
S.I. Ltd Contract No: 5831

Client: Cairn Homes PLC
Engineer: Waterman Moylan
Contractor: Site Investigations Ltd

Brennanstown Road Additional Investigation,
Cabinteely, Dublin 18
Site Investigation Report

Prepared by:

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Stephen Letch

Issue Date:	12/05/2021
Status	Final
Revision	1

Contents:

	Page No.
1. Introduction	1
2. Site Location	1
3. Fieldwork	1
4. Recommendations and Conclusions	3

Appendices:

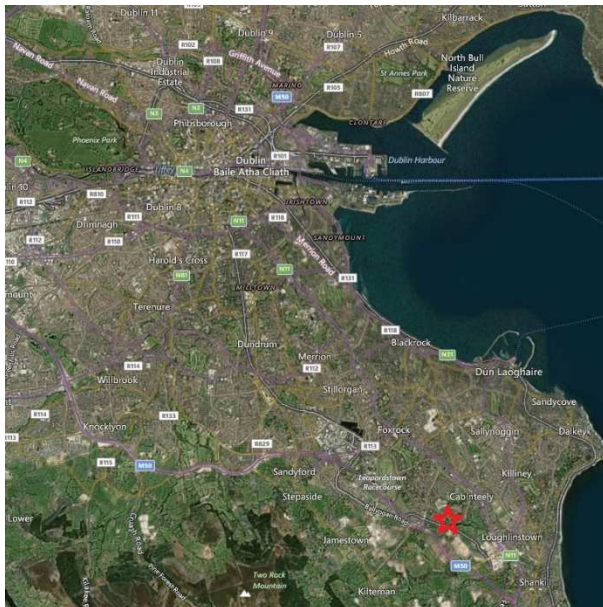
1. Rotary Corehole Logs and Photographs
 2. Minorex Geophysics Ltd Report
 3. Trial Excavation Log and Photographs
 4. Survey Data
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1. Introduction

In 2020, on the instructions of Waterman Moylan, Site Investigations Ltd (SIL) was appointed to complete a ground investigation at Brennanstown Road, Cabinteely, Dublin 18. The investigation was for a residential development on the site and was completed on behalf of the Client, Cairn Homes PLC. The site is spread either side of the Brennanstown Road with housing to the North of the road and apartment blocks planned to the South. Following this investigation, SIL were requested to complete some additional investigation on the South site and this report covers the additional work.

2. Site Location

The site is located in Cabinteely in the South East of Dublin. The M50 motorway is to the South of the site as well as the Luas Green line. The first map below shows the location of the site in Dublin and the second map shows the entire site, with the South site shown in green.



3. Fieldwork

The additional fieldworks comprised a programme of rotary coreholes, geophysics and a trial excavation. All fieldwork was carried out in accordance with BS 5930:2015, Engineers Ireland GI Specification and Related Document 2nd Edition 2016 and Eurocode 7: Geotechnical Design. The fieldworks comprised of the following:

- 5 No. rotary coreholes
- Geophysics
- 1 No. trial excavation

3.1. Rotary Coreholes

At 5 No. locations, rotary coreholes were completed to investigate the depth and type of bedrock. The rotary drilling was carried out using a Sondeq SS71 top drive rig. Open hole drilling techniques were used to advance through the overburden where encountered and bedrock was recovered from the coreholes from 3.00mbgl to 4.80mbgl. The bedrock was then cored and the corehole terminated when 3m of core was recovered.

Once the coreholes were completed, the rock cores were returned to SIL, where they were logged and photographed by a SIL geotechnical engineer. Provided on the logs are engineering geological descriptions of the rock cores with details of the bedding/discontinuities and mechanical indices for each core run, i.e., TCR, SCR, RQD and Fracture Index.

The rotary corehole logs and photographs are presented in Appendix 1.

3.2. Geophysics

Geophysics was undertaken by Minerex Geophysics Ltd as part of this additional investigation and this consisted of Seismic Refraction profiling. The objectives of the investigation were to determine the overburden thickness and bedrock quality.

The works were completed across eight designated profiles, 1-8. The seismic refraction datasets totalled 802m with the methods of investigation discussed as part of the geophysical report provided by Minerex Geophysics Ltd. This report is presented in Appendix 2.

3.3. Trial Excavation

Following the geophysical profiling and analysis of the rotary coreholes, a rock excavation trial was complete. A 16-tonne tracked excavator with a rock breaker using a 120mm diameter working tool was used to complete the works. Initially the excavator exposed the top of the weathered bedrock and then the time taken to excavate the weathered bedrock was recorded. Once the top of the solid bedrock was exposed, the rock breaker was used to break out an area of bedrock and then the broken rock was excavated. The time taken to break out the rock and then excavate it was recorded along with the volume of material. Four cycles were completed and then the excavation was backfilled.

The log and photographs are presented in Appendix 3.

3.4. Surveying

Following completion of the fieldworks, a survey of the exploratory hole locations was completed using a GeoMax GPS Rover. The data is supplied on each individual log and along with a site plan in Appendix 4.

4. Recommendations and Conclusions

Please note the following caveats:

The recommendations given, and opinions expressed in this report are based on the findings as detailed in the exploratory hole records. Where an opinion is expressed on the material between the exploratory hole locations or below the final level of excavation, this is for guidance only and no liability can be accepted for its accuracy. No responsibility can be accepted for adjacent unexpected conditions that have not been revealed by the exploratory holes. It is further recommended that all bearing surfaces when excavated should be inspected by a suitably qualified Engineer to verify the information given in this report.

Excavated surfaces in clay strata should be kept dry to avoid softening prior to foundation placement. Foundations should always be taken to a minimum depth of 0.50mBGL to avoid the effects of frost action and possible seasonal shrinkage/swelling.

If it is intended that on-site materials are to be used as fill, then the necessary laboratory testing should be specified by the Client to confirm the suitability. Also, relevant lab testing should be specified where stability of side slopes to excavations is a concern, or where contamination may be an issue.

4.1. Rock Excavation

The geophysics report provides a good analysis of the rock profile across the area where the basement for the multi-story structures will be built. The geophysics report also states in the conclusions that the rock will require breaking or blasting. The rock excavation trial shows that the initial 0.80m of the solid bedrock was broken at a rate of 8.80m³/hr but this rate reduces very quickly to around 1.00m³/hr. Therefore, analysis needs to be completed on the volume of rock that needs to be removed as to whether breaking with very large excavators or blasting will be required.

