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## Appendix 7-4

### Site Investigation Report Series

**Appendix 7-4**

**Site Investigation Reports**

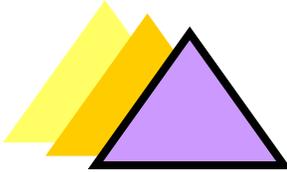
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Apex (2005)

Priority Geotechnical BH Logs (2020)

Apex (2021)

Irish Drilling (2021)



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**DRAFT REPORT ON THE  
GEOPHYSICAL SURVEY  
AT  
ARDGAINEN QUARRY, CLAREGALWAY, CO. GALWAY  
FOR  
JOHN BARNETT AND ASSOCIATES LTD.**

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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 GEOSERVICES 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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**APPENDICES**

Appendix I	Methodology
Appendix II	Seismic Data

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## **1. INTRODUCTION**

APEX Geoservices Ltd. was requested by John Barnett and Associates Ltd. to carry out a geophysical survey at a 14.8 hectare site adjacent to Ardgaineen Quarry, Claregalway, Co. Galway.

### **1.1 Survey Objectives**

The objective of the survey was:

- To map variations in overburden type and thickness across the site.
- To determine depth to bedrock across the site.
- To identify locations of possible karst features.

### **1.2 Survey Methodology**

- ❖ Electromagnetic conductivity surveying to outline zones of shallow rock.
- ❖ 2D Resistivity profiling to map variations in type and thickness of overburden and rock type and to investigate the presence of karst features.
- ❖ Seismic refraction profiles to provide information on depth to bedrock, rock type and strength.

### **1.3 Site Background**

The site comprises 14.8 hectares of undeveloped land to the east of the existing Ardgaineen Quarry which is located approximately 6km north of Claregalway, Co. Galway. The exposed quarry faces indicate thickly bedded limestones interbedded with thinner less prominent mudstone and shales.

The geological map for the area (Geology of Galway Bay, Sheet 14, GSI) indicates that the site is underlain by Carboniferous Visean undifferentiated Limestones. The geological map 'Geology of South Mayo', Sheet 11 lies 1km north of the site and has a more detailed description of the Visean limestones. This map would suggest that the site is underlain by either the Knockmaa Formation thick-bedded pure limestone or the Two Mile Ditch Member comprising thick-bedded limestone with clay wayboards.

No borehole information was available at time of interpretation. Site photographs of the face show clay infill zones and a depression is visible in the Greenfield area.

### **1.4 Report Outline**

- ❖ The survey results are discussed in Section 2.
- ❖ Conclusions and recommendations are given in Section 3.
- ❖ The locations of the geophysical readings are shown on Map 1.
- ❖ The electromagnetic conductivity values are plotted on Map 2.
- ❖ Summary results and proposed borehole locations are shown on Map 3.
- ❖ The interpreted resistivity and seismic data are shown on Sections 1 to 8.
- ❖ The survey methodology is contained in Appendix I.
- ❖ The seismic data are contained in Appendix II.

## 2. INTERPRETED RESULTS

### 2.1 Electromagnetic Conductivity Surveying

The results of the EM31 Conductivity Survey were contoured and plotted on Map 2. The conductivity data values ranged from 0 to over 37.9 mS/m with the majority of the values between 3.2 and 8 mS/m. The data were interpreted on the following basis:

Conductivity (mS/m)	Interpretation of 0 – 6m Below Ground Level
3.0 – 5.5	Thin <i>gravelly clay</i> overburden (1 - 3m) over limestone
5.5 - 7.0	Thin <i>silt/clay</i> overburden (1 - 3m) over limestone
7.0 – 9.0	Thick <i>silt/clay</i> (1.5 – 10m) overburden over limestone
> 9.0	Local interference from fencing and/or surface metal

### 2.2 2D Resistivity Profiling

Eight 2D Resistivity profiles were recorded across the site (Map 1, Sections 1 to 8). The resistivity data were interpreted in conjunction with the seismic refraction profiles on the following basis:

Resistivity (Ohm-m)	Interpretation
50 - 130	Silt/Clay Overburden
130 - 330	Gravelly Clay Overburden
330 - 840	Highly to moderately weathered/Fissured Limestone with Clay infill
840 – 50,000	Fresh Limestone

The resistivity data have been plotted at a constant resistivity colour scale on Sections 1 to 8 for comparison purposes. Section 7 has also been plotted at a lower resistivity colour scale (Section 7A) to emphasize the low resistivity features within the bedrock.

### 2.3 Seismic Refraction Profiling

Five seismic spreads were recorded across the site (Map 1, Sections 1-2, 5-7). The seismic data have been summarized and overlaid on the resistivity profiles and the individual plates can be seen in Appendix II.

The seismic data were interpreted on the following basis:

Velocity (m/s)	Interpretation
416-888	Soft to Firm/Loose Overburden
769-1265	Firm to Stiff/Medium Dense Overburden
1538-2222	Highly to moderately weathered/Fissured Rock
2469 - 5217	Fresh Rock

## 2.4 Integrated Interpretation

The combined geophysical data can be summarized as follows:

P-Seismic Velocity (m/sec)	Resistivity (ohm-m)	Interpretation	Stiffness/Rock Quality
416-888	50 - 130	Silt/Clay	Soft to Firm
	130 - 330	Gravelly Clay	
769-1265	50 - 130	Silt/Clay	Firm to Stiff
1538-2222	330 - 840	Highly to Moderately Weathered/Fissured Limestone with Clay Infill	Fair
2469-5217	840-50,000	Fresh Limestone	Good

The geophysical data generally indicate thin (1-3m) soft to firm gravelly clay overburden across the site.

Increased conductivity values (5.5 – 7 mS/m) and low resistivity values (50 – 130 Ohm-m) have been interpreted as indicating zones of soft to firm silty clayey overburden material across the site (Map 3).

Some localized zones of higher conductivity (>7 mS/m) and low resistivity values (50 – 130 Ohm-m) have been interpreted as indicating thicker pockets of soft to firm to stiff silty clayey overburden material up to 10.7m thick (Map 3).

The contoured EM data (Map 2) appears to indicate that the fissuring follows an approximate NNW and ENE trend and these are likely to be encountered as the face move to the ENE.

Limestone quality decreases from west to east across the site with evidence of a relatively high degree of weathering in the upper 1-9m, fissure infill and thick pockets of overburden in the centre and east of the site.

The geophysical data generally indicate a layer of moderately to slightly weathered/fissured (possibly karstified) limestone. This weathered layer has been interpreted on all sections. The thickness of this layer ranges from 1.0 - 9.0m across the area of the site. Sections 6 and 7 indicate deeper zones of this weathered/fissured (possibly karstified) limestone to the east of the site.

The main seismic refractor has a velocity of 2469 - 5217 m/s which indicates a generally strong fresh limestone. The very high resistivities recorded for the strong fresh limestone (typically from 840 to >50,000 ohm-m) would indicate that the limestone has open joints and fissures throughout, with no water present.

Possible sinkholes occur in the eastern part of the site (Sections 6 & 7). Better resolution of this particular profile can be seen on the resistivity plot R7A.

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**3.0 CONCLUSIONS AND RECOMMENDATIONS**

- The geophysical survey has outlined significant variations in the degree of weathering and fissure infill of the limestone across the site. Limestone quality decreases from west to east across the site with evidence of a relatively high degree of weathering in the upper 1-9m, fissure infill and thick pockets of overburden in the centre and east of the site.
- The main infilled fissuring appears to follow an approximate NNW and ENE trend and these are likely to be encountered as the face move to the ENE. The resistivity data indicate that these infilled fissures can extend as deep as 30m bgl in places.
- The very high resistivities indicate a clean dry limestone with small scale open fissuring.
- Overburden appears relatively thin (1 – 3m) across most of the site apart from localized pockets of thicker material (up to 10 m).
- A key factor in the future development of this area will be the degree of weathering and particularly the amount of clay infill in the weathered zones and layers outlined by the geophysical survey.
- The following rotary core (RC) boreholes are recommended:

Bore-hole No.	Type	National Grid Reference		Min.Depth (m) bgl	Target
		Easting	Northing		
BH1	RC	138472	240632	20	Weathered zone to 10-15 m bgl on R2
BH2	RC	138528	240675	25	Thick overburden and weathered rock on R5
BH3	RC	138609	240652	25	Vertical fissure on R7
BH4	RC	138491	240505	30	Weathered zone/layer on R6
BH5	RC	138362	240542	20	EM31 high east of face – no major anomaly on R1.

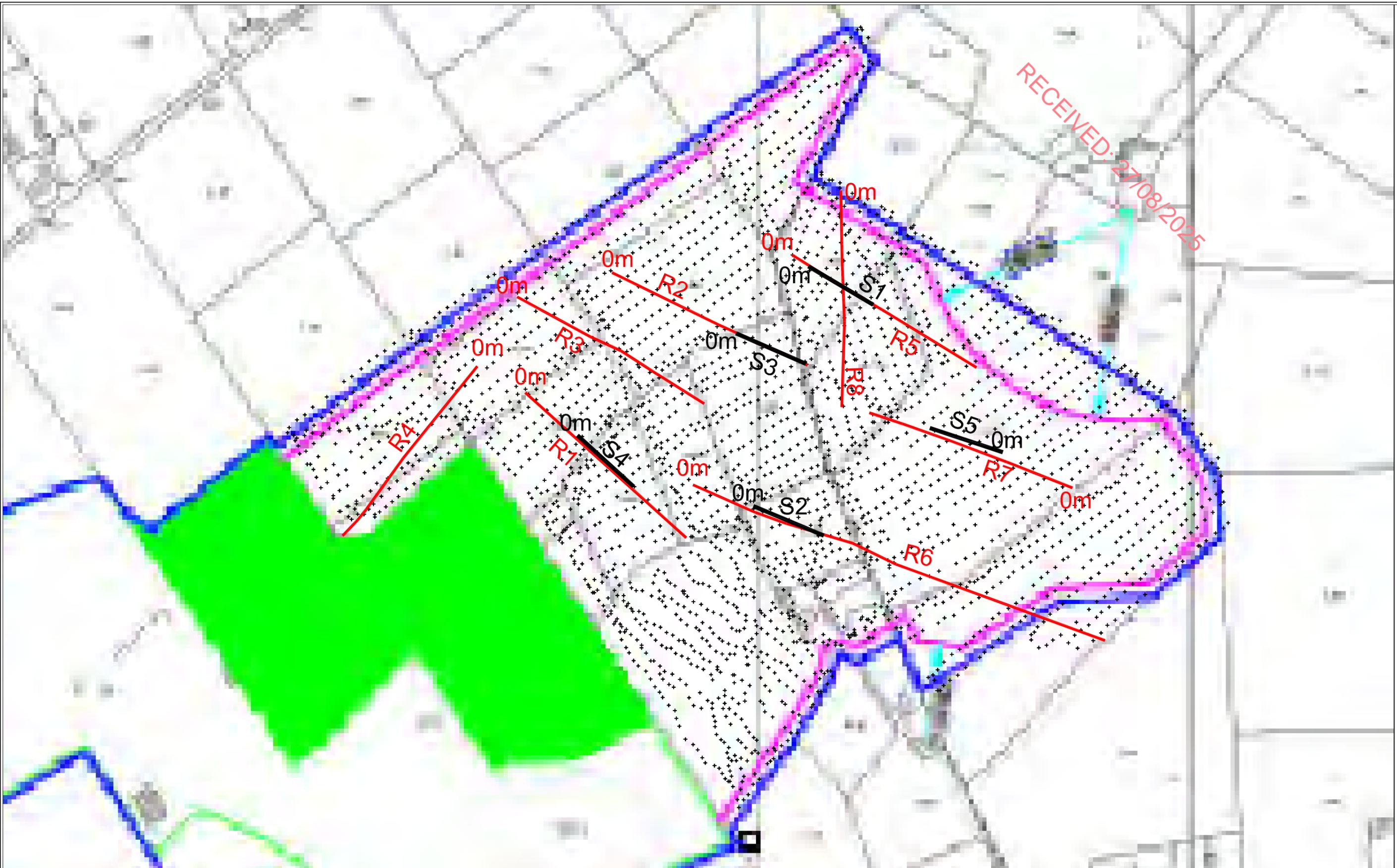
- The interpretation of the geophysical data should be reviewed on completion of the drilling program.

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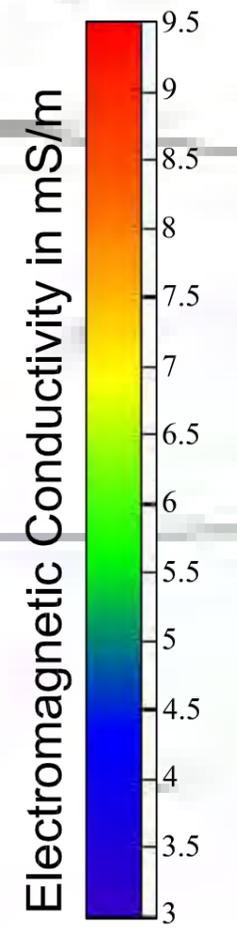
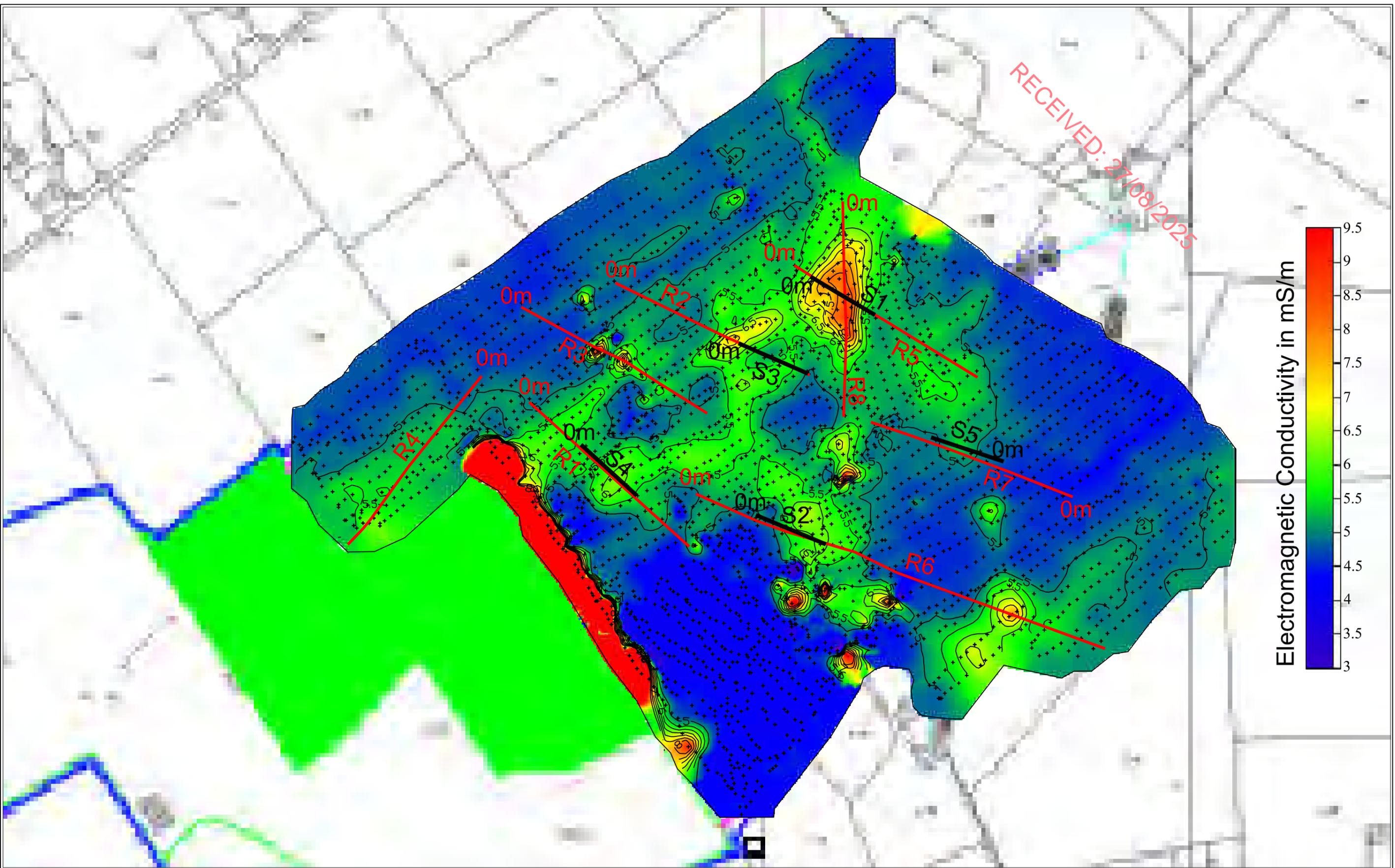


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- + EM31 Conductivity Locations
- 0m R2 2D Resistivity Profile
- 0m S1 Seismic Spread

PROJECT:	Ardgaineen Quarry Geophysical Survey
DRAWING TITLE:	Map 1: Geophysical Survey Locations
DATE:	November 2005
CLIENT:	JBA Ltd.
SCALE:	1:2500

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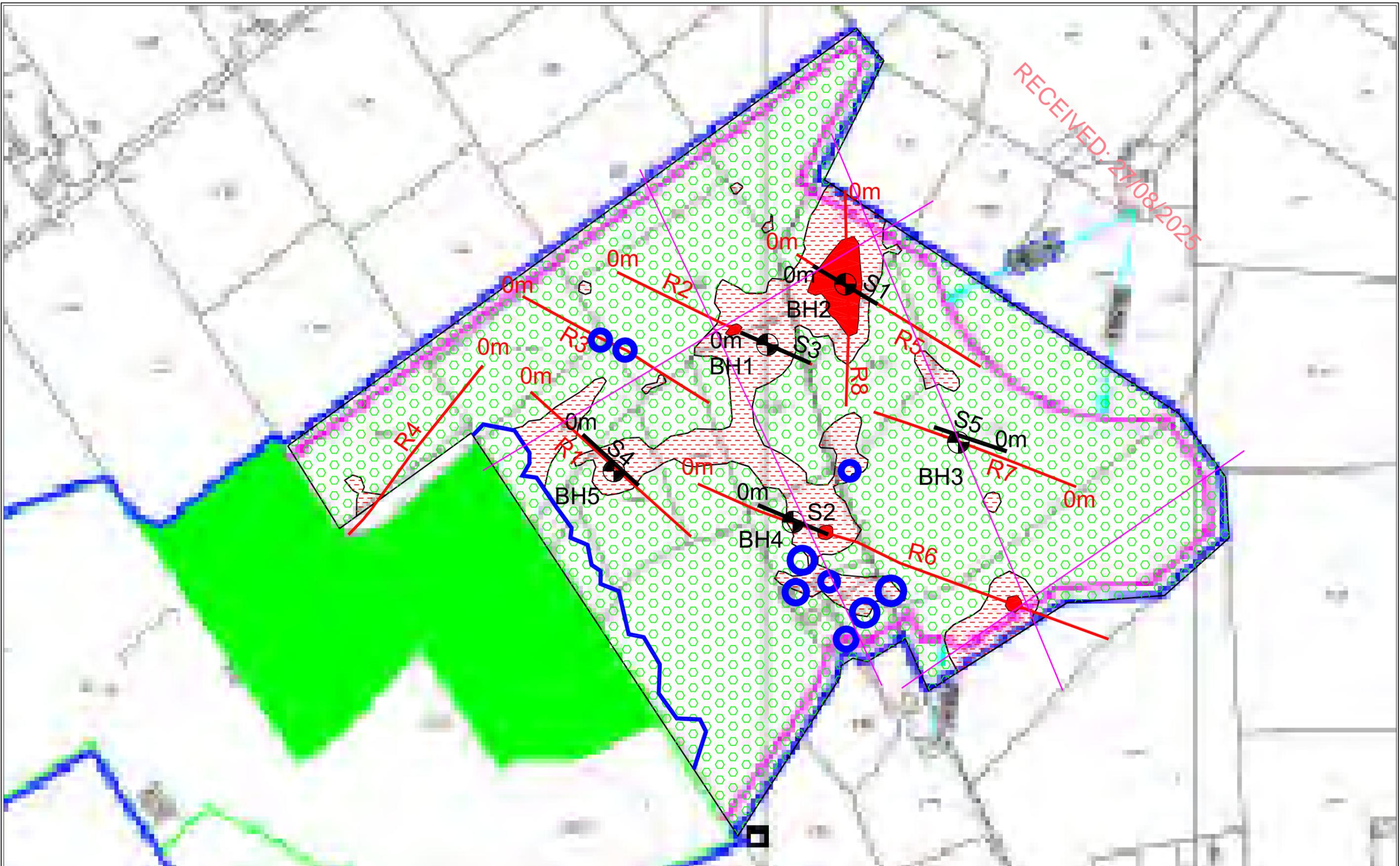


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+ EM31 Conductivity Locations

PROJECT:	Ardgaineen Quarry Geophysical Survey
DRAWING TITLE:	Map 2: Electromagnetic Conductivity Contours
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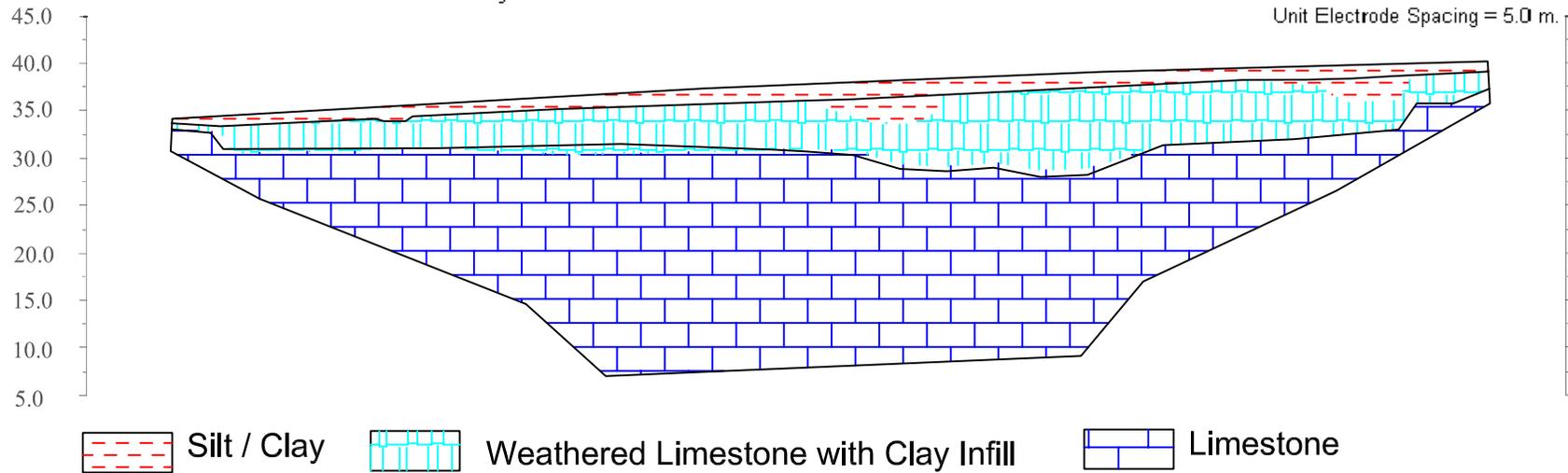
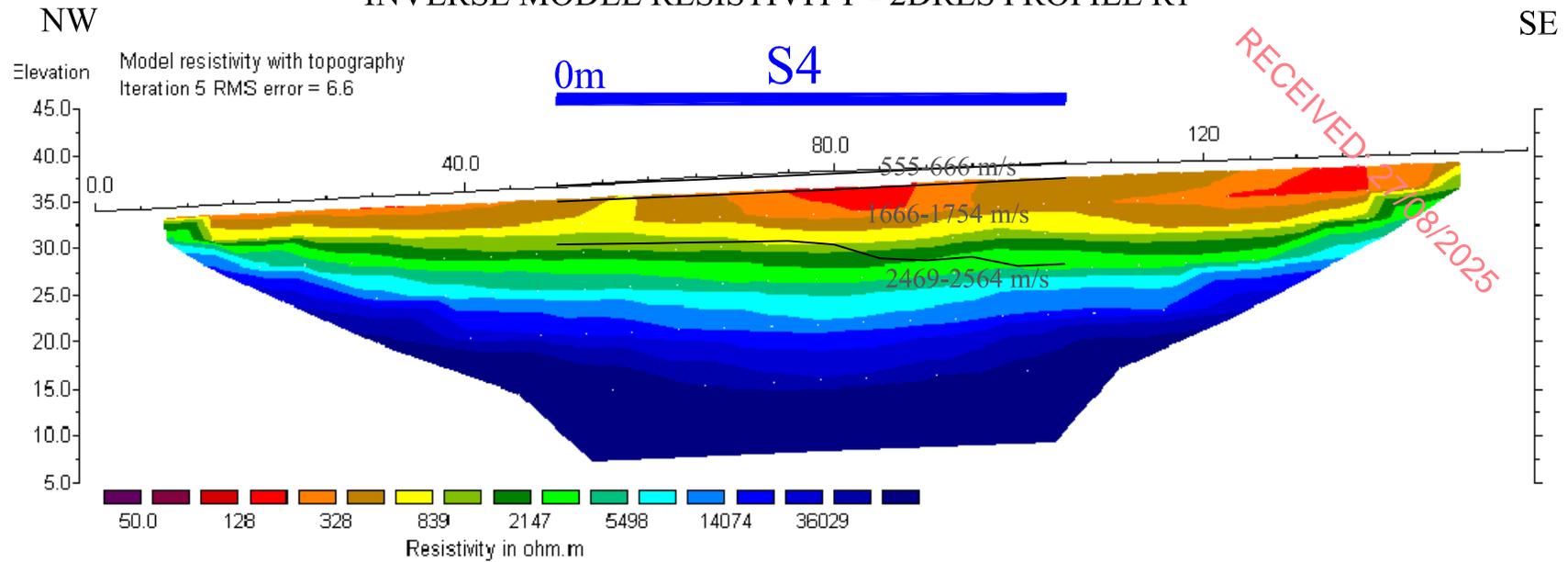
<b>0m R2</b>	2D Resistivity Profile		<1.5m gravelly Clay over Limestone
<b>0m S1</b>	Seismic Spread		<1.5m Silt/Clay over Limestone
	Cultural Interference		1.5-10.7m Silt/Clay over Limestone
	Proposed Boreholes		Approximate trends of main fissures from EM data

PROJECT:	Ardgaineen Quarry Geophysical Survey
DRAWING TITLE:	Map 3: Summary Map
DATE:	November 2005
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SCALE:	1:2500

***INTERPRETED SECTIONS***  
Interpreted 2D Resistivity & Seismic Profiles

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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R1



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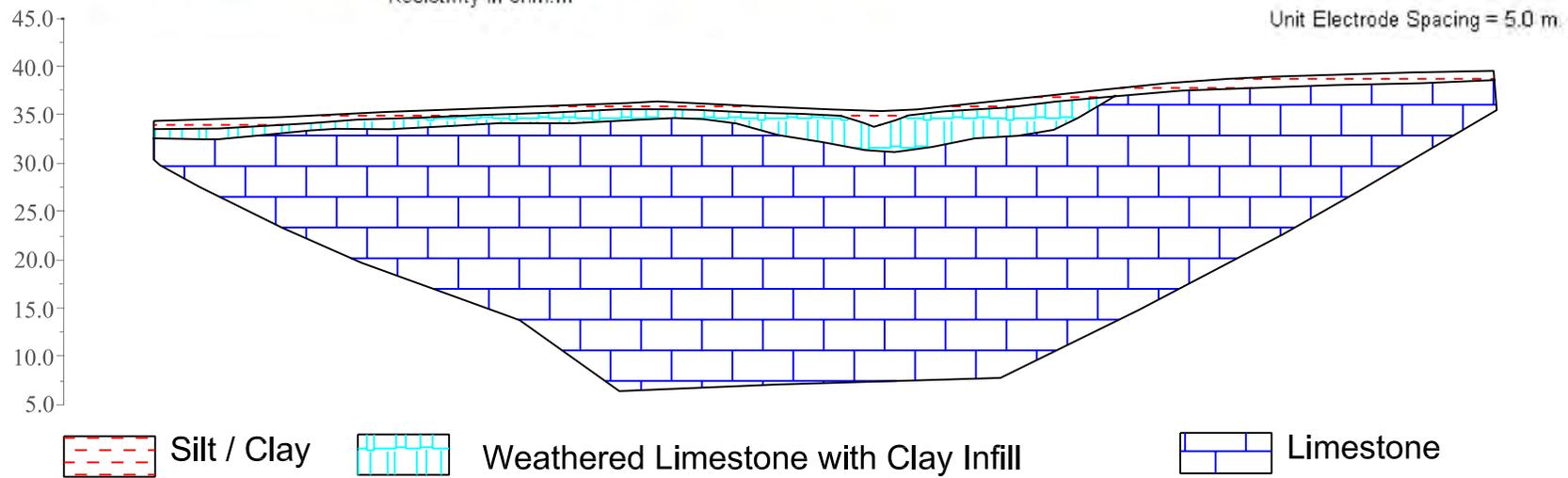
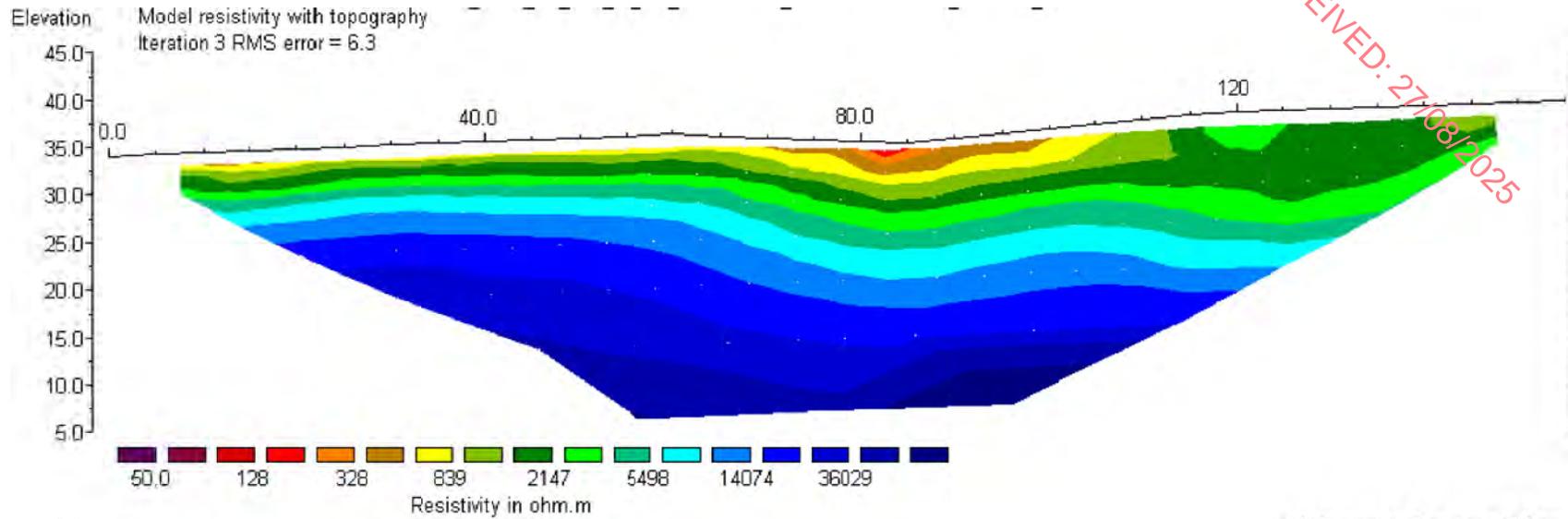
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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R3

