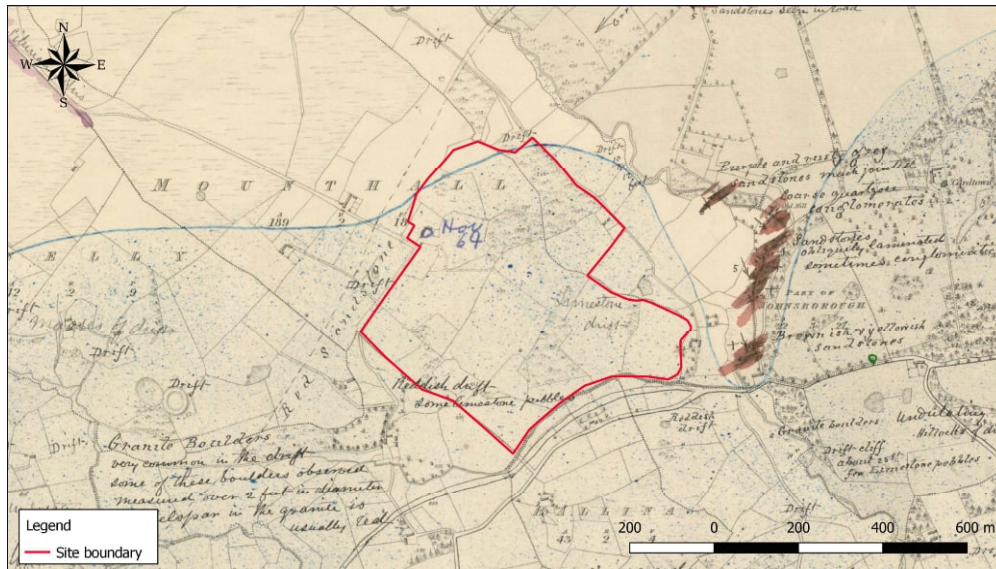


Fig 2.6: The historical 6-inch map.

2.3 Survey Rationale

The investigation consisted of reconnaissance EM ground conductivity mapping with follow-up 2D ERT and Seismic Refraction profiling:

EM ground conductivity mapping operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). This technique will provide information on the shallow (0-6m below ground level) variation of the superficial deposits and outline shallow bedrock.

ERT images the electrical resistivity of the materials in the subsurface along a profile to produce a cross-section showing the variation in resistivity with depth. Each cross-section will be interpreted to determine the material type along the profile based on typical resistivities returned for Irish ground materials.

Seismic Refraction profiling measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

As with all geophysical methods the results are based on indirect readings of the subsurface properties. The effectiveness of the proposed approach will be affected by variations in the ground properties. By combining a number of techniques it is possible to provide a higher quality interpretation and reduce any ambiguities which may otherwise exist. Further information on the detailed methodology of each geophysical method employed in this investigation is given in **APPENDIX A: DETAILED GEOPHYSICAL METHODOLOGY**.

3. RESULTS

The survey was carried out on the 7th, 8th and 14th July 2022 with the collection of EM conductivity readings, 10 ERT profiles and 3 seismic refraction profiles. The geophysical survey locations are indicated on Drawing AGP22128_01 (Appendix B). No readings were obtained within the forested areas in the west of the site.

3.1 EM Ground Conductivity Mapping

The EM ground conductivity results (Drawing AGP22128_02, Appendix B) show the bulk conductivity of the ground materials from 0 - 6.0 m bgl. The recorded conductivity values ranged from 0.5 to 10 mS/m and have been generally interpreted in conjunction with the ERT and seismic data as follows:

Conductivity (mS/m)	Interpretation
0.5 – 3.0	Topsoil over SAND/GRAVEL and silty SAND/GRAVEL
3.0 – 5.0	Topsoil over silty SAND/GRAVEL
5.0 – 8.0	Topsoil over gravelly CLAY
8.0 – 10.0	Alluvium.

3.2 ERT

Ten ERT Profiles (R1-R10) have been acquired across the site. The resistivity values have been interpreted on the following basis.

Resistivity (Ohm-m)	Interpretation
100-250	Topsoil and sandy gravelly CLAY
250-500	Clayey silty SAND/GRAVEL
500-1,000	Silty SAND/GRAVEL
1,000-3,000	'Clean' SAND/GRAVEL
100-315	MUDSTONE/SHALE
315-3,175	SANDSTONE

3.3 Seismic refraction profiling

Three seismic refraction spreads were recorded across the site (S1, S2 and S3, Appendix C). The seismic velocities indicated 3 seismic velocity layers that have been interpreted on the following basis:

P-Wave Seismic Velocity (m/s)	Interpretation	Estimated Stiffness/ Rock Quality
250-300	Topsoil, SAND/GRAVEL, silty SAND/GRAVEL	Soft/Loose
800-950	SAND/GRAVEL, silty SAND/GRAVEL, clayey SAND/GRAVEL	Medium Dense
2,500-3,400	MUDSTONE/SHALE/SANDSTONE	Fair - Good

4. DISCUSSION

The geophysical results are presented on Drawings AGP22128_R1 to AGP22128_R10, Appendix B and summarised on Drawing AGP22128_03.

Electrical resistivity values for Irish sand and gravel deposits are generally within the following ranges:

Material	*Fines Content %	Resistivity (Ohm-m)	Economic Potential
'Clean' SAND/GRAVEL	< 5	> 1000	Yes
Silty SAND/GRAVEL	5 - 15	500-1000	<u>may</u> have, subject to screening/washing.
Clayey SAND/GRAVEL	> 15%	250-500	<u>unlikely</u> , due to fines content

**Fines refer to the clay and silt content of the sand/gravel material. The higher the fines content the poorer the material and use is restricted and screening/or washing required. These estimates should be confirmed by subsequent sampling and testing.*

The geophysical survey has outlined the following zones across the site (Drawing AGP22128_03):

- Zone A is a zone of mainly **'clean' SAND/GRAVEL** underlain by some **silty SAND/GRAVEL** that includes the kame type small hill in the east of the site. It extends to approximately 9.1 ha and interpreted sand/gravel thickness ranges from 7 to 15 m. Topsoil/overburden thickness appears to be around 1m. This zone may have economic potential and direct investigation by trial pitting is recommended.
- Zone B is a larger zone of mainly **silty SAND/GRAVEL** with some **'clean' SAND/GRAVEL** that covers the lower ground in the west of the site and flanks the partially forested slopes rising to the southeast and northwest. It extends to approximately 12.3 ha and interpreted sand/gravel thickness is thinner than Zone A ranging from 3 m to 8 m and may be discontinuous in places. Topsoil/overburden thickness appears to be around 1m. This zone may have some economic potential but the thickness and quality may not be sufficient to merit development. Some direct investigation by trial pitting is recommended.
- Zone C is a smaller area of **'clean' SAND/GRAVEL** surrounded by **silty SAND/GRAVEL** that forms the rising ground in the north of the site. It extends to approximately 5.3 ha and interpreted sand/gravel thickness ranges from 5 to 8 m. The area immediately to the southeast has been previously excavated and topsoil/overburden thickness appears to be around 1m. This zone may have some economic potential and direct investigation by trial pitting is recommended.
- There is a further area of around 5.2 ha consisting of the excavated area referred to above and an area to the southwest of it where sand/gravel is very thin or absent (See red dashed area on Drawing AGP22128_03).

Bedrock has been indicated by the seismic data at depths ranging from 3 to 25 m bgl depending on location and topography and generally corresponding to between 170 and 225 mOD with the deepest bedrock in the southeast of the site and shallowest in the northwest. The electrical resistivity of the rock (100 – 3,175 Ohm-m) and seismic velocities (2,500-3,400 m/s) are typical of thinly bedded sandstone, shale and mudstone.

5. RECOMMENDATIONS

Trial pits to confirm the findings of the geophysical survey are recommended at the following locations:

No.	Easting (ITM)	Northing (ITM)
TP1	626860.1	698102.7
TP2	626705.6	698119.0
TP3	626698.0	698214.2
TP4	626584.0	698091.4
TP5	626515.8	698006.1
TP6	626408.2	698078.5
TP7	626303.3	698125.5
TP8	626463.3	698176.4
TP9	626379.2	698250.7
TP10	626483.4	698481.9

A machine with a reach of 6 – 7 m should be used to open the pits. Samples should be taken for Particle Size Distribution (PSD) analysis and for chemical, physical, mechanical and laboratory tests to assess suitability for use.

Given the variable topography across the site a topographic survey is also recommended if Trial Pit results are positive.

The geophysical report should be reviewed after any direct investigation.

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APPENDIX A: DETAILED GEOPHYSICAL METHODOLOGY

A combination of geophysical techniques was used to provide a high-quality interpretation and reduce any ambiguities, which may otherwise exist.

EM Ground Conductivity Mapping

Principles

This is an electromagnetic technique used to investigate lateral variations in overburden material and to assist with the indication of the depth to bedrock. This method operates on the principle of inducing currents in conductive substrata and measuring the resultant secondary electro-magnetic field. The strength of this secondary EM field is calibrated to give apparent ground conductivity in milliSiemens/metre (mS/m). Readings over material such as organic waste and peat give high conductivity values while readings over dry materials with low clay mineral content such as gravels, limestone or quartzite give low readings. The EM31 survey technique determines the apparent conductivity of the different overburden layers from 0-6m bgl depending on the dipole mode used.

Data collection

The EM31 equipment used was a GF CMD-4 conductivity meter equipped with data logger and integrated GPS. This instrument features a real time graphic display of the previous 20 measurement points to monitor data quality and results. Conductivity and in-phase values were recorded across the site. Local conditions and variations were recorded.

Data processing

The conductivity and in-phase field readings were downloaded, contoured and plotted using the SURFER 12 program (Golden Software, 2015). Data which was affected by metallic objects was removed. Assignment of material types and possible anomaly sources was carried out, with cross-reference to other data.

Electrical Resistivity Tomography (ERT)

Electrical Resistivity Tomography was carried out to provide information on lateral variations in the overburden material as well as on the underlying overburden and bedrock.

Principles

This surveying technique makes use of the Wenner resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in material types. This method involves the use of electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

Data Collection

Profiles were recorded using an ABEM LS4 resistivity meter, imaging software, four 21 takeout multicore cables and up to 80 stainless steel electrodes. Saline solution was used at the electrode/ground interface in order to gain a good electrical contact required for the technique to work effectively. The recorded data were processed and viewed immediately after surveying.

Data Processing

The field readings were stored in computer files and inverted using the RES2DINV package (Geotomo Software, 2006) with up to 5 iterations of the measured data carried out for each profile to obtain a 2D-depth model of the resistivities.

The inverted 2D resistivity models and corresponding interpreted geology are displayed on the accompanying drawings alongside the processed seismic sections. Profiles have been contoured using the same contour intervals and colour codes. Distance is indicated along the horizontal axis of the profiles.

Seismic Refraction Profiling

Principles

This method measures the velocity of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher seismic velocities while soft, loose or fractured materials have lower velocities.

Seismic profiling measures the p-wave velocity (V_p) of refracted seismic waves through the overburden and rock material and allows an assessment of the thickness and quality of the materials present to be made. Stiffer and stronger materials usually have higher V_p velocities while soft, loose or fractured materials have lower V_p velocities. Readings are taken using geophones connected via multi-core cable to a seismograph.