Appendix 1
Rotary Corehole Logs and Photographs

Contract No: 5831	<h1>Rotary Corehole Log</h1>				Corehole No: BH26S
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Contract:	Brennanstown Road	Easting:	722526.698	Date Started:	09/04/2021
Location:	Cabinteely, Dublin 18	Northing:	724254.096	Date Completed:	09/04/2021
Client:	Cairn Homes PLC	Elevation:	74.95	Drilled By:	MEDL
Engineer:	Waterman Moylan	Rig Type:	Sondeq	Status:	FINAL

Depth (m)		Stratum Description	Legend	Level (mOD)		Samples	Rock Indices				Backfill
Scale	Depth			Scale	Depth		TCR/%	SCR/%	RQD/%	FI/m	
		Open hole drilling - driller reports returns of sand and gravel - possible highly weathered granite.									
0.5											
1.0											
1.5											
2.0											
2.5											
3.0											
3.5											
4.0											
4.5	4.50	Very strong light grey coarse grained GRANITE. Fresh to slightly weathered. <i>Discontinuities - rough, planar, tight to open, sub-horizontal dip, clean surfaces.</i>	+								
5.0			+								
5.5		<i>Discontinuities - rough, planar to slightly undulating, tight to open, sub-horizontal to sub-vertical dip, clean with occasional brown staining.</i>	+								
6.0			+								
6.20	6.20	Very strong to extremely strong light grey coarse grained GRANITE with occasional inclusions of pegmatite. Fresh to slightly weathered. <i>Discontinuities - smooth to rough, planar to slightly undulating, tight to open, 30° to 50° dip, clean surfaces.</i>	+								
6.5			+								
7.0			+								
7.5	7.50	End of Corehole at 7.50m	+								
8.0											
8.5											
9.0											
9.5											

	Installation:			Backfill:			Remarks:
	From:	To:	Pipe Type:	From:	To:	Type:	-
			0.00	7.50	Bentonite		

Contract No: 5831	<h1>Rotary Corehole Log</h1>				Corehole No: BH27S
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Contract:	Brennanstown Road	Easting:	722615.186	Date Started:	08/04/2021
Location:	Cabinteely, Dublin 18	Northing:	724256.932	Date Completed:	08/04/2021
Client:	Cairn Homes PLC	Elevation:	74.56	Drilled By:	MEDL
Engineer:	Waterman Moylan	Rig Type:	Sondeq	Status:	FINAL

Depth (m)		Stratum Description	Legend	Level (mOD)		Samples	Rock Indices				Backfill
Scale	Depth			Scale	Depth		TCR/%	SCR/%	RQD/%	FI/m	
		Open hole drilling - driller reports returns of sand and gravel - possible highly weathered granite.		74.5							
0.5				74.0							
1.0				73.5							
1.5				73.0							
2.0				72.5							
2.5				72.0							
3.0	3.00	Strong to very strong light grey coarse grained GRANITE. Fresh to slightly weathered. <i>Discontinuities - rough, planar, tight to open, 45° to 60°, occasionally sub-horizontal and sub-vertical dip, surfaces stained brown.</i>	+	71.5	71.56	N=29 (6,7,7,7,8,7)					
3.5			+	71.0		3.00 - 4.00	95	70	35		10
4.0			+	70.5							
4.5		<i>Discontinuities - rough, planar to slightly undulating and stepped, tight to open, 60° to 70°, occasionally sub-horizontal and sub-vertical dip, surfaces stained brown.</i>	+	70.0		4.00 - 5.00	94	82	45		
5.0			+	69.5							
5.5			+	69.0		5.00 - 6.00	95	76	55		9
6.0	6.00	End of Corehole at 6.00m		68.5	68.56						
6.5				68.0							
7.0				67.5							
7.5				67.0							
8.0				66.5							
8.5				66.0							
9.0				65.5							
9.5				65.0							

	Installation:			Backfill:			Remarks:
	From:	To:	Pipe Type:	From:	To:	Type:	-
			0.00	6.00	Bentonite		

Contract No: 5831	Rotary Corehole Log				Corehole No: BH28S
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Contract:	Brennanstown Road	Easting:	722636.161	Date Started:	08/04/2021
Location:	Cabinteely, Dublin 18	Northing:	724228.544	Date Completed:	08/04/2021
Client:	Cairn Homes PLC	Elevation:	72.43	Drilled By:	MEDL
Engineer:	Waterman Moylan	Rig Type:	Sondeq	Status:	FINAL

Depth (m)		Stratum Description	Legend	Level (mOD)		Samples	Rock Indices				Backfill
Scale	Depth			Scale	Depth		TCR/%	SCR/%	RQD/%	FI/m	
0.5		Open hole drilling - driller reports returns of sand and gravel - possible highly weathered granite.		72.0		N=20 (4,4/5,4,5,6)					
1.0				71.5							
1.5				71.0							
2.0				70.5							
2.5				70.0							
3.0				69.5							
3.5				69.0							
4.0				68.5							
4.5				68.0							
4.80							67.63				
5.0		Very strong to extremely strong light grey coarse grained GRANITE with occasional inclusions of pegmatite. Fresh to slightly weathered. <i>Discontinuities - rough, planar to undulating, tight to open, sub-horizontal to sub-vertical dip, clean with occasional brown staining.</i>		67.5		4.80 - 5.80	95	79	25	15	
5.5				67.0							
6.0		<i>Discontinuities - rough, occasionally smooth, planar, occasionally stepped, tight to open, 45° to 60°, occasionally sub-horizontal and sub-vertical dip, clean with occasional brown staining.</i>		66.5		5.80 - 6.80	94	82	53	7	
6.5				66.0							
7.0		<i>Discontinuities - smooth to rough, planar, tight to open, 60° to 75°, surfaces stained brown.</i>	65.5		6.80 - 7.80	94	94	94	3		
7.5			65.0								
7.80		End of Corehole at 7.80m		64.63							
8.0				64.5							
8.5				64.0							
9.0				63.5							
9.5				63.0							
				62.5							

	Installation:			Backfill:			Remarks:
	From:	To:	Pipe Type:	From:	To:	Type:	-
			0.00	7.80	Bentonite		

Contract No: 5831	<h1>Rotary Corehole Log</h1>				Corehole No: BH29S
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Contract:	Brennanstown Road	Easting:	722631.311	Date Started:	09/04/2021
Location:	Cabinteely, Dublin 18	Northing:	724143.491	Date Completed:	09/04/2021
Client:	Cairn Homes PLC	Elevation:	68.48	Drilled By:	MEDL
Engineer:	Waterman Moylan	Rig Type:	Sondeq	Status:	FINAL

Depth (m)		Stratum Description	Legend	Level (mOD)		Samples	Rock Indices				Backfill				
Scale	Depth			Scale	Depth		TCR/%	SCR/%	RQD/%	FI/m					
0.5		Open hole drilling - driller reports returns of sand and gravel - possible highly weathered granite.		68.0		N=22 (5,4/5,5,6,6)									
1.0				67.5											
1.5				67.0											
2.0				66.5											
2.5		Very strong to extremely strong light grey coarse grained GRANITE with occasional inclusions of pegmatite. Fresh to slightly weathered. <i>Discontinuities - smooth to rough, planar to slightly undulating, tight to open, sub-horizontal to sub-vertical dip, clean with occasional brown staining.</i>		66.0		4.20 - 5.20	96	96	76	7					
3.0				65.5								5.20 - 6.20	98	98	92
3.5				65.0											
4.0				64.5		6.20 - 7.20	96	92	80	5					
4.20				64.28											
4.5				64.0											
5.0		63.5													
5.5		63.0													
6.0		62.5													
6.5		62.0													
7.0		61.5		61.28											
7.20		End of Corehole at 7.20m		61.0											
7.5				60.5											
8.0				60.0											
8.5				59.5											
9.0				59.0											
9.5															