NW

SE



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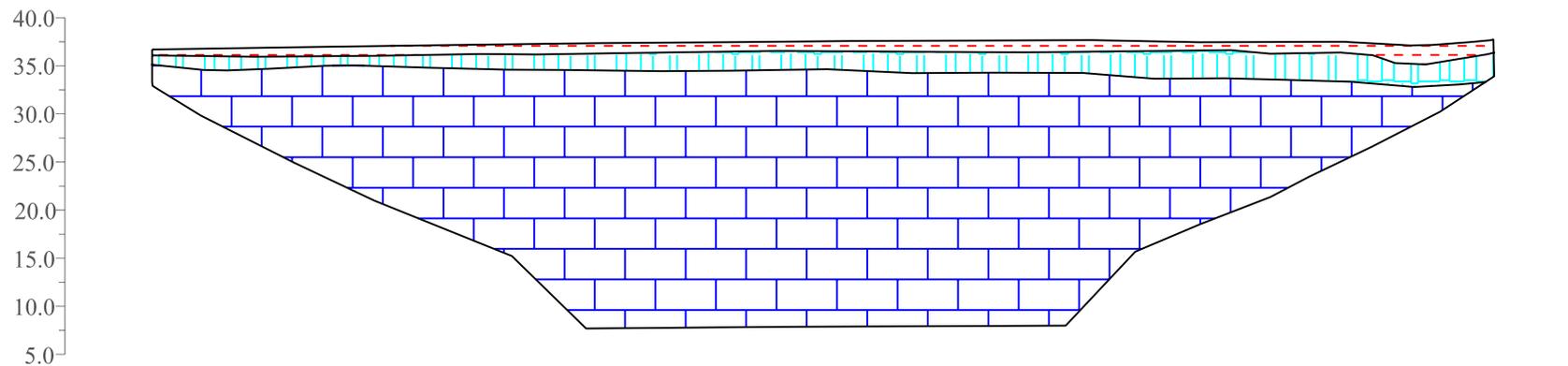
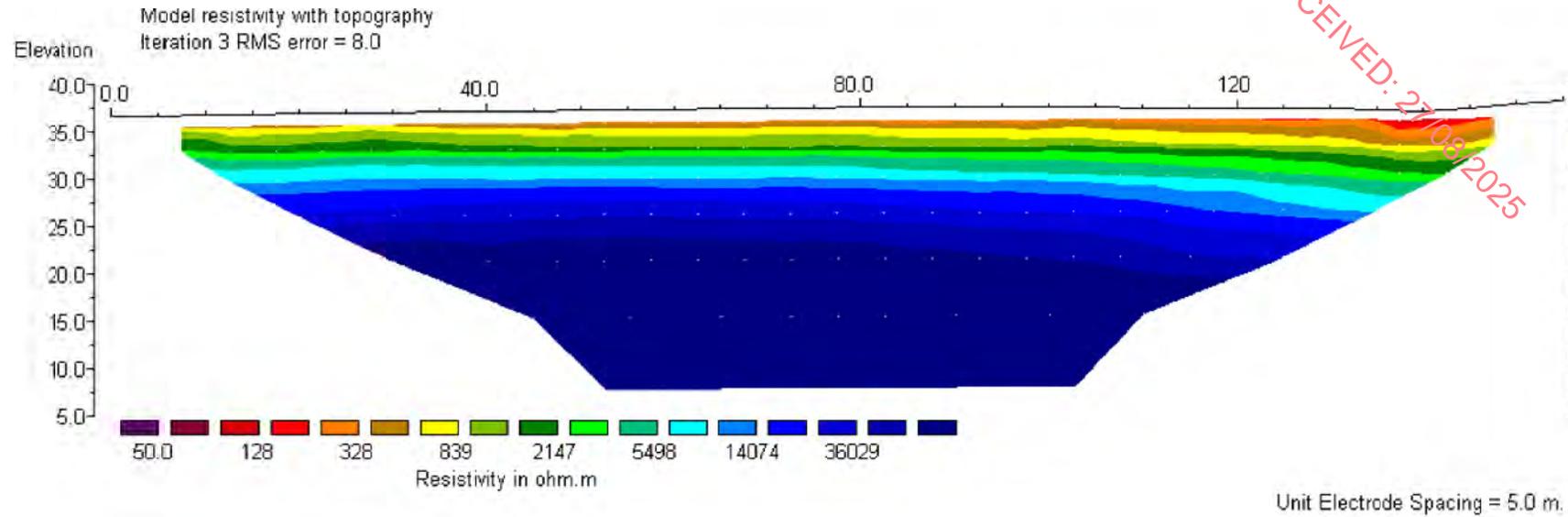
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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R4

NE

SW



Silt / Clay    
  Weathered Limestone with Clay Infill    
  Limestone



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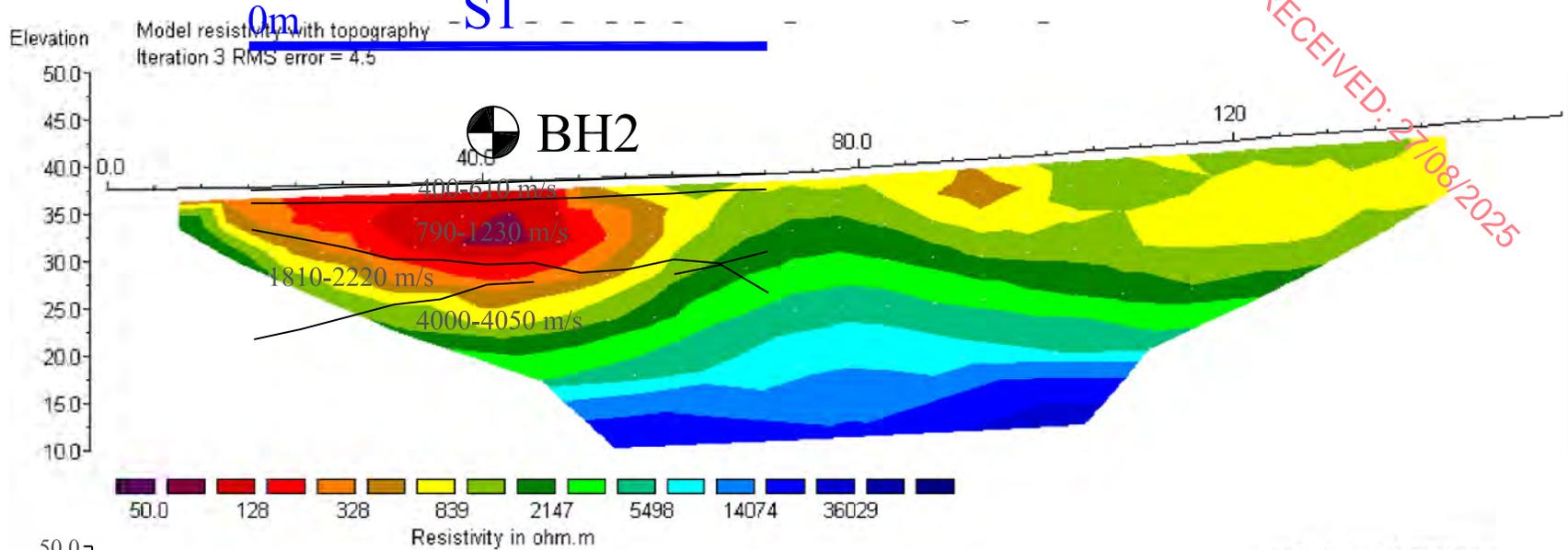
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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R5

NW

SE



- Silt / Clay
- Weathered Limestone with Clay Infill
- Limestone



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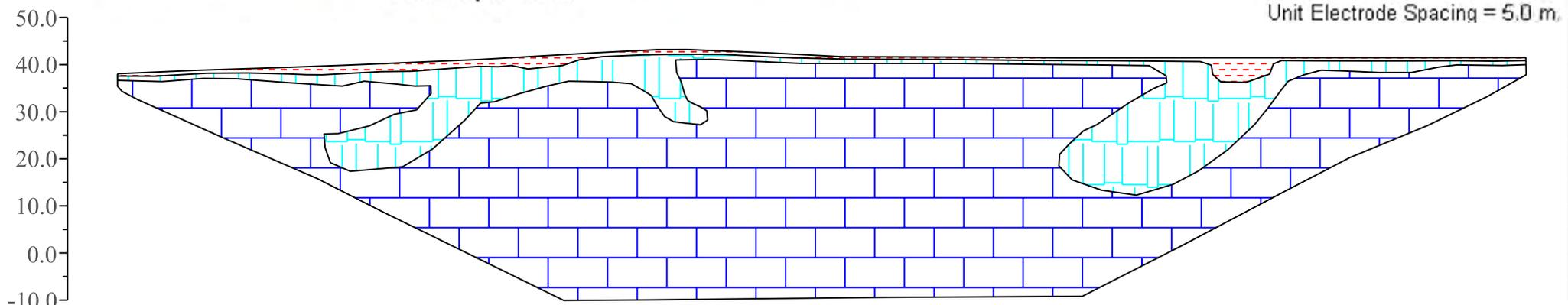
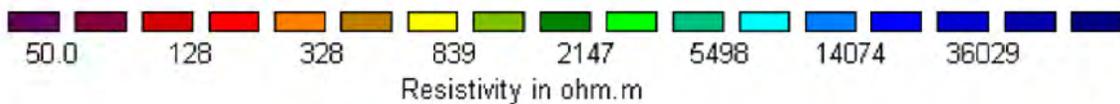
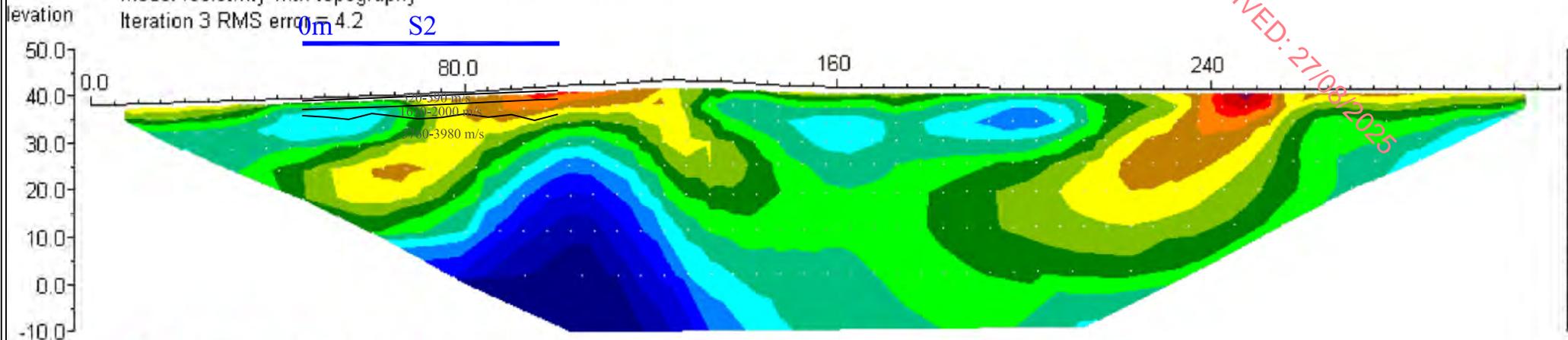
# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R6

NW

SE

Model resistivity with topography BH4

Iteration 3 RMS error = 4.2



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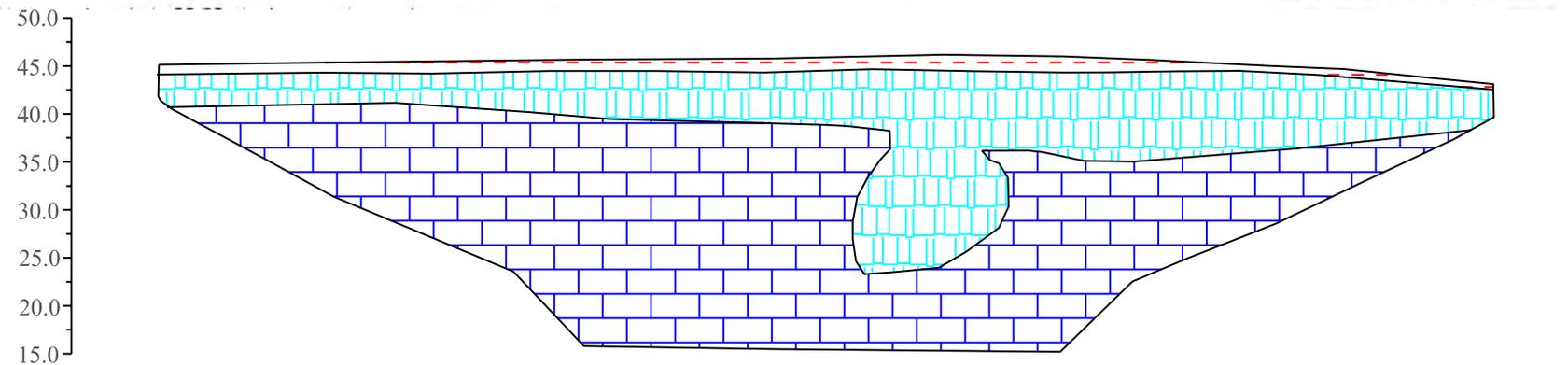
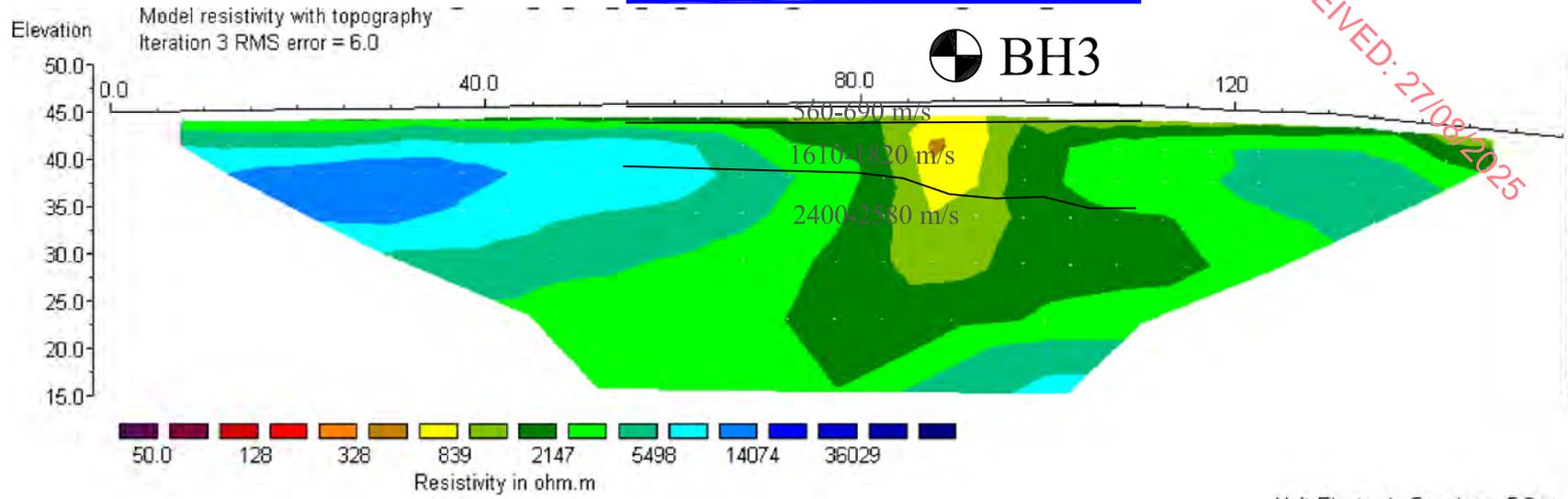
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S5

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  Silt / Clay    
   Weathered Limestone with Clay Infill    
   Limestone



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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R7A

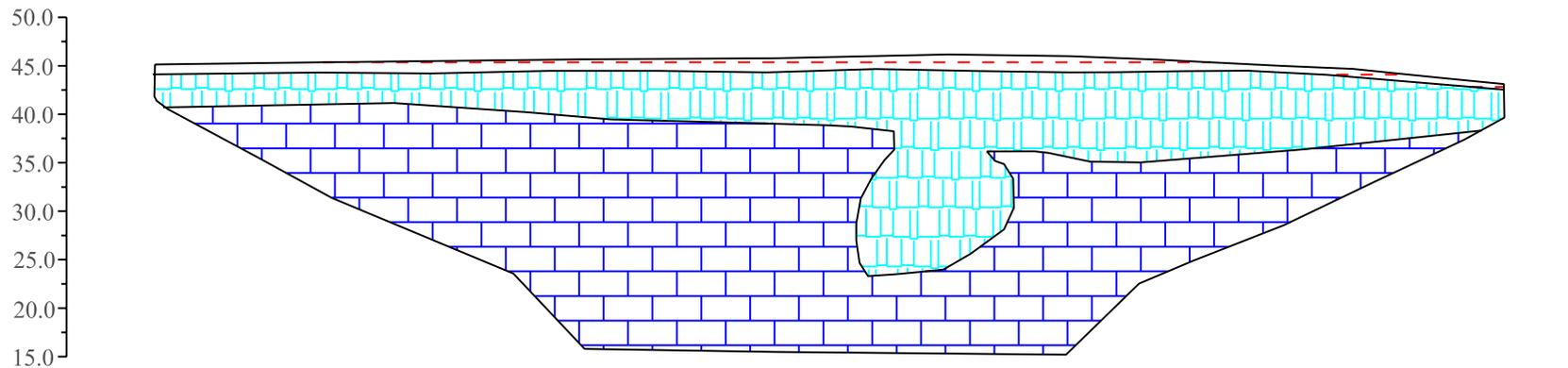
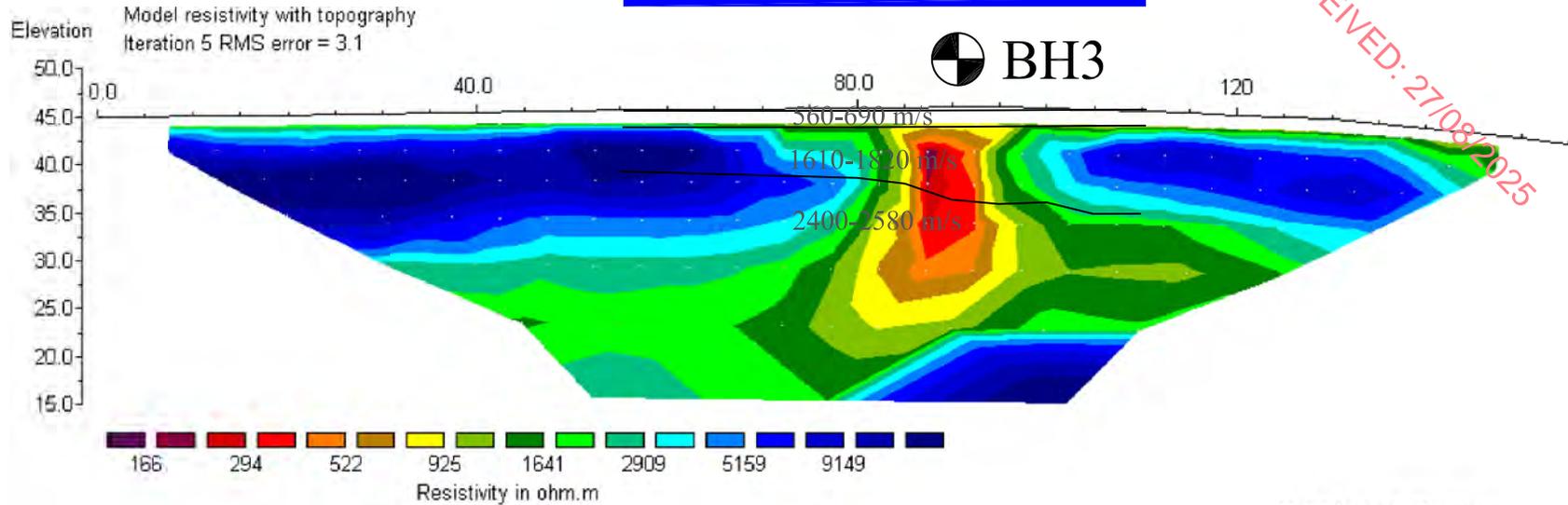
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S5

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Silt / Clay
  Weathered Limestone with Clay Infill
  Limestone

Unit Electrode Spacing = 5.0 m.



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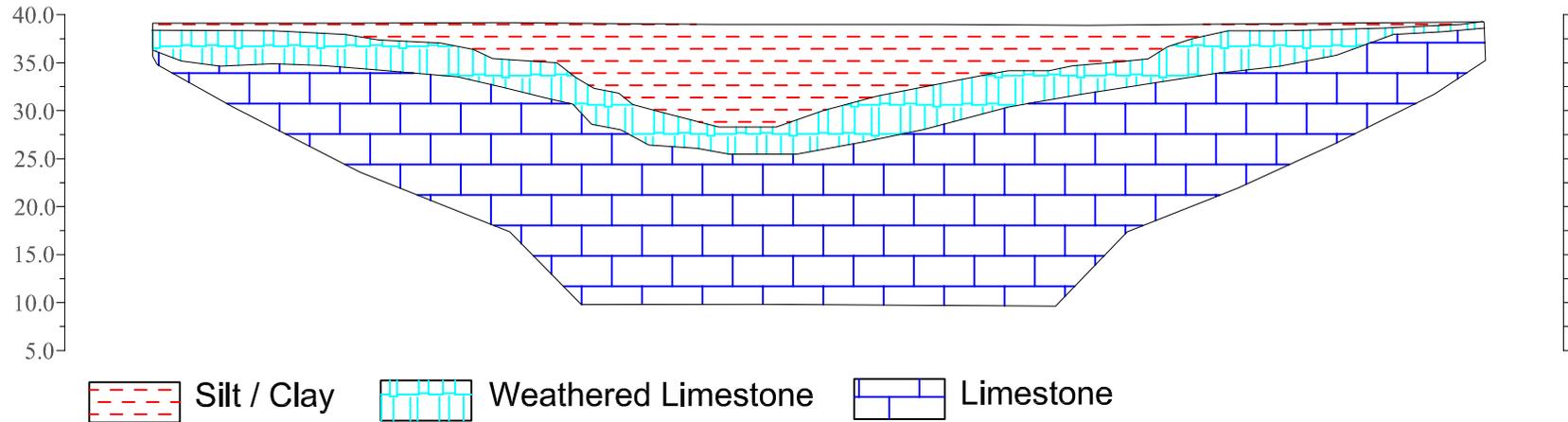
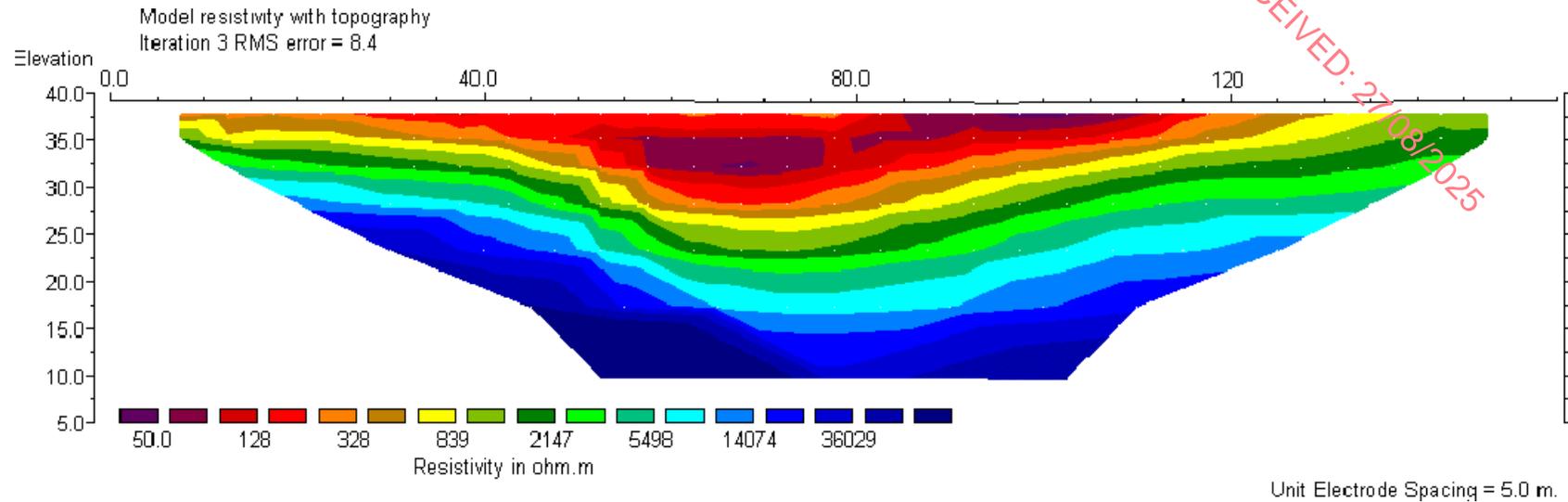
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# INVERSE MODEL RESISTIVITY - 2DRES PROFILE R8

N

S



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## **APPENDIX I      GEOPHYSICAL METHODOLOGY**

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- M1.            Methods Used**
- 1.1            CM31 Conductivity Mapping
  - 1.2            2D-Resistivity Profiling
  - 1.3            Seismic Refraction Profiling

- M2.            Equipment Used**
- 2.1            CM31 Conductivity Mapping
  - 2.2            2D-Resistivity Profiling
  - 2.3            Seismic Refraction Profiling

- M3.            Field Procedure**
- 3.1            CM31 Conductivity Mapping
  - 3.2            2D-Resistivity Profiling
  - 3.3            Seismic Refraction Profiling

- M4.            Data Processing**
- 4.1            CM31 Conductivity Mapping
  - 4.2            2D-Resistivity Profiling
  - 4.3            Seismic Refraction Profiling

## **M1. Methods Used**

### **1.1 CM31 Conductivity Mapping**

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). As the effective penetration of this method is around 6m below ground level the measured conductivity is a function of the different overburden layers and/or rock from 0 to 6m below ground level.

### **1.2 2D-Resistivity Profiling**

This surveying technique also 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. The 2D-resistivity profiling method involves the use of up to 32 electrodes connected to a resistivity meter, using computer software to control the process of data collection and storage.

### **1.3 Seismic Refraction Profiling**

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. Readings are taken using geophones connected via multi-core cable to a seismograph.

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## **M2. Equipment Used**

### **2.1 CM31 Conductivity Mapping**

The equipment used was a GF CM31 Conductivity meter equipped with data logger. This instrument features a real time graphic display of the previous 20 measurement points to monitor data quality and results. 3137 processed conductivity readings were recorded on 19<sup>th</sup> October 2005.

### **2.2 2D-Resistivity Profiling**

Eight profiles were recorded on 13<sup>th</sup> October 2005 using a Tigre resistivity meter, imaging software, a 32 takeout multicore cable and 32 stainless steel electrodes. The recorded data was processed and viewed immediately after the survey.

### **2.3 Seismic Refraction Profiling**

Five spreads were recorded on 13<sup>th</sup> October 2005 using a Ras-24 high resolution 12 channel digital seismograph with geophone spacings of 5m. The source of the seismic waves was a sledgehammer.

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### M3. Field Procedure

#### 3.1 CM31 Conductivity Mapping

Conductivity and in-phase values were recorded on a 10 m x 10 m grid over an approximate area of 36 acres. Local conditions and variations were recorded.

#### 3.2 2D-Resistivity Profiling

Resistances were measured for expanding arrays. 2 cycles were recorded to 3% repeatability. Saline solution was added around electrodes in areas of high contact resistance. Local conditions and variations were recorded. QC inversion of each profile was carried out before removal of electrodes.

The 2D-Resistivity profiles have the following recording parameters:

Profile	Electrodes	Spacing	Length	Depth of Investigation	Azimuth
No.	No.	(m)	(m)	(m)	
1	32	5	155	30	NW - SE
2	32	5	155	30	NW - SE
3	32	5	155	30	NW - SE
4	32	5	155	30	NE - SW
5	32	5	155	30	NW - SE
6	64	5	315	50	NW - SE
7	32	5	155	30	E - W
8	32	5	155	30	N - S

#### 3.3 Seismic Refraction Profiling

The seismic refraction profiles have the following recording parameters:

Profile	Geophones	Spacing	Length	Depth of Investigation	Azimuth
No.	No.	(m)	(m)	(m)	
1	12	5	55	18	NW - SE
2	12	5	55	18	NW - SE
3	12	5	55	18	NW - SE
4	12	5	55	18	NW - SE
5	12	5	55	18	E-W

Records from five different positions were taken (2 x off-end, 2 x end, 1 x middle) for spreads 1, 2, 4 and 5 to ensure optimum coverage of all refractors. Records from four different positions were taken for spread 3 (1 x off-end, 2 x end, 1 x middle). Ongoing estimation of refractor velocities was carried out to monitor refractor type and depth.

## **M4. Data Processing**

### **4.1 CM31 Conductivity Mapping**

The data were downloaded and plotted. Assignment of material types and possible anomaly sources was carried out, with cross-reference to other data. A contoured plot of conductivity was prepared (Map 2).

### **4.2 2D-Resistivity Profiling**

The field readings were stored in computer files and inverted using the RES2DINV package (Campus Geophysical Instruments, 1997) 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 Sections 1 to 8. The chainage is indicated along the horizontal axis of the profile and the depth below ground level is indicated on the vertical axis. All profiles have been contoured using the same contour intervals and colour codes.

*It is important to note that the data displayed on the 2D-Resistivity profiles is real physical data however interpretation of the geophysical results is required to transform the resistivities directly into geological layers.*

### **4.3 Seismic Refraction Profiling**

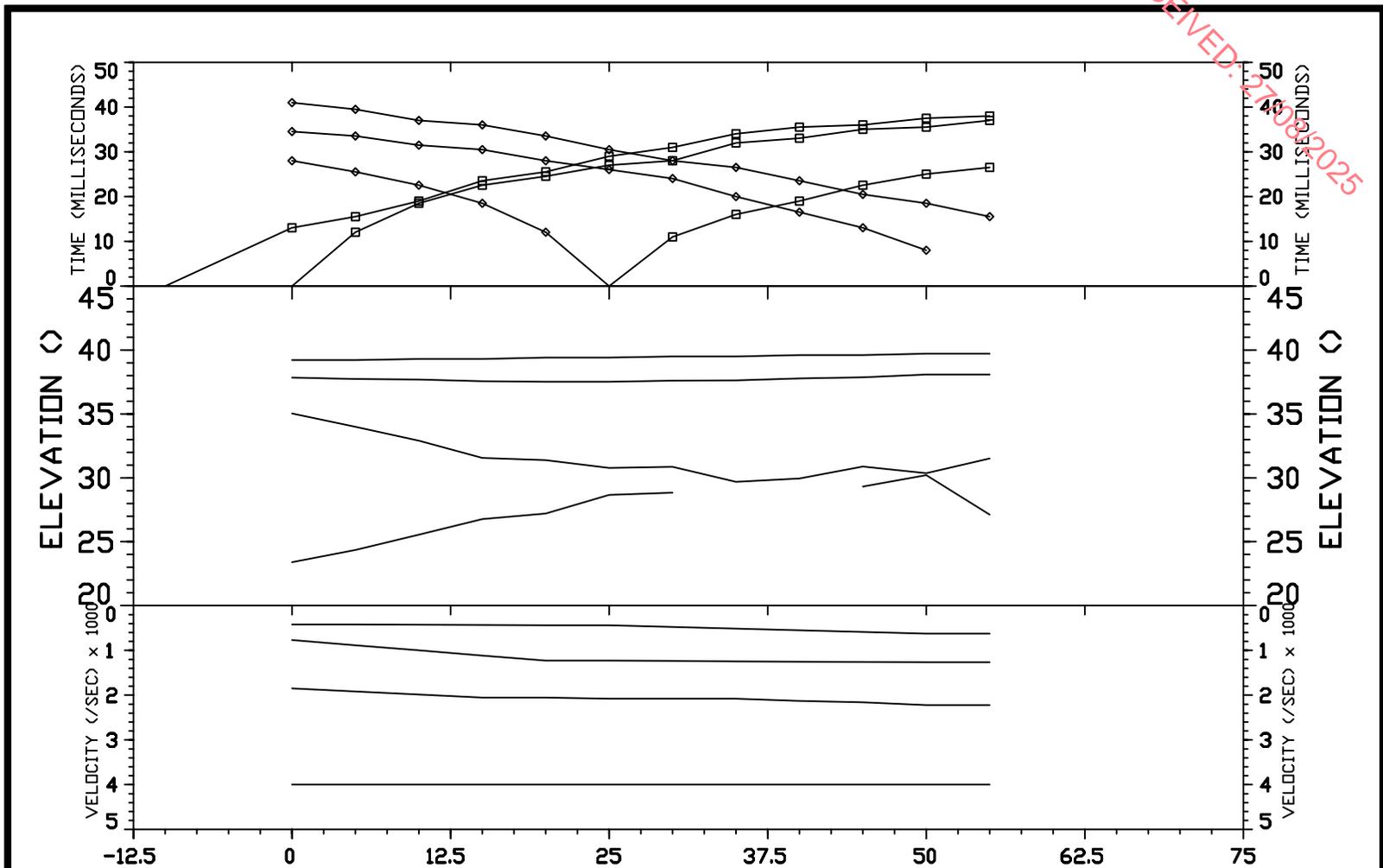
The recorded data was interpreted using the ray-tracing and intercept time methods. The thickness estimates were plotted at the relevant locations on interpreted sections 1, 2, 5, 6 and 7.