Data Collection

A Geode high resolution 24 channel digital seismograph, 24 10HZ vertical geophones and a 10 kg hammer were used to provide first break information, with a 24 take-out cable. Equipment was carried and operated by a two-person crew.

Readings are taken using geophones connected via multi-core cable to a seismograph. The depth of resolution of soil/bedrock boundaries is determined by the length of the seismic spread, typically the depth of resolution is about one third the length of the profile. (eg. 69m profile ~23m depth, 33m profile ~ 11m depth).

Data Processing

First break picking in digital format was carried out using the FIRSTPIX software program to construct p-wave (V_p) traveltime plots for each spread. Velocity phases were selected from these plots using the GREMIX software program and were used to calculate the thickness of individual velocity units. Topographic data were input. Material types were assigned and estimation made of material properties. The processed seismic data are displayed in Appendix C.

GREMIX interprets seismic refraction data as a laterally varying layered earth structure. It incorporates the slope-intercept method, parts of the Plus-Minus Method of Hagedoorn (1959), Time-Delay Method, and features the Generalized Reciprocal Method (GRM) of Palmer (1980). Up to four layers can be mapped; one deduced from direct arrivals and three deduced from refractions. Phantomming of all possible travel time pairs can be carried out.

Approximate errors for V_p velocities are estimated to be +/- 10%. Errors for the calculated layer thicknesses are

of the order of +/-20%. Possible errors due to the "hidden layer" and "velocity inversion" effects may also occur (Soske, 1959).

Spatial Relocation

All ERT and Seismic Refraction locations were acquired using a Trimble Geo 7X high-accuracy GNSS handheld system using the settings listed below. This system allows collection of GPS data with c.20mm accuracy.

Projection:	Irish Transverse Mercator
Datum:	Ordnance
Coordinate units:	Metres
Altitude units:	Metres
Survey altitude reference:	MSL
Geoid model:	Republic of Ireland

The EM conductivity locations were acquired using a system integrated GPS receiver to an x,y accuracy of +/- 5m or better and converted to ITM.

APPENDIX B: DRAWINGS

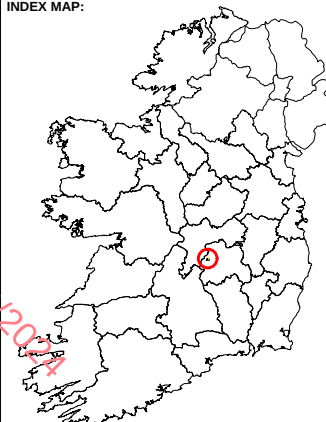
The information derived from the geophysical investigation presented in the following drawings:

AGP22128_01 Geophysical Locations	1:4000	@ A4
AGP22128_02 EM Conductivity Results	1:4000	@ A4
AGP22128_03 Summary Interpretation Map	1:4000	@ A4
AGP22128_R1 ERT Profile R1 & Seismic Profile S2 Results & Interpretation	1:2000	@ A4
AGP22128_R2 ERT Profile R2 Results & Interpretation	1:1000	@ A4
AGP22128_R3 ERT Profile R3 Results & Interpretation	1:1000	@ A4
AGP22128_R4 ERT Profile R4 Results & Interpretation	1:1000	@ A4
AGP22128_R5 ERT Profile R5 Results & Interpretation	1:1000	@ A4
AGP22128_R6 ERT Profile R6 & Seismic Profile S1 Results & Interpretation	1:1000	@ A4
AGP22128_R7 ERT Profile R7 Results & Interpretation	1:1000	@ A4
AGP22128_R8 ERT Profile R8 Results & Interpretation	1:1000	@ A4
AGP22128_R9 ERT Profile R9 & Seismic Profile S3 Results & Interpretation	1:1000	@ A4
AGP22128_R10 ERT Profile R10 Results & Interpretation	1:1000	@ A4

GEOPHYSICAL LOCATIONS
SCALE 1:4000



INDEX MAP:



LEGEND:

- Site
- EM conductivity reading
- 2D resistivity profile
- Seismic refraction profile

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



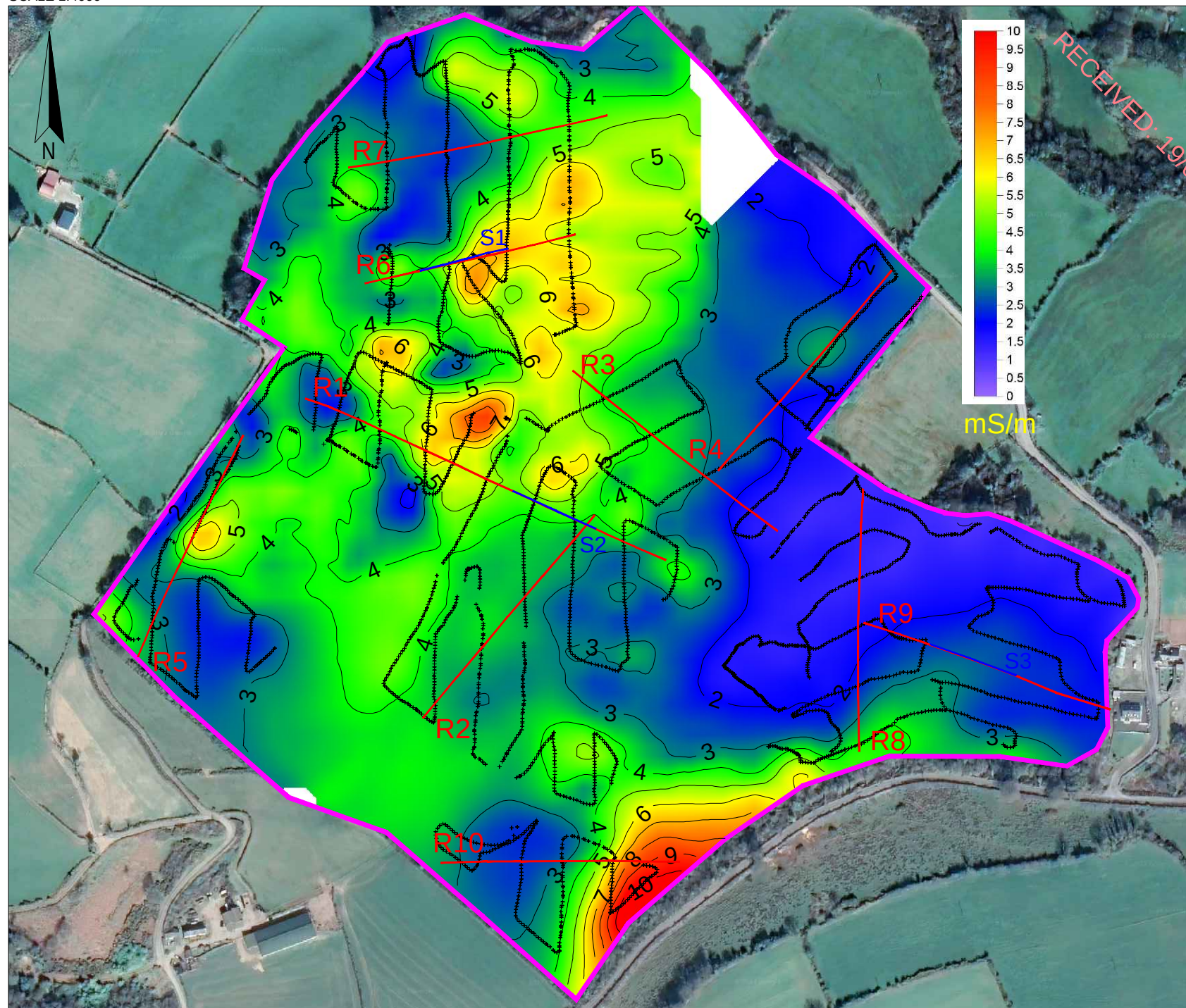
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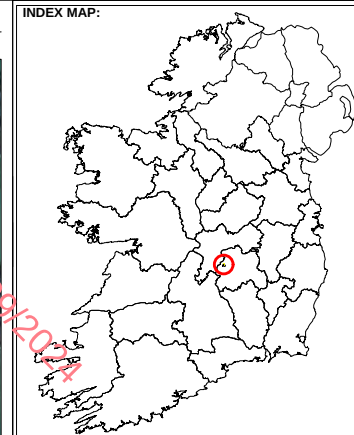
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

EM CONDUCTIVITY RESULTS

SCALE 1:4000



INDEX MAP:



LEGEND:

- Site
- EM conductivity reading
- R1 2D resistivity profile
- S1 Seismic refraction profile

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_02

SCALE: AS INDICATED @ A4

DATE: 08-08-2022

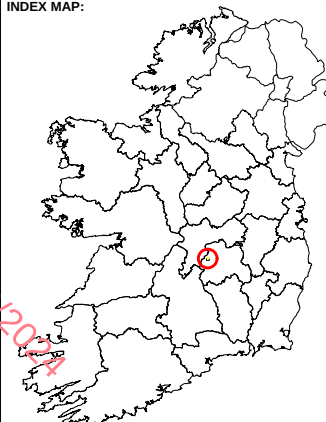
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SUMMARY INTERPRETATION

SCALE 1:4000



INDEX MAP:



LEGEND:

- SAND/GRAVEL and silty SAND/GRAVEL
- Silty SAND/GRAVEL
- Sandy/gravelly Clay
- Alluvium
- Potential Resource Area
- Proposed Trial Pit