	Installation:			Backfill:			Remarks:
	From:	To:	Pipe Type:	From:	To:	Type:	-
			0.00	7.20	Bentonite		

Contract No: 5831	<h1>Rotary Corehole Log</h1>				Corehole No: BH30S
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Contract:	Brennanstown Road	Easting:	722528.385	Date Started:	12/04/2021
Location:	Cabinteely, Dublin 18	Northing:	724137.111	Date Completed:	12/04/2021
Client:	Cairn Homes PLC	Elevation:	66.73	Drilled By:	MEDL
Engineer:	Waterman Moylan	Rig Type:	Sondeq	Status:	FINAL

Depth (m)		Stratum Description	Legend	Level (mOD)		Samples	Rock Indices				Backfill
Scale	Depth			Scale	Depth		TCR/%	SCR/%	RQD/%	FI/m	
		Open hole drilling - driller reports returns of sand and gravel - possible highly weathered granite.									
0.5											
1.0											
1.5											
2.0											
2.5											
3.0											
3.5											
4.0											
4.5	4.50	Strong to very strong light grey coarse grained GRANITE. Fresh to slightly weathered. <i>Discontinuities - smooth to rough, planar, tight to open, sub-horizontal to 60° dip, clean with occasional brown staining.</i>	+++								
5.0			+++								
5.5			+++								
6.0			+++								
6.5		<i>Discontinuities - smooth to rough, planar, tight to open, 40° to 50° dip, clean with occasional brown staining.</i>	+++								
7.0			+++								
7.5	7.50	End of Corehole at 7.50m	+++								
8.0											
8.5											
9.0											
9.5											

	Installation:			Backfill:			Remarks:
	From:	To:	Pipe Type:	From:	To:	Type:	
				0.00	7.50	Bentonite	-

5831 – Brennanstown Road Additional Investigation
Rotary Core Photographs

BH26S Box 1 of 1



BH27S Box 1 of 1



5831 – Brennanstown Road Additional Investigation
Rotary Core Photographs

BH28S Box 1 of 1



BH29S Box 1 of 1



5831 – Brennanstown Road Additional Investigation
Rotary Core Photographs

BH30S Box 1 of 1



Appendix 2
Minerex Geophysics Ltd Report

Brennanstown Road
Cabinteely, Dublin 18

Geophysical Survey

Report Status: Draft

MGX Project Number: 6548

MGX File Ref: 6548d-005.doc

22nd April 2021

Confidential Report To:

Site Investigations Ltd.

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Subsurface Geophysical Investigations

EXECUTIVE SUMMARY

1. Minerex Geophysics Ltd. (MGX) carried out a geophysical survey consisting of eight seismic refraction (p-wave) profiles for the ground investigation for a proposed development at Brennanstown Road, Cabinteely, Dublin D18.
2. The main objectives of the survey were to determine ground conditions under the site, to determine the depth to the granite, the quality and excavatability of the granite and to make contour maps displaying the top of the granite across the survey area.
3. The ground model was developed with four layers. Layers 1 and 2 are overburden material, mainly with granular and non-cohesive material and can be excavated by digging.
4. Layers 3 and 4 are granite but with large differences in the properties. Layer 3 is interpreted as weathered granite that can be excavated by digging and marginal ripping. The quality of the granite is poor to fair.
5. Layer 4 is good granite that would have to be excavated by breaking or blasting. The depth to the top of the good granite varies between 2 to 8 m bgl.
6. Large residual granite boulders may occur within Layer 3 and they may have to be broken up.
7. The logs of rotary core holes were used in the interpretation, they are annotated in the figures and added data for the contour maps.
8. The top of the elevation of the weathered and good granite are shown on contour maps (Maps 2 and 3). These surfaces show a general dip from North to South with some modulations of the elevations.

CONTENTS

1. INTRODUCTION	1
1.1 Background.....	1
1.2 Objectives.....	1
1.3 Site Description.....	1
1.4 Geology.....	1
1.5 Report.....	2
2. GEOPHYSICAL SURVEY	3
2.1 Methodology.....	3
2.2 Seismic Refraction.....	3
2.3 Site Work.....	4
3. RESULTS AND INTERPRETATION	5
3.1 Seismic Refraction Models.....	5
3.2 Interpretation of Seismic Velocities.....	6
3.3 Elevation of Weathered and good Granite.....	7
4. CONCLUSIONS AND RECOMMENDATIONS.....	8
5. REFERENCES.....	9

List of Tables, Maps and Figures:

Title	Pages	Document Reference
Table 1: Geophysical Survey Locations and Acquisition Parameters	In text	In text
Table 2: Summary of Results and Interpretation	In text	In text
Map 1: Geophysical Survey Location Map	1 x A3	6548d_MapsFigs.dwg
Map 2: Contour Map of Interpreted Weathered Granite	1 x A3	6548d_MapsFigs.dwg
Map 3: Contour Map of Interpreted Good Granite	1 x A3	6548d_MapsFigs.dwg
Figure 1: Models of Geophysical Survey	1 x A3	6548d_MapsFigs.dwg
Figure 2: Interpretation of Geophysical Survey	1 x A3	6548d_MapsFigs.dwg

1. INTRODUCTION

1.1 Background

Minerex Geophysics Ltd. (MGX) carried out a seismic survey for the proposed development at Brennanstown Road. The survey consisted of seismic refraction (p-wave) measurements. The survey was commissioned by Site Investigations Ltd.

The project involves the construction of a large building and previous ground investigation has indicated granite bedrock with different rockhead elevations and various degrees of weathering. The geophysical survey was done to obtain more information about the depth to granite and the weathering.

The role of geophysics as a non-destructive fast method is to provide a geological interpretation over a wide area to complement direct ground investigations at specific locations. The direct ground investigation results can be used to improve the initial geophysical results and interpretation.

1.2 Objectives

The objectives for the survey are:

- To determine the ground conditions under the site
- To determine the depth to granite rock
- To interpret the amount of weathering of the granite
- To estimate the excavatability and rippability of the granite
- To create a contour map of the granite

1.3 Site Description

The site is located at Brennanstown Road (Map 1). The site elevations slope from around 75 mOD in the north to 66 mOD in the south. The proposed development is in the area where the seismic lines are drawn.

1.4 Geology

GSI describes the bedrock as a pale grey fine to coarse-grained granite of Caledonian orogeny- part of the Northern and Upper Liffey Valley Plutons. The granite consists of quartz, plagioclase, microcline, muscovite and biotite with grain size 1-5mm. The Quaternary sediment overlaying the bedrock is described as Till derived from Granites.

Rotary core holes have encountered the granite at various depth and the granite is weathered to various degrees. Rotary core logs near the seismic lines have been annotated on the sections.