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**APPENDIX II                      Seismic Data**

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DISTANCE

Plate: 10a

for: JBA	4148
by: APEX Geoservices Ltd.	ARDGAINEE GALWAY
Data Set: S1	Date: 10-14-2005
Equipment: Setstronix RAS	Spread: 1
	Azimuth:

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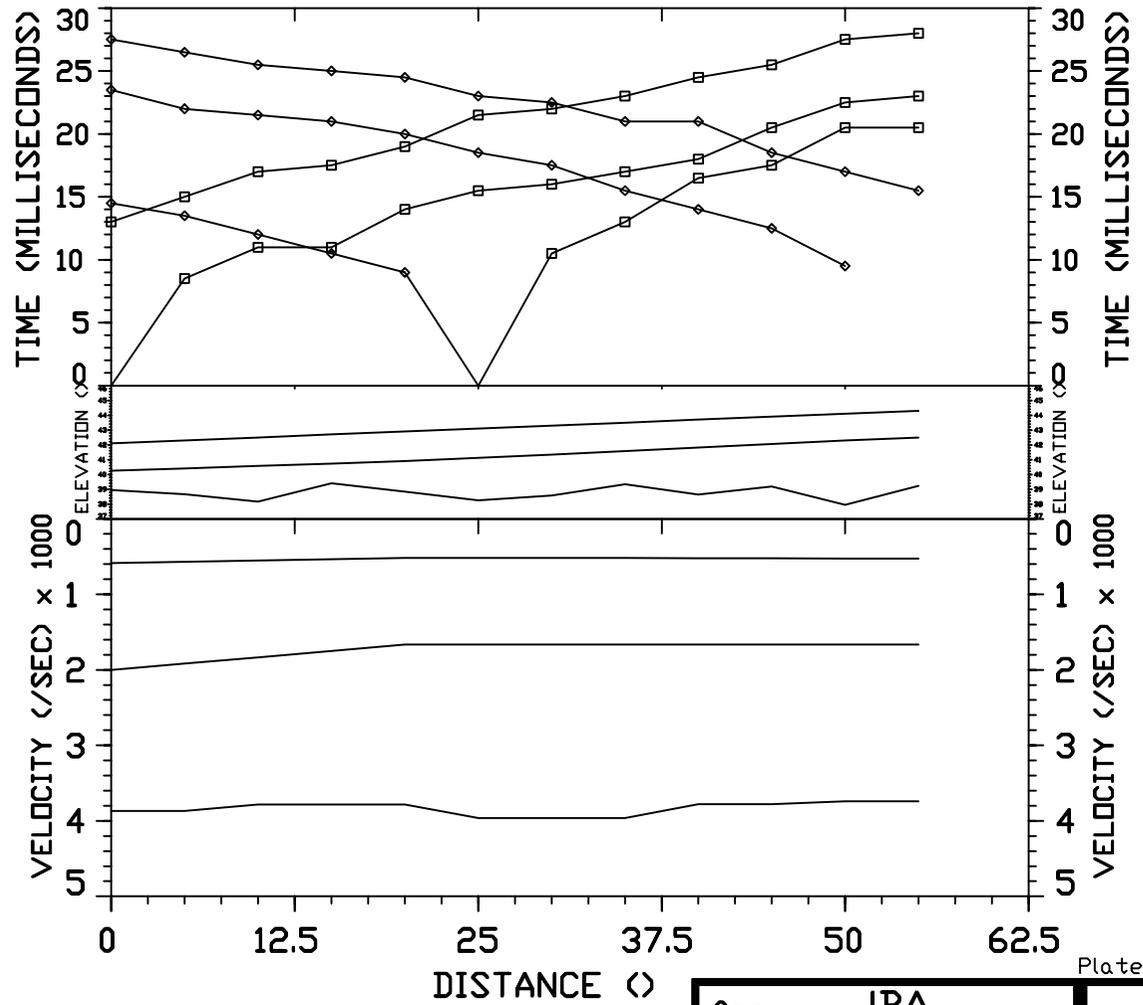
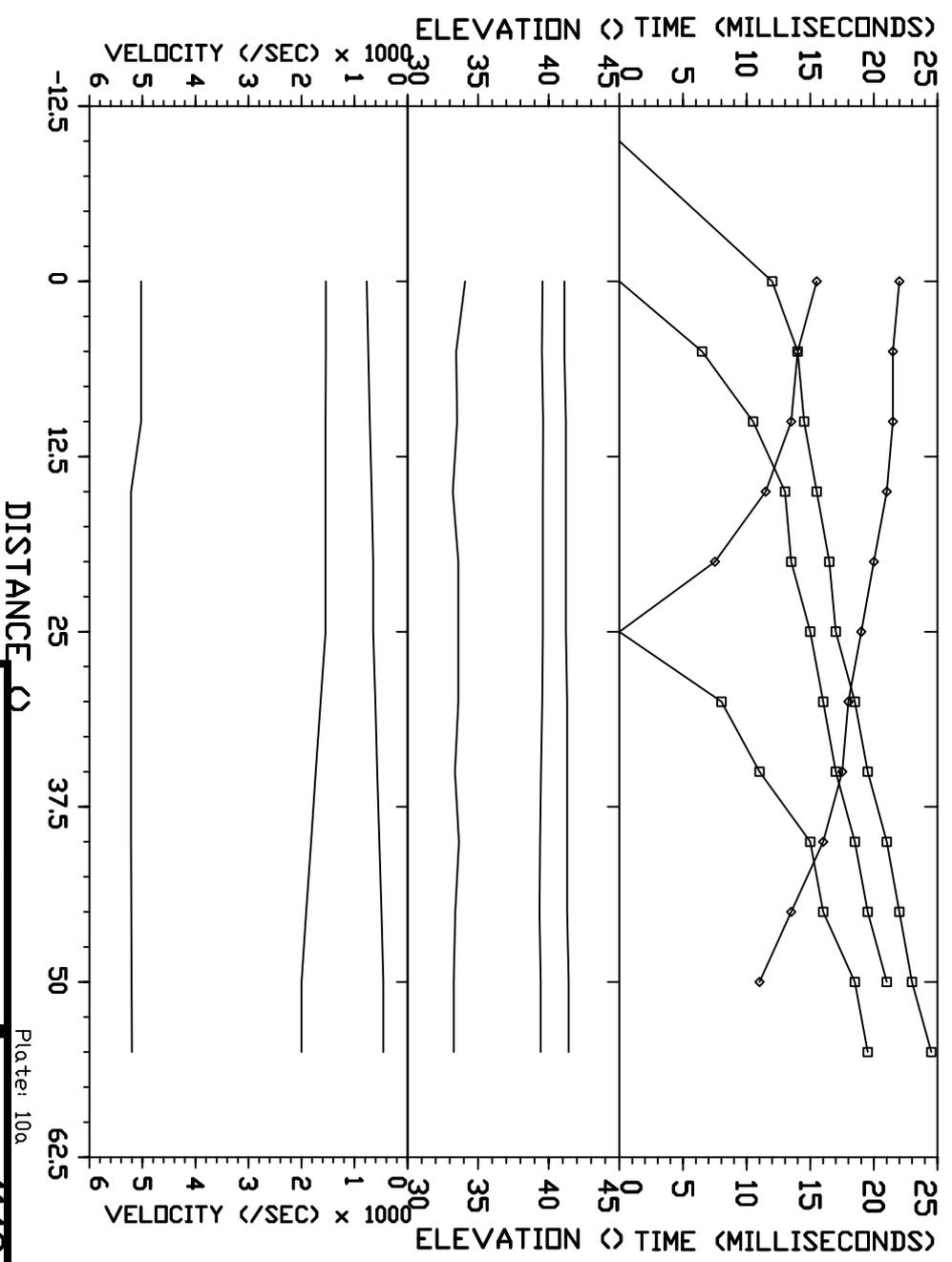


Plate: 10a

for: JBA	4148
by: APEX Geoservices Ltd.	ARDGAINEE GALWAY
Data Set: S2	Date: 10-14-2005
Equipment: Seistronix RAS	Spread: 1
	Azimuth:

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for: <b>JBA</b>		<b>4148</b>	
by:	APEX Geoservices Ltd.	<b>ARDGAINEE</b>	
<b>Data Sets3</b>	Date: 10-14-2005	<b>GALWAY</b>	
Equipment: SeisTrak RAS	<b>Spread 1</b>	<b>Azimuth</b>	

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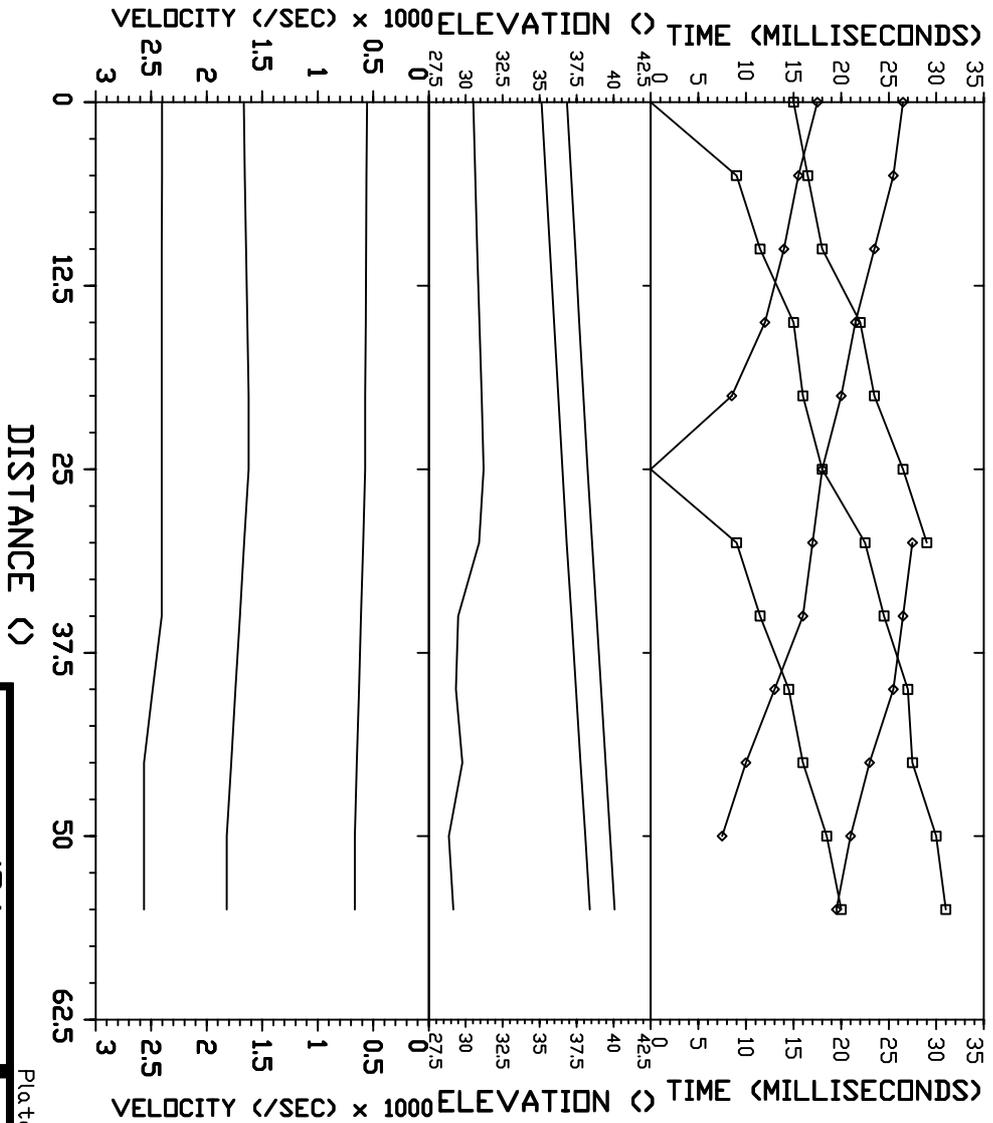
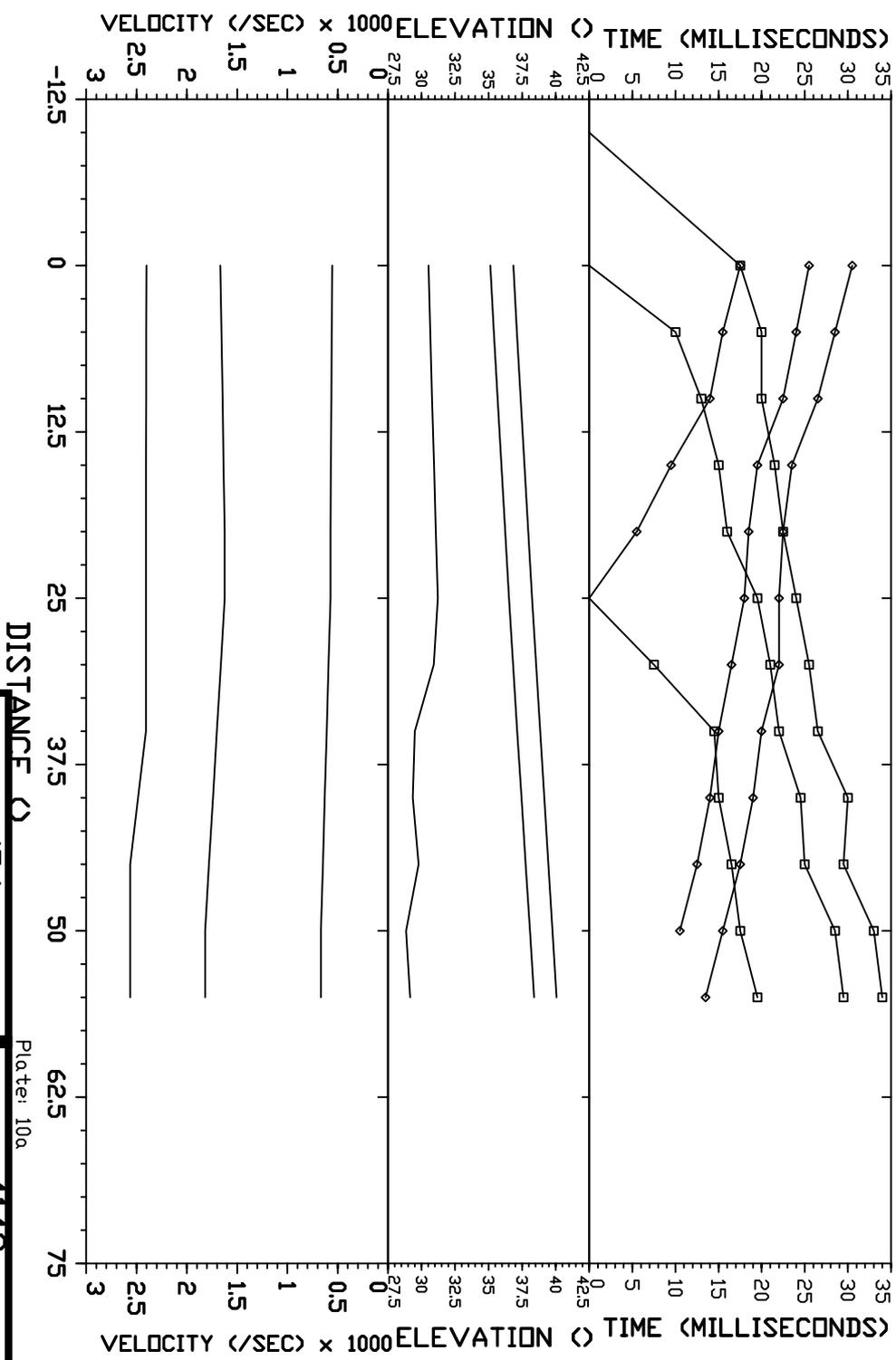


Plate: 10a

for: **JBA**  
 by: APEX Geoservices Ltd.  
**Data Sets4** Date: 10-14-2005  
 Equipment: SISTRONIK RAS **Spread 1**

**4148**  
**ARDGAINEE**  
**GALWAY**  
 Azimuth

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for: <b>JBA</b>	<b>4148</b>
by: APEX Geoservices Ltd.	<b>ARDGAINEE</b>
Data Set: 5	<b>GALWAY</b>
Equipment: Siertronic RAS	Azimuth:
Date: 10-14-2005	<b>Spread: 1</b>



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Drilled By

GW

Logged By

N/A

Borehole No.

RC01

Sheet 1 of 5

Project Name: Harrington's Quarry Project No. P20148 Co-ords: Hole Type RO

Location: Claregalway, Co. Galway Level: m OD Scale 1:50

Client: Hydro-G Date: 27/10/2020 - 27/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					0.40		Open hole boring. Driller described: Topsoil.		
					1.50		Open hole boring. Driller described: Rock. Assumed Limestone.	1	
							Down-the-hole boring. Driller described: Solid Limestone rock, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong sulfur odour. Some layers of slightly harder grey to dark grey rock. No decent water strikes, with water slightly sinking into borehole below 43.00m bgl.	2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
43.00					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
	27/10/2020 08:00	0.00		Start of shift.		
	27/10/2020 18:00	45.00		End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

RC01

Sheet 2 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 27/10/2020 - 27/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong sulfur odour. Some layers of slightly harder grey to dark grey rock. No decent water strikes, with water slightly sinking into borehole below 43.00m bgl.	10	
								11	
								12	
								13	
								14	
								15	
								16	
								17	
								18	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
43.00					45.00	100	131				
					<b>Equipment:</b>	Soilmec PSM.					

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
	GW (m bgl)		27/10/2020 08:00	0.00	Start of shift.
			27/10/2020 18:00	45.00	End of borehole.

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC01**

Sheet 3 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 27/10/2020 - 27/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong sulfur odour. Some layers of slightly harder grey to dark grey rock. No decent water strikes, with water slightly sinking into borehole below 43.00m bgl.	19	
								20	
								21	
								22	
								23	
								24	
								25	
								26	
								27	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
43.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		27/10/2020 08:00	0.00	Start of shift.		
		27/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC01**

Sheet 4 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 27/10/2020 - 27/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong sulfur odour. Some layers of slightly harder grey to dark grey rock. No decent water strikes, with water slightly sinking into borehole below 43.00m bgl.	28	
								29	
								30	
								31	
								32	
								33	
								34	
								35	
								36	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
43.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>			<b>Remarks</b>
	GW (m bgl)	Shift	Depth (m bgl)	
		27/10/2020 08:00	0.00	Start of shift.
	27/10/2020 18:00	45.00	End of borehole.	

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Drilled By  
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 N/A

Borehole No.  
**RC01**  
 Sheet 5 of 5

Project Name: Harrington's Quarry Project No. P20148 Co-ords: Hole Type RO

Location: Claregalway, Co. Galway Level: m OD Scale 1:50

Client: Hydro-G Date: 27/10/2020 - 27/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock, with no voids, no clay bands and no heavily weathered zones. Mostly a black soft rock, with strong sulfur odour. Some layers of slightly harder grey to dark grey rock. No decent water strikes, with water slightly sinking into borehole below 43.00m bgl.	37	
								38	
								39	
								40	
								41	
								42	
								43	
								44	
					45.00		End of Borehole at 45.000m	45	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
43.00					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		27/10/2020 08:00	0.00	Start of shift.		
		27/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC02**

Sheet 1 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 28/10/2020 - 28/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					0.30		Open hole boring. Driller described: Topsoil.		
							Open hole boring. Driller described: clayey sandy Gravel.	1	
								2	
								3	
					3.70		Open hole boring. Driller described: Rock. Assumed Limestone.	4	
					4.50		Down-the-hole boring. Driller described: Black to grey/ dark grey, solid Limestone. Easy drilling.	5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
42.50					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
	GW (m bgl)		28/10/2020 08:00	0.00	Start of shift.
			29/10/2020 18:00	45.00	End of borehole.

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Drilled By

GW

Logged By

N/A

Borehole No.

RC02

Sheet 2 of 5

Project Name: Harrington's Quarry Project No. P20148 Co-ords: Hole Type RO

Location: Claregalway, Co. Galway Level: m OD Scale 1:50

Client: Hydro-G Date: 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Black to grey/dark grey, solid Limestone. Easy drilling.	10	
					11.90			11	
					12.20		Down-the-hole boring. Driller described: Very weathered rock with clay bands and loose material. Assumed weathered Limestone.	12	
					12.50		Down-the-hole boring. Driller described: Void.		
							Down-the-hole boring. Driller described: Very weathered rock with clay bands and loose material. Assumed weathered Limestone.	13	
					13.80		Down-the-hole boring. Driller described: Solid Limestone.	14	
								15	
								16	
								17	
								18	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
42.50					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>	
	28/10/2020	08:00	0.00	Start of shift.	29/10/2020	18:00	45.00

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Drilled By  
GW

Logged By  
N/A

Borehole No.

**RC02**

Sheet 3 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone.		
								19	
								20	
								21	
								22	
								23	
								24	
								25	
								26	
								27	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
42.50					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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GW

Logged By

N/A

Borehole No.

**RC02**

Sheet 4 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					28.40		Down-the-hole boring. Driller described: Solid Limestone.	28	
							Down-the-hole boring. Driller described: Weathered rock with clay bands. Assumed Limestone.	29	
								30	
								31	
								32	
					33.00		Down-the-hole boring. Driller described: Solid Limestone.	33	
								34	
								35	
								36	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
42.50					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

RC02

Sheet 5 of 5

Project Name: Harrington's Quarry Project No. P20148 Co-ords: Hole Type RO

Location: Claregalway, Co. Galway Level: m OD Scale 1:50

Client: Hydro-G Date: 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone.		
								37	
								38	
								39	
								40	
								41	
								42	
								43	
								44	
					45.00		End of Borehole at 45.000m	45	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
42.50					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 39.00 to 45.00m bgl.	<b>Shift Data:</b>			<b>Remarks</b>
	GW (m bgl)	Shift	Depth (m bgl)	
		28/10/2020 08:00	0.00	Start of shift.
	29/10/2020 18:00	45.00	End of borehole.	

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Drilled By  
GW

Logged By  
N/A

Borehole No.

**RC03**

Sheet 1 of 5

Project Name: Harrington's Quarry Project No. P20148 Co-ords: Hole Type RO

Location: Claregalway, Co. Galway Level: m OD Scale 1:50

Client: Hydro-G Date: 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					0.40		Open hole boring. Driller described: Topsoil.		
							Open hole boring. Driller described: clayey sandy Gravel or very weathered rock.	1	
								2	
								3	
								4	
								5	
								6	
					7.00		Open hole boring. Driller described: Rock. Assumed Limestone.	7	
					7.50		Down-the-hole boring. Driller described: Solid Limestone rock with no voids, no clay bands. Mostly black, soft, easy to drill rock with strong sulfur smell and some slightly harder, grey to dark grey, Limestone.	8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
38.00					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		28/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC03**

Sheet 2 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 28/10/2020 - 28/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock with no voids, no clay bands. Mostly black, soft, easy to drill rock with strong sulfur smell and some slightly harder, grey to dark grey, Limestone.		
								10	
								11	
								12	
								13	
								14	
								15	
								16	
								17	
								18	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
38.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		28/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC03**

Sheet 3 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 28/10/2020 - 28/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock with no voids, no clay bands. Mostly black, soft, easy to drill rock with strong sulfur smell and some slightly harder, grey to dark grey, Limestone.	19	
								20	
								21	
								22	
								23	
								24	
								25	
								26	
								27	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
38.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		28/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC03**

Sheet 4 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 28/10/2020 - 28/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock with no voids, no clay bands. Mostly black, soft, easy to drill rock with strong sulfur smell and some slightly harder, grey to dark grey, Limestone.	28	
								29	
								30	
								31	
								32	
								33	
								34	
								35	
								36	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
38.00					45.00	100	131				
					<b>Equipment:</b>	Soilmec PSM.					

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>			<b>Remarks</b>
	GW (m bgl)	Shift	Depth (m bgl)	
		28/10/2020 08:00	0.00	Start of shift.
	28/10/2020 18:00	45.00	End of borehole.	

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Drilled By  
GW

Logged By  
N/A

Borehole No.

**RC03**

Sheet 5 of 5

Project Name: Harrington's Quarry      Project No. P20148      Co-ords:      Hole Type RO

Location: Claregalway, Co. Galway      Level: m OD      Scale 1:50

Client: Hydro-G      Date: 28/10/2020 - 28/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
▼							Down-the-hole boring. Driller described: Solid Limestone rock with no voids, no clay bands. Mostly black, soft, easy to drill rock with strong sulfur smell and some slightly harder, grey to dark grey, Limestone.	37	
								38	
								39	
								40	
								41	
								42	
								43	
								44	
				45.00			End of Borehole at 45.000m	45	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
38.00					45.00	100	131				
					<b>Equipment:</b>						
					Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		28/10/2020 08:00	0.00	Start of shift.		
		28/10/2020 18:00	45.00	End of borehole.		

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Drilled By

GW

Logged By

N/A

Borehole No.

**RC04**

Sheet 1 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 29/10/2020 - 29/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
					0.30		Open hole boring. Driller described: Topsoil.		
					1.20		Open hole boring. Driller described: clayey sandy Gravel.	1	
					1.50		Open hole boring. Driller described: Rock. Assumed Limestone.		
							Down-the-hole boring. Driller described: Solid Limestone rock. Mostly black, soft rock, easy drilling with strong sulfur odour. Layers of slightly harder grey to dark Grey Limestone.	2	
								3	
								4	
								5	
								6	
								7	
								8	
								9	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
40.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		29/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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Drilled By

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Logged By

N/A

Borehole No.

**RC04**

Sheet 2 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 29/10/2020 - 29/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock. Mostly black, soft rock, easy drilling with strong sulfur odour. Layers of slightly harder grey to dark Grey Limestone.		
								10	
								11	
								12	
								13	
								14	
								15	
								16	
								17	
								18	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
40.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		29/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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Borehole No.

**RC04**

Sheet 3 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 29/10/2020 - 29/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock. Mostly black, soft rock, easy drilling with strong sulfur odour. Layers of slightly harder grey to dark Grey Limestone.	19	
								20	
								21	
								22	
								23	
								24	
								25	
								26	
								27	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
40.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		29/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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Logged By

N/A

Borehole No.

**RC04**

Sheet 4 of 5

<b>Project Name:</b> Harrington's Quarry	<b>Project No.:</b> P20148	<b>Co-ords:</b>	<b>Hole Type:</b> RO
--	----------------------------	-----------------	----------------------

<b>Location:</b> Claregalway, Co. Galway	<b>Level:</b> m OD	<b>Scale:</b> 1:50
--	--------------------	--------------------

<b>Client:</b> Hydro-G	<b>Date:</b> 29/10/2020 - 29/10/2020
------------------------	--------------------------------------

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock. Mostly black, soft rock, easy drilling with strong sulfur odour. Layers of slightly harder grey to dark Grey Limestone.		
								28	
								29	
								30	
								31	
								32	
								33	
								34	
								35	
								36	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
40.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
		29/10/2020 08:00	0.00	Start of shift.		
		29/10/2020 18:00	45.00	End of borehole.		

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N/A

Borehole No.

**RC04**

Sheet 5 of 5

**Project Name:** Harrington's Quarry **Project No.:** P20148 **Co-ords:** **Hole Type:** RO

**Location:** Claregalway, Co. Galway **Level:** m OD **Scale:** 1:50

**Client:** Hydro-G **Date:** 29/10/2020 - 29/10/2020

Well Backfill	Water Strike (m bgl)	Sample and In Situ Testing			Depth (m bgl)	Level (mOD)	Legend	Stratum Description	
		Depth (m bgl)	Type	Results					
							Down-the-hole boring. Driller described: Solid Limestone rock. Mostly black, soft rock, easy drilling with strong sulfur odour. Layers of slightly harder grey to dark Grey Limestone.	37	
								38	
								39	
								40	
								41	
								42	
								43	
								44	
					45.00		End of Borehole at 45.000m	45	

<b>Groundwater:</b>					<b>Hole Information:</b>			<b>Chiselling Details:</b>			
Struck (m bgl)	Rose to (m bgl)	After (mins)	Sealed (m bgl)	Comment	Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	Top (m)	Base (m)	Duration (hh:mm)	Tool
40.00					45.00	100	131				
					<b>Equipment:</b> Soilmec PSM.						

<b>Remarks:</b> Borehole terminated at required depth. Standpipe (50mm dia) installed from GL to 45.00m bgl. Response zone from 36.00 to 45.00m bgl.	<b>Shift Data:</b>		<b>GW (m bgl)</b>	<b>Shift</b>	<b>Depth (m bgl)</b>	<b>Remarks</b>
				29/10/2020 08:00	0.00	Start of shift.
				29/10/2020 18:00	45.00	End of borehole.

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**REPORT  
ON THE  
GEOPHYSICAL INVESTIGATION  
AT THE  
ARDGAINEN QUARRY  
CLAREGALWAY, Co. GALWAY  
FOR  
HARRINGTON CONCRETE**



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**26TH JULY 2021**

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*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.*

<b>PROJECT NUMBER</b>	AGP21055		
<b>AUTHOR</b>	<b>CHECKED</b>	<b>REPORT STATUS</b>	<b>DATE</b>
EURGEOL PETER O'CONNOR P.GEO., M.SC (GEOPHYSICS), DIP. EIA MGT.	EURGEOL YVONNE O'CONNELL P.GEO., PH.D (GEOPHYSICS),	V.01	26 <sup>TH</sup> JULY 2021

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## 1. EXECUTIVE SUMMARY

APEX Geophysics Limited was requested by Hydro-G on behalf of Harrington Concrete to carry out a geophysical survey at Ardgaineen Quarry, Claregalway, Co. Galway. The objectives of the survey were to provide information on overburden thickness, presence of karst/fault/fissure zones in the bedrock, the type and the quality of bedrock.

The area of interest comprises around 0.7 ha of a low-lying vegetated area to the south of existing quarry into which the water discharge from the quarry is currently pumped. Some of this discharge appears to be returning into the quarry via underground fissures or conduits. Site topography ranges from 32-38 mOD across the site.

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area indicates the site lies within Burren Formation, pale grey clean skeletal limestone. Rock outcrop or shallow bedrock is indicated across the survey area. The GSI Quaternary sediments map indicates karstified bedrock outcrop/subcrop in the north and limestone till in the south of the survey area. The closest karst feature is located c. 2 km north of the survey area. The Burren Formation is classified as a 'Regionally Important Aquifer - Karstified (conduit)'.

Lands adjacent to the quarry in the northeast were surveyed by Apex Geoservices Ltd. in 2004 and indicated thin overburden over clean limestone with areas of weathering and clay infill.

The survey was carried out on the 21<sup>st</sup> and 22<sup>nd</sup> June, 2021 involving the collection of 5 ERT profiles and 2 seismic refraction profiles. Soil resistivities are indicative of sandy gravelly CLAY and soil cover is generally thin at between 1 and 3 m. A soft to firm material is indicated.

Up to 10 m bgl (c.32 – 23 mOD) low resistivity and low seismic velocity values have been interpreted as indicating limestone that is highly to moderately weathered/fractured. The thickness of the weathered layer on the seismic profiles is generally between 3 and 4 m and greater in local zones. Higher values greater have been interpreted as indicating limestone that is slightly weathered to fresh.

Below around 10 m bgl, (c.23 mOD) low resistivity zones on the profiles recorded in the west and southwest have been interpreted as moderately weathered/fractured LIMESTONE with increased water content. The lateral extent of this water bearing zone or plume has been outlined on Drawing AGP21055\_02.

Localised sub-vertical low resistivity features at shallow depths have been interpreted as possible sinkholes or vertical conduits. Some may represent fissure or fracture zones in the limestone where water is making its way back into the quarry from the dispersal area.

The geophysical data has outlined a possible plume of groundwater within the limestone to the south of the low-lying discharge area which appears to be at a higher level (20 – 22 mOD) than the standing water in the quarry. Possible fissures back to the southern quarry face have also been mapped.

Three borehole/well locations around the perimeter are proposed to confirm the geophysical interpretation and provide information on the groundwater regime.

The findings of the geophysical investigation should be reviewed following any further direct investigations.

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## 2. INTRODUCTION

APEX Geophysics Limited was requested by Hydro-G on behalf of Harrington Concrete to carry out a geophysical survey at Ardgaineen Quarry, Claregalway, Co. Galway.

### 2.1 Survey Objectives

The objectives of the survey were to provide information on:

- overburden thickness,
- presence of karst/fault/fissure zones in the bedrock,
- type and quality of bedrock.

### 2.2 Site Background

Ardgaineen Quarry is located approximately 9 km north of Claregalway. The N83 is located c.1 km east of the site. The area of interest comprises around 0.7 ha of a low-lying vegetated ground to the south of the existing quarry into which the water discharge from the quarry is currently pumped (see Fig. 2.1). Some of this discharge appears to be returning into the quarry via underground fissures or conduits. Site topography ranges from 32-38m OD across the site. The eastern part of the quarry floor is at 5 – 10 mOD.



Fig. 2.1: Site location map.

#### 2.2.1 Geology

The Geological Survey of Ireland (GSI) 1:100k Bedrock Geology map for the area (GSI, 2018) shows that the survey area is underlain by the Burren Formation, described as pale grey clean skeletal limestone (Fig. 2.2). Rock outcrop or shallow bedrock is indicated across the survey area.