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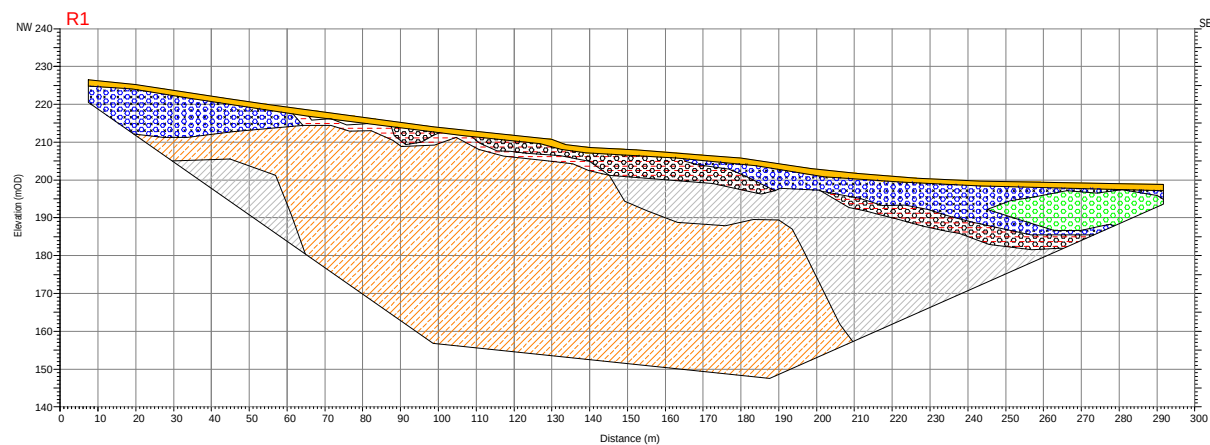
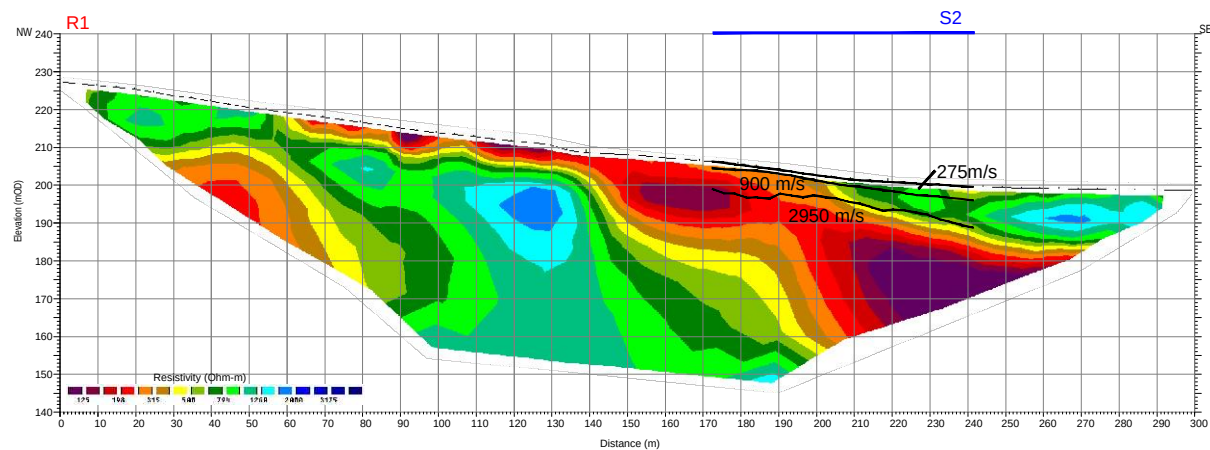
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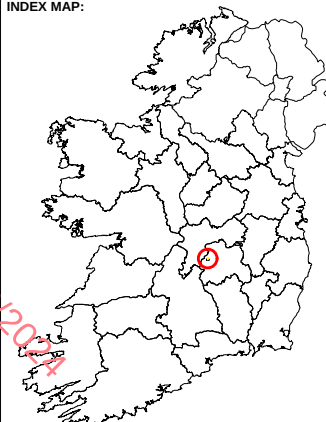
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ERT PROFILE R1 AND SEISMIC PROFILE S2 RESULTS AND INTERPRETATION

SCALE 1:2000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



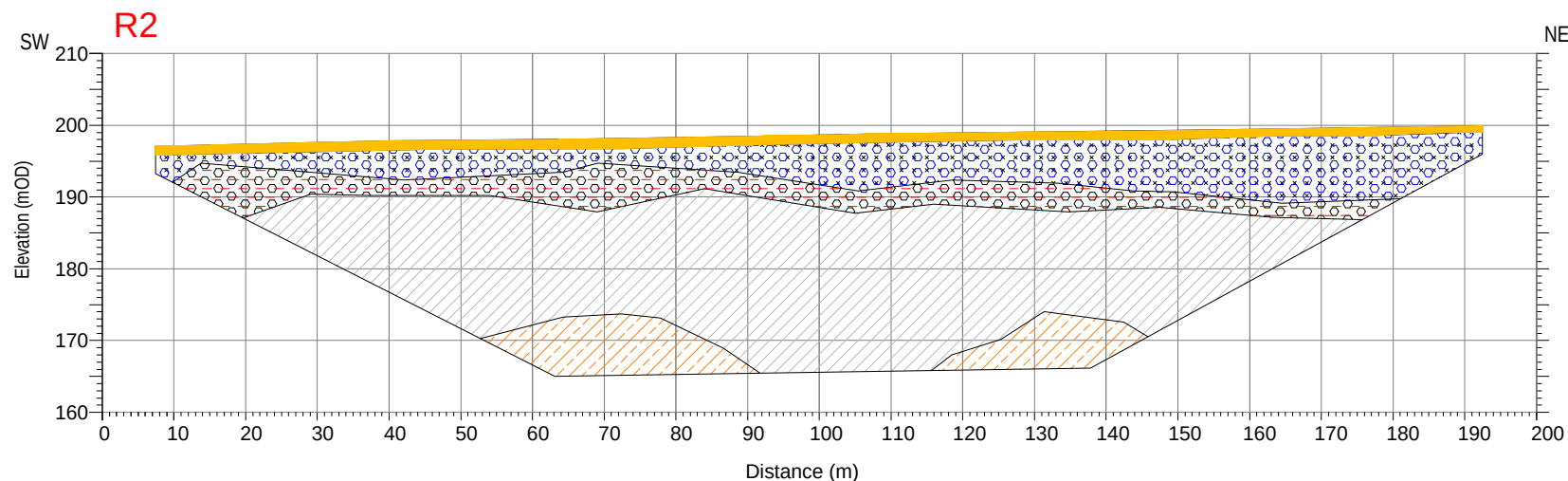
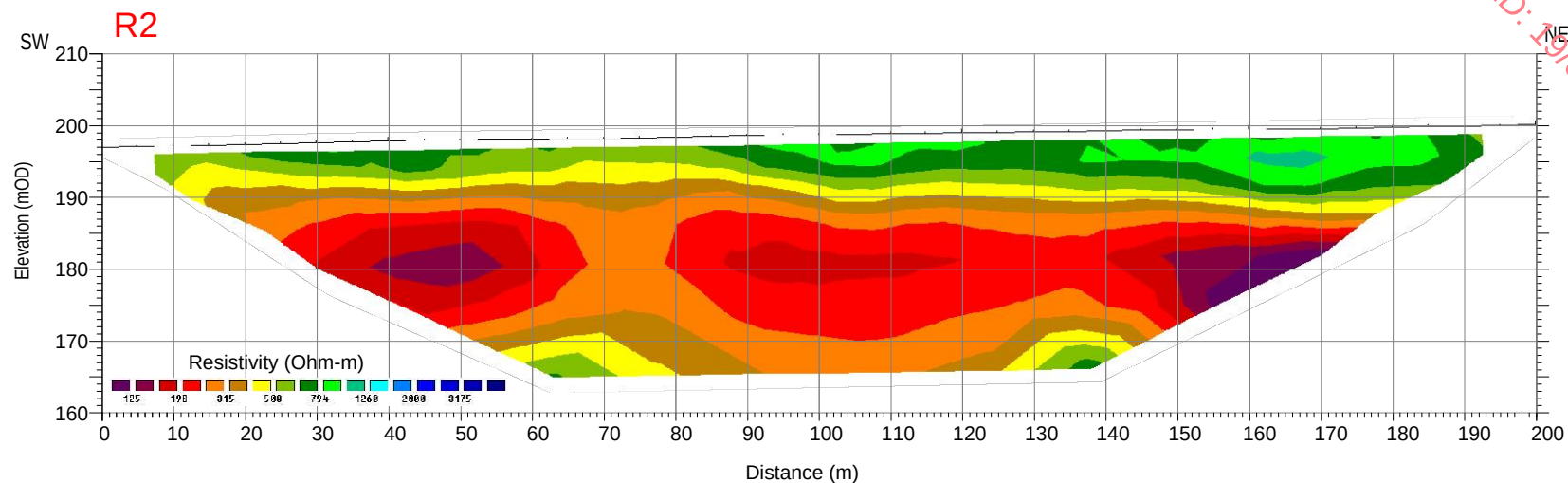
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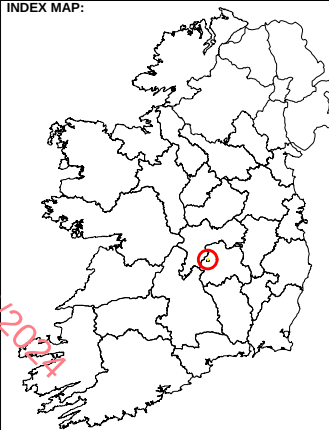
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Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R2 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



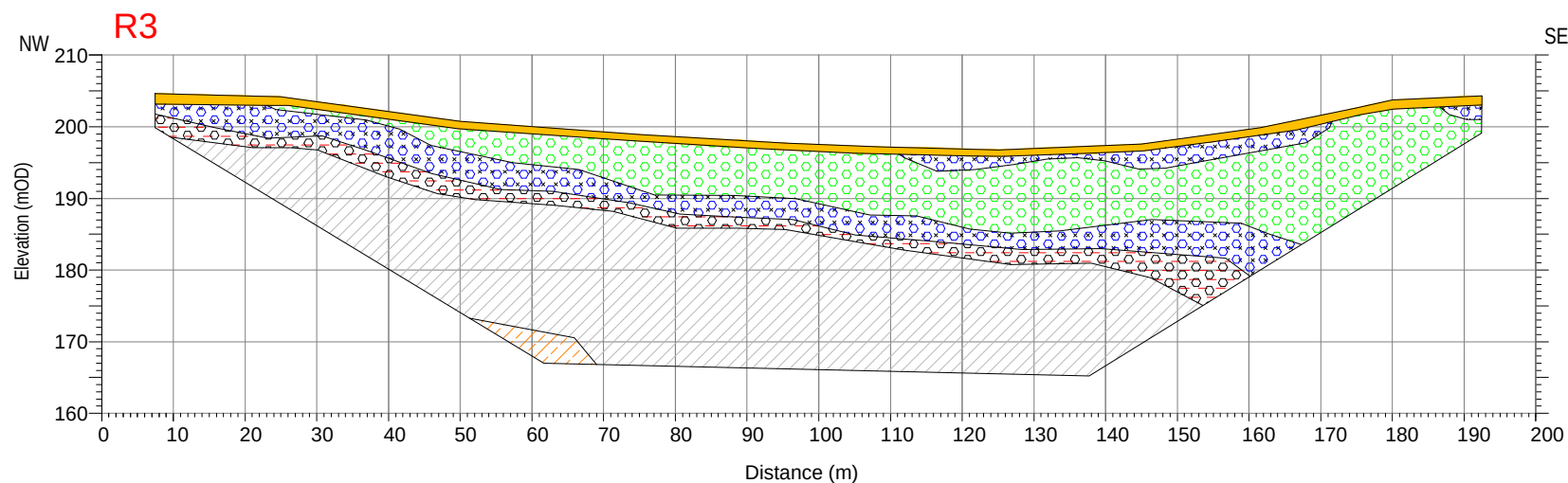
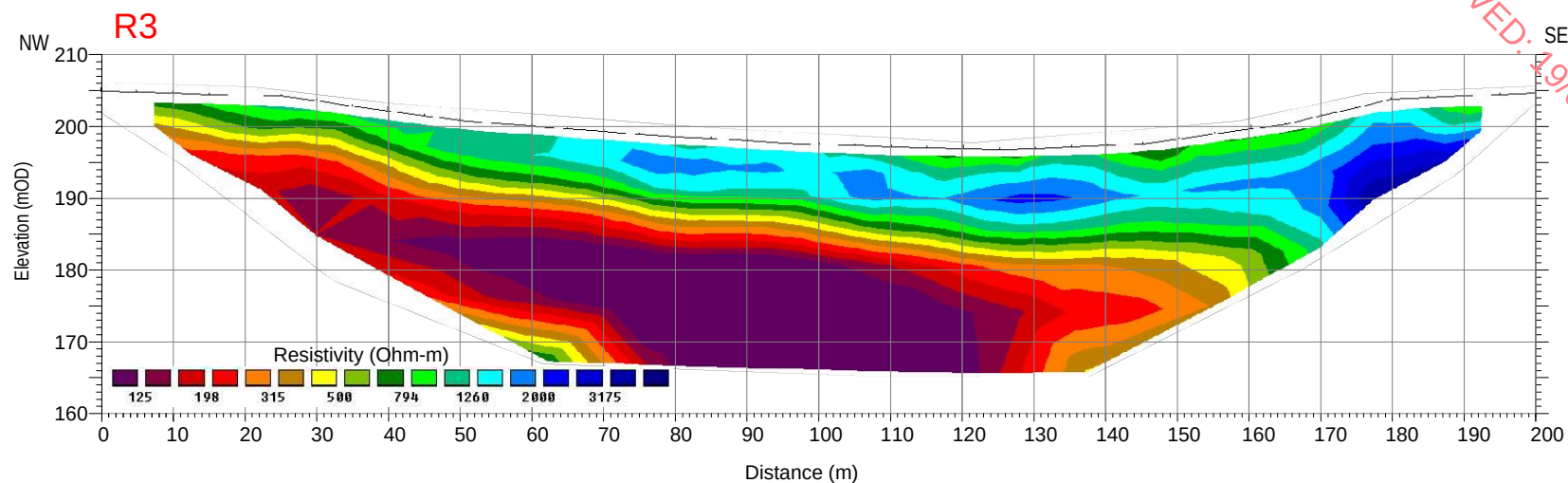
6 Knockmullen Business Park
Gorey
Co. Wexford
Ireland