1.5 Report

This report includes the results and interpretation of the geophysical survey. Maps, figures and tables are included to illustrate the results of the survey. More detailed descriptions of geophysical methods and measurements can be found in GSEG (2002), Milsom (1989) and Reynolds (1997).

The description of soil, rock and the use of geotechnical terms (soft, stiff, dense etc) follows Eurocode (2007) and BSI (2015) standards. The terms are defined in the standards and the physical parameters are related from experience. This geophysical survey has been acquired, processed, interpreted and reported in accordance with these guidelines.

The client provided maps of the site and the digital version was used as the background map in this report. Elevations were surveyed on site and are used in the vertical sections.

The interpretative nature and the non-invasive survey methods must be taken into account when considering the results of this survey and Minerex Geophysics Limited, while using appropriate practice to execute, interpret and present the data, give no guarantees in relation to the existing subsurface.

2. GEOPHYSICAL SURVEY

2.1 Methodology

The methodology consisted of using seismic refraction lines at a close spacing to map the depth to rock.

The survey locations are indicated on Map 1. The lines and parameters are tabulated in Table 1.

Table 1: Geophysical Survey Locations and Acquisition Parameters

Seismic profile	Geophone Spacing/m	Number of Geophones	Line Length/m
S1	2	61	120
S2	2	61	120
S3	2	61	120
S4	2	48	94
S5	2	45	88
S6	2	48	94
S7	2	61	120
S8	2	24	46
SUM			802

Lines S4-S6 ended at a large hedge so their profiles were cut short from 120m. A further horizontal line (S8) was taken beyond the hedge crossing the ends of the S4-S6 profiles to account for this.

2.2 Seismic Refraction

Seismic refraction lines were surveyed with geophone spacing of 2m and 24 geophones per set-up resulting in a 46m length per set-up. Adjacent set-ups were concatenated to achieve longer lines. The recording equipment consisted of a 24 Channel GEOMETRICS ES-3000 engineering seismograph with 4.5Hz vertical geophones. The seismic energy source consisted of a hammer and plate. A zero-delay trigger was used to start the recording. Normally 7 shot points per p-wave set-up were used.

Set-ups were acquired in longer continuous lines using common shot points between set-ups and concatenating into longer lines at the processing stage.

The seismic refraction survey method focuses on propagating p-waves travelling through the subsurface, which are generated by hitting a hammer on a plate. As the wave propagates through the subsurface, its velocity varies as it travels through overburden, rock with different elastic properties, and along geological

boundaries. Velocity data is recorded via the surveying equipment, which is then processed, allowing geological layer thicknesses and boundaries to be established.

Seismic Refraction generally determines the depth to horizontal or near horizontal layers where the compaction or strength or rock quality changes with an accuracy of 10 – 20% of depth to that layer. Where low velocity layers or shadow zones are present (e.g., below solid ground surface) or where layers dip with more than 20 degree angle the accuracy becomes much less.

The seismic refraction set-ups with 46m individual length have a reasonable penetration depth of around 10m. An internationally accepted maximum depth estimate for a seismic refraction set-up is 1/6 of the set-up length including offshots.

2.3 Site Work

The data acquisition was conducted on the 2nd of April 2021. The weather conditions were fair throughout the day, with health and safety standards adhered to at all times.

The locations and elevations were surveyed with a Trimble R6 RTK-GPS to accuracy < 0.05m.

3. RESULTS AND INTERPRETATION

The interpretation of geophysical data was executed utilizing the known response of geophysical measurements, typical physical parameters for subsurface features that may underlay the site, and the experience of the authors.

Seismic refraction was conducted and a layered ground model interpretation was based on seismic velocities while taking the rotary core hole information into account.

Ground investigation results were available before and after the survey and the abbreviated borehole logs are indicated on the sections. The rock was generally divided into good granite and poor weathered granite rock based on the RQD value of more or less than 50%. This can be done only to a certain extent as the rock is very variable, RQD values and fracture index often changes rapidly with depth and the small size of a borehole only represents a very small volume of ground. The geophysical survey on the other end of the scale averages over a large volume of ground.

3.1 Seismic Refraction Models

The seismic refraction data was positioned and processed with the SEISIMAGER software package to give a layered model of the subsurface. The number of layers is determined by analysing the seismic traces and four layers were used in the models. All seismic lines were subject to a standardised processing sequence which consisted of a topographic correction which was based on integrated elevation data, first break picking, tomographic inversion, travel-time computation via ray-tracing and velocity modelling. Residual deviations of typically 0.6 to 1.9 msec RMS have been obtained for each line. Following each processing stage QC procedures were adhered to. The resulting layer boundaries are shown as thick lines on the cross sections (Figure 1). The average seismic velocities obtained within the layers are annotated on the sections as bold black numbers.

The p-wave seismic velocity is closely linked to the density of subsurface materials and to parameters like compaction, stiffness, strength and rock quality. The higher the density of the subsurface materials the higher the seismic velocity. More compacted, stiffer, denser and stronger material will have a higher seismic velocity. For rock, the seismic velocity is higher when the rock is stronger, less weathered and has a higher quality. If the rock is more weathered, broken, fractured or fissured then the seismic velocity will be reduced compared to that of intact fresh rock.

Because of the above relationship, the seismic refraction method and seismic velocities are suitable to investigate ground where the layers get denser, more compacted and stronger with depth. A disadvantage is that some materials may have the same seismic velocity. Very stiff or very dense highly consolidated overburden and a weathered granite can have the same seismic velocity range (as is the case in the layer 3 below).

3.2 Interpretation of Seismic Velocities

The modelled seismic data has created the following layered ground model and an interpretation has been made for each layer.

Layer 1 is generally thin (around 1m) and comprises topsoil. The seismic velocity of 150 - 200 m/s indicates that the geological material in this layer would be mainly soft or loose in term of stiffness and compaction.

Layer 2 was modelled with an average velocity of 1200 m/s and has a thickness range between 1 and 4m. This layer is mainly overburden with firm or dense compaction but may contain some highly weathered and decomposed granite. Borehole logs indicate generally granular non-cohesive material like sand, gravel and boulders. This material could be derived from high weathering of granite. The layer can be excavated by digging.

Layer 3 velocities of 2000 m/s indicate a poor to fair weathered granite. This layer could also contain some consolidated very stiff or very dense overburden material. The thickness range is 0 – 4.5m along the survey lines. The excavatability for this layer is diggable to marginal rippable though may require some breaking where large residual granite boulders are present.

The depth to top of good granite (Layer 4 with a seismic velocity of 3500 m/s) varies between 2 and 8m bgl. under the survey lines. This layer requires breaking/blasting for removal.

Table 2 summarises the interpretation. Interpreted cross sections are shown in Figure 2. The stiffness or compaction and the rock strength or quality have been estimated from the seismic velocity. The estimation of the excavatability for the bedrock has been made according to the caterpillar chart published in Reynolds (1997). The geotechnical assessment for rippability will have to take factors like rock type and jointing into account and the estimation in this report is solely based on the seismic velocities.