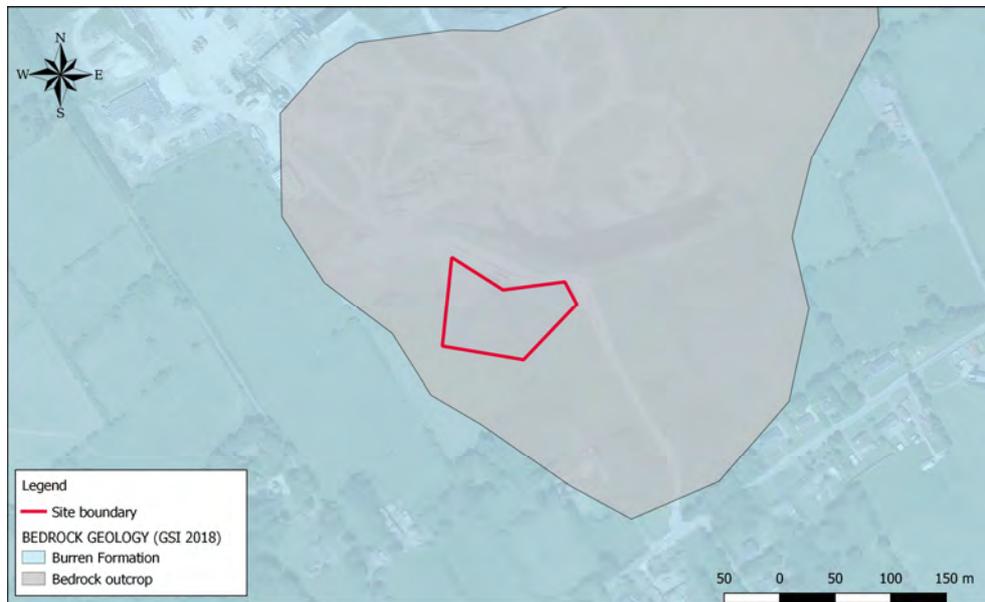


Fig. 2.3: Bedrock geology.

### 2.2.2 Soils

The GSI Quaternary sediments map for the area (GSIa, 2019) indicates that the north of the site is within karstified bedrock outcrop/subcrop and the southern part of the site (Fig. 2.3) is within limestone till.



Fig. 2.3: Quaternary sediments.

### 2.2.3 Karst

The Burren Formation is known to be prone to solution weathering and karstification. The closest karst feature (a cave) identified on the GSI karst database is located c. 2 km north of the survey area.

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### 2.2.4 Vulnerability

The groundwater vulnerability rating (GSIb, 2019) for the site (Fig. 2.4) is classified as 'rock at or near surface or karst' in the north and 'extreme' in the south of the area.

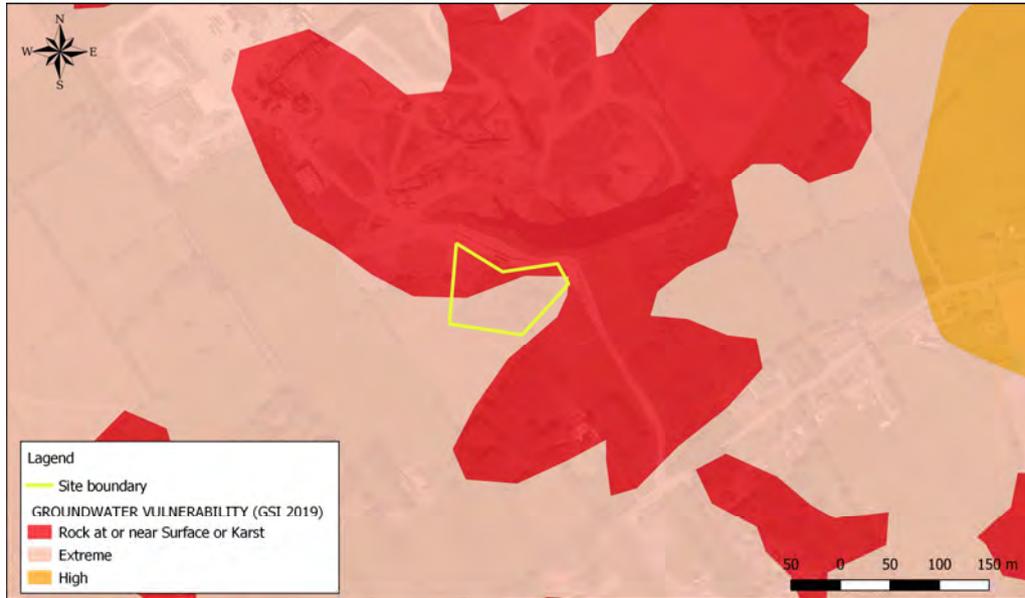


Fig. 2.4: Groundwater vulnerability.

### 2.2.5 Aquifer Classification

The Burren Formation (Fig. 2.5) is classified as a 'Regionally Important Aquifer - Karstified (conduit)' (GSI, 2019).



Fig. 2.5: The GSI aquifer map.

## 2.2.6 Historical Data

The historical 6 inch sheet for the area indicates that the site is within an area of limestone 'crag'.



Fig 2.6: The historical 6 inch map.

## 2.2.7 Previous surveys

Lands adjacent to the quarry in the northeast were surveyed by Apex Geoservices Ltd. in 2004 and consisted of EM conductivity, ERT profiles and seismic profiles. The survey indicated thin overburden over clean limestone with areas of weathering and clay infill.

## 2.3 Survey Rationale

The investigation consisted of 2D Electrical Resistivity Tomography (ERT) and Seismic Refraction profiling:

**ERT** images the resistivity of the materials in the subsurface along a profile to produce a cross-section showing the variation in resistivity with depth, depending on the length of the profile. Each cross-section will be interpreted to determine the material type along the profile at increasing depth, based on the 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. This method should allow us to profile the depth to the top of the bedrock, along profiles across the site.

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 B: DETAILED GEOPHYSICAL METHODOLOGY**.

### 3. RESULTS

The survey was carried out on the 21<sup>st</sup> - 22<sup>nd</sup> June, 2021 involving the collection of 5 ERT profiles and 2 seismic refraction profiles. The ERT profiles run around the perimeter of the low-lying area with thick vegetation to the south of the southern face into which the water from the quarry sump is currently directed. The geophysical survey locations are shown on Drawing AGP21055\_01 (Appendix B).

#### 3.1 ERT

The five resistivity profiles (R1 to R5) and are plotted on Drawings AGP21055\_R1-R5.

The resistivity values recorded at this site ranged from 150 – 10,000 Ohm-m and have been interpreted as follows:

Resistivity (Ohm-m)	Interpretation
150 - 375	Sandy gravelly CLAY/completely – highly weathered LIMESTONE
150 – 498	Shallow - Highly-moderately weathered/potentially karstified LIMESTONE with clay infill  At depth - Moderately weathered/fractured LIMESTONE (water-bearing)
498 – 1,200	Moderately weathered/potentially karstified LIMESTONE with clay infill
1,200 – 10,000	Slightly weathered – fresh LIMESTONE

#### 3.2 Seismic refraction profiling

The seismic refraction profiles (S1 – S2) were recorded to check rock quality and the degree of weathering at selected locations. Their locations are shown on Drawing AGP21055\_01 and the results are included on the interpreted cross sections Drawing AGP21055\_R3 and R5, and in Appendix C.

The P-wave seismic velocities have been interpreted as follows:

Layer	P-wave Velocity (m/s)	Interpretation
1	400 - 500	Soft-firm topsoil/subsoil.
2	1,000 – 1,800	Highly – moderately weathered LIMESTONE
3	3,400 – 4,050	Moderately – slightly weathered LIMESTONE

#### 4. DISCUSSION

The integrated geophysical results and interpreted cross sections are presented on Drawings AGP21055\_R1 to AGP21055\_R5. The results are summarised on Drawing AGP21055\_02. The recorded resistivity and seismic values are similar to those recorded on the 2004 survey.

##### Soil

Soil cover is generally thin (between 1 and 3 m) with the thickest sequence found on R2 and R3 which run along the west and south of the low-lying vegetated area. Soil resistivities are indicative of sandy gravelly CLAY. Seismic velocities of the soil are in the range 400 – 500 m/s indicating a soft-firm material.

##### Bedrock

The ERT profiles show a variable resistivity bedrock with values ranging from 150 Ohm-m to 10,000 Ohm-m that have been interpreted as indicating limestone with varying degrees of weathering/fracturing and clay infill:

- At shallow depths (up to 10 m bgl, 32 – 22 mOD) resistivity values in the range 150 – 498 Ohm-m have been interpreted as highly to moderately weathered LIMESTONE with clay infill, and values in the range 498 to 1200 Ohm-m have been interpreted as moderately to slightly weathered LIMESTONE with clay infill. The corresponding seismic data record a velocity of between 1000 and 1800 m/s which is typical of highly to moderately weathered/fractured bedrock. The thickness of the weathered layer on the seismic profiles is generally between 3 and 4 m and greater in local zones.
- Values greater than 1200 Ohm-m have been interpreted as slightly weathered to fresh LIMESTONE.
- Low values (150 – 498 Ohm-m and 498 to 1200 Ohm-m) also occur below around 10 m bgl, 23 mOD) on ERT profiles R1, R2 and R3 but correlate with a higher seismic velocity (3,400 – 4,050 m/s) for the rock. These have been interpreted as moderately weathered/fractured LIMESTONE with increased water content. The lateral extent of the water bearing zone has been outlined on Drawing AGP21055\_02 (F1). The upper level of the water bearing zone is at around 20 – 22 mOD which appears to be 10-15 m higher than the standing water level in the quarry.
- The ERT profiles also show localised sub-vertical low resistivity features which occur at shallow depths. Their strongest expression is at 24 m and 133 m on R4, at 47 m on R5, at 108 m on R1, at 59 m on R2 and at 112 m on R3 (see Drawings AGP21055\_R1-R5). These features have been interpreted as possible sinkholes or vertical conduits. On R4 and R5 they may represent fissure or fracture zones in the limestone where water is making its way back into the quarry from the dispersal area (Drawing AGP21055\_02).

In summary the geophysical data has outlined a possible plume of groundwater within the limestone to the south of the low-lying discharge area which appears to be at a higher level than the standing water in the quarry, as well as possible conduits from the surface and back to the southern quarry face.

## 5. RECOMMENDATIONS

It is understood that there are concerns about drilling in the centre of the low-lying area due to possible stability issues but three borehole/well locations around the perimeter are proposed as follows:

No.	Easting	Northing	Objective
PBH1	538168.9	740170.0	Investigate main water bearing zone
PBH2	538250.0	740204.1	Investigate possible fissure zone to north
PBH3	538160.8	740269.4	Investigate possible fissure zone to east

The findings of the geophysical investigation should be reviewed following any further direct investigations.

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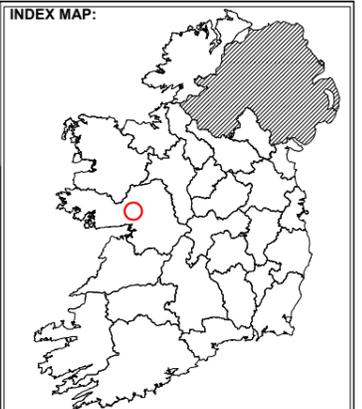
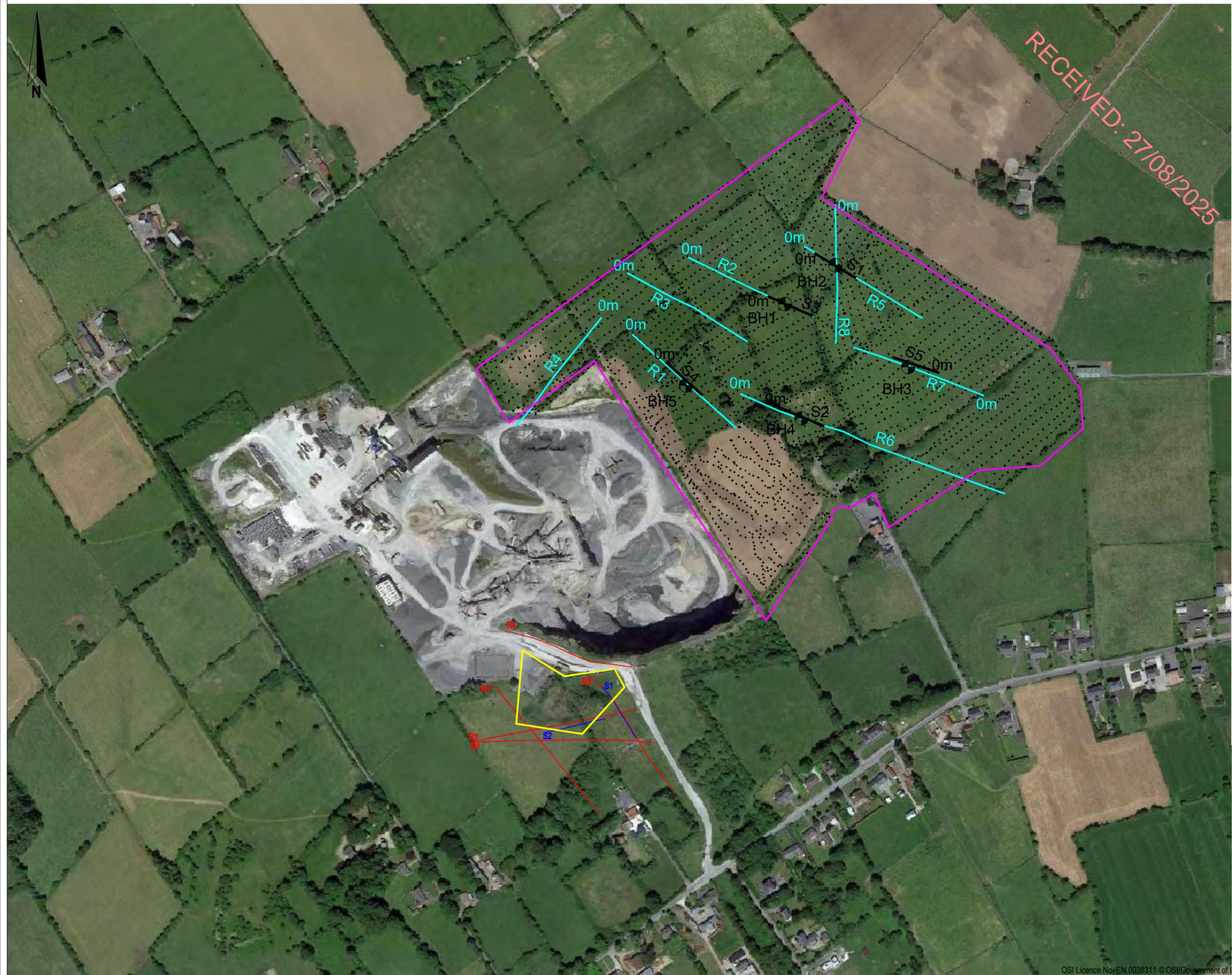
## APPENDIX A: DRAWINGS

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

AGP21055_01	Geophysical Locations	1:4000	@ A3
AGP21055_02	Summary Interpretation Map	1:1000	@ A3
AGP21055_R1	Results & Interpretation – ERT R1	1:1000	@ A4
AGP21055_R2	Results & Interpretation – ERT R2	1:1000	@ A4
AGP21055_R3	Results & Interpretation – ERT R3 and seismic profile S2	1:1000	@ A4
AGP21055_R4	Results & Interpretation – ERT R4	1:1000	@ A4
AGP21055_R5	Results & Interpretation – ERT R5 and seismic profile S1	1:1000	@ A4

GEOPHYSICAL LOCATIONS

SCALE 1:4000



- LEGEND:**
- Site boundary 2021
  - Site boundary 2004
  - R1 2D resistivity profile (AGP21055)
  - S1 Seismic refraction profile (AP21055)
  - R1 2D resistivity profile (2004)
  - S1 Seismic refraction profile (2004)
  - + EM conductivity station (2004)

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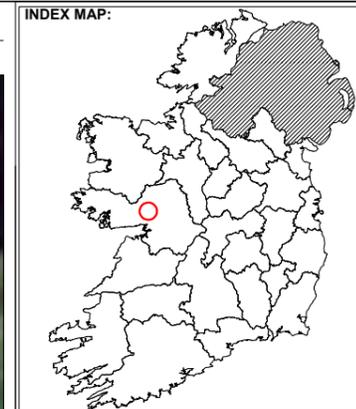
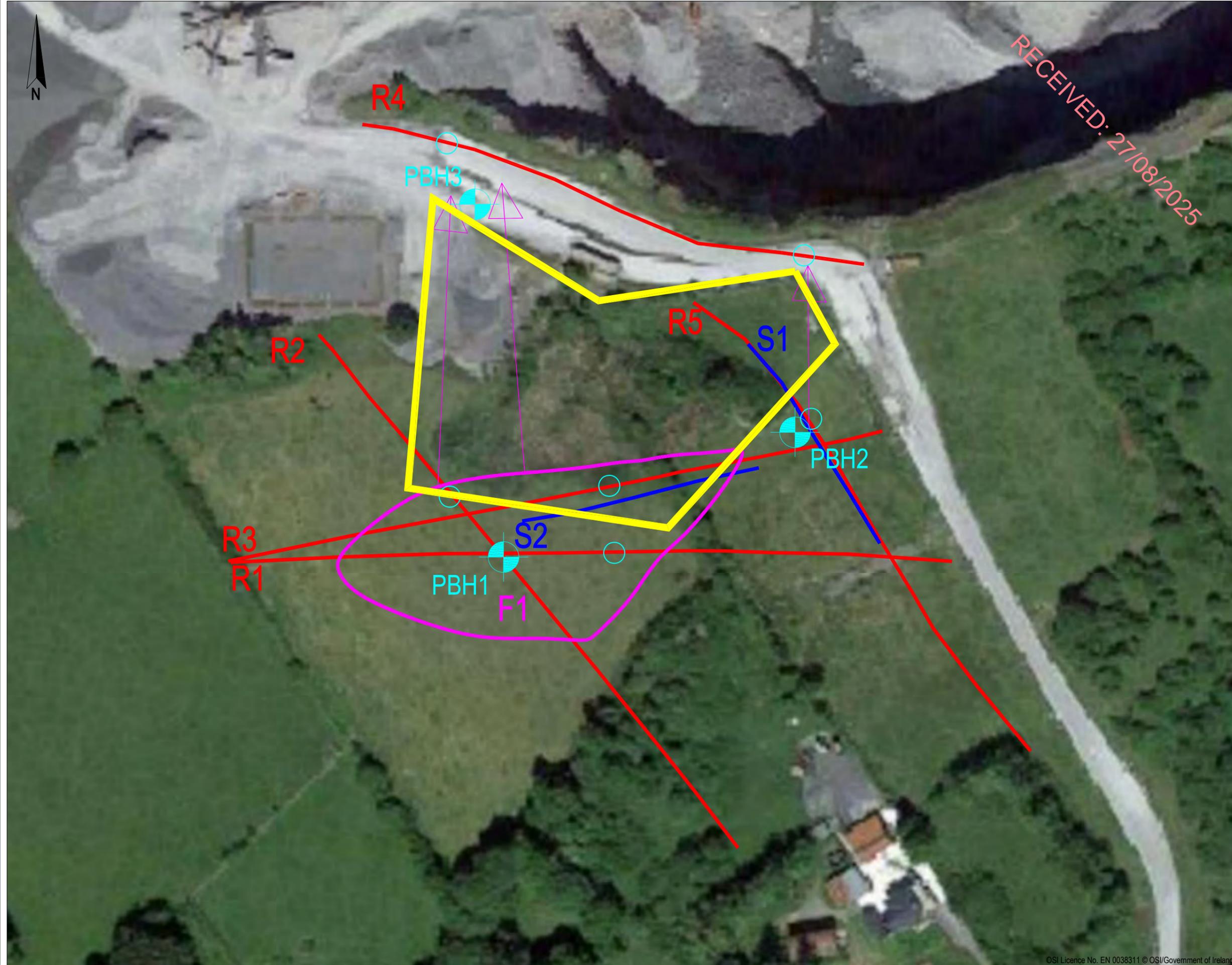


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SUMMARY INTERPRETATION MAP

SCALE 1:1000



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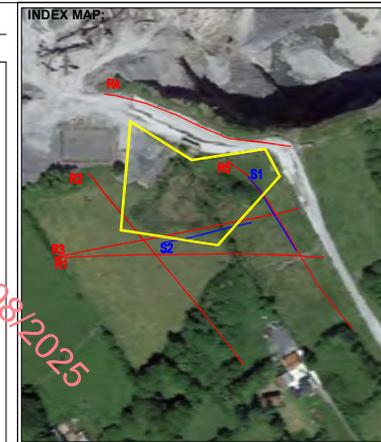
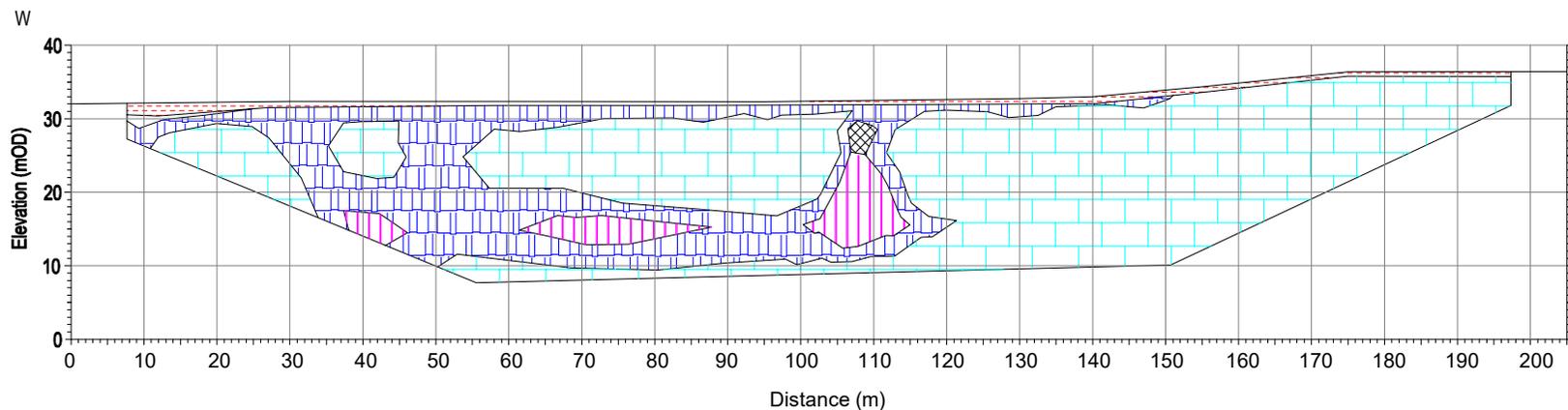
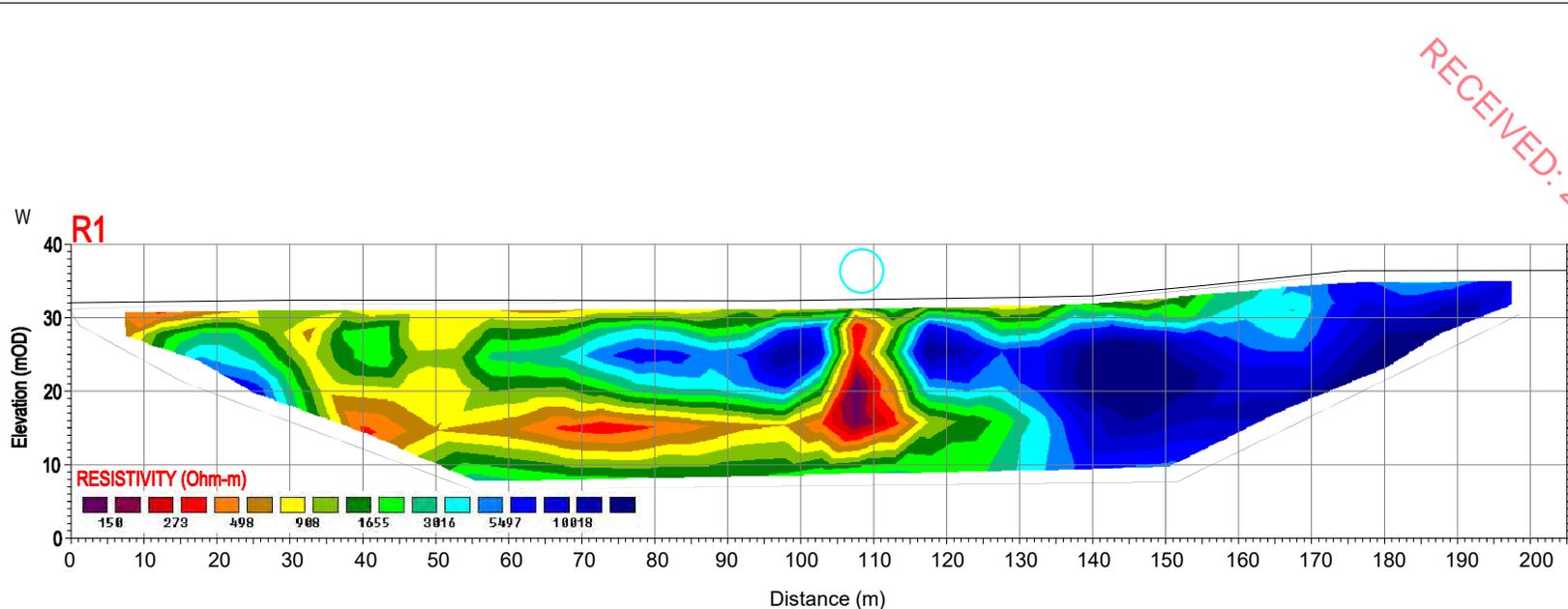
- Site boundary 2021
- R1 2D resistivity profile (AGP21055)
- S1 Seismic refraction profile (AP21055)
- F1 Extent of Weathered/Fractured Rock (water bearing)
- Location of possible sinkhole/vertical conduit
- Possible flow direction into quarry
- Proposed borehole/well  
PBH1

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- LEGEND:**
- 500 m/s Seismic Velocity (metres/second)
  - [Red dashed pattern] Sandy gravelly CLAY/Completely - Highly Weathered LIMESTONE
  - [Cross-hatch pattern] Highly - Mod. Weathered potentially karstified LIMESTONE with clay infill
  - [Blue grid pattern] Moderately weathered /fractured LIMESTONE with clay infill
  - [Pink grid pattern] Moderately weathered/fractured LIMESTONE (water bearing)
  - [Light blue grid pattern] Slightly Weathered - Fresh LIMESTONE
  - [Blue circle] Location of possible sinkhole/vertical conduit

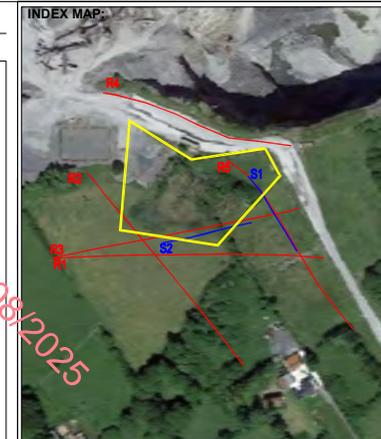
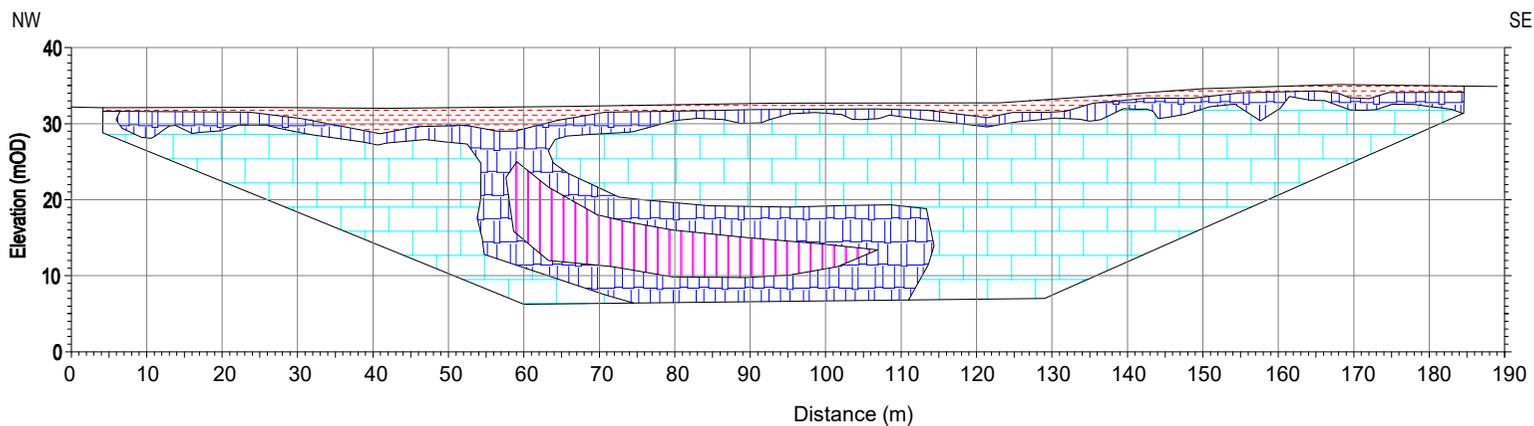
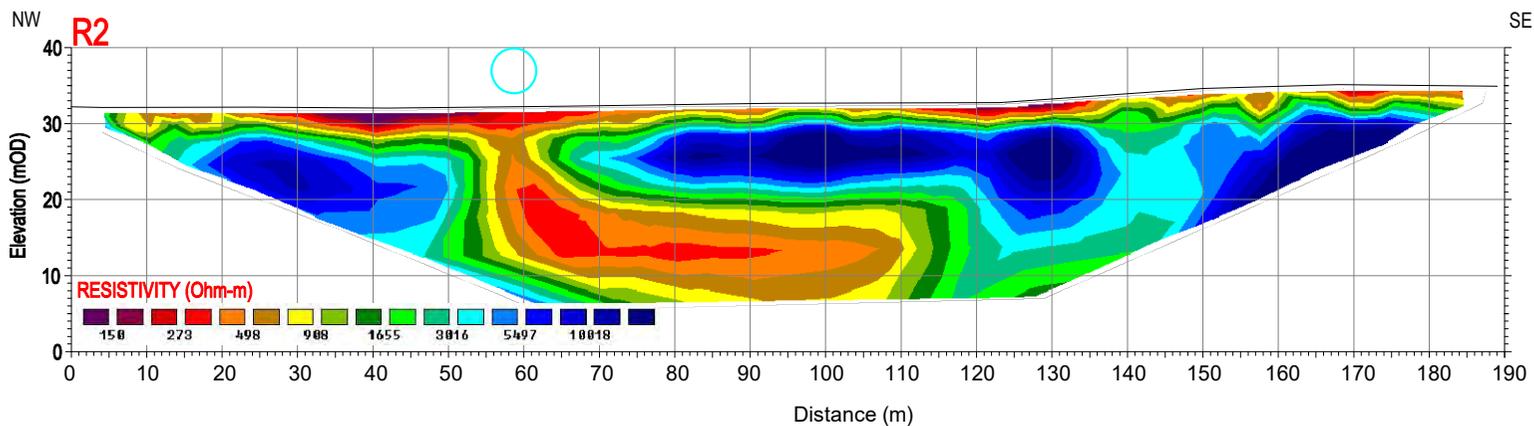
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- LEGEND:**
- 500 m/s Seismic Velocity (metres/second)
  - Sandy gravelly CLAY/Completely - Highly Weathered Limestone
  - Highly - Mod. Weathered potentially karstified LIMESTONE with clay infill
  - Moderately weathered /fractured LIMESTONE with clay infill
  - Moderately weathered/fractured LIMESTONE (water bearing)
  - Slightly Weathered - Fresh LIMESTONE
  - Location of possible sinkhole/vertical conduit