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E info@apexgeophysics.ie
www.apexgeophysics.ie

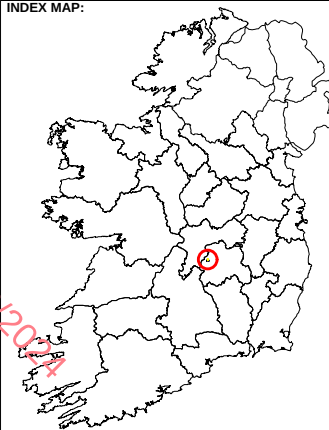
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CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_R2		
SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R3 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_R3

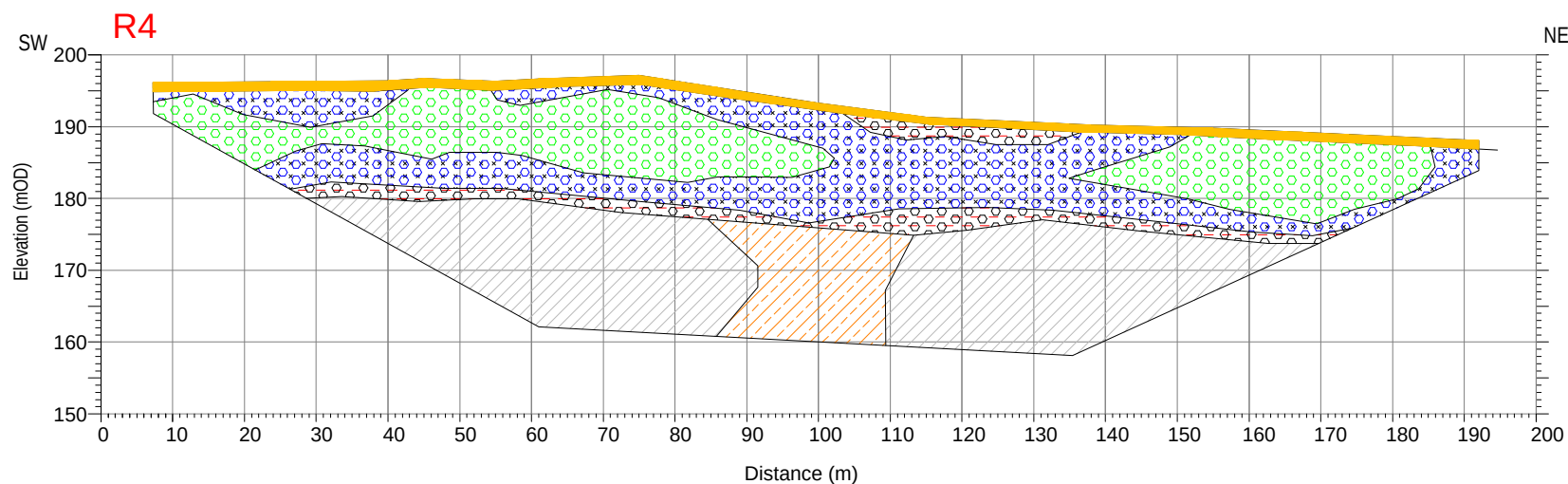
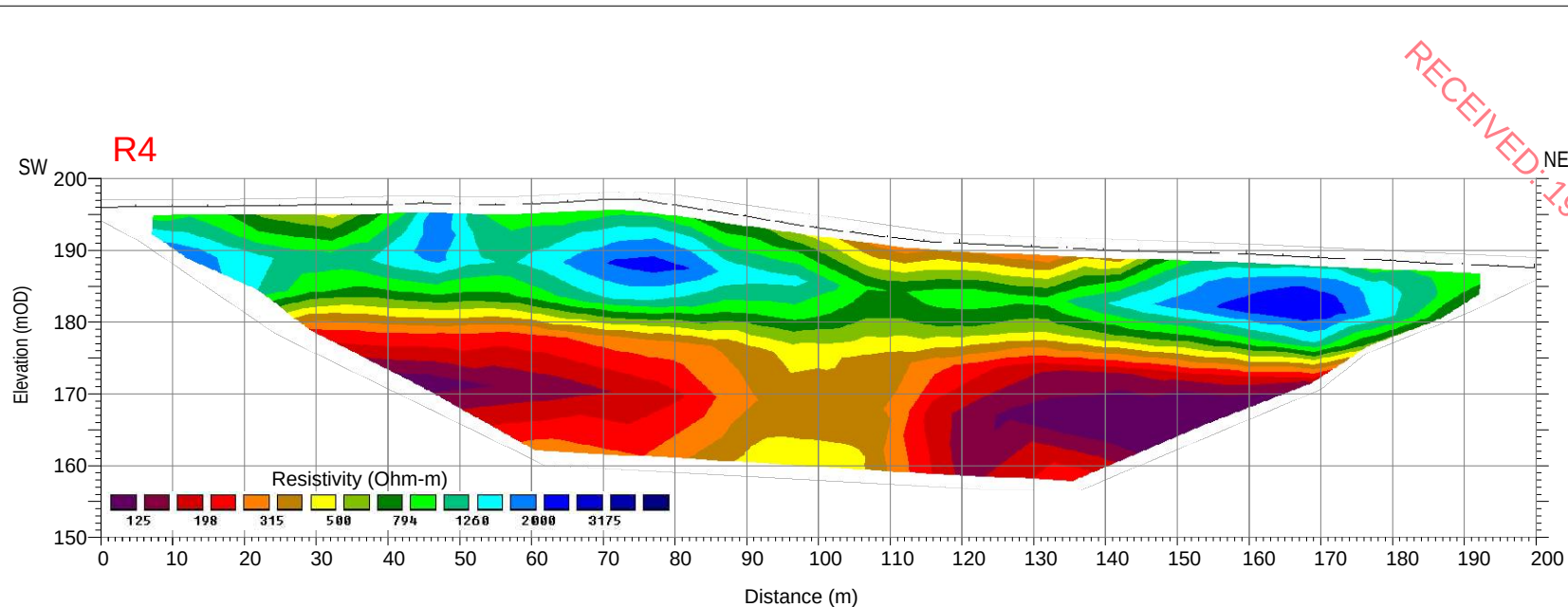
SCALE: AS INDICATED @ A4

DATE: 08-08-2022

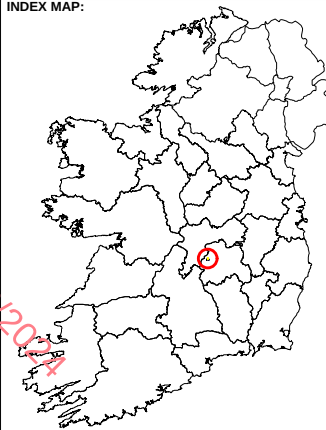
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R4 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