Table 2: Summary of Results and Interpretation

Layer	General Seismic Velocity Range (km/sec)	Compaction or Strength or Rock Quality	Interpretation	Estimated Excavation Method
1	150 - 200	Soft or loose	Topsoil	Diggable
2	1200	Firm or dense	Overburden	Diggable
3	2000	Poor to fair Rock	Weathered Granite	Diggable to marginal rippable or some breaking of Boulders
4	3500	Good Rock	Granite	Breaking & Blasting

3.3 Elevation of Weathered and good Granite

Contour maps of the elevation (in mOD) for the weathered and good granite have been made in Maps 2 and 3. The contours were created from the seismic model layers and the borehole data within the survey lines area. In the rotary core holes, the criterium for weathered or good granite was a RQD value of 50%.

The maps were created using a Kriging algorithm in the SURFER software programme. The colour contours show the elevation in mOD with the red areas indicating higher elevations and the blue areas lower elevations.

There is a general trend in the top of weathered and good rock dipping from North to the South.

The data could be used to compute volumes and the data file is delivered with this report.

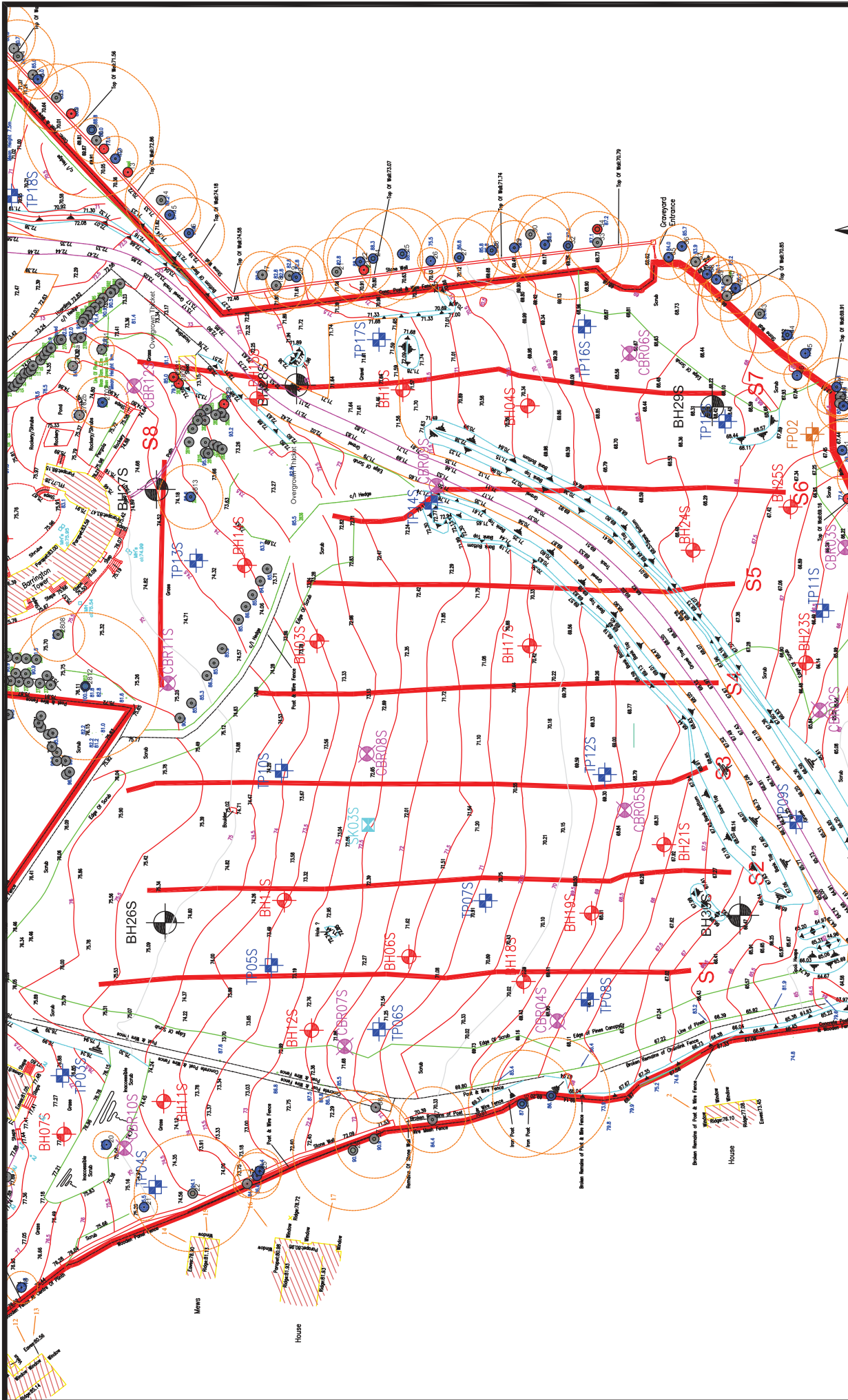
4. CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are made:

- Ground investigations at the proposed development have encountered granite at various depth and of various degree of weathering and quality. A seismic refraction survey was done to create a better image of the conditions of the granite under the site.
- A ground model with four layers has been developed:
- Layer 1 is topsoil with an average thickness of 1m and has a soft or loose stiffness.
- Layer 2 is mainly overburden with firm or dense stiffness. Borehole logs indicate mainly granular non-cohesive material like sand, granite and boulders. This layer can also contain highly weathered or decomposed granite which we interpret to behave rather like overburden and which can be excavated by digging.
- Layer 3 is mainly weathered granite up to 4.5 m thick with poor to fair rock quality. There could be minor amount of very stiff or very dense overburden material included in this layer. We estimate that this layer can be removed by digging or that it is marginal rippable. It can contain large residual granite boulders that may have to be broken up.
- Layer 4 is good granite where the depth to the top varies between 2 and 8m bgl. This layer requires breaking/blasting for removal.
- Rotary core hole logs were used in this report to improve the interpretation and to add data for the contour maps.
- The contour maps for the top of the weathered and good granite (Maps 2 and 3) show a general dip from North to South. Overlaid over this trend are some modulations of the layer surfaces.
- The data for the contour maps can be used to compute volumes over certain areas or footprints.

5. REFERENCES

1. **BSI, 2015.** BS5930, Code of Practice for Ground Investigations, British Standards Institute 2015.
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3. **GSEG, 2002.** Geophysics in Engineering Investigations. Geological Society Engineering Geology Special Publication 19, London, 2002.
4. **GSI, 2021.** Online Bedrock Geological Map of Ireland. Geological Survey of Ireland 2020.
5. **Milsom, 1989.** Field Geophysics. John Wiley and Sons.
6. **Reynolds, 1997.** An Introduction to Applied and Environmental Geophysics. John Wiley and Son.
7. **Weaver, 1975.** Geological Factors significant in the Assessment of Rippability.