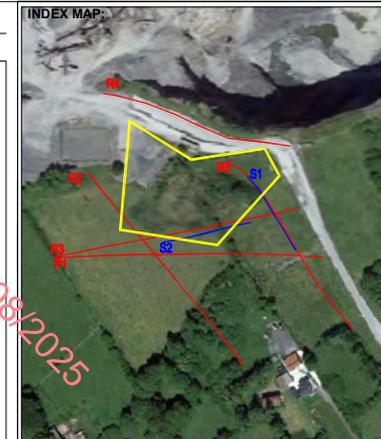
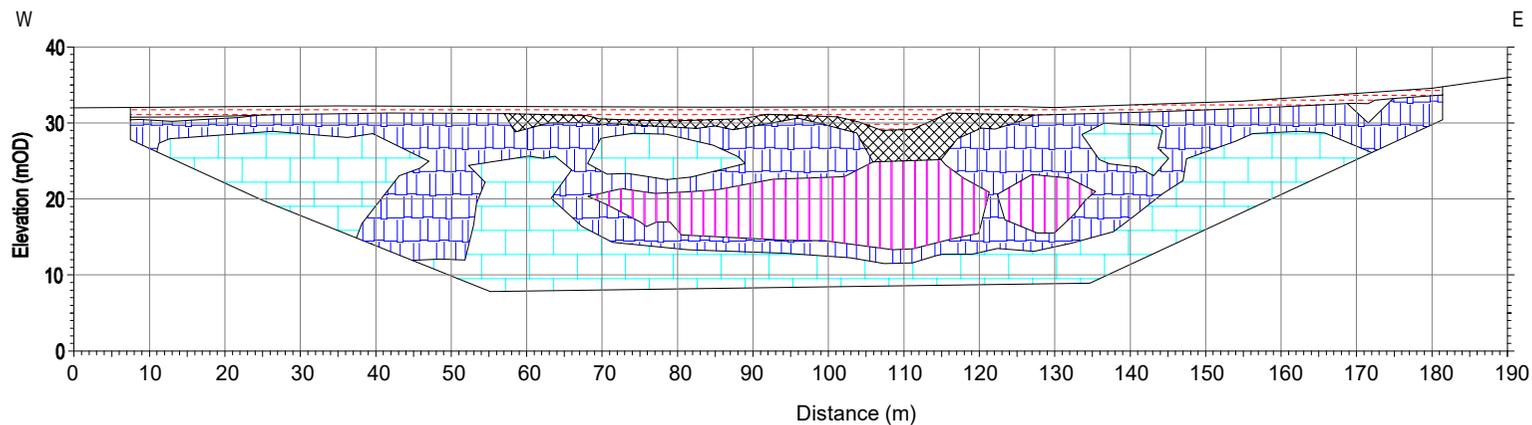
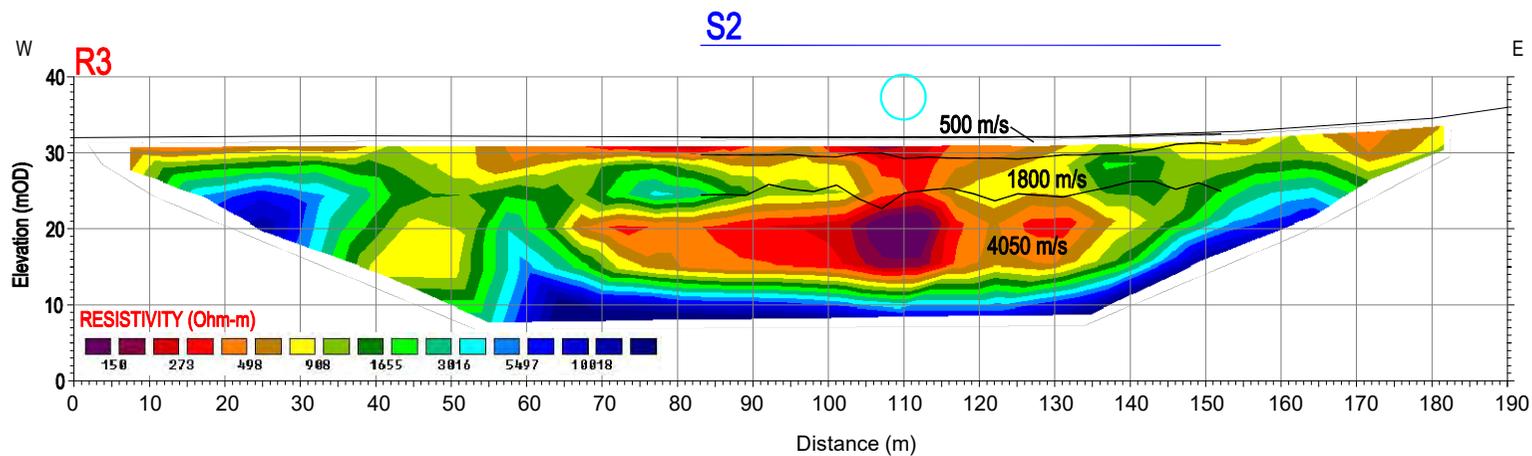
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- LEGEND:**
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  - Sandy gravelly CLAY/Completely - Highly Weathered Limestone
  - Highly - Mod. Weathered potentially karstified LIMESTONE with clay infill
  - Moderately weathered /fractured LIMESTONE with clay infill
  - Moderately weathered/fractured LIMESTONE (water bearing)
  - Slightly Weathered - Fresh LIMESTONE
  - Location of possible sinkhole/vertical conduit

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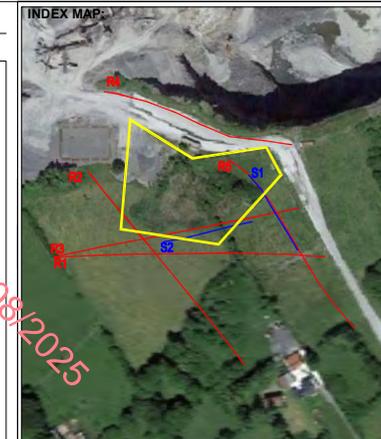
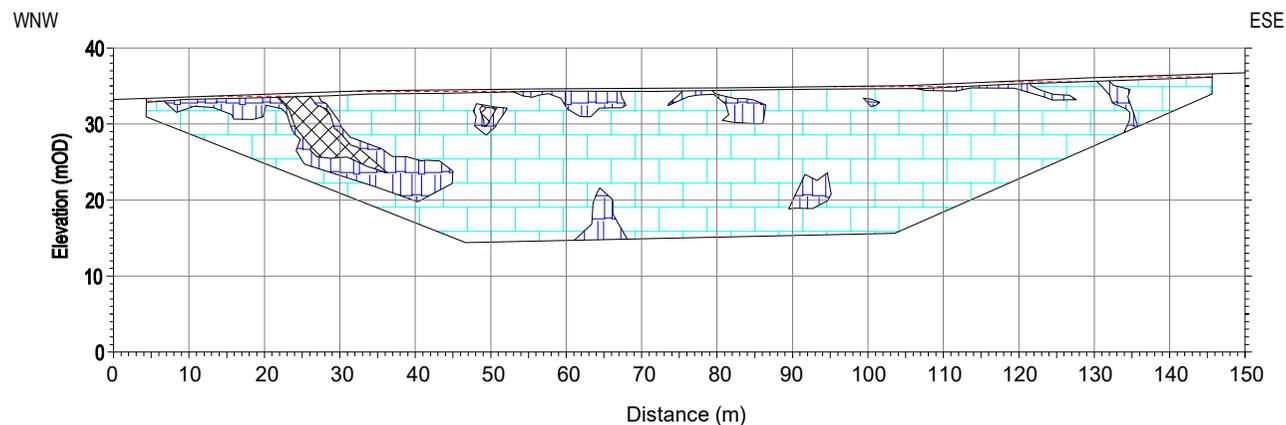
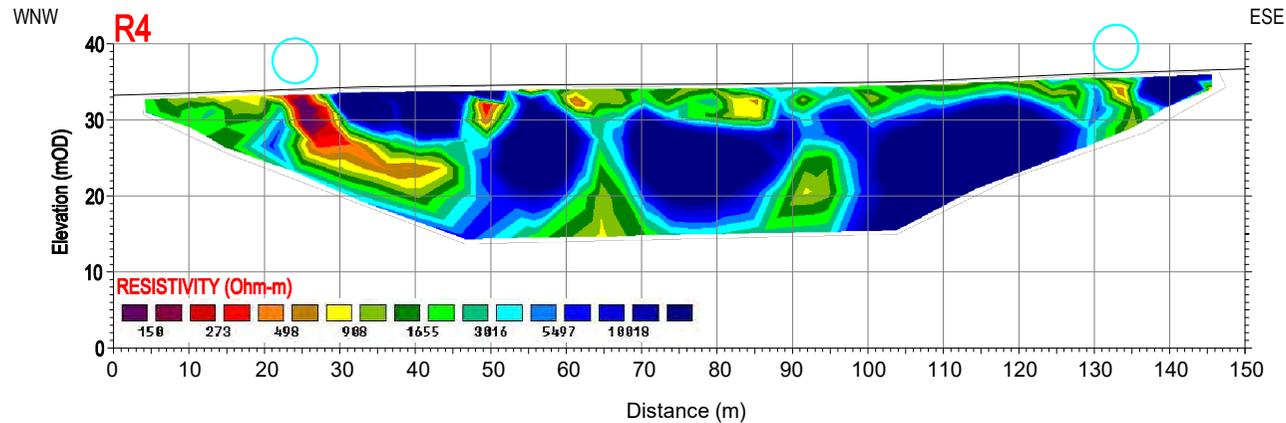
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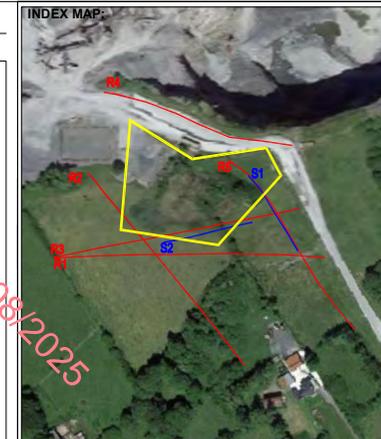
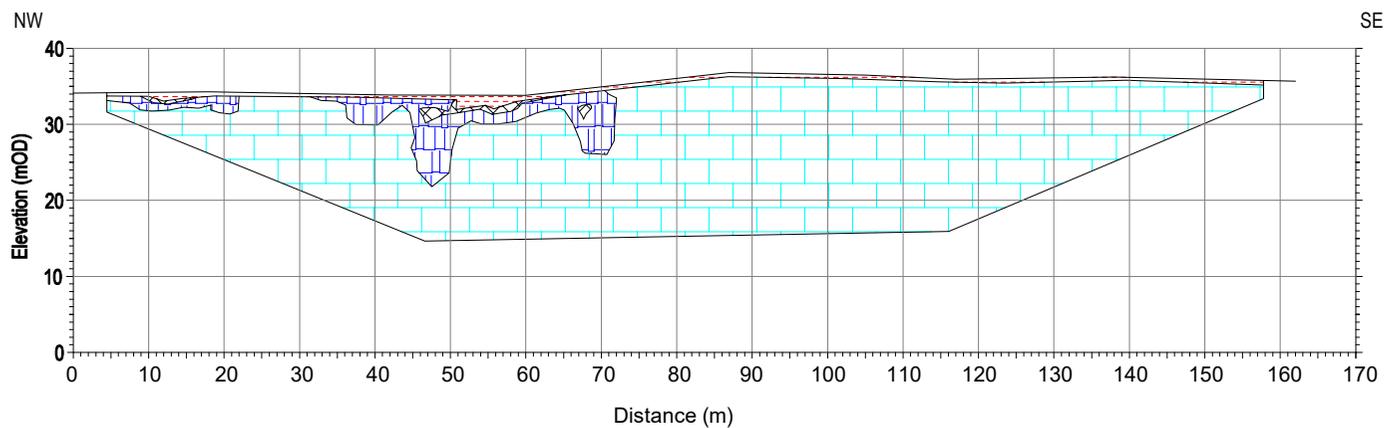
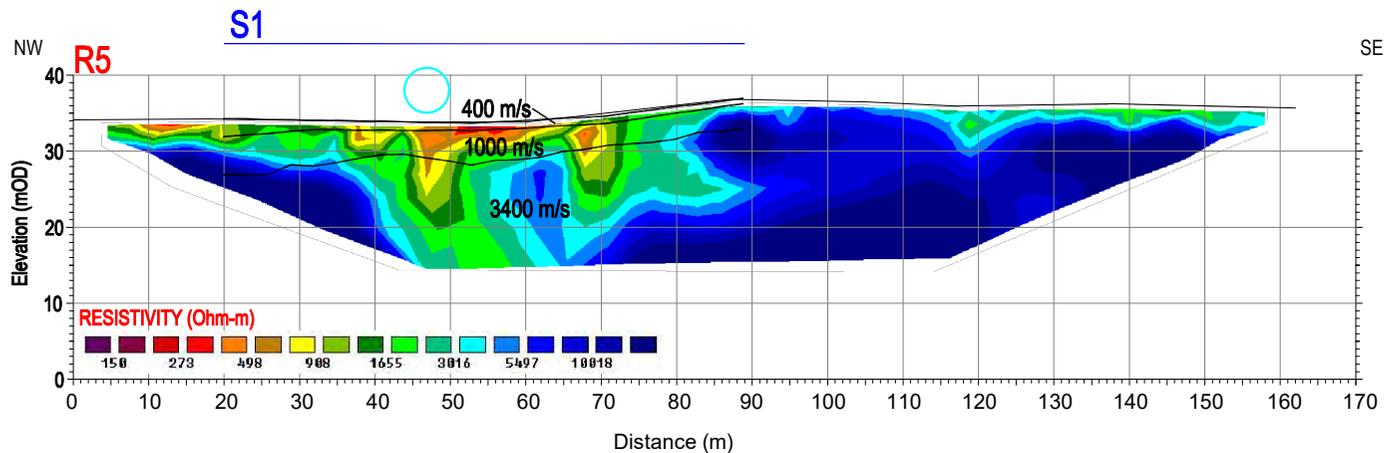
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  - Moderately weathered /fractured LIMESTONE with clay infill
  - Moderately weathered/fractured LIMESTONE (water bearing)
  - Slightly Weathered - Fresh LIMESTONE
  - Location of possible sinkhole/vertical conduit

The information displayed here is to be used in conjunction with AGP21055\_01 Report on the Geophysical Investigation at Ardgaheen Quarry, Co. Galway for Harrington Concrete, APEX Geophysics Ltd. 26th July 2021

**apex geophysics**

6 Knockmullen Business Park  
Gorey  
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Ireland

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E info@apexgeophysics.ie  
www.apexgeophysics.ie

PROJECT:	ARDGAIENEN QUARRY GEOPHYSICAL SURVEY		
CLIENT:	HARRINGTON CONCRETE AND QUARRIES		
DRAWING NO:	AGP21055_R5		
SCALE:	AS INDICATED @ A4		
DATE:	26-07-2021		
Version:	Date:	Drawn By:	Checked:
01	26-07-2021	MN	POC

## APPENDIX B: DETAILED GEOPHYSICAL METHODOLOGY

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

### 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.

This surveying technique makes use of the Gradient resistivity array. The 2D-resistivity profiling method records a large number of resistivity readings in order to map lateral and vertical changes in subsurface 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 a Tigre resistivity meter, imaging software, two 32 takeout multicore cables and up to 64 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 Vp velocities while soft, loose or fractured materials have lower Vp 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 (Vp) 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. The processed seismic data are displayed in Appendix A.

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 by adjusting reciprocal times of off shots.

Approximate errors for Vp 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 the geophysical investigation 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.

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

**APPENDIX C: SEISMIC PLATES**

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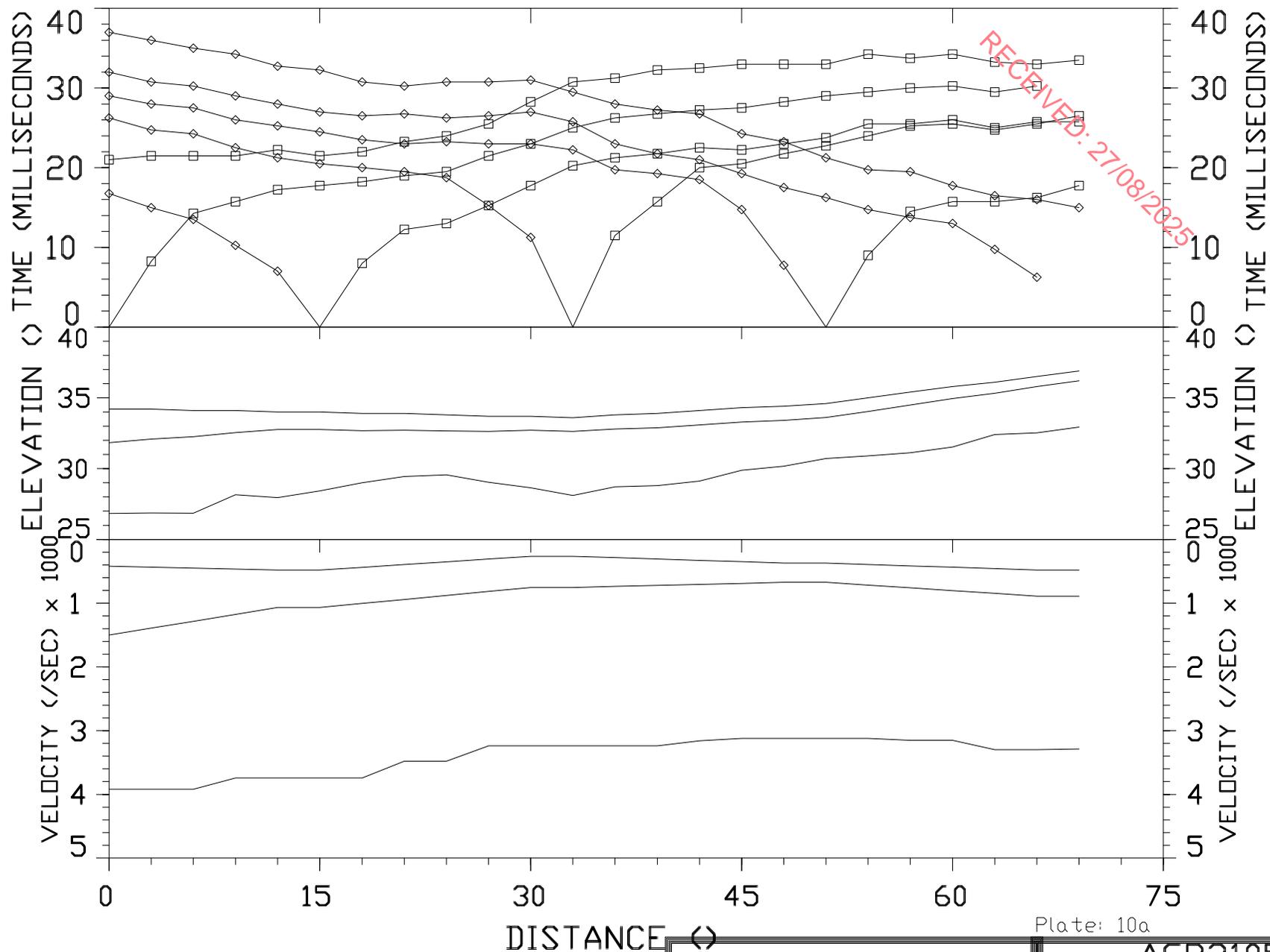


Plate: 10a

for: Harrington Concrete		AGP21055
by: APEX Geophysics Ltd.		
Data Set: S1	Date: 11/06/21	Claregalway Galway
Equipment: Geode	Spread: S1	

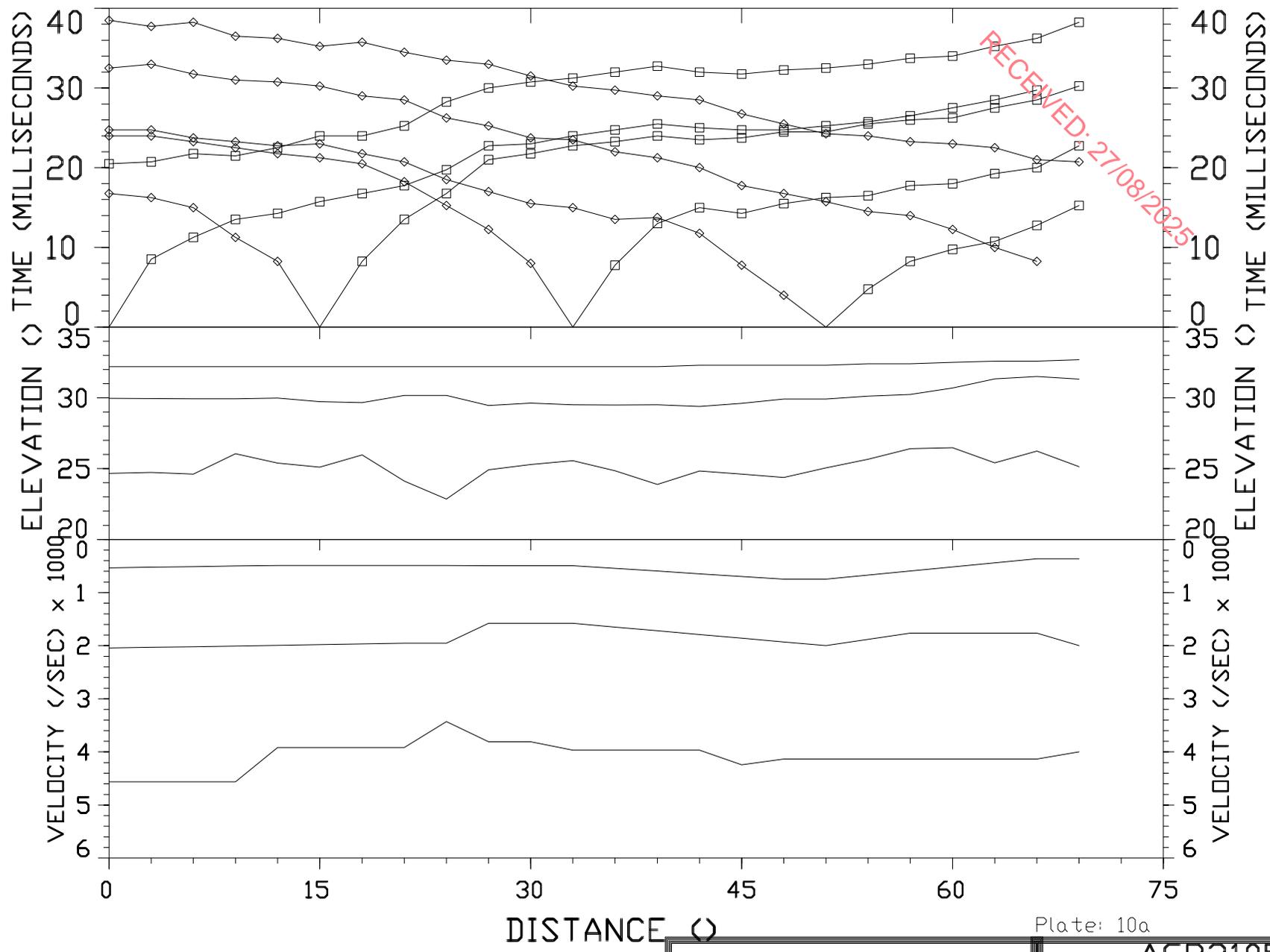


Plate: 10a

for: Harrington Concrete		AGP21055
by: Strata Geophysical, Inc.		
Data Set: S2ALT	Date: 11/06/21	Claregalway Galway
Equipment: Geode	Spread: S2	

**APPENDIX D: 2007 Geophysical Survey Report**

RECEIVED: 27/08/2025



# IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING  
SITE INVESTIGATION

Phone: (091) 841 274  
Fax: (091) 880 861

email: [info@irishdrilling.ie](mailto:info@irishdrilling.ie)

RECEIVED: 27/08/2025

## QUARRY AT ARDGAINEN, CLAREGALWAY, CO. GALWAY

### SITE INVESTIGATION REPORT

Dr. Pamela Bartley,  
Hydro-G,  
50 Henry St.,  
Galway

Frank Harrington Ltd.  
Ardgainen,  
Claregalway,  
Co. Galway.

Aug. 2021  
Job Nr. 21G121

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**Contents:**

**1.0 Introduction**

**2.0 The Site & Geology**

**3.0 Fieldwork**

**4.0 Ground Conditions**

**4.1 Groundwater & Infiltration Tests**

**Site Location**

**Site Plan**

**Appendix 1**

**Appendix 2**

**Appendix 3**

**Appendix 4**

**Trial Pit Records**

**Infiltration Records**

**Laboratory Test Results**

**Photographs**

## **1.0 Introduction.**

Irish Drilling Ltd. was instructed by Dr Pamela Bartley to carry out a site investigation on the site of a runoff area for an existing quarry at Ardgaineen, Claregalway, Co. Galway.

The fieldwork was carried out between 17<sup>th</sup> and 18<sup>th</sup> June 2021.

## **2.0 The Site & Geology.**

The site is located on the south side of the existing Frank Harrington Ltd. quarry, at Ardgaineen, Claregalway.

The area investigated was covered in grass and scrub, with some small trees, at the time of this investigation.

Geological Survey maps of the area indicate that the site is underlain by the Carboniferous Limestone Formation.

## **3.0 Fieldwork.**

The fieldwork consisted of the following:

Six trial pits (TP-1 to TP-6) were excavated and were logged and photographed by a geotechnical engineer and samples were taken for testing in the laboratory. The trial pit records are included in Appendix 1.

Three Infiltration tests (PT-1, PT-2, PT-3), carried out to BRE 365, were completed and the records are included in Appendix 2.

Laboratory testing was carried out on representative samples. Tests carried out were natural moisture content, Atterberg limits and Particle Size Distribution tests. The laboratory test results are included in Appendix 3.

Photographs of the trial pits are included in Appendix 4.

All test locations were surveyed, to National co-ordinates, using a Trimble CU Bluetooth Total Station.

The fieldwork was carried out in accordance with BS5930 (2015): Code of Practice for Site Investigations.

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#### 4.0 Ground Conditions

Beneath a thin layer of topsoil the trial pits encountered gravelly sandy silt, with cobbles and boulders, overlying bedrock.

Rock was encountered at the following depths:

Location	Depth	Remarks
TP-1	1.40m (30.59m O.D.)	Refusal on limestone
TP-2	0.60m (31.13m O.D.)	Refusal on limestone
TP-3	0.90m (31.15m O.D.)	Refusal on limestone
TP-4	0.70m (33.20m O.D.)	Refusal on limestone
TP-5	0.60m (34.11m O.D.)	Refusal on limestone
TP-6	0.70m (34.98m O.D.)	Refusal on limestone
PT-1	1.00m (30.76m O.D.)	Refusal on limestone
PT-2	0.70m (31.27m O.D.)	Refusal on limestone
PT-3	0.20m (31.93m O.D.)	Refusal on limestone

For detailed descriptions of the soils and rock, refer to Appendix 1.

#### 4.1 Groundwater

Water was not encountered in the trial pits, however it should be noted that they were left open for a short time period.

*Infiltration tests:*

Infiltration tests carried out at three locations recorded the following infiltration rates:

Location	First Fill	Second Fill	Third Fill
PT 1	$7.1 \times 10^{-5}$ m/s	$5.6 \times 10^{-5}$ m/s	$4.6 \times 10^{-5}$ m/s
PT 2	$1.8 \times 10^{-4}$ m/s	$1.0 \times 10^{-4}$ m/s	$6.9 \times 10^{-5}$ m/s
PT 3	Very low permeability, test abandoned		

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Declan Joyce B.E., M.Eng.Sc., C.Eng., M.I.E.I  
Chartered Geotechnical Engineer

---

**REFERENCES:**

- (1) B.S.5930:(1981), Code of Practice for Site Investigation.
- (2) B.S.1377:(1990), Methods of Test for Soils for Civil Engineering Purposes.
- (3) BRE Special Digest (1:2005) Concrete in aggressive ground.

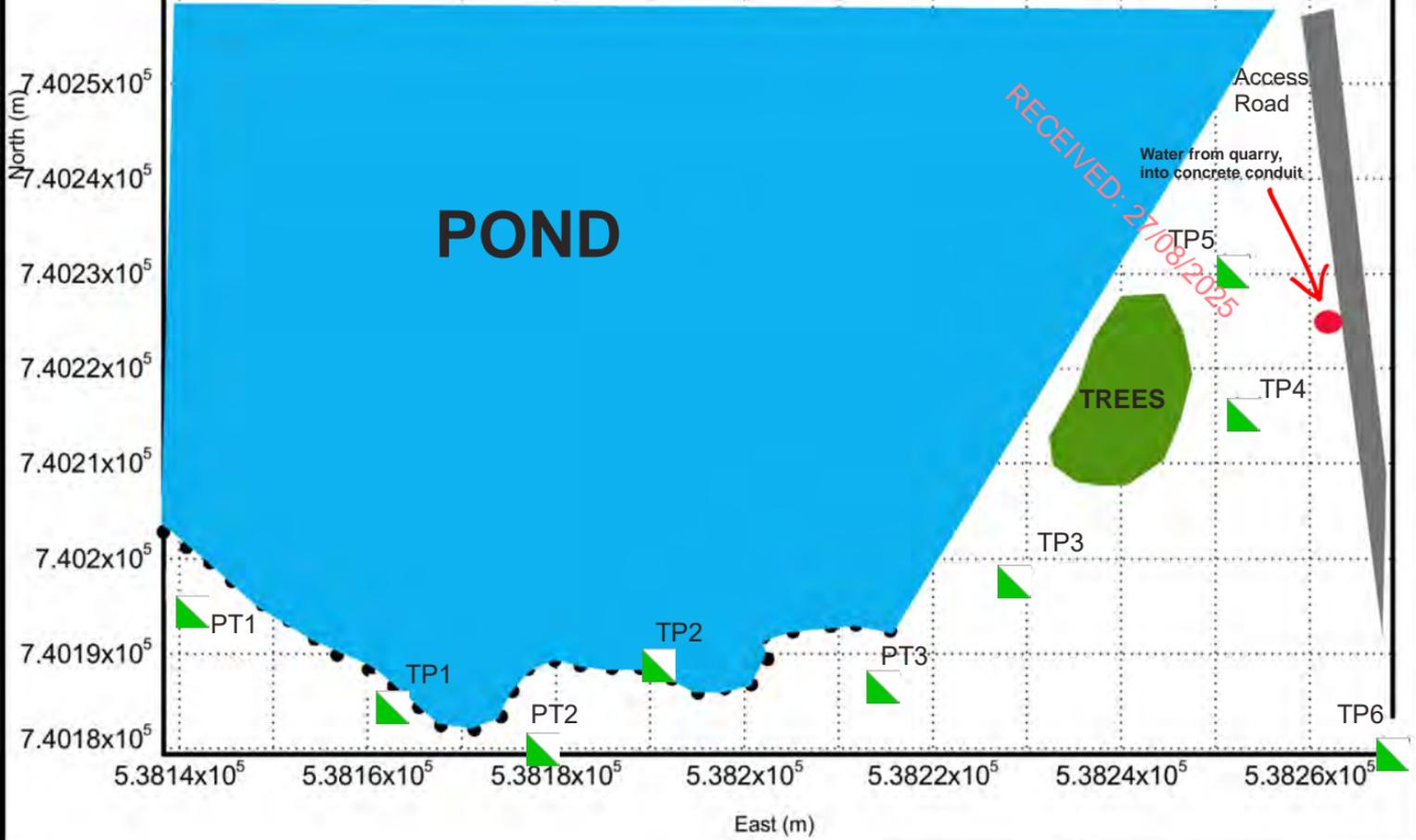


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Ardgaheen, Claregalway  
Trial Pit & Infiltration Test Locations  
Irish Drilling Ltd. June 2021



1.GDT 13/8/21

Irish Drilling Ltd.  
 Loughrea, Co. Galway  
 093 941274  
 info@irishdrilling.ie



Drawing Title:  
 Ardgaheen, Claregalway  
 Trial Pit Locations  
 Date: 17.6.2021  
 Drg. No.:

RECEIVED: 27/08/2025

## **APPENDIX 1**

### **TRIAL PIT RECORDS**

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 1  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,162.8 N 740,184.7

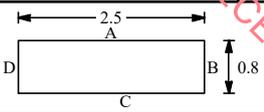
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 31.99m O.D.

**DATE:** 18.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 2.50m  
**LOGGED BY:** DF



Shoring/Support:  
 Stability: Pit sides stable

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Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21								TOPSOIL
			B D	0.30-0.50 0.30-0.50			31.69	0.30	Firm, light grey, slightly gravelly, slightly sandy SILT, with high cobble content. Cobbles are subrounded, of limestone.
1			B D	1.10-1.30 1.10-1.30			31.14	0.85	Firm, light grey, slightly sandy, slightly gravelly SILT, with high cobble content. Cobbles are subrounded.
	18.06.21						30.59	1.40	Refusal - limestone rock
2						END			
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

**Scale:**  
 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 2  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,190.9 N 740,188.8

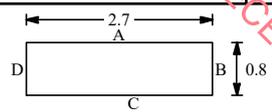
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 31.73m O.D.

**DATE:** 18.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 2.70m  
**LOGGED BY:** DF



**Shoring/Support:**  
**Stability:** Pit sides stable

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21		B	0.20-0.40		—	31.53	0.20	TOPSOIL
			D	0.20-0.40		⊗	31.33	0.40	Firm, brown, slightly sandy, slightly gravelly, organic SILT. (Silt has high plasticity)
	18.06.21		B	0.40-0.60		⊗	31.13	0.60	Firm, brown, slightly sandy, gravelly, organic SILT, with high cobble content. Cobbles are angular, of limestone.
			D	0.40-0.60		END			Refusal - limestone rock
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

**Scale:**  
 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 3  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,228.6 N 740,197.7

**Rig:** CAT EX23  
**Rev:**

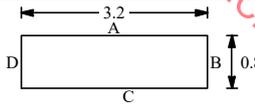
**Ground level:** 32.05m O.D.

**DATE:** 18.6.21

**GROUNDWATER**

**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 3.20m  
**LOGGED BY:** DF



Shoring/Support:  
 Stability: Pit sides stable

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Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21		B D	0.10-0.30 0.10-0.30			31.95	0.10	TOPSOIL Firm, brown, slightly gravelly, slightly sandy SILT, with high cobble content. Cobbles are angular to subangular, of limestone.
	18.06.21		B D	0.70-0.90 0.70-0.90			31.35 31.15	0.70 0.90	Brown, very silty, very sandy GRAVEL, with high cobble content. Cobbles are angular to subangular, of limestone. Refusal - limestone rock
1						END			Rock at 0.4m at northern end of pit and 0.9m at southern end of pit
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

**Scale:**

**1:50**

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 4  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,253.2 N 740,215.1

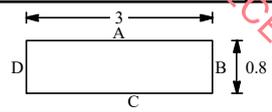
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 33.90m O.D.