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PROJECT: MOUNTHALL CAMROSS
GEOPHYSICAL SURVEY

CLIENT: BREEDON GROUP

DRAWING NO: AGP22128_R4

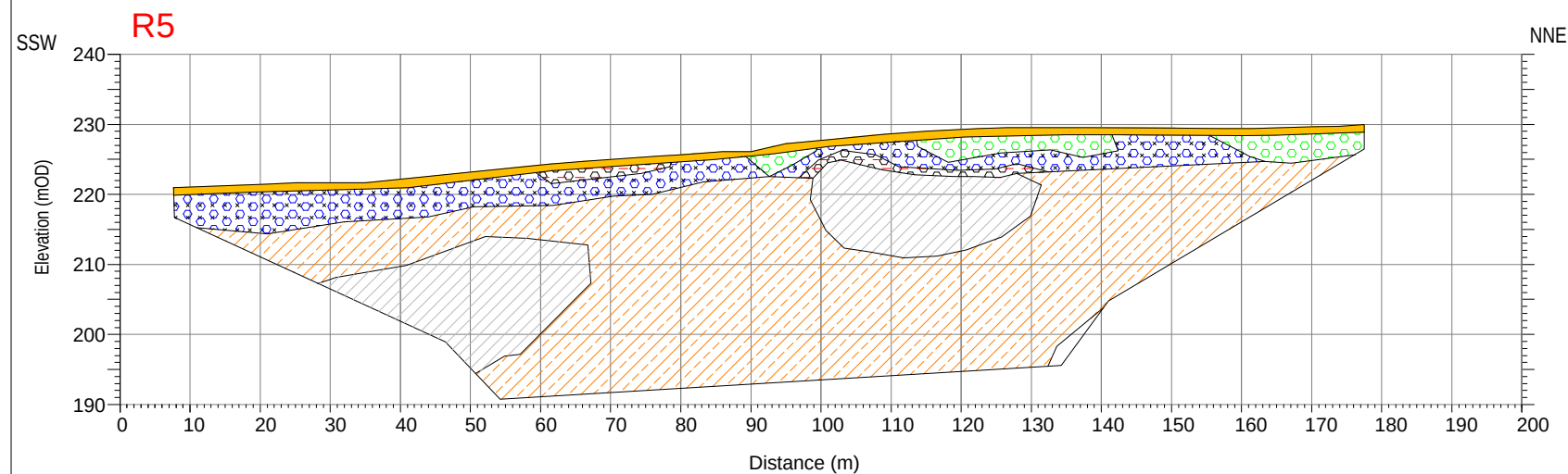
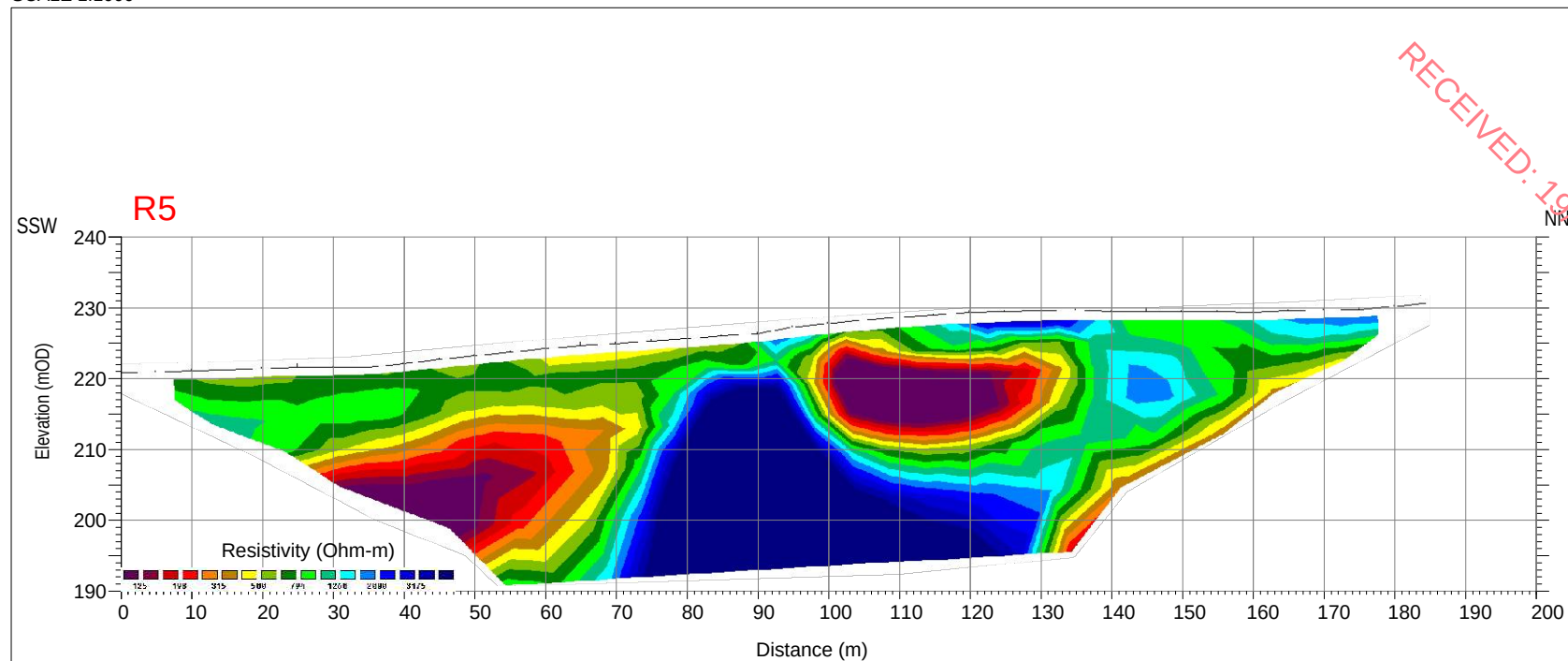
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DATE: 08-08-2022

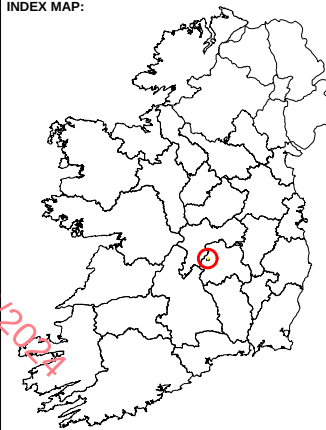
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R5 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



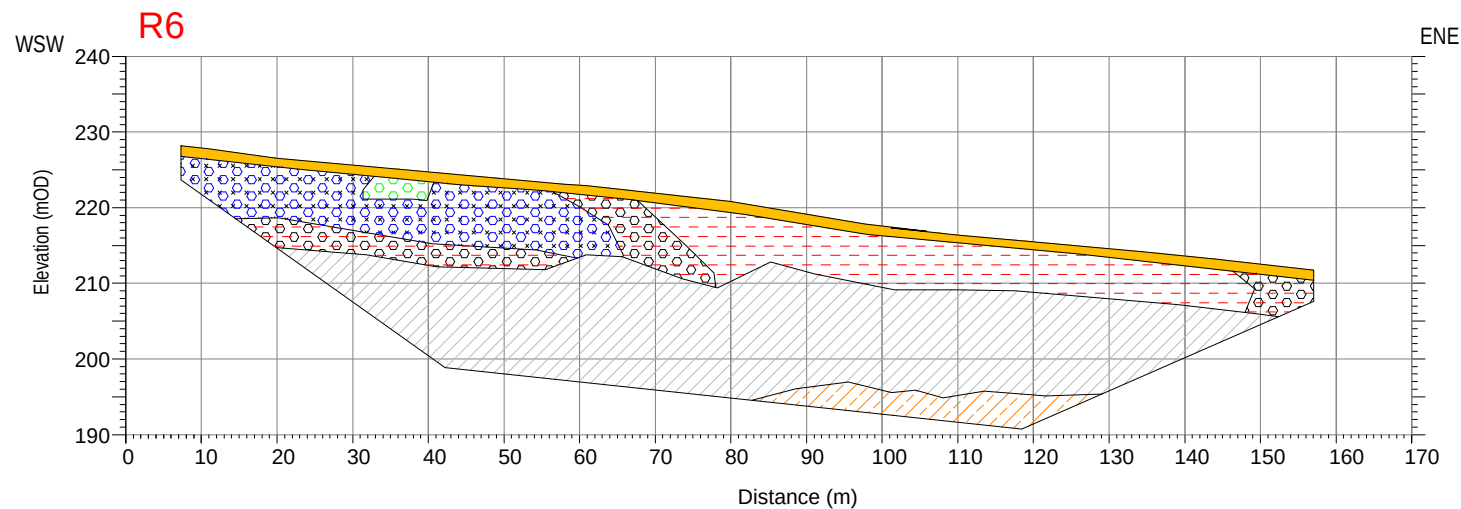
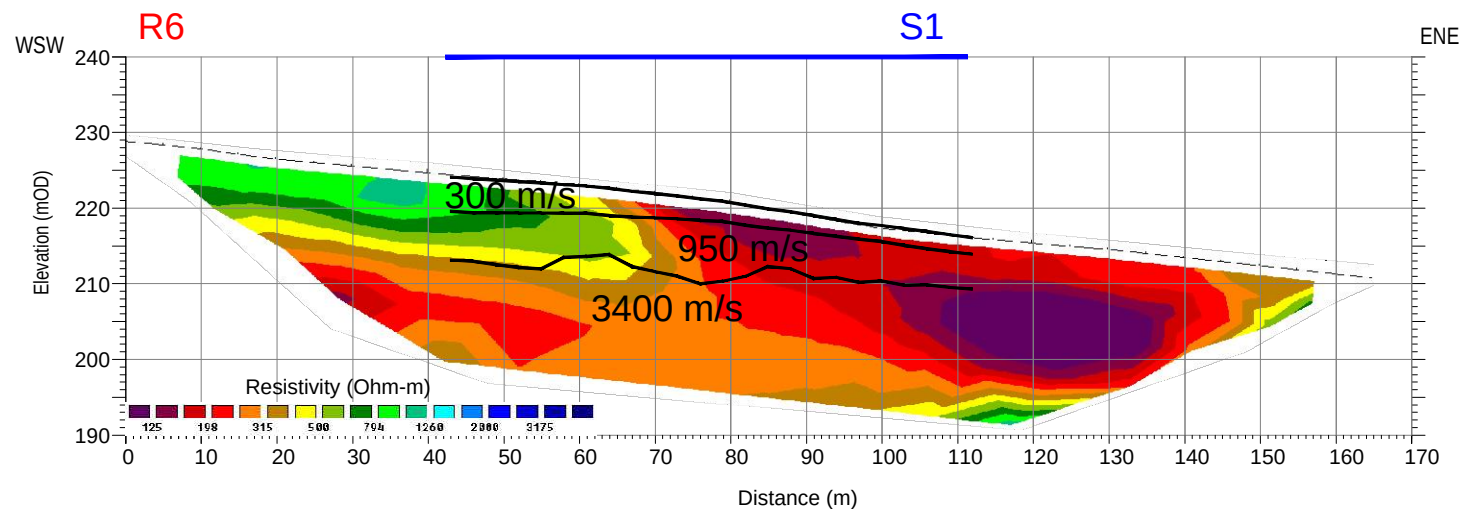
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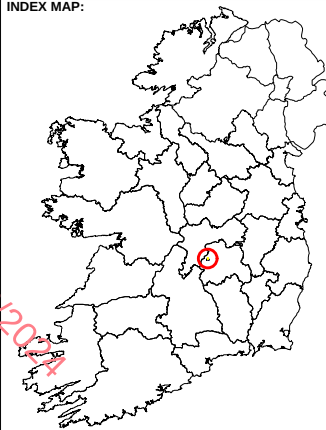
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CLIENT:	BREEDON GROUP		
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R6 AND SEISMIC PROFILE S1 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