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CLIENT: Site Investigations Ltd.

PROJECT: Brennamstown Road Cabinteely D18
Geophysical Survey

TITLE: Map 1: Geophysical Survey
Location Map

SCALE: 1:750 @ A3

PROJECT: 6548

DRAWN: HK

DATE: 10/04/2021

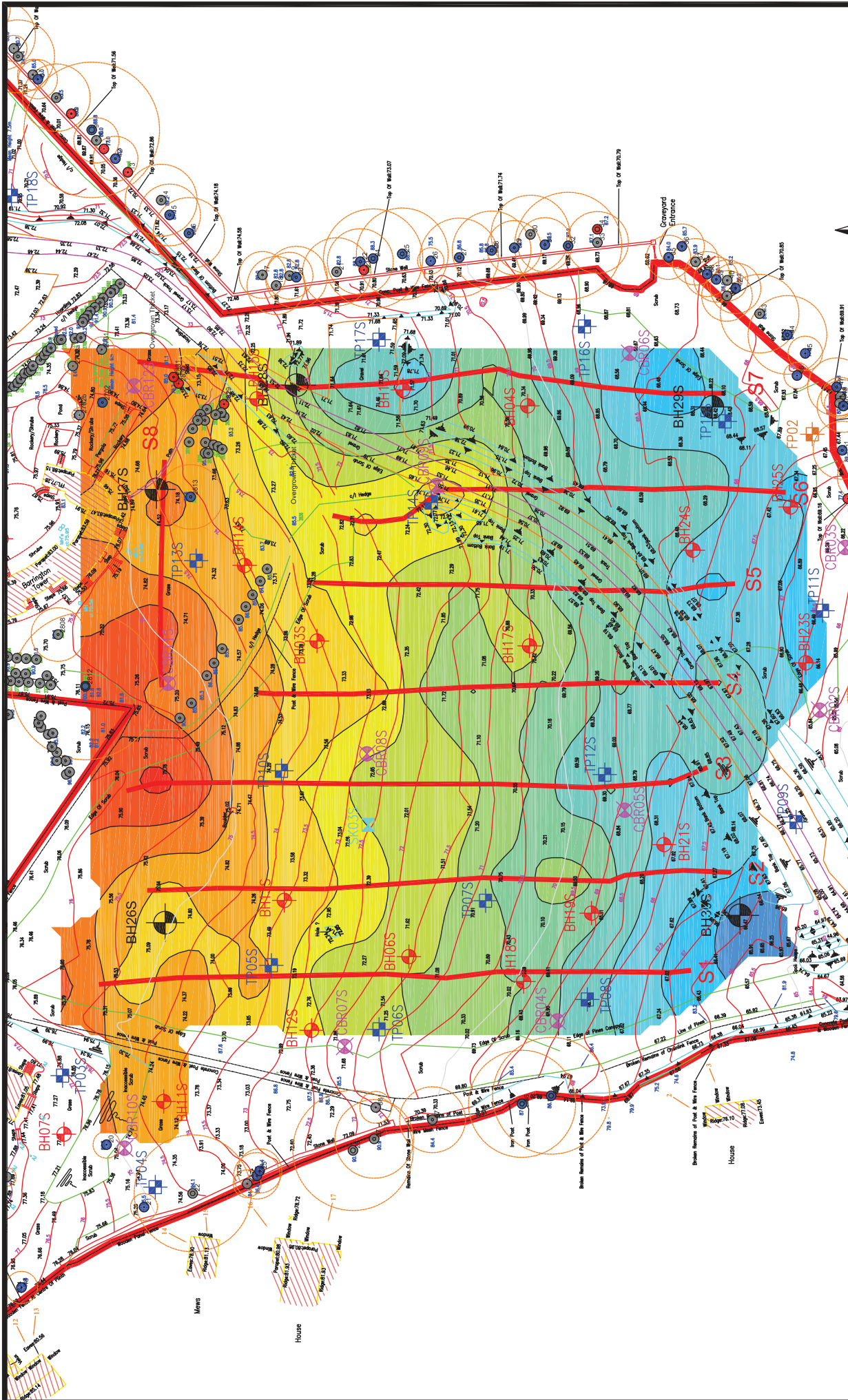
MGX FILE: 6548d_MapsFigs.dwg

STATUS: Draft

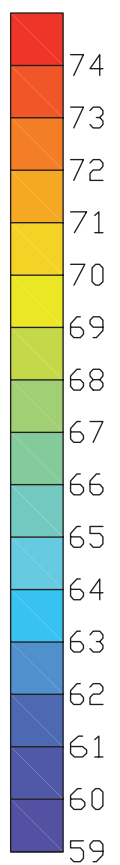
LEGEND: Geophysical Survey Locations:
— S1 Seismic Refraction Line
⊕ BH25S Rotary Core Hole

Direct Ground Investigation Locations:
⊕ BH25S Rotary Core Hole

Locations are in Irish National Grid. Elevations are in mOD (Mean Head)



LEGEND: Elevations (mOD) of the Interpreted Weathered Granite:

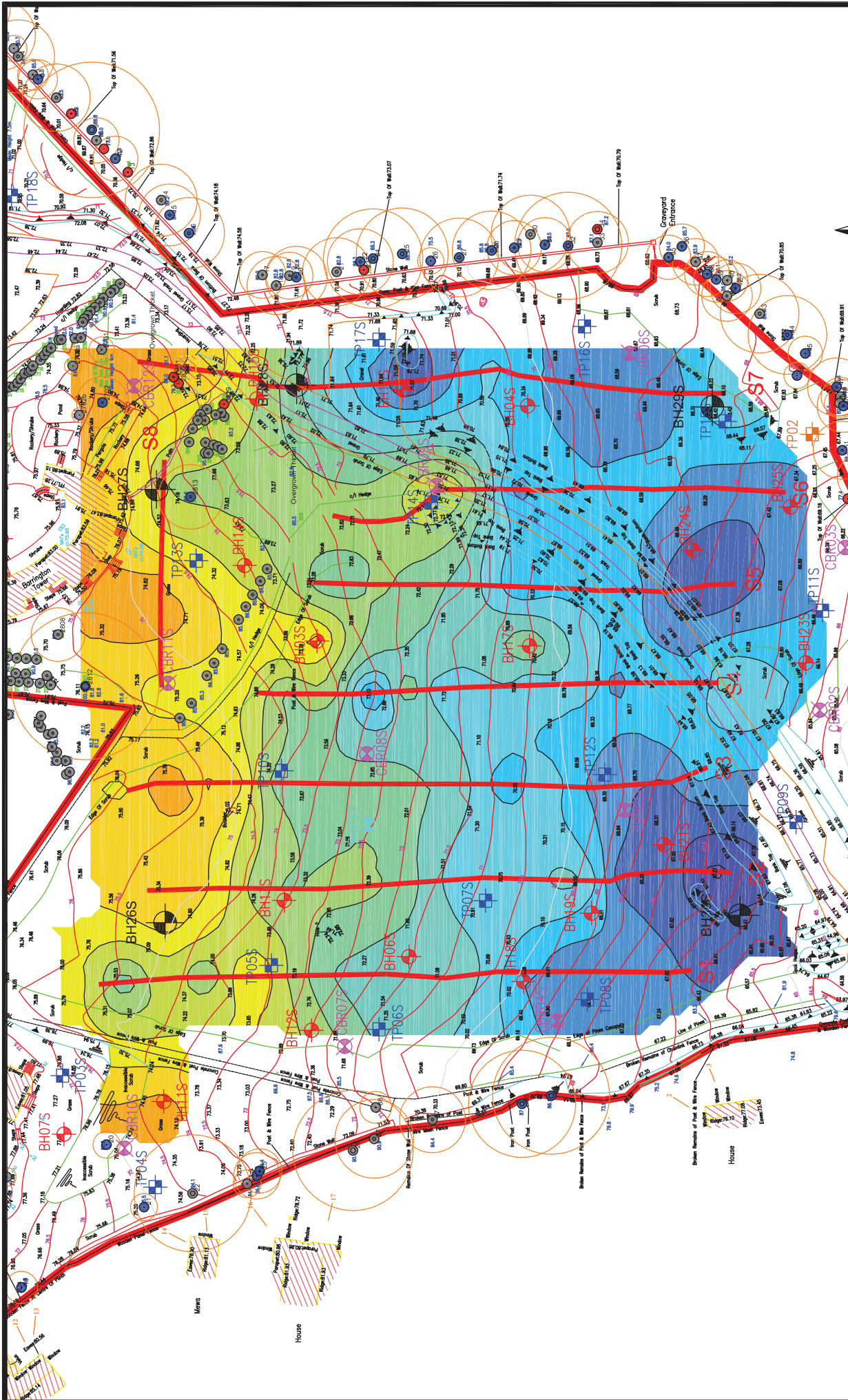


SCALE:	1:750 @ A3
PROJECT:	6548
DRAWN:	HK
DATE:	10/04/2021
MGX FILE:	6548d_MapsFigs.dwg
STATUS:	Draft

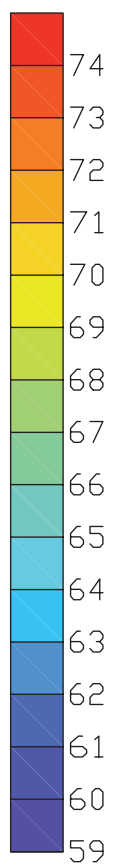
CLIENT:	Site Investigations Ltd.
PROJECT:	Brennanstown Road Cabinteely D18 Geophysical Survey
TITLE:	Map 2: Contour Map of Interpreted Weathered Granite

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LEGEND: Elevations (mOD) of the Interpreted Good Granite:

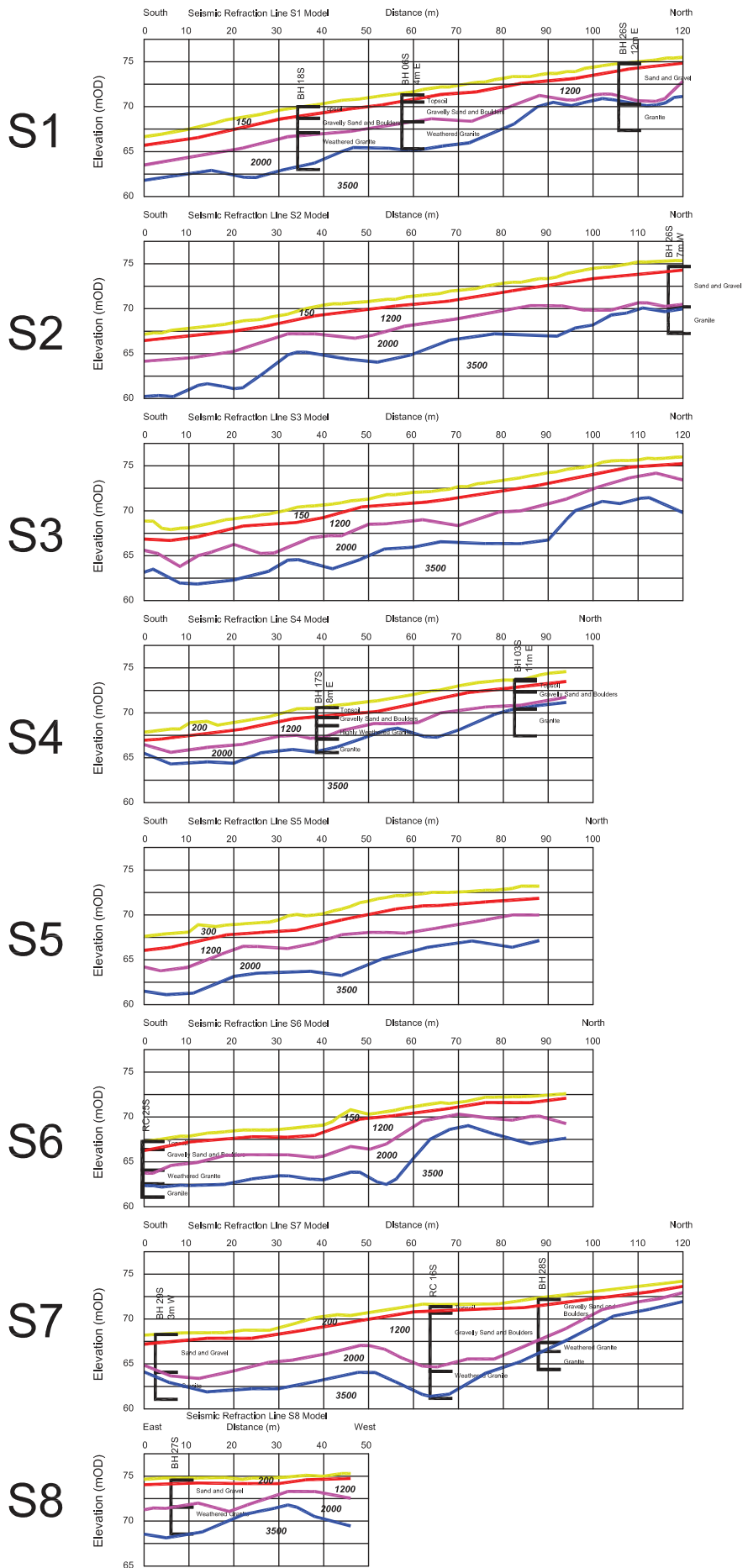


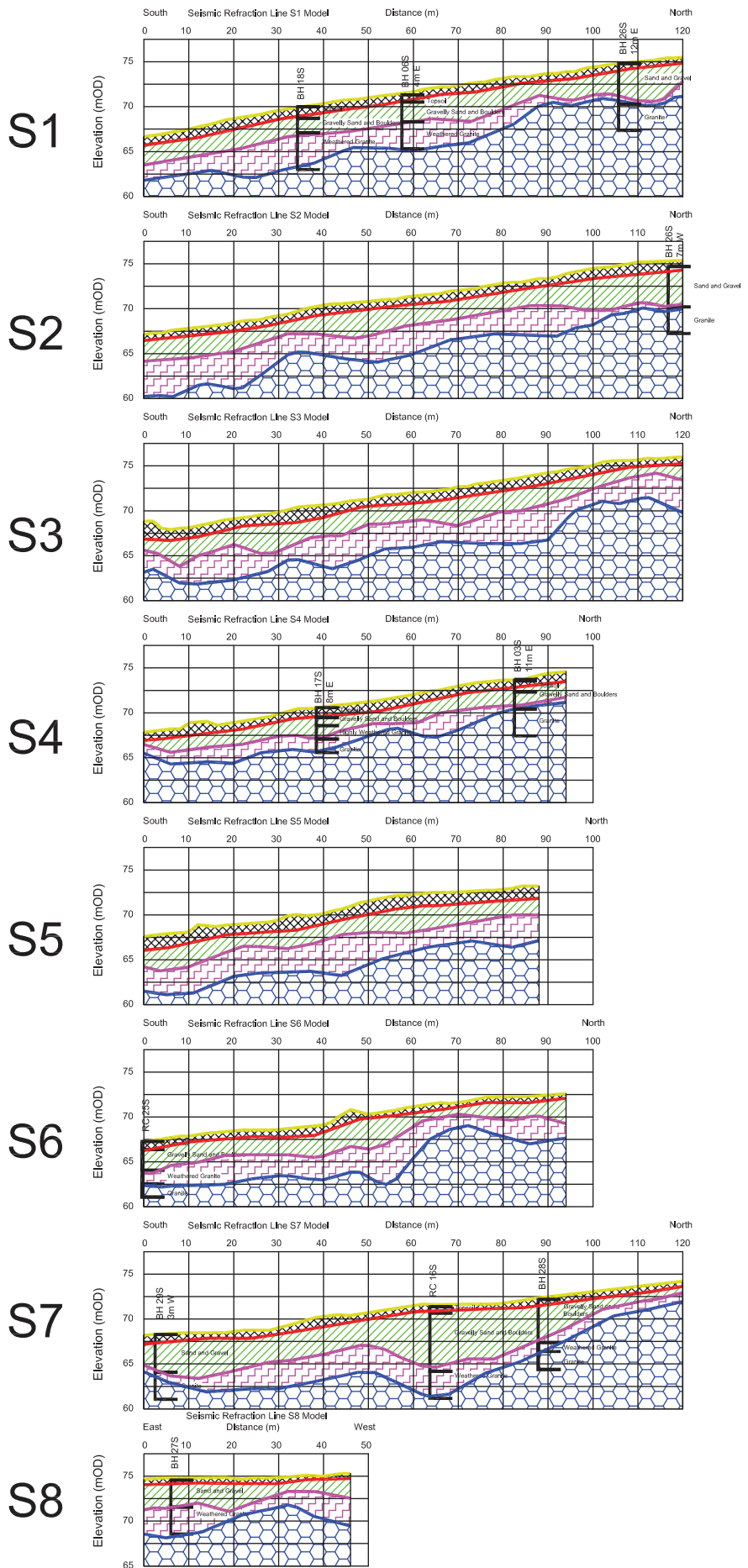
SCALE:	1:750 @ A3
PROJECT:	6548
DRAWN:	HK
DATE:	10/04/2021
MGX FILE:	6548d_MapsFigs.dwg
STATUS:	Draft

CLIENT	Site Investigations Ltd.
PROJECT	Brennanstown Road Cabinteely D18 Geophysical Survey
TITLE	Map 3: Contour Map of Interpreted Good Granite

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CLIENT	Site Investigations Ltd.
PROJECT	Brennanstown Road Cabinteely D18 Geophysical Survey
TITLE	Figure 2: Interpretation of Geophysical Survey

SCALE:	1:1000 @ A3, VE x 2
PROJECT:	6548
DRAWN:	HK
DATE:	12/04/2021
MGX FILE:	6548d_MapsFigs.dwg
STATUS:	Draft

LEGEND:	Interpretation of Seismic Refraction
	1 Soft or loose Topsoil
	2 Firm or dense Overburden
	3 Poor to fair weathered Granite
	4 Good Granite

Appendix 3
Trial Excavation Log and Photographs

ROCK EXCAVATION TRIAL



Project Reference:	5831
Contract name:	Brennanstown Road Additional Investigation
Location:	Cabinteely, Dublin 18
Test No:	ET01
Date:	10/05/2021

Ground Conditions		
From	To	
0.00	0.30	TOPSOIL.
0.30	0.90	Brown very clayey sandy GRAVEL with high cobble and low boulder content.
0.90	2.30	Firm grey sandy slightly gravelly silty CLAY.
2.30	3.20	Extremely strong light grey with orange staining, coarse crystalline GRANITE.

Remarks:
 Co-ordinates: E: 722588.106, N: 724222.997, Z: 73.58
 Excavator - CASE CX160D. Rockbreaker - Montabert 501 R/B with 120mm diameter working tool.
 Cycle 1 is weathered bedrock excavation.

Excavation Details:

Breaking							Excavating	
Cycle	Time/ mins	Length / m	Width / m	Depth / m	Volume / m ³	m ³ /hr	Time/mins	m ³ /hr
0.90-2.30m	-	4.10	3.05	1.40	17.51	-	15.00	70.0
2.30-2.70m	24.50	4.10	2.20	0.40	3.61	8.84	6.25	34.6
2.70-3.10m	22.50	4.10	2.00	0.40	3.28	8.75	7.00	28.1
3.10-3.20m	25.00	2.50	1.90	0.10	0.48	1.14	5.25	5.4
3.20-3.30m	30.00	2.50	1.90	0.10	0.48	0.95	6.00	4.8

Top of Weathered Bedrock



Top of Solid Bedrock



Weathered Bedrock Spoil



Base of Pit



Final Spoil Heap



Appendix 4
Survey Data

Survey Data

Location	Irish Transverse Mercator		Elevation	Irish National Grid	
	Easting	Northing		Easting	Northing
Rotary Coreholes					
BH26S	722526.698	724254.096	74.95	322602.606	224225.717
BH27S	722615.186	724256.932	74.56	322691.113	224228.555
BH28S	722636.161	724228.544	72.43	322712.093	224200.161
BH29S	722631.311	724143.491	68.48	322707.243	224115.089
BH30S	722528.385	724137.111	66.73	322604.294	224108.707
Rotary Coreholes					
RE01	722588.106	724222.997	73.58	322664.027	224194.612

Legend Key

- ▣ Locations By Type - IP
- ⊕ Locations By Type - RC



Contract No:	5831
Contract Name:	Brennanstown Road
Location:	Cabinteely, Dublin 18
Client:	Cairn Homes PLC
Engineer:	Waterman Moylan
Title:	Site Plan
Scale:	1:1250
Drawn By:	SL



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