**DATE:** 18.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 3.00m  
**LOGGED BY:** DF



**Shoring/Support:**  
**Stability:** Pit sides stable

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21		B D	0.20-0.40 0.20-0.40					Angular COBBLES & BOULDERS of grey limestone, with much brown slightly sandy, gravelly SILT
	18.06.21						33.20	0.70	
1						END			Refusal - limestone rock
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

**Scale:**  
 1:50

TRIALPIT ARDGAAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 5  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,251.9 N 740,230.3

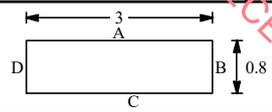
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 34.71m O.D.

**DATE:** 18.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 3.00m  
**LOGGED BY:** DF



**Shoring/Support:**  
**Stability:** Pit sides stable

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21						34.61	0.10	TOPSOIL
	18.06.21		B	0.40-0.60			34.11	0.60	Subangular to subrounded COBBLES & BOULDERS (to maximum size 500mm) of grey limestone, with much brown slightly sandy, gravelly SILT.
						END			Refusal - limestone rock
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

**Scale:**  
 1:50

TRIALPIT ARDGAAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** TP 6  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,268.8 N 740,179.4

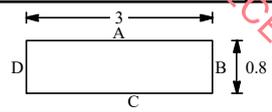
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 35.68m O.D.

**DATE:** 18.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 0.80 \* 3.00m  
**LOGGED BY:** DF



Shoring/Support:  
 Stability: Pit sides stable

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	18.06.21						35.53	0.15	TOPSOIL
	18.06.21		B D	0.40-0.60 0.40-0.60			34.98	0.70	Angular COBBLES & BOULDERS (to maximum size 400mm) of grey limestone, with much brown slightly sandy, gravelly SILT.
1						END			Refusal - limestone rock
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Pit dry during excavation

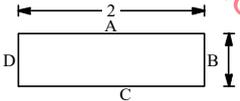
**Scale:**  
 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway **TRIALPIT:** PT 1  
**LOCATION:** Claregalway, Co. Galway **Sheet 1 of 1**

**CLIENT:** Harringtons Quarry **Co-ordinates:** E 538,141.4 N 740,194.9 **Rig:** CAT EX23  
**ENGINEER:** **Rev:**

**Ground level:** 31.76m O.D. **DATE:** 17.6.21

**GROUNDWATER**  
**Water strikes:** 1st: dry 2nd: 3rd: **Rose to after:**  
**PIT DIRECTION:**  **Shoring/Support:**  
**PIT DIMENSION:** 1.00 \* 2.00m **Stability:** Pit sides stable  
**LOGGED BY:** DF

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	17.06.21						31.61	0.15	TOPSOIL
							31.31	0.45	Firm, brown, slightly gravelly SILT.
1	17.06.21						30.76	1.00	Firm, light grey, sandy, gravelly SILT, with high cobble content and low boulder content. Cobbles and boulders are subangular to subrounded, to maximum 800mm size
						END			Terminated
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Infiltration Test carried out at 1m **Scale:** 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

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**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** PT 2  
**Sheet 1 of 1**

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,178.6 N 740,180.0

**Rig:** CAT EX23  
**Rev:**

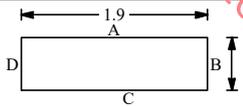
**Ground level:** 31.97m O.D.

**DATE:** 17.6.21

**GROUNDWATER**

**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 1.00 \* 1.90m  
**LOGGED BY:** DF



Shoring/Support:  
 Stability: Pit sides stable

RECEIVED: 27/08/2025

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	17.06.21						31.82	0.15	TOPSOIL
									Angular BOULDERS of grey limestone
	17.06.21						31.27	0.70	Refusal - limestone rock
1						END			
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Infiltration Test carried out at 0.7m

**Scale:**  
 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

**PROJECT:** Ardgaheen, Claregalway  
**LOCATION:** Claregalway, Co. Galway

**TRIALPIT:** PT 3  
 Sheet 1 of 1

**CLIENT:** Harringtons Quarry  
**ENGINEER:**

**Co-ordinates:**  
 E 538,214.5 N 740,186.4

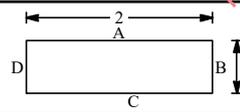
**Rig:** CAT EX23  
**Rev:**

**Ground level:** 32.13m O.D.

**DATE:** 17.6.21

**GROUNDWATER**  
**Water strikes:** Rose to after:  
 1st: dry  
 2nd:  
 3rd:

**PIT DIRECTION:**  
**PIT DIMENSION:** 1.00 \* 2.00m  
**LOGGED BY:** DF



**Shoring/Support:**  
**Stability:** Pit sides stable

Depth (m)	Date	Water	Samples	Depth (m)	In Situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0	17.06.21					END	31.93	0.20	TOPSOIL
									Refusal - limestone rock
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

**Remarks:** Infiltration Test carried out at 0.2m

**Scale:**  
 1:50

TRIALPIT ARDGAHEEN CLAREGALWAY 2021.GPJ IRISHDRL.GDT 13/8/21

RECEIVED: 27/08/2025

## **APPENDIX 2**

# **INFILTRATION TEST RECORDS**

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

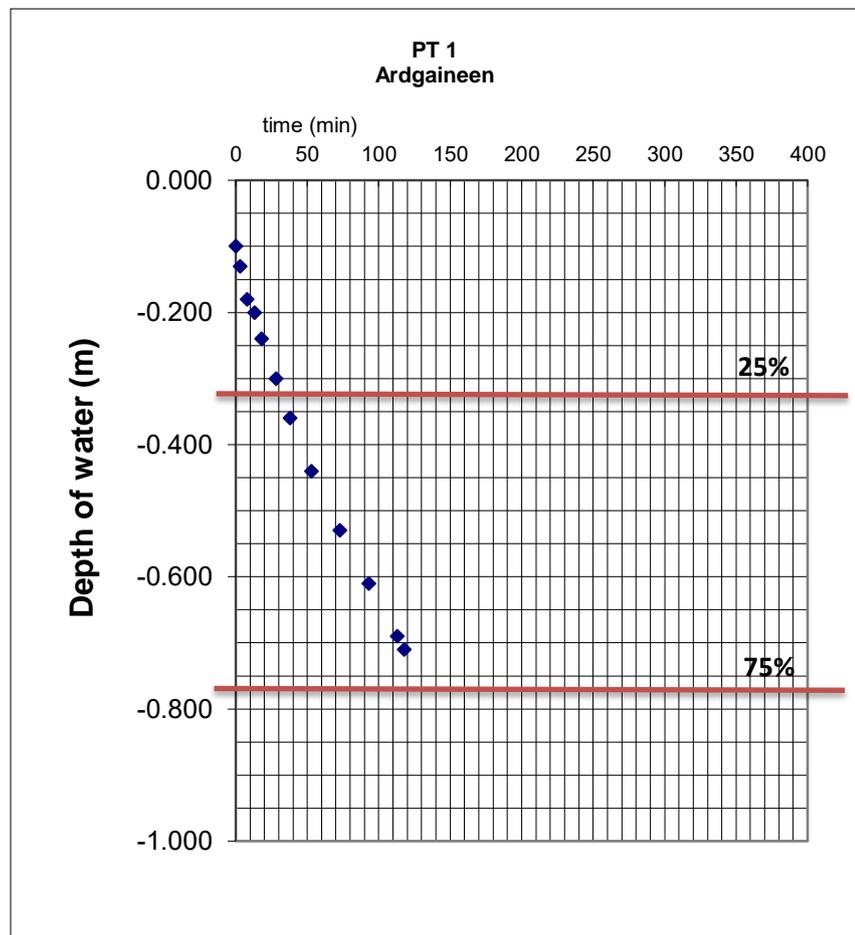
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 1

2nd FILL      Top of water level:      0.10 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.100
3	-0.130
8	-0.180
13	-0.200
18	-0.240
28	-0.300
38	-0.360
53	-0.440
73	-0.530
93	-0.610
113	-0.690
118	-0.710



Result:

Soil Infiltration Rate =  $5.6 \times 10^{-5}$  m/s

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

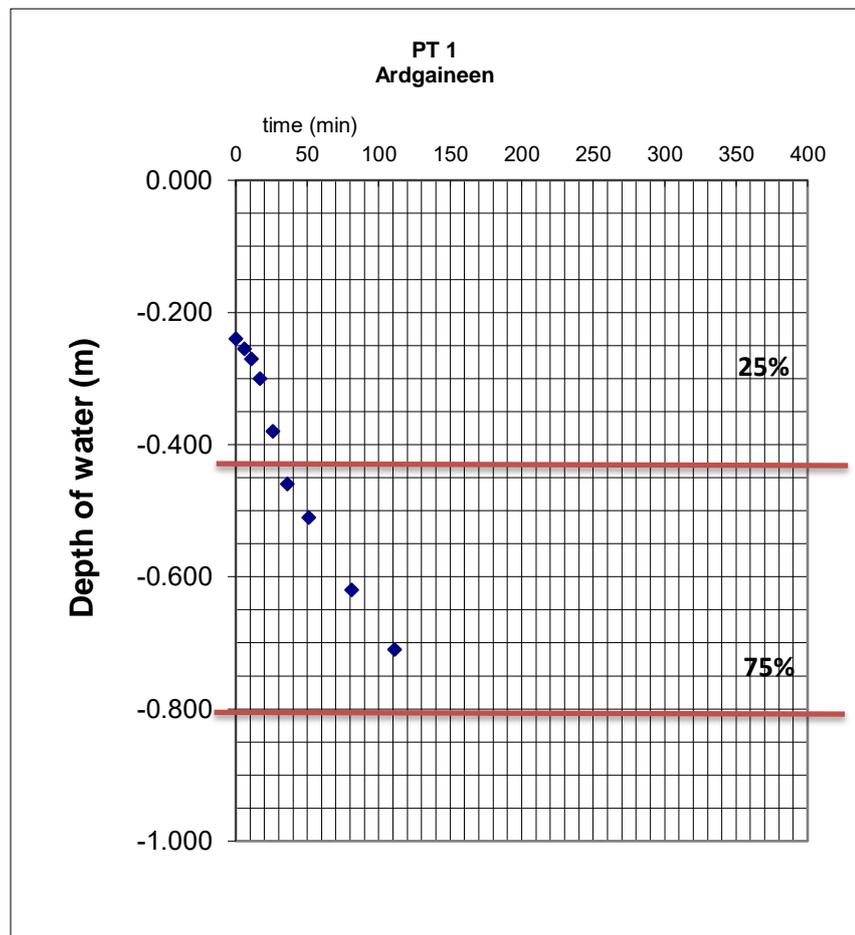
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 1

3rd FILL      Top of water level:      0.24 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.240
6	-0.255
11	-0.270
17	-0.300
26	-0.380
36	-0.460
51	-0.510
81	-0.620
111	-0.710



Result:

Soil Infiltration Rate =  $4.6 \times 10^{-5}$  m/s

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

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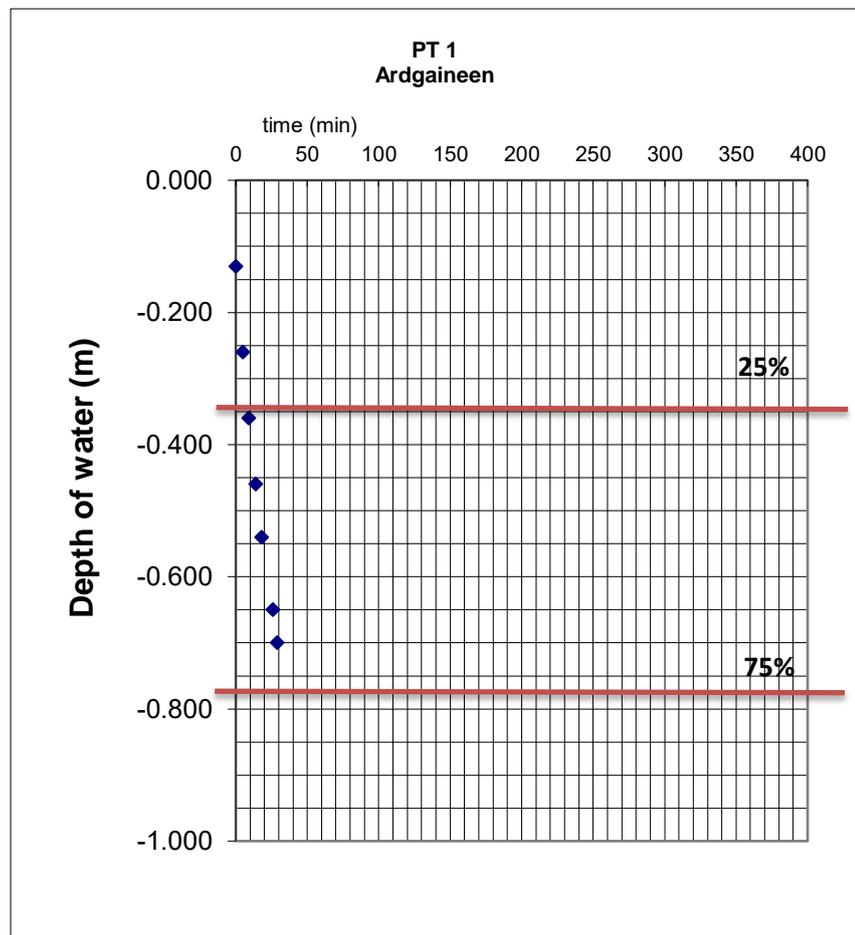
## INFILTRATION TEST - to BRE 365

### PT 2

1st FILL

Top of water level: 0.13 m  
Base of trial pit: 1.00 m  
Dims. of trial pit: 2 x 1

time min	WL m
0	-0.130
5	-0.260
9	-0.360
14	-0.460
18	-0.540
26	-0.650
29	-0.700



Result:

Soil Infiltration Rate =  $1.8 \times 10^{-4}$  m/s

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaheen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

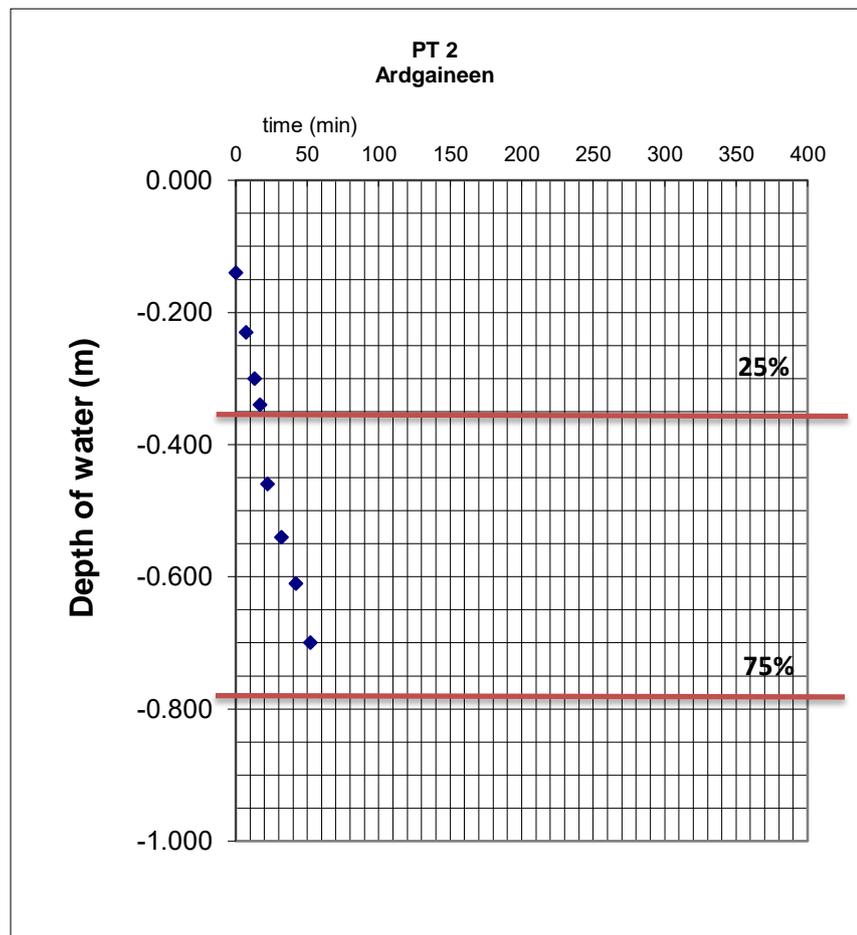
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 2

2nd FILL      Top of water level:      0.13 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.140
7	-0.230
13	-0.300
17	-0.340
22	-0.460
32	-0.540
42	-0.610
52	-0.700



Result:

Soil Infiltration Rate =  $1.01 \times 10^{-4}$  m/s

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

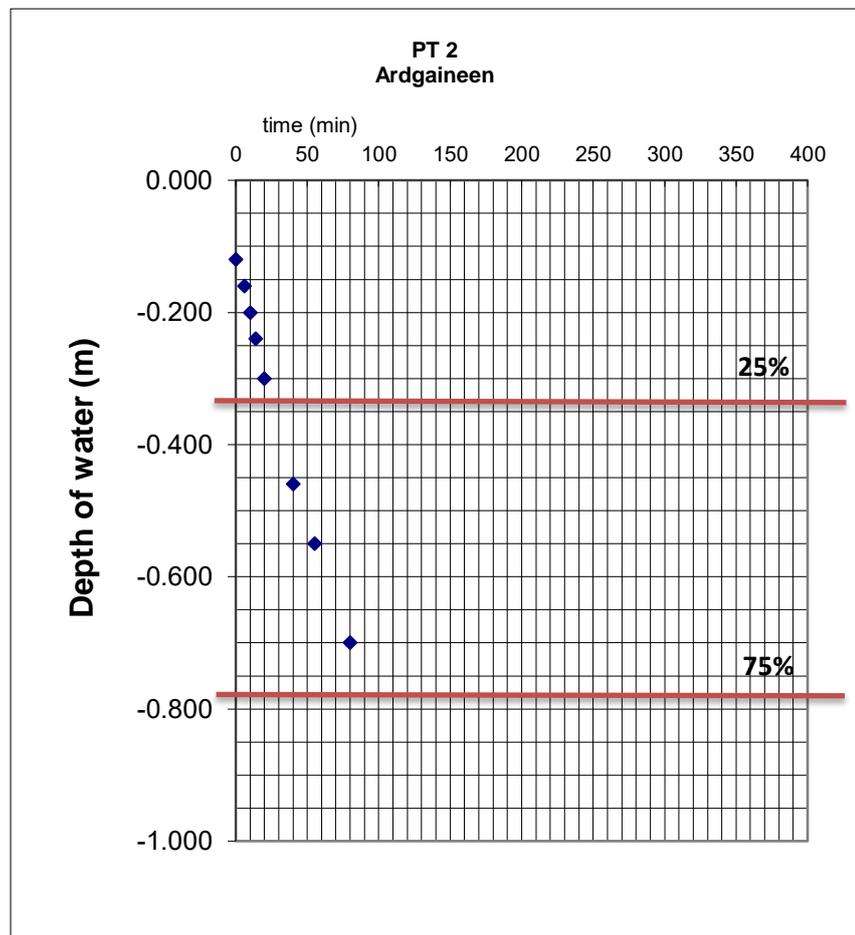
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 2

3rd FILL      Top of water level:      0.12 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.120
6	-0.160
10	-0.200
14	-0.240
20	-0.300
40	-0.460
55	-0.550
80	-0.700



Result:

Soil Infiltration Rate =  $6.9 \times 10^{-5}$  m/s

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

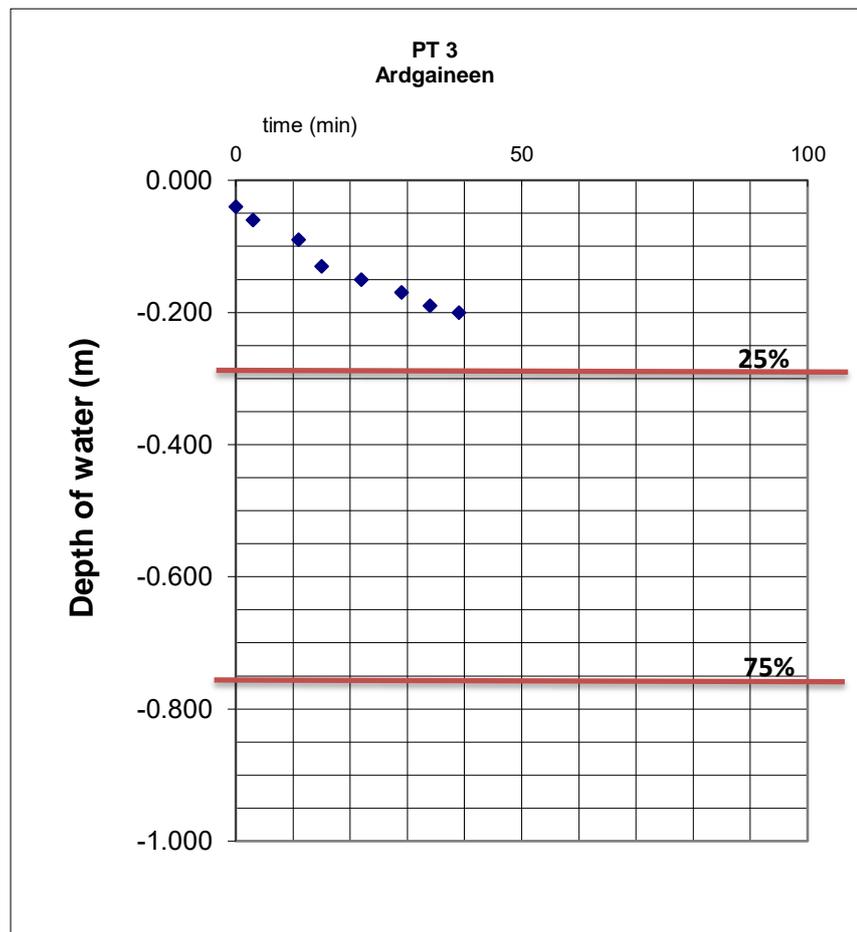
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 3

1st FILL      Top of water level:      0.04 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.040
3	-0.060
11	-0.090
15	-0.130
22	-0.150
29	-0.170
34	-0.190
39	-0.200



Result:

Soil Infiltration Rate = 'very poor' - abandoned

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

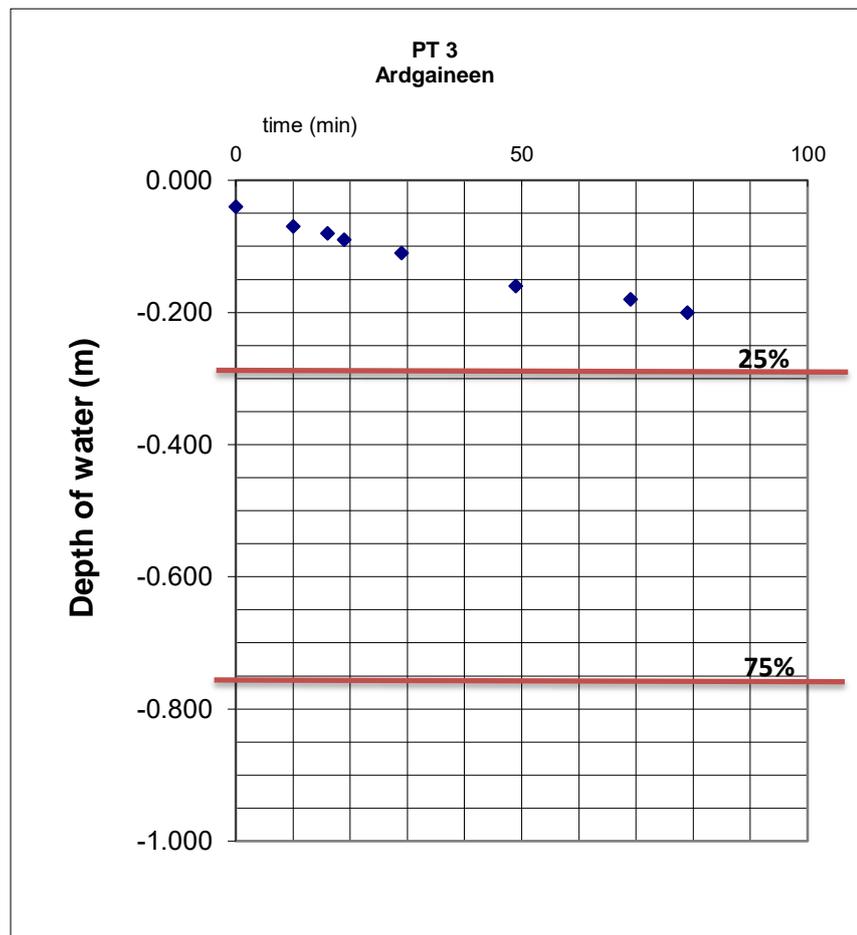
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 3

2nd FILL      Top of water level:      0.04 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.040
10	-0.070
16	-0.080
19	-0.090
29	-0.110
49	-0.160
69	-0.180
79	-0.200



Result:

Soil Infiltration Rate = 'very poor' - abandoned

IRISH DRILLING LTD.  
Loughrea Co. Galway



Tel: (091) 841274 info@irishdrilling.ie

Contract: Ardgaineen, Claregalway

Client:

Engineer: Dr. Pamela Bartley

Date: 17.06.'21

Tested by: DF

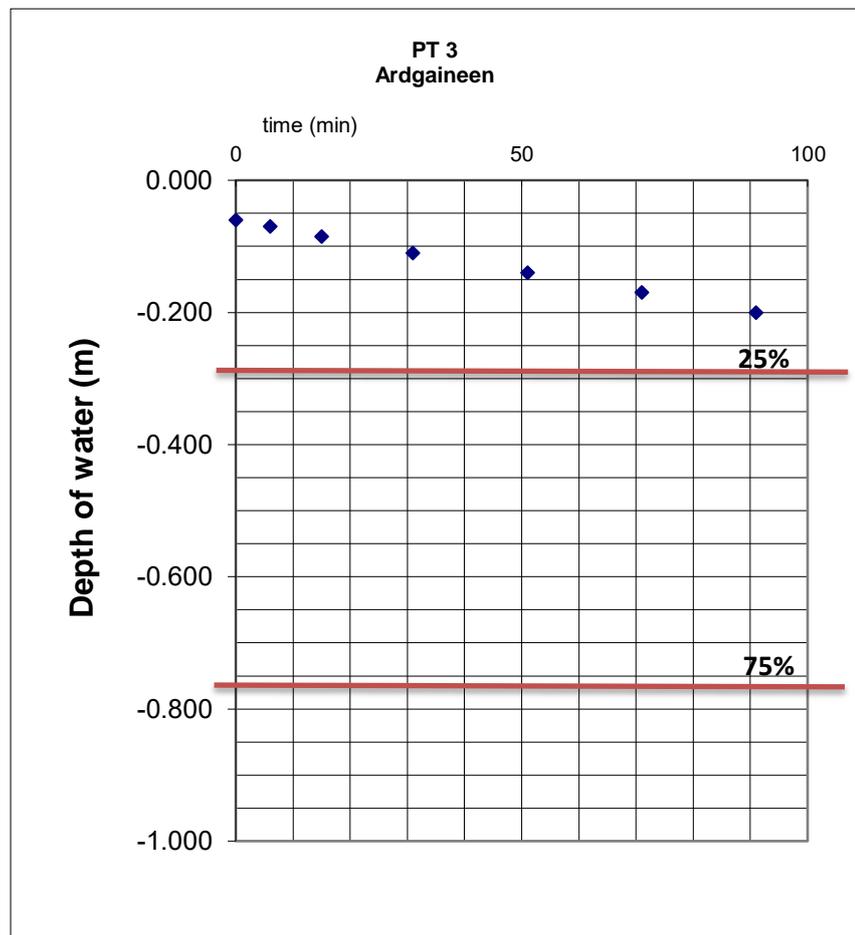
RECEIVED: 27/08/2025

## INFILTRATION TEST - to BRE 365

### PT 3

3rd FILL      Top of water level:      0.06 m  
Base of trial pit:      1.00 m  
Dims. of trial pit:      2      x      1

time min	WL m
0	-0.060
6	-0.070
15	-0.085
31	-0.110
51	-0.140
71	-0.170
91	-0.200



Result:

Soil Infiltration Rate = 'very poor' - abandoned

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## **APPENDIX 3**

# **LABORATORY TEST RESULTS**

**CONTRACT:** Ardgaheen, Claregalway

Sack:

Schedule:

Client

Date: 22.06.21

Engineer

Pamela Bartley

Scheduled B.D.J.

BH/TP No.	Sample Type	Sample Depth	Classification		Bulk Density	PSD	Hydro	Earthworks		* Specify Rammer			Settlement			Strength			Chemical				Organic Content	Remarks/Loading
			MC (%)	Atterberg Limits				5-point MCV	CBR 1 point*	MCV 1 Point	5 Point Comp only*	5 Point Comp with CBR*	Consol (Oed)	Triaxial (Q-U)	Triaxial (Con-U)	FALL CONE	Shear Box	SO3	pH	Chloride				
<b>TP 1</b>	B	0.3 - 0.5	<b>1</b>			<b>1</b>																		
	D	0.3 - 0.5	<b>1</b>																					
	B	1.1 - 1.3	<b>1</b>	<b>1</b>		<b>1</b>																		
	D	1.1 - 1.3	<b>1</b>																					
<b>TP 2</b>	B	0.2 - 0.4	<b>1</b>	<b>1</b>		<b>1</b>																		
	D	0.2 - 0.4	<b>1</b>																					
	B	0.4 - 0.6	<b>1</b>	<b>1</b>		<b>1</b>																		
	D	0.4 - 0.6	<b>1</b>																					
<b>TP 3</b>	B	0.1 - 0.3	<b>1</b>			<b>1</b>																		
	D	0.1 - 0.3	<b>1</b>																					
	B	0.7 - 0.9	<b>1</b>			<b>1</b>																		
	D	0.7 - 0.9	<b>1</b>																					
<b>TP 4</b>	B	0.2 - 0.4	<b>1</b>			<b>1</b>																		
	D	0.2 - 0.4	<b>1</b>																					
<b>TP 5</b>	B	0.4 - 0.6	<b>1</b>			<b>1</b>																		
<b>TP 6</b>	B	0.4 - 0.6	<b>1</b>	<b>0*</b>		<b>1</b>																	* smelly	
	D	0.4 - 0.6	<b>1</b>																					

Tests scheduled:  
Test completed

12.08.21	17	3	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
----------	----	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---





Plasticity (A-Line) Chart

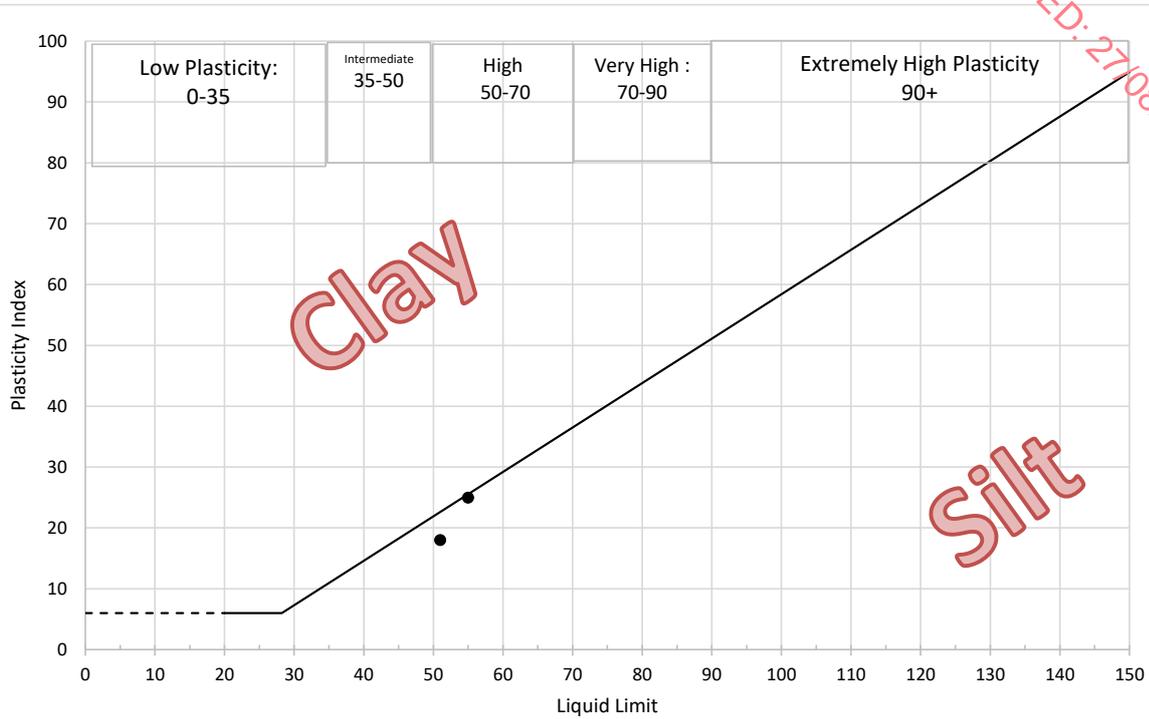
Project Number  
21G121

Project Name:

Ardgaineen, Claregalway

Location:

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Abbreviations in the remarks column of the Classification Summary Sheet: C = Clay, M = Silt

Plasticity abbreviations: L = Low, I = Intermediate, H = High, V = Very High, E = Extremely High.