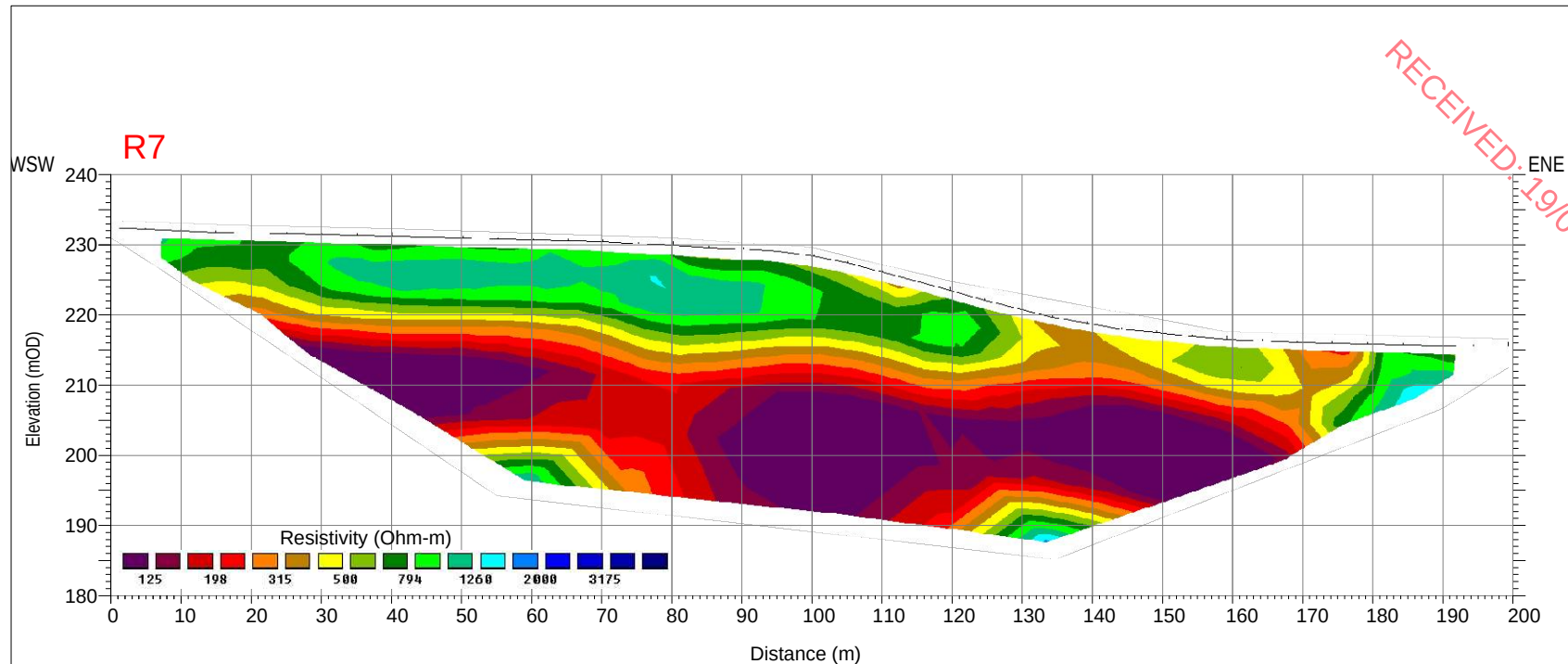
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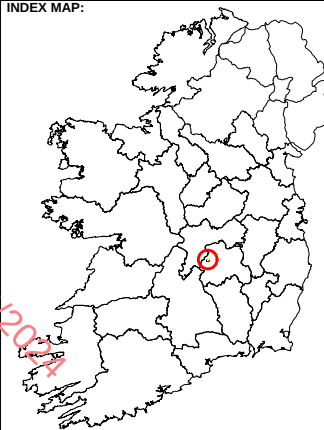
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CLIENT:	BREEDON GROUP		
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SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R7 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



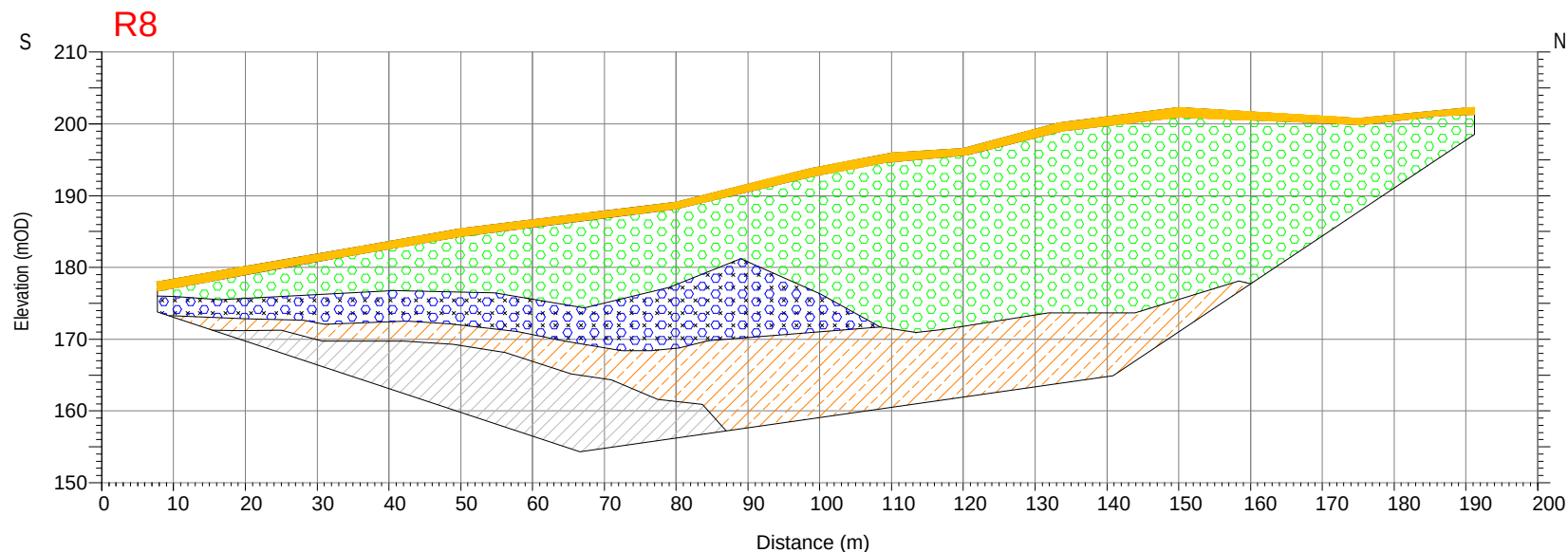
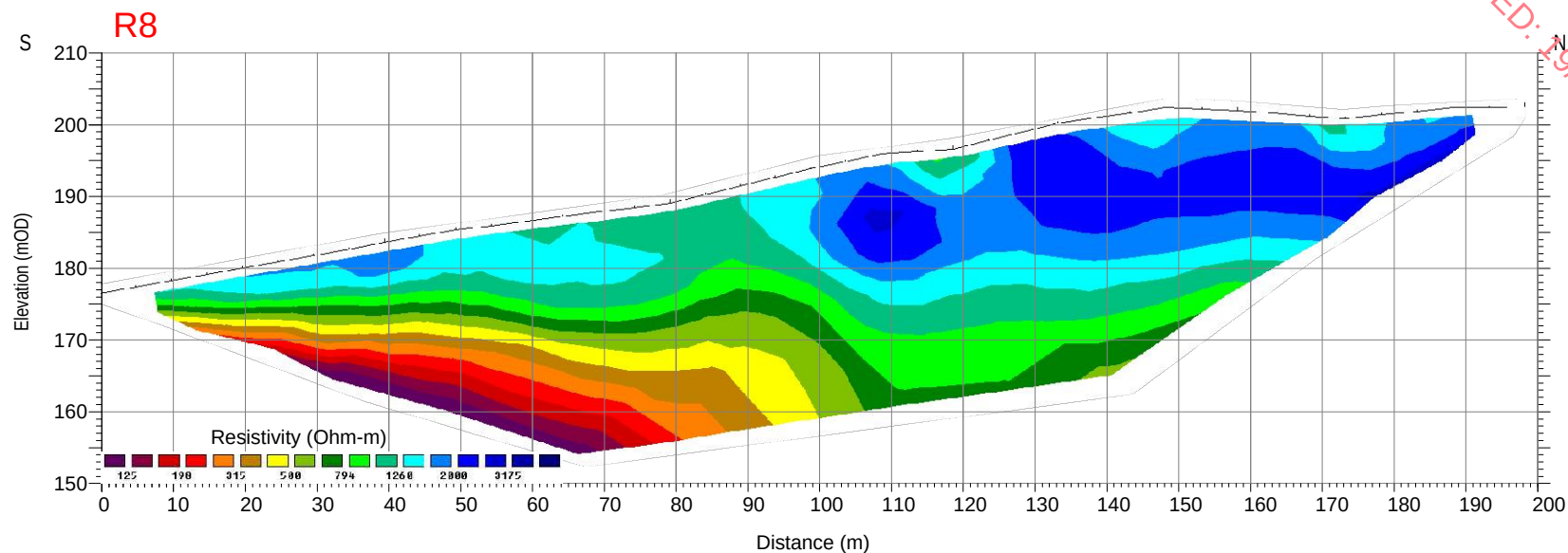
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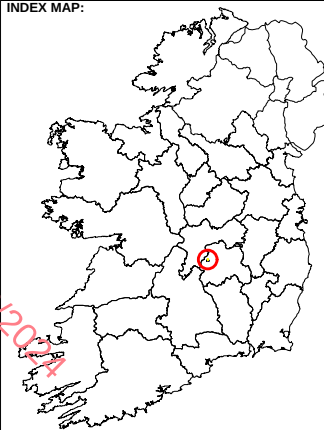
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CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_R7		
SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R8 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



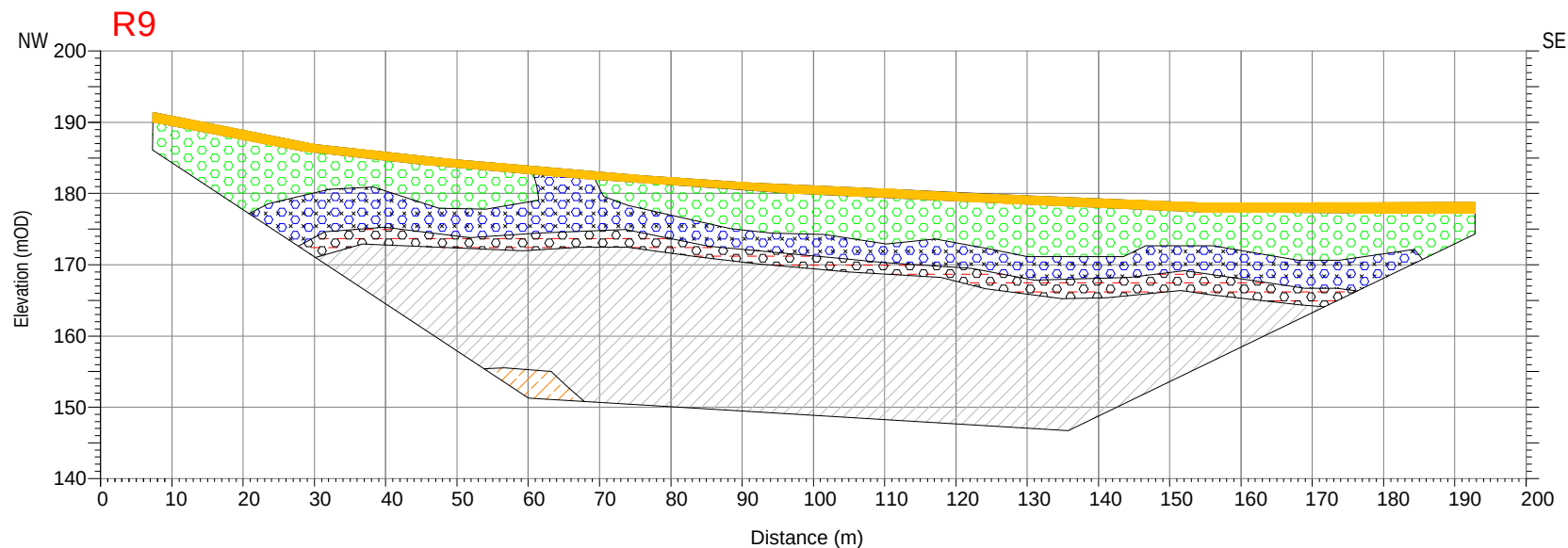
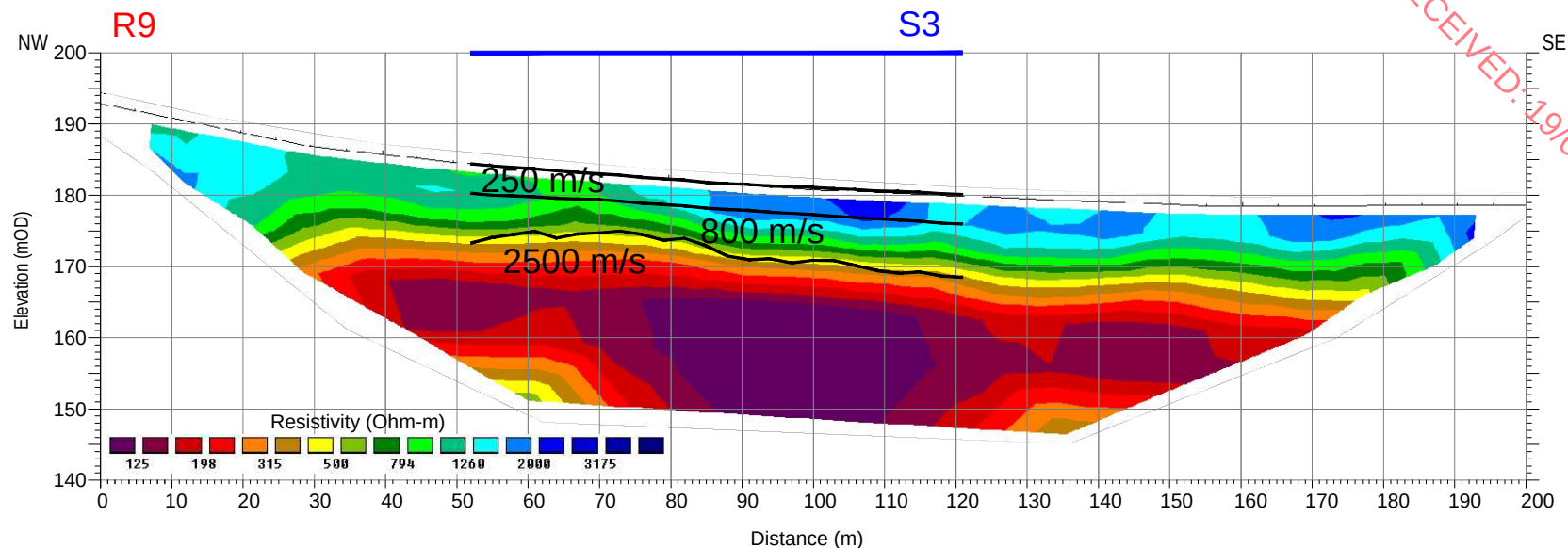
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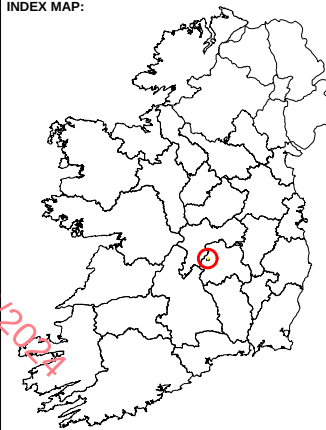
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DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R9 AND SEISMIC PROFILE S3 RESULTS AND INTERPRETATION

SCALE 1:2000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



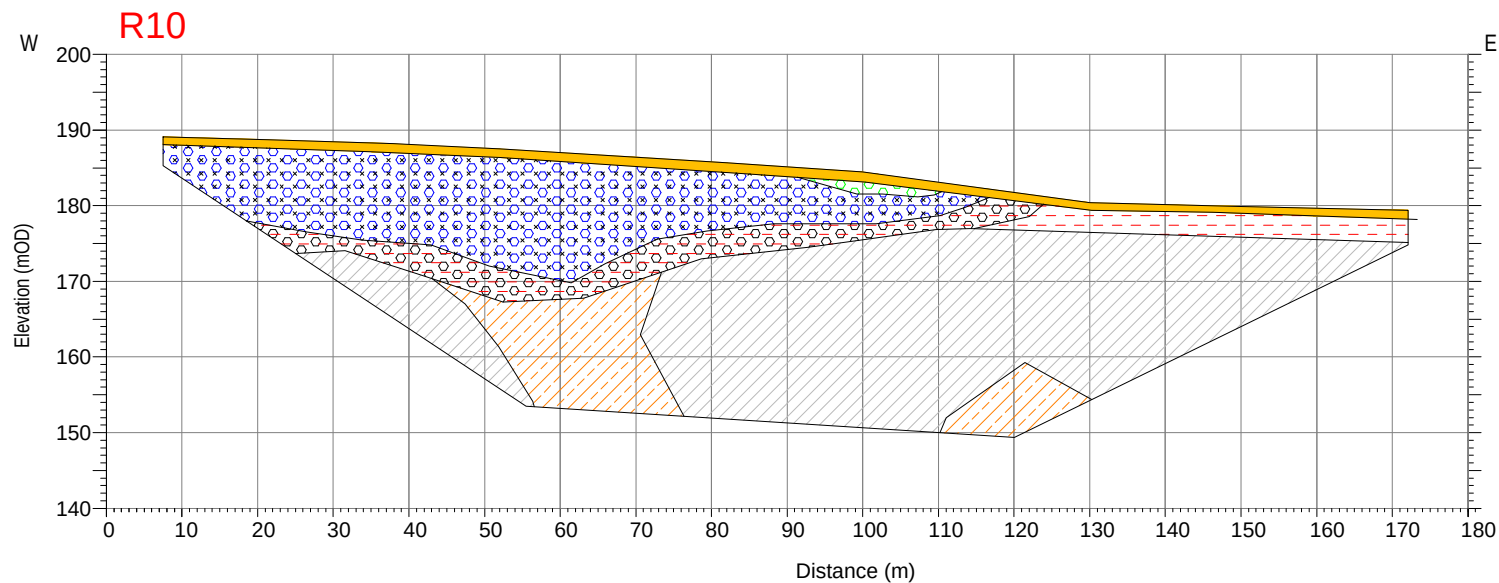
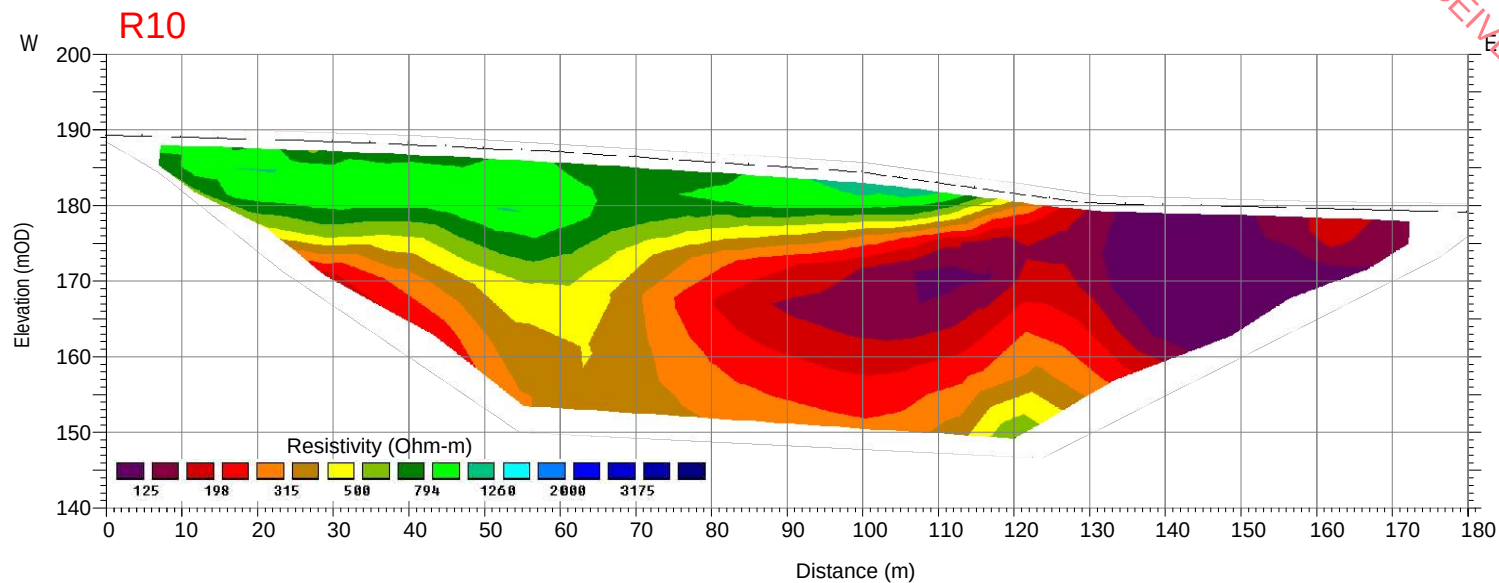
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www.apexgeophysics.ie

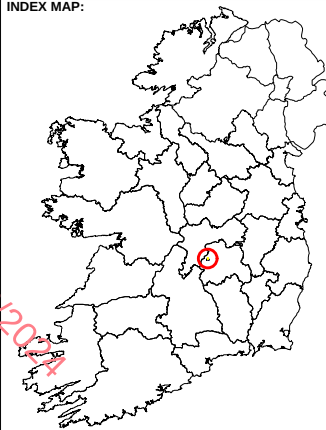
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SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

ERT PROFILE R10 RESULTS AND INTERPRETATION

SCALE 1:1000



INDEX MAP:



LEGEND:

- Topsoil
- Sandy gravelly CLAY
- Clayey silty SAND/GRAVEL
- Silty SAND/GRAVEL
- SAND/GRAVEL
- MUDSTONE/SHALE
- SANDSTONE
- Seismic refraction layer with velocity in metres/second

The information displayed here is to be used in conjunction with AGP22128_01 Report on the Geophysical Investigation at Mounthall, Camross for the Breedon Group, APEX Geophysics Ltd. 8th August 2022.