The letter O is added to the symbol of any material containing a significant proportion of organic material.

Chart taken from BS5930: 2010

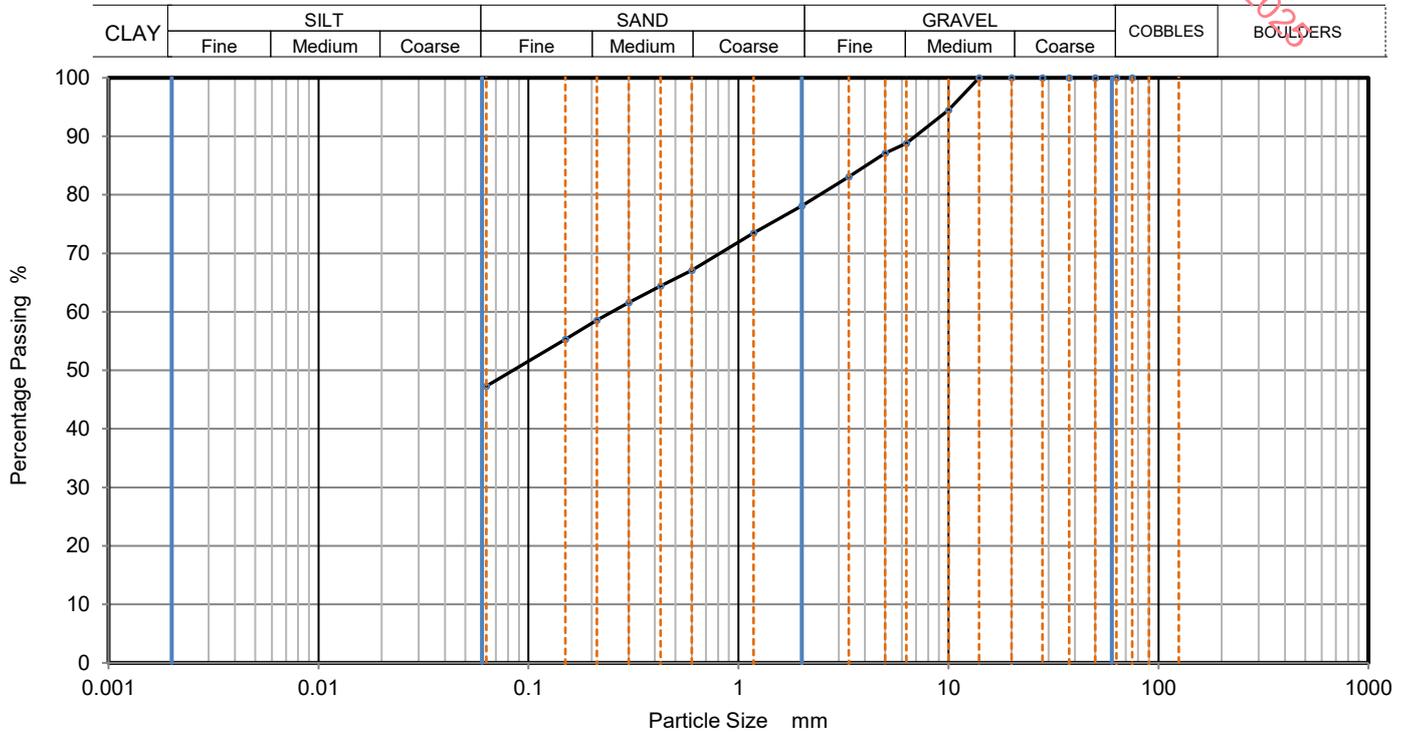


## PARTICLE SIZE DISTRIBUTION

Job Ref	21G121
Borehole/Pit No.	TP 1
Sample No.	
Depth, m	0.30
Sample Type	B
KeyLAB ID	IDL12021062297

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly gravelly slightly sandy SILT.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

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Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	100		
10	95		
6.3	89		
5	87		
3.35	83		
2	78		
1.18	74		
0.6	67		
0.425	64		
0.3	62		
0.212	59		
0.15	55		
0.063	47		

Dry Mass of sample, g 356

Sample Proportions	% dry mass
Very coarse	0
Gravel	22
Sand	31
Fines <0.063mm	47

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

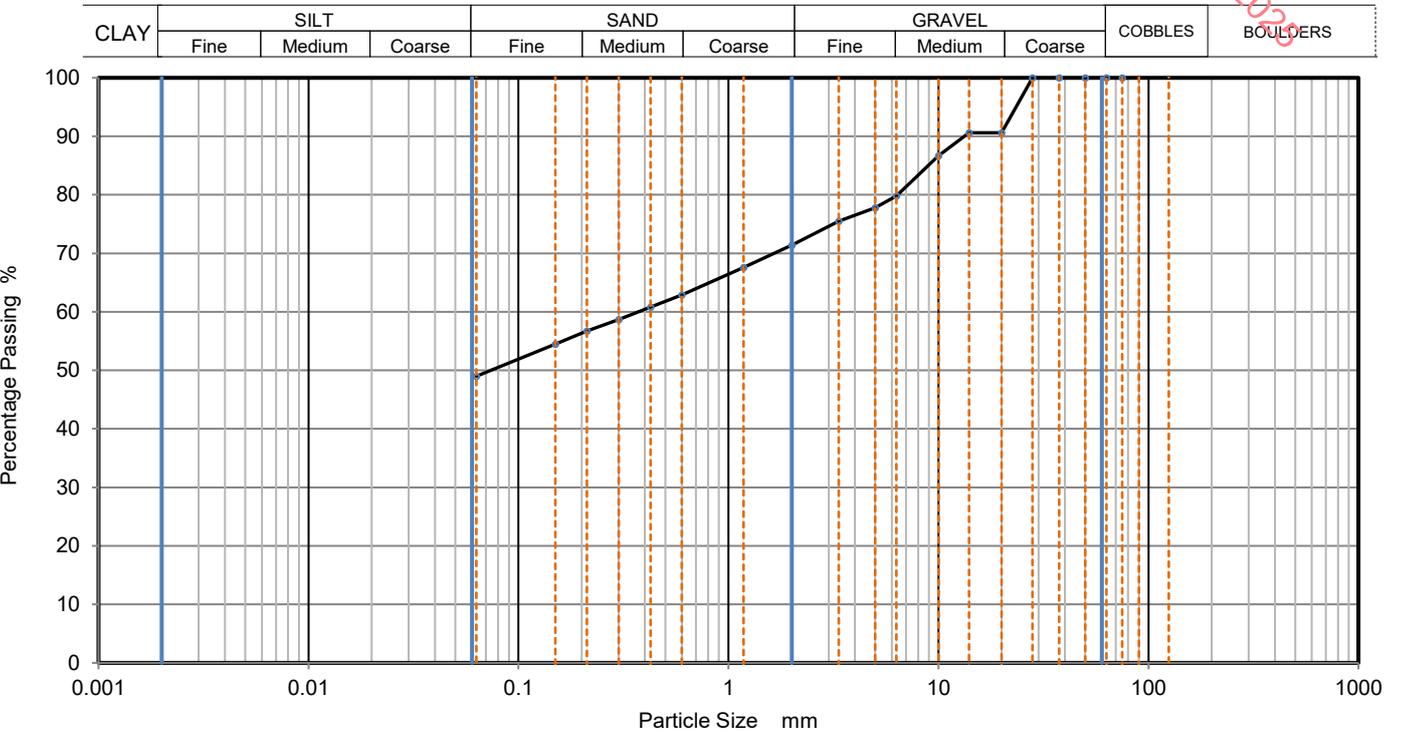
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		Dympna Darcy B.Sc.	12/08/2021 12:30	
				QC From No:R2



## PARTICLE SIZE DISTRIBUTION

Job Ref	<b>21G121</b>
Borehole/Pit No.	TP 1
Sample No.	
Depth, m	1.10
Sample Type	B
KeyLAB ID	IDL12021062299

Site Name	Ardgaineen, Claregalway	
Soil Description	Grey slightly sandy slightly gravelly SILT.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	91		
14	91		
10	87		
6.3	80		
5	78		
3.35	76		
2	71		
1.18	68		
0.6	63		
0.425	61		
0.3	59		
0.212	57		
0.15	55		
0.063	49		

Dry Mass of sample, g 366

Sample Proportions	% dry mass
Very coarse	0
Gravel	29
Sand	22
Fines <0.063mm	49

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
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				QC From No:R2

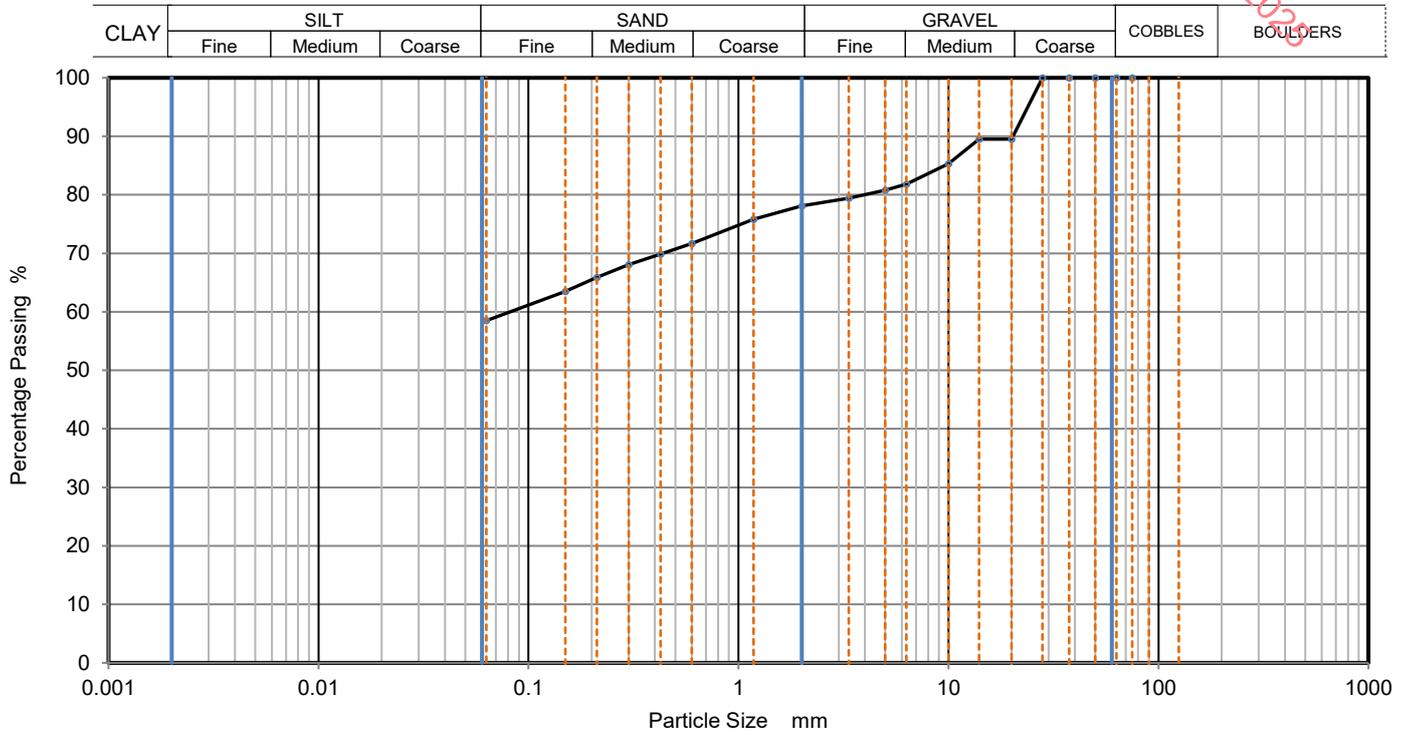


## PARTICLE SIZE DISTRIBUTION

Job Ref	21G121
Borehole/Pit No.	TP 2
Sample No.	
Depth, m	0.20
Sample Type	B
KeyLAB ID	IDL120210622101

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly sandy slightly gravelly SILT.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

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Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	90		
14	90		
10	85		
6.3	82		
5	81		
3.35	79		
2	78		
1.18	76		
0.6	72		
0.425	70		
0.3	68		
0.212	66		
0.15	64		
0.063	59		

Dry Mass of sample, g 331

Sample Proportions	% dry mass
Very coarse	0
Gravel	22
Sand	20
Fines <0.063mm	58

Grading Analysis		
D100	mm	
D60	mm	0.0821
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

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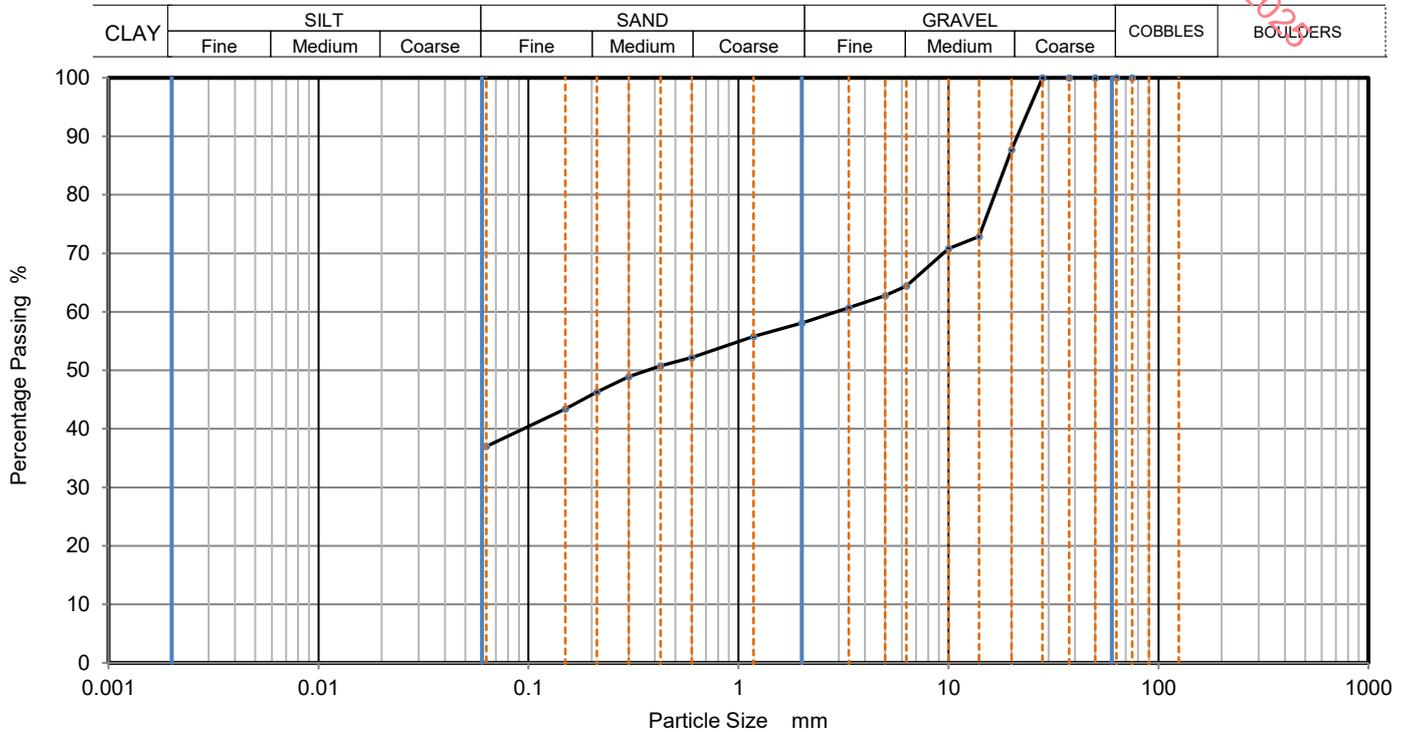


## PARTICLE SIZE DISTRIBUTION

Job Ref	<b>21G121</b>
Borehole/Pit No.	TP 2
Sample No.	
Depth, m	0.40
Sample Type	B
KeyLAB ID	IDL120210622103

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly sandy gravelly SILT. Gravel is medium.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

RECEIVED: 27/08/2023



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	88		
14	73		
10	71		
6.3	64		
5	63		
3.35	61		
2	58		
1.18	56		
0.6	52		
0.425	51		
0.3	49		
0.212	46		
0.15	43		
0.063	37		

Dry Mass of sample, g 331

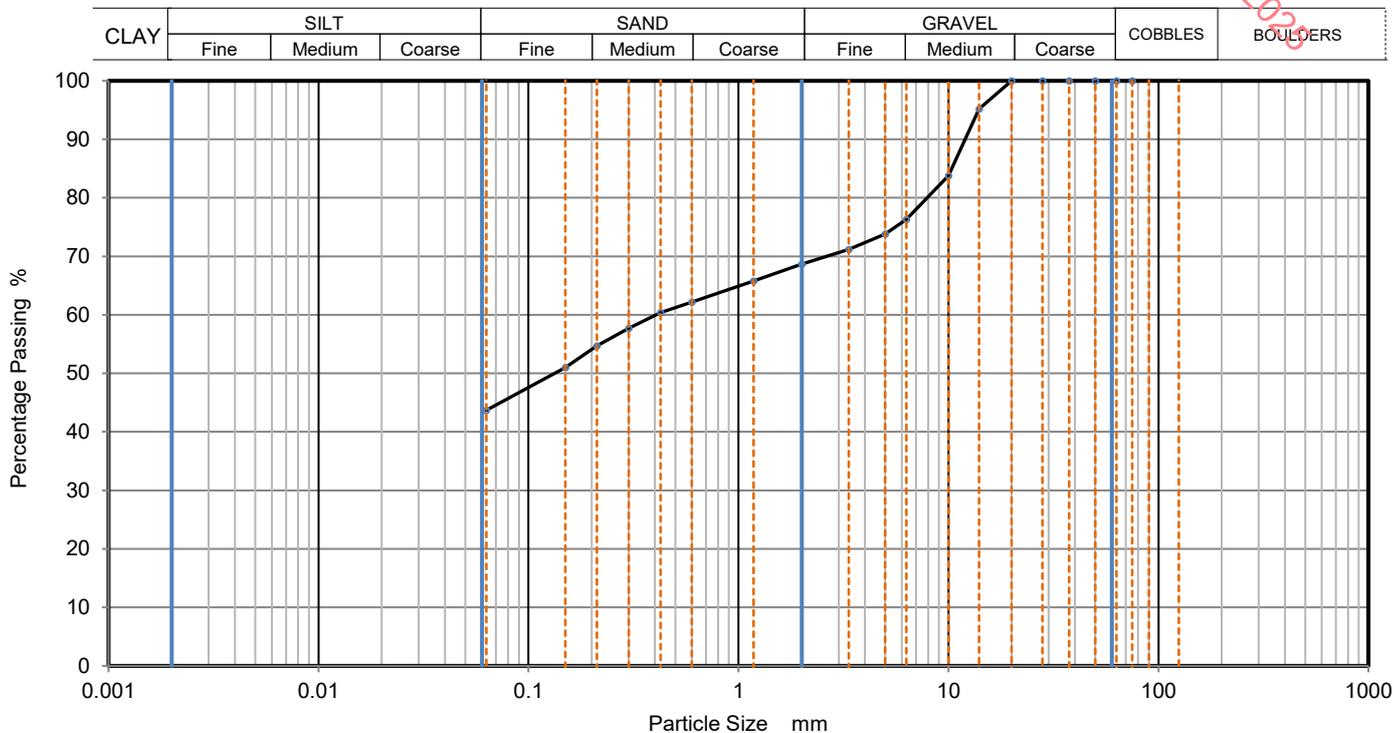
Sample Proportions	% dry mass
Very coarse	0
Gravel	42
Sand	21
Fines <0.063mm	37

Grading Analysis	
D100	mm
D60	mm 2.91
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
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				QC From No:R2

	<b>PARTICLE SIZE DISTRIBUTION</b>		Job Ref	21G121	
			Borehole/Pit No.	TP 3	
Site Name	Ardgaineen, Claregalway		Sample No.		
Soil Description	Brown slightly sandy slightly gravelly SILT. Gravel is medium.		Depth, m	0.10	
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2		KeyLAB ID	IDL120210622105	



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	95		
10	84		
6.3	76		
5	74		
3.35	71		
2	69		
1.18	66		
0.6	62		
0.425	60		
0.3	58		
0.212	55		
0.15	51		
0.063	44		

Dry Mass of sample, g

283

Sample Proportions	% dry mass
Very coarse	0
Gravel	31
Sand	25
Fines <0.063mm	44

Grading Analysis		
D100	mm	
D60	mm	0.404
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

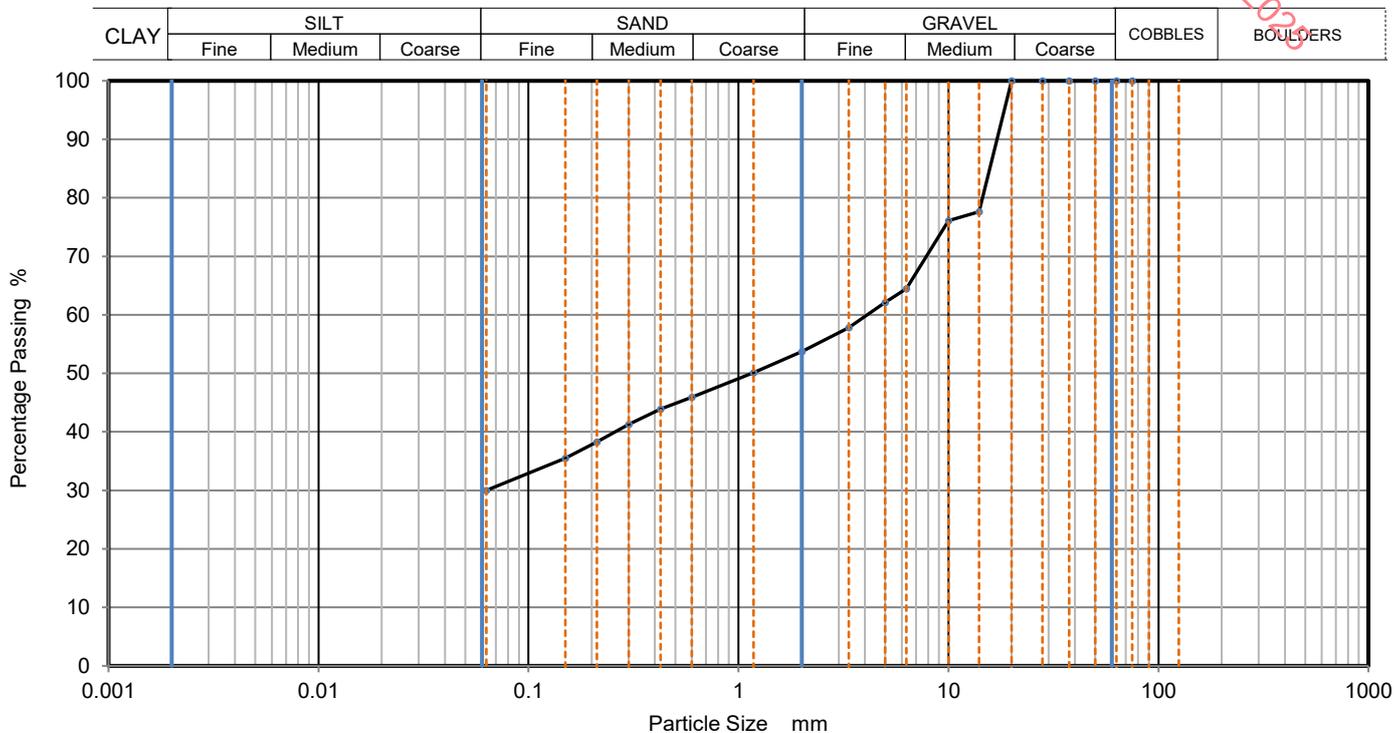
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
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				QC From No:R2

	<b>PARTICLE SIZE DISTRIBUTION</b>		Job Ref	<b>21G121</b>
			Borehole/Pit No.	TP 3
Site Name	Ardgaineen, Claregalway		Sample No.	
Soil Description	Brown very sandy very silty medium GRAVEL.		Depth, m	0.70
Specimen Reference	Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2		KeyLAB ID	IDL120210622107

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Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	100		
14	78		
10	76		
6.3	65		
5	62		
3.35	58		
2	54		
1.18	50		
0.6	46		
0.425	44		
0.3	41		
0.212	38		
0.15	36		
0.063	30		

Dry Mass of sample, g

256

Sample Proportions	% dry mass
Very coarse	0
Gravel	46
Sand	24
Fines <0.063mm	30

Grading Analysis		
D100	mm	
D60	mm	4.12
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
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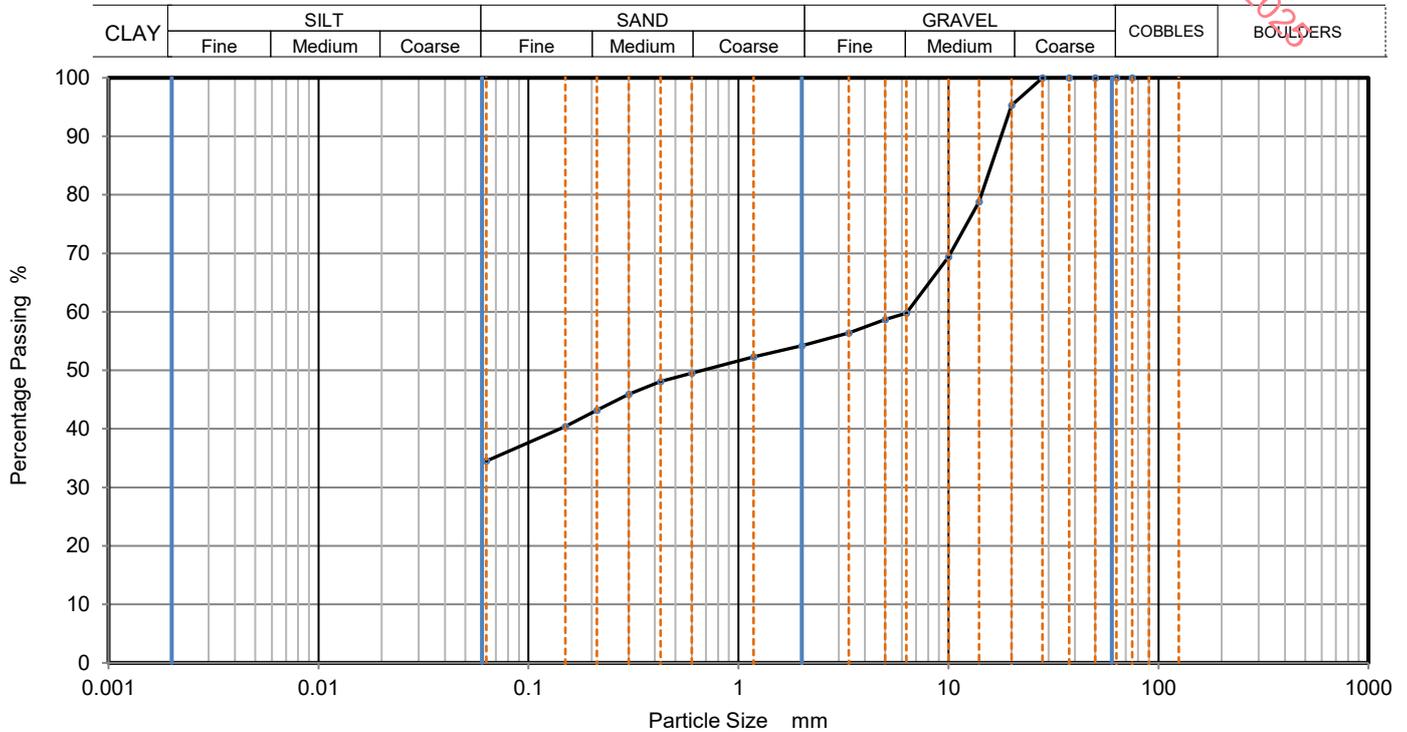


## PARTICLE SIZE DISTRIBUTION

Job Ref	<b>21G121</b>
Borehole/Pit No.	TP 4
Sample No.	
Depth, m	0.20
Sample Type	B
KeyLAB ID	IDL120210622109

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly sandy gravelly SILT. Gravel is medium.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

RECEIVED: 27/08/2021



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	79		
10	69		
6.3	60		
5	59		
3.35	56		
2	54		
1.18	52		
0.6	50		
0.425	48		
0.3	46		
0.212	43		
0.15	40		
0.063	35		

Dry Mass of sample, g 206

Sample Proportions	% dry mass
Very coarse	0
Gravel	46
Sand	20
Fines <0.063mm	35

Grading Analysis	
D100	mm
D60	mm
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
		Dympna Darcy B.Sc.	12/08/2021 12:30	
				QC From No:R2

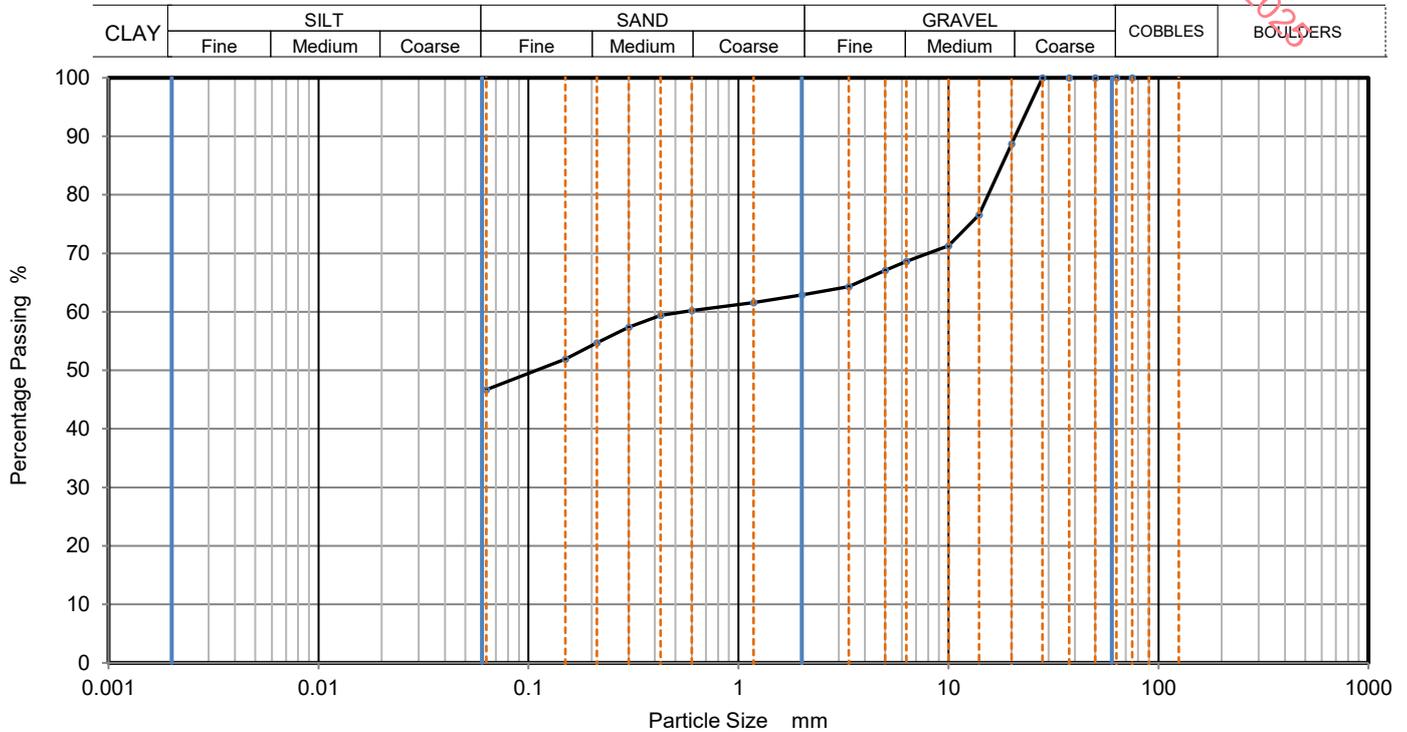


## PARTICLE SIZE DISTRIBUTION

Job Ref	<b>21G121</b>
Borehole/Pit No.	TP 5
Sample No.	
Depth, m	0.40
Sample Type	B
KeyLAB ID	IDL120210622111

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly sandy gravelly SILT. Gravel is medium.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

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Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	89		
14	77		
10	71		
6.3	69		
5	67		
3.35	64		
2	63		
1.18	62		
0.6	60		
0.425	59		
0.3	57		
0.212	55		
0.15	52		
0.063	47		

Dry Mass of sample, g 245

Sample Proportions	% dry mass
Very coarse	0
Gravel	37
Sand	16
Fines <0.063mm	47

Grading Analysis	
D100	mm
D60	mm 0.548
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

Remarks  
Preparation and testing in accordance with BS1377 unless noted below

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		Dympna Darcy B.Sc.	12/08/2021 12:30	
				QC From No:R2

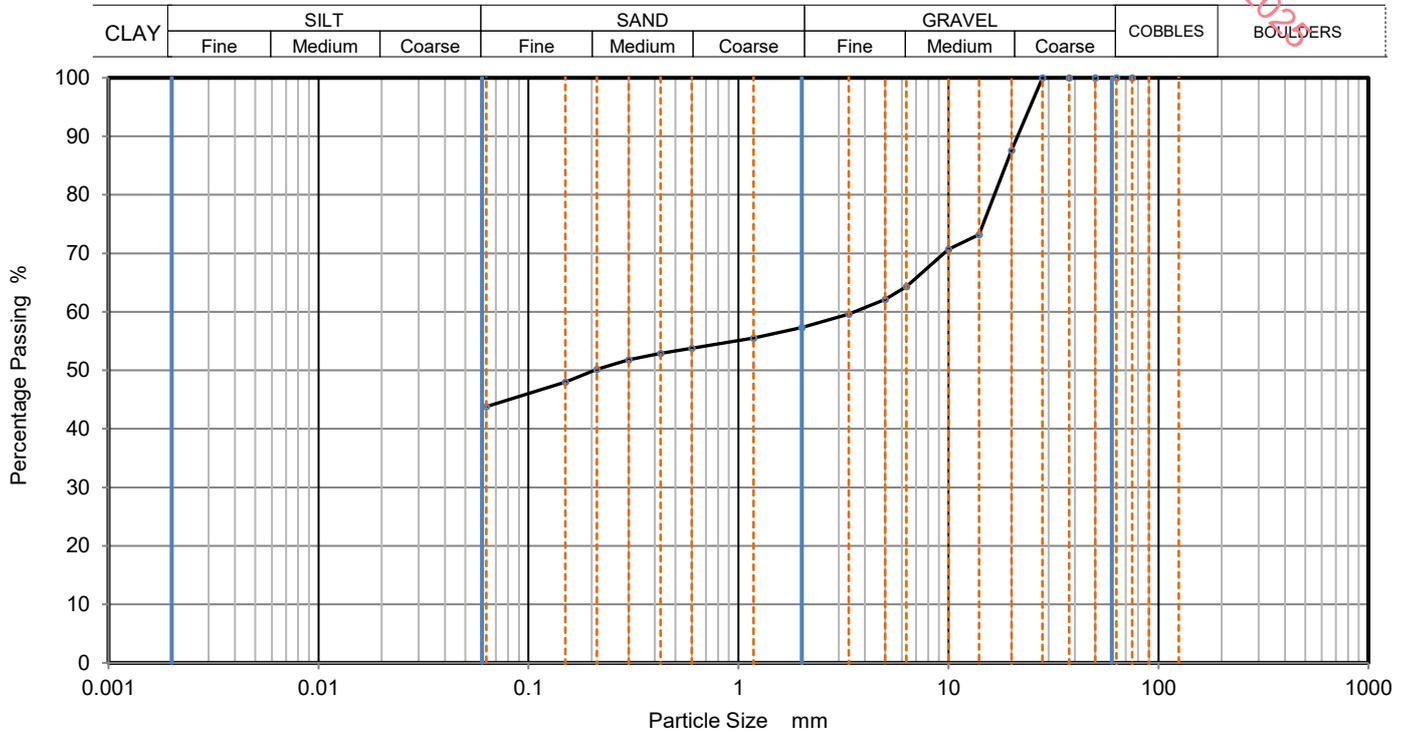


## PARTICLE SIZE DISTRIBUTION

Job Ref	<b>21G121</b>
Borehole/Pit No.	TP 6
Sample No.	
Depth, m	0.40
Sample Type	B
KeyLAB ID	IDL120210622112

Site Name	Ardgaineen, Claregalway	
Soil Description	Brown slightly sandy gravelly SILT. Gravel is medium.	
Specimen Reference	Specimen Depth	m
Test Method	BS1377:Part 2:1990, clause 9.2	

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Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	88		
14	73		
10	71		
6.3	64		
5	62		
3.35	60		
2	57		
1.18	56		
0.6	54		
0.425	53		
0.3	52		
0.212	50		
0.15	48		
0.063	44		

Dry Mass of sample, g 227

Sample Proportions	% dry mass
Very coarse	0
Gravel	43
Sand	14
Fines <0.063mm	44

Grading Analysis	
D100	mm
D60	mm 3.58
D30	mm
D10	mm
Uniformity Coefficient	
Curvature Coefficient	

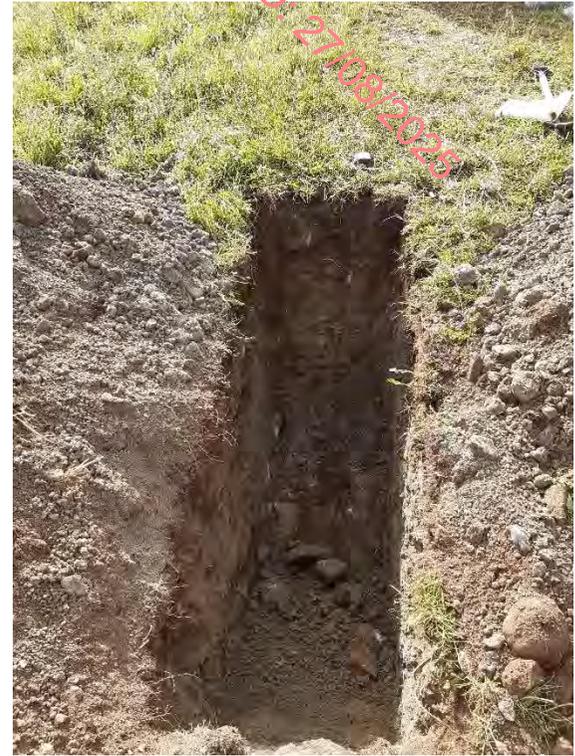
Remarks  
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	<b>1</b>
		Dympna Darcy B.Sc.	12/08/2021 12:30	
				QC From No:R2

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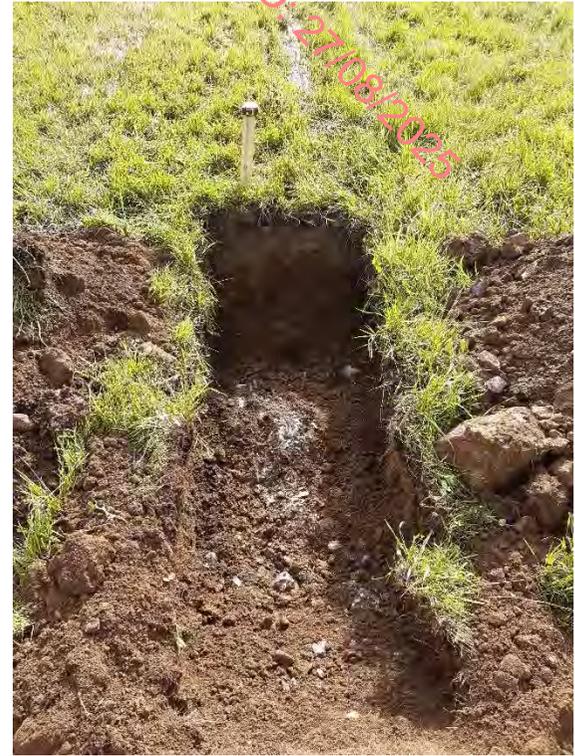
**APPENDIX 4**

**PHOTOGRAPHS**



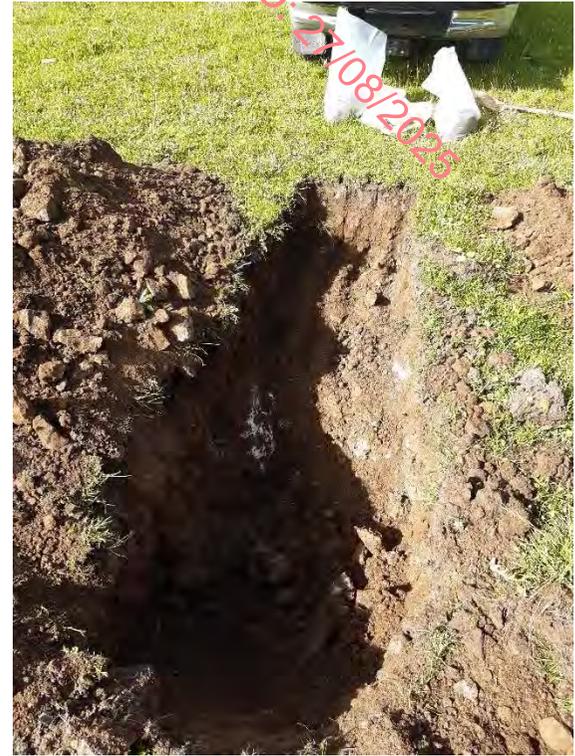
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Trial Pit 1, Ardgainen – June 2021. Irish Drilling Ltd.



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Trial Pit 2, Ardgainen – June 2021. Irish Drilling Ltd.



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Trial Pit 3, Ardgainen – June 2021. Irish Drilling Ltd.



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Trial Pit 4, Ardgaineen – June 2021. Irish Drilling Ltd.



Trial Pit 5, Ardgaheen – June 2021. Irish Drilling Ltd.

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Trial Pit 6, Ardgainen – June 2021. Irish Drilling Ltd.



PT1



PT2



PT3

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Infiltration Tests – Ardgaheen Claregalway – June 2021. Irish Drilling Ltd.

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## Hydraulic Response Test Results

Hydraulic Conductivity

Falling Head Tests

February 2018

### Summary Results

	K sat (m/s)	K sat (m/d)	K sat (m/d)
<b>BH1</b>	4E-07	0.03	3.E-02
<b>BH2</b>	8E-10	0.00007	7.E-05
<b>BH3</b>	4E-08	0.004	4.E-03
<b>BH4</b>	5E-09	0.0004	4.E-04
<b>BH5</b>	2E-09	0.0002	2.E-04
<b>BH8</b>	3E-08	0.0025	3.E-03
<b>BH9</b>	8E-10	0.0001	1.E-04
<b>BH10</b>	1E-08	0.0008	8.E-04
<b>BH11</b>	2E-07	0.02	2.E-02
<b>Average</b>	7E-08	6E-03	6E-03
<b>Min</b>	8E-10	7E-05	7E-05
<b>Max</b>	4E-07 m/s	3E-02 m/d	3E-02 m/d

BH 1 Harrington's Argaineen, Co. Galway – Limestone Bedrock

BH1 = in the floor. Drilled December 2017. Solid clean Limestone all the way, no clay, no discernible karst features, no caves, no fissures.

BH1 GL = 11m OD Floor Level, 21.6m deep BH = 9.6m OD base level of BH. Static WL = 2.05m bgl.

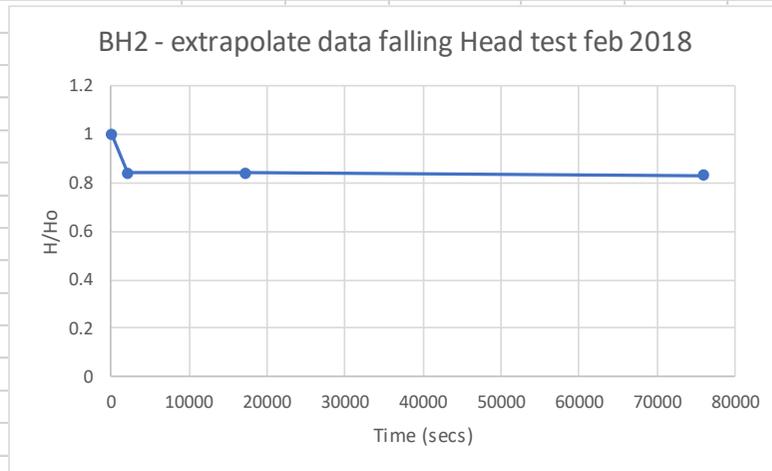
RECEIVED: 27/08/2025

Harringtons Argaineen, Co. Galway		BH1 (WL m bgl)	Head Ho (m)	H (m)	H/Ho	Time (mins)	Time (secs)																
19/02/2018	12:00	2.05																					
19/02/2018	12:05																						
19/02/2018	12:10							H/Ho	Time (secs)	To													
19/02/2018	12:15	0.00	2.05	2.05	1.00	0		1	0														
19/02/2018	12:20					5		0.7916667	300														
<div style="display: flex; justify-content: space-between;"> <div style="width: 60%;"> <p style="text-align: center;"><b>Falling Head Test February 2018</b></p> <p style="text-align: center;"><b>Harringtons Ardgaineen</b></p> <p style="text-align: right;"><b>BH 1</b></p> </div> <div style="width: 35%;"> <p><b>Cedergren, 1967</b></p> <p><b><math>k = r^2 \ln(L/r) / (2 * L * T)</math></b></p> <p>D (mm) 100</p> <p>r (m) 0.05</p> <p>L (m) 19</p> <p>L/r 380 must be &gt;8 = ok</p> <p>To (sec) 1100</p> <p>Ksat (m/s) 3.5527E-07 BH 1 limestone bedrock</p> <p><math>k = ((r^2) * \ln(L/r)) / (2 * L * T_o)</math></p> <p>RESULT BH1 3.5 * 10^-7 m/s K sat</p> <p>RESULT BH1 0.03 m/d K sat</p> </div> </div>																							
																				0.6333333	600		
																				0.475	900	1100	
																				0.3166667	1200		
																				0.1583333	1500		
																				0.05	1800		

BH2

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Harringtons Argaineen, Co. Galway		Date & Time	H/Ho	BH2	Head Ho (m)	H (m)	H/Ho	Time (mins)	Time (secs)								
19/02/2018	12:00	19/02/2018 12:00		14.00													
19/02/2018	12:05	19/02/2018 12:05															
19/02/2018	12:10	19/02/2018 12:10															
19/02/2018	12:15	19/02/2018 12:15	0				1.00	0	0								
19/02/2018	12:20	19/02/2018 12:20		0.00	14.00	14		5	300								
19/02/2018	12:25							10	600								
19/02/2018	12:30							15	900								
19/02/2018	12:35							20	1200								
19/02/2018	12:40							25	1500								
19/02/2018	12:45							30	1800								
19/02/2018	12:50							35	2100								
19/02/2018	12:55							40	2400								
19/02/2018	13:00							45	2700								
19/02/2018	13:05							50	3000								
19/02/2018	13:10							55	3300								
19/02/2018	13:15							60	3600								
19/02/2018	13:20							65	3900								
19/02/2018	13:25							70	4200								
19/02/2018	13:30							75	4500								
19/02/2018	13:35							80	4800								
19/02/2018	13:40	19/02/2018 13:40						85	5100								
19/02/2018	13:45	19/02/2018 13:45						90	5400								
19/02/2018	13:50	19/02/2018 13:50						95	5700								
19/02/2018	13:55	19/02/2018 13:55						100	6000								



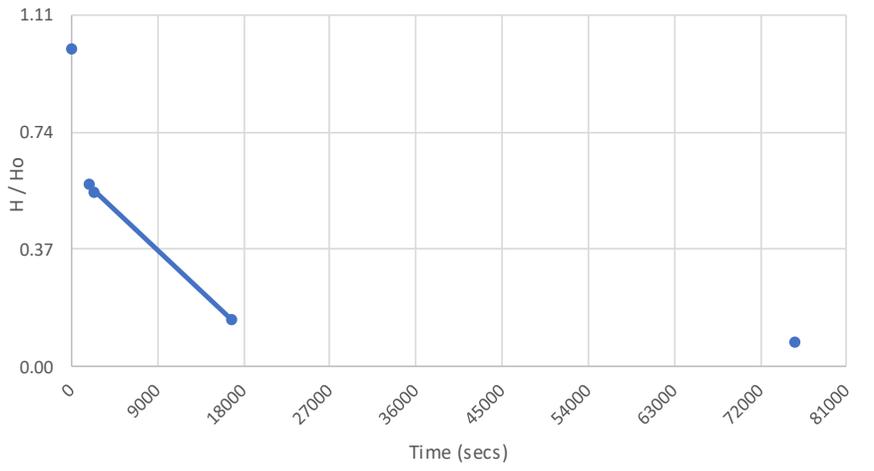
**Cedergren, 1967**  
 $k = r^2 \ln(L/r) / (2 * L * T)$   
 D (mm) 100  
 r (m) 0.05  
 L (m) 19  
 L/r 380 must be >8 = ok  
 To (sec) 500000 > (extrapolated)  
 Ksat (m/s) 7.816E-10 BH2 limestone bedrock  
 $k = ((r^2) * \ln(L/r)) / (2 * L * To)$   
 RESULT BH2 > 8\*10^-10 m/s K sat  
 RESULT BH2 0.00007 m/d K sat

BH3

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Harringtons Argaineen, Co. Galway		Date & Time					BH3 WL (m bgl)	Ho (m)	H/Ho	T (mins)	T (secs)
19/02/2018	12:00	19/02/2018 12:00					2.00				
19/02/2018	12:05	19/02/2018 12:05									
19/02/2018	12:10	19/02/2018 12:10									
19/02/2018	12:15	19/02/2018 12:15									
19/02/2018	12:20	19/02/2018 12:20									Time (Sec)
19/02/2018	12:25	19/02/2018 12:25					0.00	2.00	1.00	0	0
19/02/2018	12:30	19/02/2018 12:30								5	300
19/02/2018	12:35	19/02/2018 12:35								10	600
19/02/2018	12:40	19/02/2018 12:40								15	900
19/02/2018	12:45	19/02/2018 12:45								20	1200
19/02/2018	12:50	19/02/2018 12:50								25	1500
19/02/2018	12:55	19/02/2018 12:55					0.85	0.575		30	1800
19/02/2018	13:00	19/02/2018 13:00								35	2100
19/02/2018	13:05	19/02/2018 13:05					0.9	0.55		40	2400
19/02/2018	13:10	19/02/2018 13:10								45	2700
19/02/2018	13:15	19/02/2018 13:15								50	3000
19/02/2018	13:20	19/02/2018 13:20								55	3300
19/02/2018	13:25	19/02/2018 13:25								60	3600
19/02/2018	13:30	19/02/2018 13:30								65	3900
19/02/2018	13:35	19/02/2018 13:35								70	4200
19/02/2018	13:40	19/02/2018 13:40								75	4500
19/02/2018	13:45	19/02/2018 13:45								80	4800
19/02/2018	13:50	19/02/2018 13:50								85	5100
19/02/2018	13:55	19/02/2018 13:55								90	5400
19/02/2018	14:00	19/02/2018 14:00								95	5700
19/02/2018	14:05	19/02/2018 14:05								100	6000
19/02/2018	14:10	19/02/2018 14:10								105	6300
19/02/2018	14:15	19/02/2018 14:15								110	6600
19/02/2018	14:20	19/02/2018 14:20								115	6900
19/02/2018	14:25	19/02/2018 14:25								120	7200
19/02/2018	14:30	19/02/2018 14:30								125	7500
19/02/2018	14:35	19/02/2018 14:35								130	7800
19/02/2018	14:40	19/02/2018 14:40								135	8100

BH 3 Harringtons Argaineen K Tests Limestone Bedrock  
February 2018

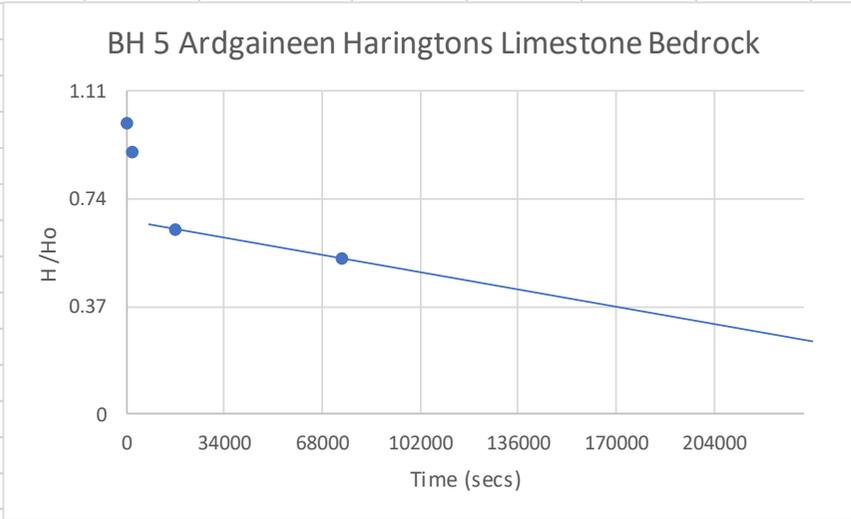




BH5

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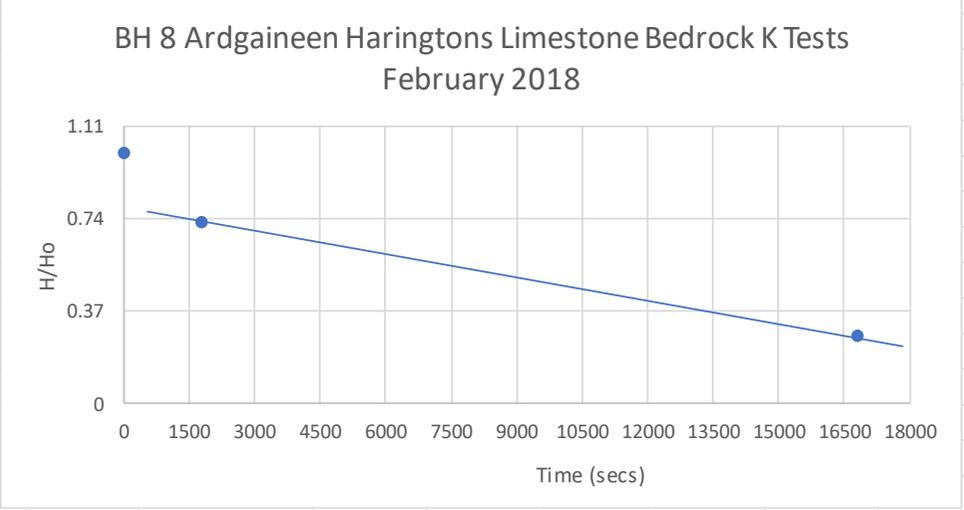
Harringtons Argaineen, Co. Galway						BH5 WL (m bgl)				
19/02/2018	12:00					3.55				
19/02/2018	12:05	<b>Cedergren, 1967</b>								
19/02/2018	12:10	<b><math>k = r^2 \ln(L/r) / (2 * L * T)</math></b>								
19/02/2018	12:15	D (mm)	100							
19/02/2018	12:20	r (m)	0.05							
19/02/2018	12:25	L (m)	19				Ho (m)	H/Ho	T (mins)	Time (Secs)
19/02/2018	12:30	L/r	380	must be >8 = ok		0.00	3.55	1	0	0
19/02/2018	12:35	To (sec)	170000						5	300
19/02/2018	12:40	Ksat (m/s)	2.29883E-09	BH5	limestone bedrock				10	600
19/02/2018	12:45	$k = ((r^2) * \ln(L/r)) / (2 * L * T_o)$							15	900
19/02/2018	12:50								20	1200
19/02/2018	12:55		<b>RESULT BH5</b>	<b><math>2 \times 10^{-9}</math></b>	<b>m/s K sat</b>				25	1500
19/02/2018	13:00		<b>RESULT BH5</b>	<b>0.0002</b>	<b>m/d K sat</b>	0.35		0.90	30	1800
19/02/2018	13:05								35	2100
19/02/2018	13:10								40	2400
19/02/2018	13:15								45	2700
19/02/2018	13:20								50	3000
19/02/2018	13:25								55	3300
19/02/2018	13:30								60	3600
19/02/2018	13:35								65	3900
19/02/2018	13:40								70	4200
19/02/2018	13:45								75	4500
19/02/2018	13:50								80	4800
19/02/2018	13:55								85	5100
19/02/2018	14:00								90	5400
19/02/2018	14:05								95	5700
19/02/2018	14:10								100	6000
19/02/2018	14:15								105	6300
19/02/2018	14:20								110	6600



BH 8

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Harringtons Argaineen,				BH8					
19/02/2018	12:00				1.1				
19/02/2018	12:05	<b>Cedergren, 1967</b>			Ho (m)	H/Ho	T (mins)	Time (Secs)	
19/02/2018	12:10	<b><math>k = r^2 \ln(L/r) / (2 * L * T)</math></b>			0.00	1.1	0	0	
19/02/2018	12:15	D (mm)	100				5	300	
19/02/2018	12:20	r (m)	0.05				10	600	
19/02/2018	12:25	L (m)	19				15	900	
19/02/2018	12:30	L/r	380	must be >8 = ok			20	1200	
19/02/2018	12:35	To (sec)	13500				25	1500	
19/02/2018	12:40	Ksat (m/s)	2.89482E-08	BH8 limestone bedrock	0.3	0.727273	30	1800	
19/02/2018	12:45		$k = ((r^2) * \ln(L/r)) / (2 * L * To)$				35	2100	
19/02/2018	12:50						40	2400	
19/02/2018	12:55	<b>RESULT BH8</b>	<b>3 x 10<sup>-8</sup> m/s K sat</b>				45	2700	
19/02/2018	13:00	<b>RESULT BH8</b>	<b>0.0025 m/d K sat</b>				50	3000	
19/02/2018	13:05						55	3300	
19/02/2018	13:10						60	3600	
19/02/2018	13:15						65	3900	
19/02/2018	13:20						70	4200	
19/02/2018	13:25						75	4500	
19/02/2018	13:30						80	4800	
19/02/2018	13:35						85	5100	
19/02/2018	13:40						90	5400	
19/02/2018	13:45						95	5700	
19/02/2018	13:50						100	6000	
19/02/2018	13:55						105	6300	
19/02/2018	14:00						110	6600	
19/02/2018	14:05						115	6900	
19/02/2018	14:10						120	7200	
19/02/2018	14:15						125	7500	
19/02/2018	14:20						130	7800	
19/02/2018	14:25						135	8100	





BH 10

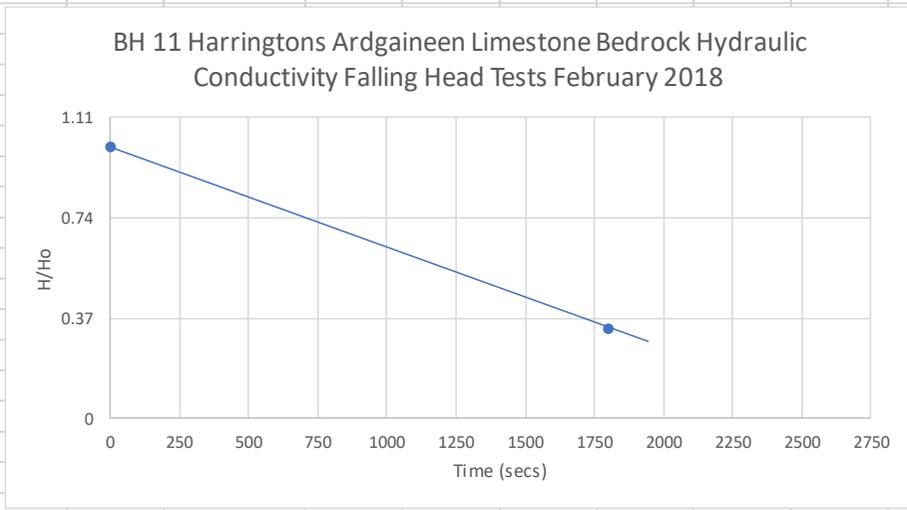
RECEIVED: 27/08/2025

Harringtons Argaineen, Co. Galway		BH10									
Date	Time					Ho (m)	H/Ho	T (mins)	Time (Secs)	H/Ho	
19/02/2018	12:00					1.45					
19/02/2018	12:05	<b>Cedergren, 1967</b>				0.00	1.45	1	0	0	1
19/02/2018	12:10	<b><math>k = r^2 \cdot \ln(L/r) / (2 \cdot L \cdot T)</math></b>							5	300	
19/02/2018	12:15	D (mm)	100						10	600	
19/02/2018	12:20	r (m)	0.05						15	900	
19/02/2018	12:25	L (m)	19						20	1200	
19/02/2018	12:30	L/r	380	must be >8 = ok					25	1500	
19/02/2018	12:35	To (sec)	40000						30	1800	
19/02/2018	12:40	Ksat (m/s)	1E-08	BH 10 limestone bedrock	0.00	1.45	1	35	2100	1	
19/02/2018	12:45	$k = ((r^2) \cdot \ln(L/r)) / (2 \cdot L \cdot T_o)$							40	2400	
19/02/2018	12:50								45	2700	
19/02/2018	12:55	<b>RESULT BH 10</b>	<b>1 x 10<sup>-8</sup></b>	<b>m/s K sat</b>					50	3000	
19/02/2018	13:00	<b>RESULT BH 10</b>	<b>0.0008</b>	<b>m/d K sat</b>					55	3300	
19/02/2018	13:05	<p style="text-align: center;">BH 10 Harringtons Ardgaineen Bedrock Limestone Hydraulic Conductivity Falling Head Test February 2018</p>								60	3600
19/02/2018	13:10									65	3900
19/02/2018	13:15									70	4200
19/02/2018	13:20									75	4500
19/02/2018	13:25									80	4800
19/02/2018	13:30									85	5100
19/02/2018	13:35									90	5400
19/02/2018	13:40									95	5700
19/02/2018	13:45									100	6000
19/02/2018	13:50									105	6300
19/02/2018	13:55									110	6600
19/02/2018	14:00									115	6900
19/02/2018	14:05									120	7200
19/02/2018	14:10									125	7500
19/02/2018	14:15									130	7800
19/02/2018	14:20	135	8100								
19/02/2018	14:25	140	8400								
19/02/2018	14:30	145	8700								
19/02/2018	14:35	150	9000								

BH 11

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Harringtons Argaineen, Co. Galway				BH11 WL (m bgl)						
Date	Time			0.9 Ho (m)	H/Ho	T (mins)	Time (Secs)	H/Ho		
19/02/2018	12:00			0.00	0.9	1	0	0	1	
19/02/2018	12:05	<b>Cedergren, 1967</b>								
19/02/2018	12:10	<b><math>k = r^2 \ln(L/r) / (2 * L * T)</math></b>					5	300		
19/02/2018	12:15	D (mm)	100				10	600		
19/02/2018	12:20	r (m)	0.05				15	900		
19/02/2018	12:25	L (m)	19				20	1200		
19/02/2018	12:30	L/r	380	must be >8 = ok			25	1500		
19/02/2018	12:35	To (sec)	1750	0.6	0.333333		30	1800	0.33	
19/02/2018	12:40	Ksat (m/s)	2.23315E-07	BH 11	limestone bedrock		35	2100		
19/02/2018	12:45	$k = ((r^2) * \ln(L/r)) / (2 * L * T_o)$					40	2400		
19/02/2018	12:50						45	2700		
19/02/2018	12:55			<b>RESULT BH 11</b>	<b>2 x 10<sup>-7</sup> m/s K sat</b>		50	3000		
19/02/2018	13:00			<b>RESULT BH 11</b>	<b>0.02 m/d K sat</b>		55	3300		
19/02/2018	13:05						60	3600		
19/02/2018	13:10						65	3900		
19/02/2018	13:15						70	4200		
19/02/2018	13:20						75	4500		
19/02/2018	13:25						80	4800		
19/02/2018	13:30						85	5100		
19/02/2018	13:35						90	5400		
19/02/2018	13:40						95	5700		
19/02/2018	13:45						100	6000		
19/02/2018	13:50						105	6300		
19/02/2018	13:55						110	6600		
19/02/2018	14:00						115	6900		
19/02/2018	14:05						120	7200		
19/02/2018	14:10						125	7500		
19/02/2018	14:15						130	7800		
19/02/2018	14:20						135	8100		
19/02/2018	14:25						140	8400		
19/02/2018	14:30						145	8700		



## RISING HEAD FIELD CONDUCTED RESPONSE TESTS

PROJECT: Harringtons Greenfield  
 LOCATION: Ardgaineen, Co. Galway  
 DATE: 11/03/2021  
 Tester: Pamela Bartley



Ksat calculation METHOD: Hvorslev as presented in Freeze & Cherry (1979); at Head ratio 0.37  
 For  $L_e/R > 8$ :

MW 02 Harringtons

BH3 = 45m deep,

**Saturated Test, WL @ start = 13m bgl, Add water to rise to 21m, record times**

Borehole Depth:		[m]	45			
Screen Depth:		[m bgl]	6			
Borehole Radius:	R	[m]	0.1			
Piezo's Radius:	r	[m]	0.05			
Gravel pack length:	$L_e$	[m]	6	$L_e/R$	60	OK
HYDRAULIC RESPONSE TEST RESULTS						
Static Level:	$h_0$	[m bgl]	13	$t_{37}$	[sec]	300
Purged Water Level:		[m bgl]	22	$K_{sat}$	[m/sec]	2.84E-06
Change in water level:		[m]	13			
Time for Full Recovery		mins	16			
Time for test% recovery ( $H/H_0 = 0.37$ )		mins	5			

RECEIVED: 27/08/2025