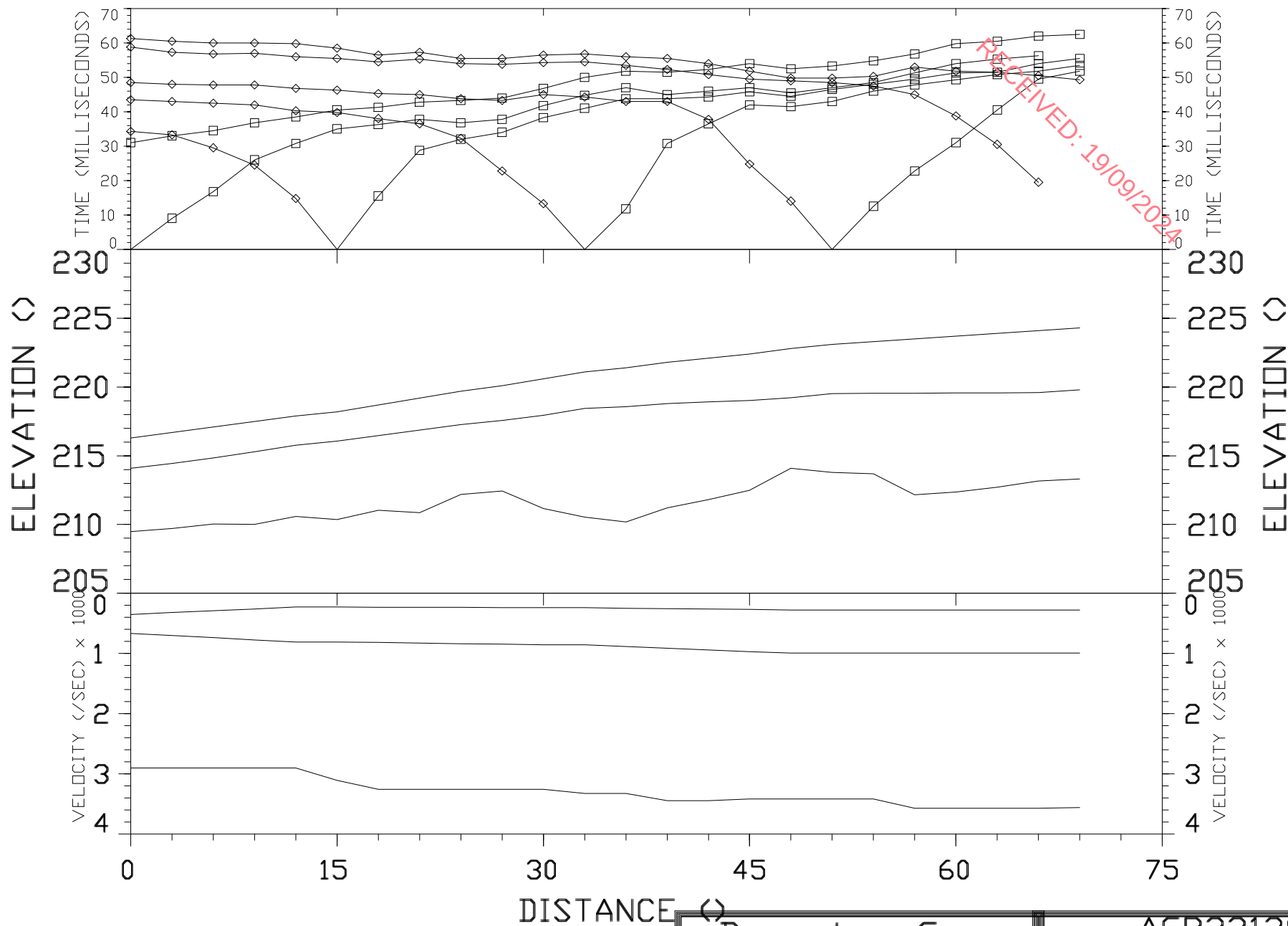
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PROJECT:	MOUNTHALL CAMROSS GEOPHYSICAL SURVEY		
CLIENT:	BREEDON GROUP		
DRAWING NO:	AGP22128_R10		
SCALE:	AS INDICATED @ A4		
DATE:	08-08-2022		
Version:	Date:	Drawn By:	Checked:
001	08-08-2022	POC	TL

APPENDIX C: SEISMIC PLATES

RECEIVED: 19/09/2024



Breedon Group		AGP22128
by: APEX Geophysics Ltd.		Mounthall Camross
Data SetS1	Date: 08/07/2022	Laois
Equipment: Geode	Spread: S1	Azimuth:

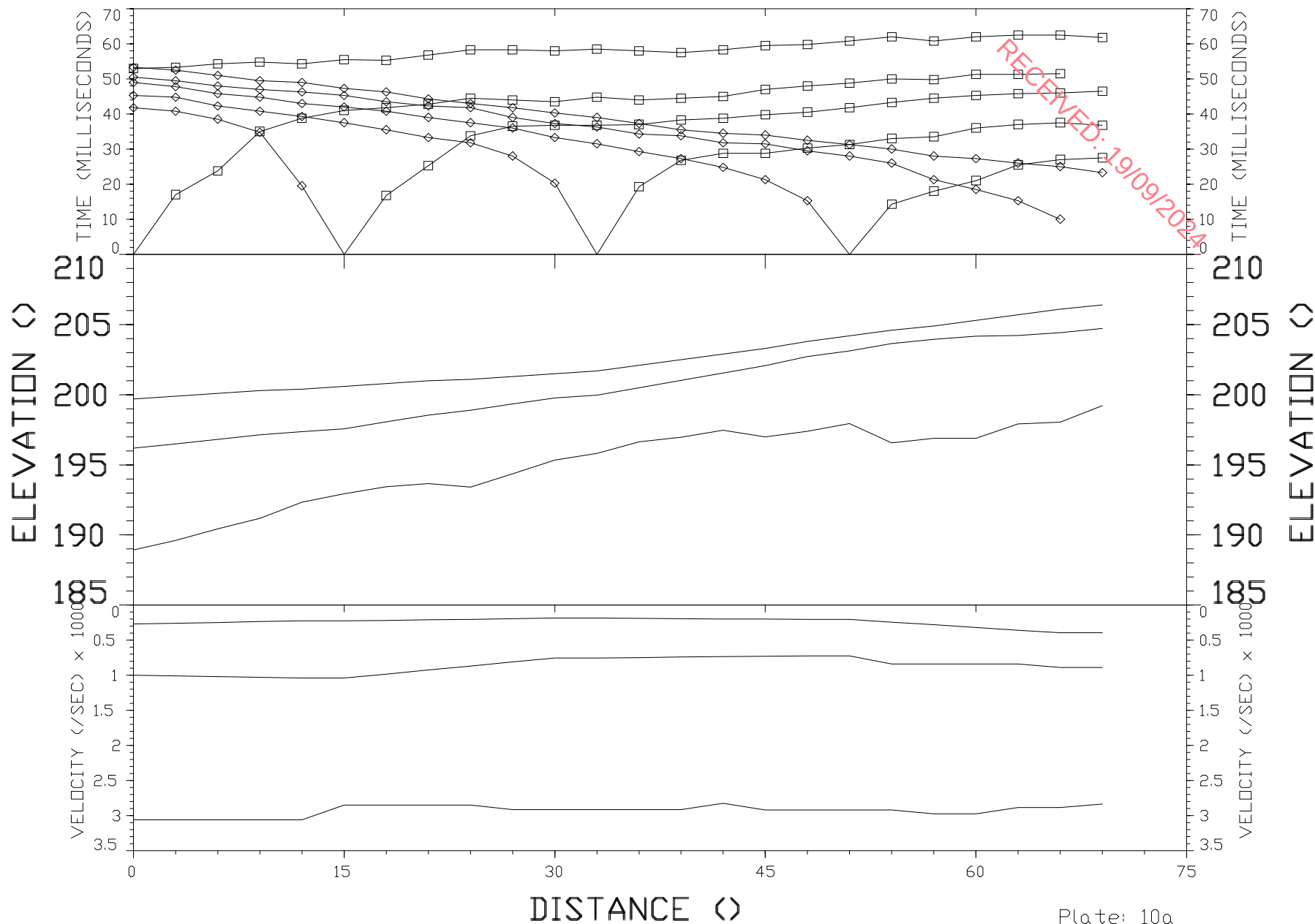
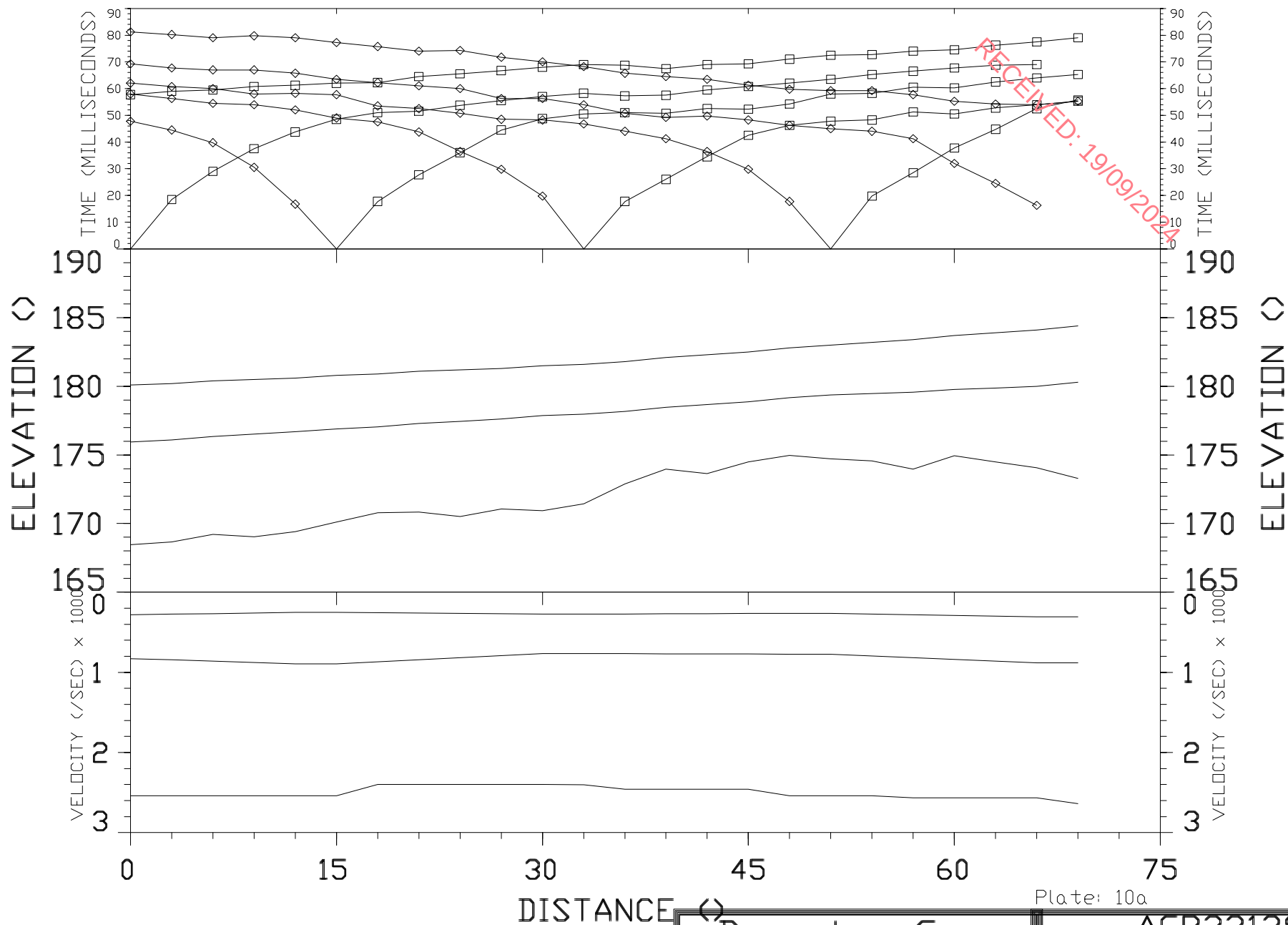


Plate: 10a

Breedon Group		AGP22128	
by: APEX Geophysics Ltd.		Mounthall Camross	
Data SetS2	Date: 08/07/2022	Laois	
Equipment: Geode	Spread: S2	Azimuth:	



Breedon Group		AGP22128
by: APEX Geophysics Ltd.		Mounthall Camross
Data SetS3	Date: 08/07/2022	Laois
Equipment: Geode	Spread: S3	Azimuth: