

## Appendix 3-6

# Ground Investigation Rotary Boreholes

Our Ref: GH/Rp/P19206 + attachments (\*.pdf)

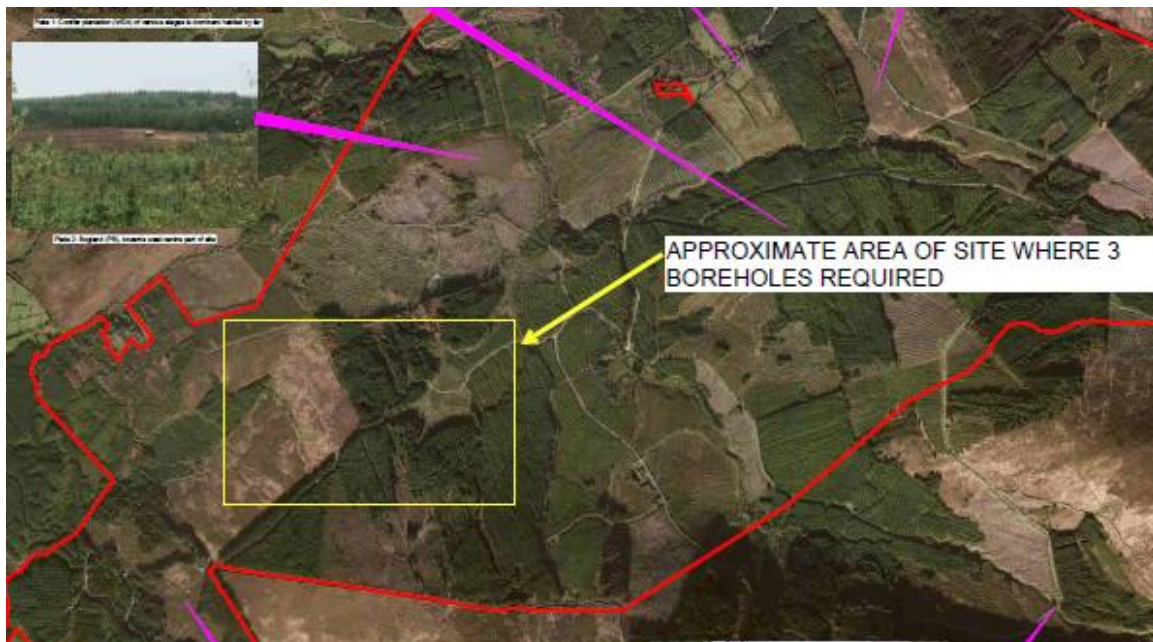
06<sup>th</sup> June, 2020

**Messrs.** Malachy Walsh & Partners  
Reen Point,  
Blennerville,  
Tralee,  
Co. Kerry.

**Re: Carrownagowan Windfarm, Co. Clare, Ground Investigation, Factual Report**

**Introduction**

In October 2019, Priority Geotechnical (PGL) were requested by Malachy Walsh & Partners, Consulting Engineers (MWP) on behalf of their Client: Coillte to undertake a ground investigation for a proposed windfarm development at Carrownagowan, Co. Clare.



## Scope

The scope of the ground investigation, which was specified by MWP Consulting Engineers, comprised of the following:

- Rotary boreholes;
- All associated *in situ* testing and sampling;
- Laboratory testing and
- Associated reporting.

## Objectives

The investigation in so far as the scope allowed, was to assess the ground and groundwater conditions present within the site; for the purpose of identifying potential borrow pits.

This report presents the factual data with regard to the ground investigation for the proposed windfarm development, Carrownagowan, Co. Clare. This report should be read in conjunction with the exploratory and laboratory test data accompanying this interpretative report.

## Site Works

This investigation was carried out between the 19<sup>th</sup> and the 22<sup>nd</sup> November, 2019 under the supervision of PGL, Engineering Geologist(s) in accordance with the contract specification: Eurocode 7- Geotechnical Design Part 2, ground investigation and testing (BS EN 1997-2: 2007) and the relevant British Standards BS 5930 (2015) Code of Practice for Site Investigation +A2:2010 and BS 1377, Method of Tests for Soil for Civil Engineering Purposes, *in situ* Tests Parts 1 to 9). Details of the plant and equipment used are detailed on the relevant exploratory records, attached.

## Rotary boreholes

Three (3) rotary boreholes were bored to a depth 7.8m below ground level (bgl) to 12.3m bgl using PGL's Deltabase 520, 6t rotary rig. The records accompany this report.

Location	Depth, m bgl
RC BP01	7.8
RC BP02	8.9
RC SS	12.3

## Sampling

A total of ninety nine, 29lin.m of drilling recovered 13.7lin.m of core from the exploratory rotary boreholes in accordance with Geotechnical Investigation and Sampling – Sampling Methods and Groundwater Measurements (EN ISO 22475-1:2006).

## In Situ Testing

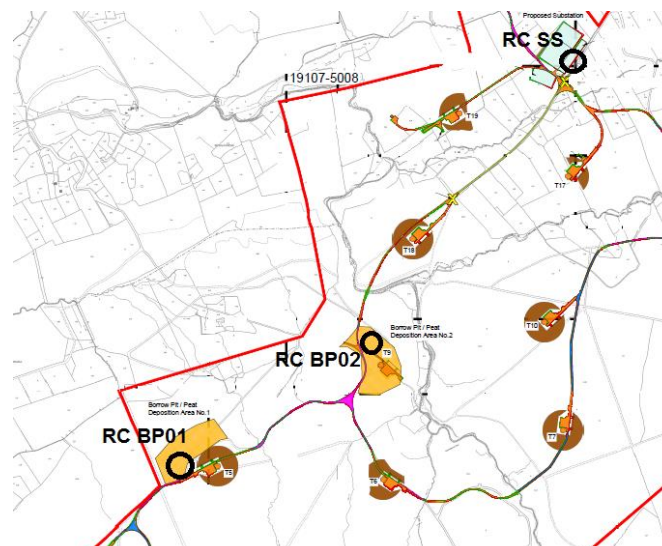
### Standard penetration test

Eleven (11) number standard penetration tests,  $N_{SPT}$  values, were typically carried out in the rotary boreholes using the 60° solid cone (CPT) in place of the standard split barrel sampler. The Standard Penetration Test was carried out in accordance with Geotechnical Investigation and Testing, Part 3 Standard penetration test, BS EN ISO 22476-3:2005+A1:2011. The data is presented on the exploratory rotary logs, accompanying this factual report.

## Survey and Drawings

The exploratory locations were set out on site with Coillte using co-ordinates provided. Under the agreed scope of works, no survey of the 'as constructed' rotary boreholes was required. A location plan is provided below for reference only.

Location	ITM	
	Easting	Northing
Borrow Pit 1, RC BP01	560259	676498
Borrow Pit 2, RC BP02	561070	676908
Substation, RC SS	561946	678248



## **Laboratory Testing**

No laboratory testing was required.

*Please note that all samples shall be retained for a period no longer than 28 days from the date of this report. Thereafter all remaining samples shall be appropriately disposed of unless a written instruction to the contrary is received by PGL prior to the date of this reporting and within the 28 day period outlined above. Laboratory testing will result in a reduction of sample quantity and in some cases the use of the full sample mass. Samples already tested may not be suitable or available for further testing.*

## **Desk Study - Published Geology**

*The Geological Survey of Ireland, 1:100,000 mapping (Sheets 17 and 18) was reviewed to determine the geology of the site. The geology of the exploratory locations were underlain by Old Red Sandstone formations (ORS described as red Conglomerate, Sandstone and Mudstone). The Slieve Bernagh Formation (SB described as fine and some coarser Greywacke) was immediately south of borrow pits 1 and 2. A non-conformity delineated the ORS and SB formations. Bedrock outcrops were noted 200m west of borrow pit 1; 960m west of borrow pit 2 and 340m north-west of the sub-station location.*

*Teagasc subsoil mapping showed Peat deposits with non-calcareous bedrock, near surface outcrops in the vicinity of borrow pits 1 and 2. Teagasc subsoil mapping showed the area for the sub-station to be underlain by glacial tills derived from Devonian Sandstones, with non-calcareous bedrock, near surface outcrops.*

## **Ground and groundwater conditions**

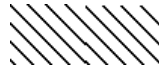
The full details of the ground conditions encountered are provided for on the exploratory records accompanying this report. The records provide descriptions, in accordance with BS 5930 (2015) and Eurocode 7, Geotechnical Investigation and Testing, Identification and classification of soils, Part 1, Identification and description (EN ISO 14688-1:2002), – Identification and Classification of Soil, Part 2: Classification Principles (EN ISO 14688-2:2004) and Identification and Classification of Rock, Part 1: Identification & Description (EN ISO 14689-1:2004) of the materials encountered,

*in situ* testing and details of the samples taken, together with any observations made during the ground investigation.

Groundwater was recorded when encountered during boring over a period of 20 minutes, noting any changes that may occur. Groundwater levels were also monitored at start and end of drilling shifts. Groundwater conditions observed in the boreholes, are those appertaining to the period of the investigation. Groundwater levels may be subject to diurnal, seasonal and climatic variations and can also be affected by drainage conditions, tidal variations etc. The groundwater regime should be assessed from standpipe well installations, where available. Under the scope of works, no standpipes were installed. The boreholes and exploratory pits were backfilled with their arisings and bentonite grout.



ARISINGS Backfill



BENTONITE Backfill to installation/ borehole

Groundwater was noted during the ground investigation within the depth of the investigation at a depth 1.0m bgl to 8.0m bgl. A summary of groundwater is presented as follows and detailed on the exploratory records, herein.

Location	Groundwater strike, mbgl	Remarks
RC BP01	1.0	4.0m bgl end shift borehole 7.8m depth
RC BP02	1.0	3.6m bgl end shift borehole 8.9m depth
RC SS	8.0	8.0m bgl end shift borehole 12.3m depth

Should you have any queries in relation to the data collected and presented, or the subsequent analysis; please do not hesitate to contact our office.

Yours sincerely,  
For **Priority Geotechnical**,

  
**Greg Hayes BE MEngSc CEng MIEI**  
**Geotechnical Specialist**

*No responsibility or liability can be held by PGL for ground conditions between or extraneous to exploratory locations. The exploratory logs provide for ground profiles and configuration of strata relevant to the investigation depths achieved during the fieldworks. Caution shall be taken when extrapolating between such exploratory locations.*

*The interpretation of the current data set may be subject to change where additional data becomes available.*

*This report has been prepared for the Client and their Representative as outline, herein. The information should not be used without their prior written permission. PGL accepts no responsibility or liability for this document being used other than for the purposes for which it was intended.*

# KEY TO SYMBOLS ON EXPLORATORY HOLE RECORDS

All linear dimensions are in metres or millimetres

## DESCRIPTIONS

\*\* Drillers Description  
Friable Easily crumbled

## SAMPLES

U( ) Undisturbed 102mm diameter sample, ( ) denotes number of blows to drive sampler  
U( )F, U( )P F- not recovered, P-partially recovered  
U38 Undisturbed 38mm diameter sample  
P(F), (P) Piston sample - disturbed  
B Bulk sample - disturbed  
D Jar Sample - disturbed  
W Water Sample  
CBR California Bearing Ratio mould sample  
ES Chemical Sample for Contamination Analysis  
SPTLS Standard Penetration Test S lump sample from split sampler

## CORE RECOVERY AND ROCK QUALITY

TCR Total Core Recovery (% of Core Run)  
SCR Solid Core Recovery (length of core having at least one full diameter as % of core run)  
RQD Rock Quality Designation (length of solid core greater than 100mm as % of core run)  
Where there is insufficient space for the TCR, SCR and RQD, the results may be found in the remarks column  
lf Fracture Spacing in mm (Minimum/Average/Maximum) NI - non intact, NR - no recovery  
AZCL Assumed Zone of Core Loss  
NI Non intact

## GROUNDWATER

▽ Groundwater strike  
▼ Groundwater level after standing period  
Date/Water Date of shift (day/month)/Depth to water at end of previous shift shown above the date and depth to water at beginning of shift given below the date

## INSITU TESTING

S Standard Penetration Test - split barrel sampler  
C Standard Penetration Test - solid 60° cone  
SW Self Weight Penetration  
Ivp, HVp (R) In Situ Vane Test, Hand Vane Test (R) demonstrates remoulded strength  
K(F), (C), (R), (P) Permeability Test  
HP Hand Penetrometer Test

## MEASURED PROPERTIES

N Standard Penetration Test - blows required to drive 300mm after seating drive  
x/y Denotes x blows for y mm within the Standard Penetration Test  
x\*/y Denotes x blows for y mm within the seating drive  
 $c_u$  Undrained Shear Strength (kN/m<sup>2</sup>)  
CBR California Bearing Ratio

## ROTARY DRILLING SIZES

Index Letter	Nominal Diameter (mm)	
	Borehole	Core
N	75	54
H	99	76
P	120	92
S	146	113



Project Id: P19206  
Project Title: Carrowmagowan Wind Farm  
Location: Co. Clare  
Client: Coillte

Title: Site Plan  
Scale: 1:14000  
Engineer: Malachy Walsh & Partners  
Contractor: PGL



Legend Key

- Locations By Type - Empty
- Locations By Type - RC
- Locations By Type - TP





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**Drilled By:**  
 KM  
**Logged By:**  
 PK

Borehole No.  
**RC BP01**  
 Sheet 1 of 1

**Project Name:** Carrowmagowan Wind Farm  
**Project No.:** P19206  
**Co-ords:** 560259E - 676498N  
**Hole Type:** Rotary cored

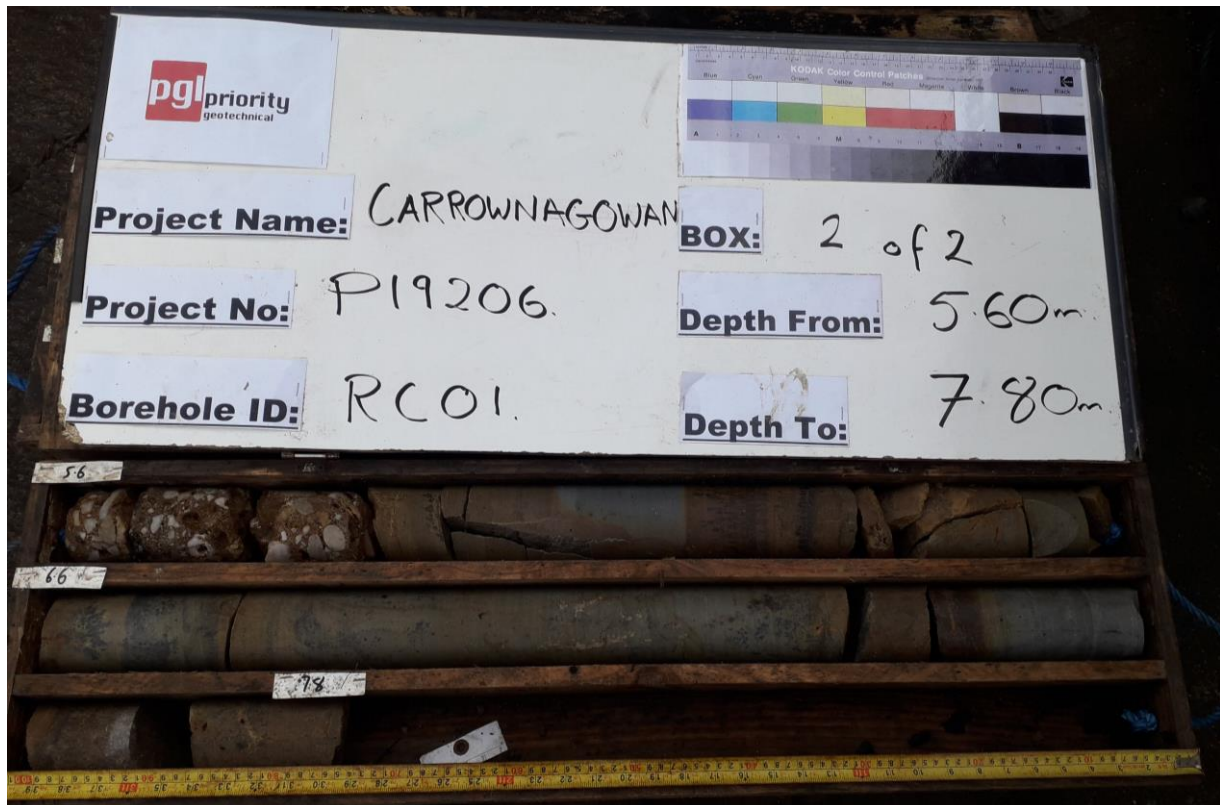
**Location:** Co. Clare  
**Level:**  
**Scale:** 1:50

**Client:** Coillte  
**Dates:** 21/11/2019 21/11/2019

Well	Water Strike (m)	Depth (m)	Type /Fs (min, max, avg)	Coring (%)			Depth (m) / Fl (/m)	Level (mOD)	Legend	Stratum Description	
				TCR	SCR	RQD					
	▼	0 (25 for 75mm/0 for 0mm) 2.6(C)β.10	50mm 110mm 100mm	100	40	0	1.50			Open hole boring. Driller described: MADE GROUND with boulder content.	1
		3.10 - 3.60		100	90	40	5/m			Open hole boring. Driller described: Boulders onto bedrock.	2
		3.60 - 4.10		90	40	0				Lithology: 2.20m to 5.60m, 5.90m to 7.80m Strong red brown medium to coarse grained SANDSTONE. 5.60m to 5.90m PARA-CONGLOMERATE with sub-rounded clasts and coarse Sandstone Matrix. 5.90m to 7.80m Fine red grey SANDSTONE.	3
		4.10 - 4.60		100	0	0					
		4.60 - 5.60		100	80	50	7/m			Fractures: Heavily fractured and not intact rock between 2.60m to 4.60m. Set 1 dipping 0 to 10 degrees, horizontal to planar rough/smooth. Set 2 dipping 65 to 80 degrees, sub-vertical planar fracture surfaces.	5
		5.60 - 6.60		100	90	15	10/m			Detail: Quartz veining.	6
		6.60 - 7.80		100	100	83	5/m				7
									End of Borehole at 7.800m	9	

<b>Groundwater:</b>				<b>Hole Information:</b>			<b>Equipment:</b>	Deltabase 520	
Struck (m bgl)	Rose to	After (min)	Sealed	Comment	Hole Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	<b>Method:</b>	Compressed air
1.00				See shift data.	7.80	76	131		

<b>Remarks:</b> Borrow pit #1. Borehole terminated at 7.80m bgl, required depth.	<b>Shift Data:</b>	Groundwater (m bgl)	Shift	Hole Depth (m bgl)	Remarks
		4.0	21/11/2019 08:00 21/11/2019 18:00	0.00 7.80	Start of shift. End of borehole.



<p><b>Number:</b> RC BP01</p>	<p><b>Project</b> Carrownagowan WF, Co. Clare  <b>Project No</b> P19206  <b>Engineer</b> Malachy Walsh &amp; Partners</p>	<p><b>Borrow Pit # 1</b></p>
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<b>Drilled By:</b>	Borehole No.
KM	<b>RC BP02</b>
<b>Logged By:</b>	
PK	
Sheet 1 of 1	

<b>Project Name:</b> Carrowmagowan Wind Farm	<b>Project No.:</b> P19206	<b>Co-ords:</b> 561072E - 676904N	<b>Hole Type:</b> Rotary cored
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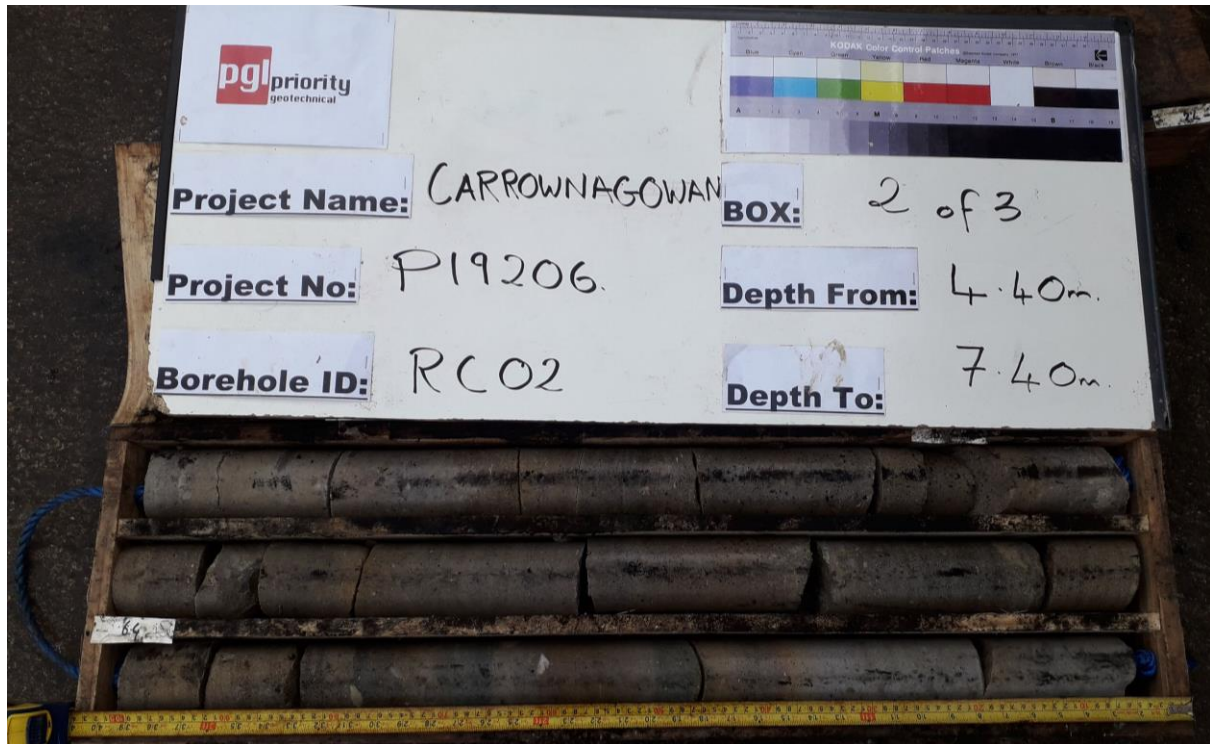
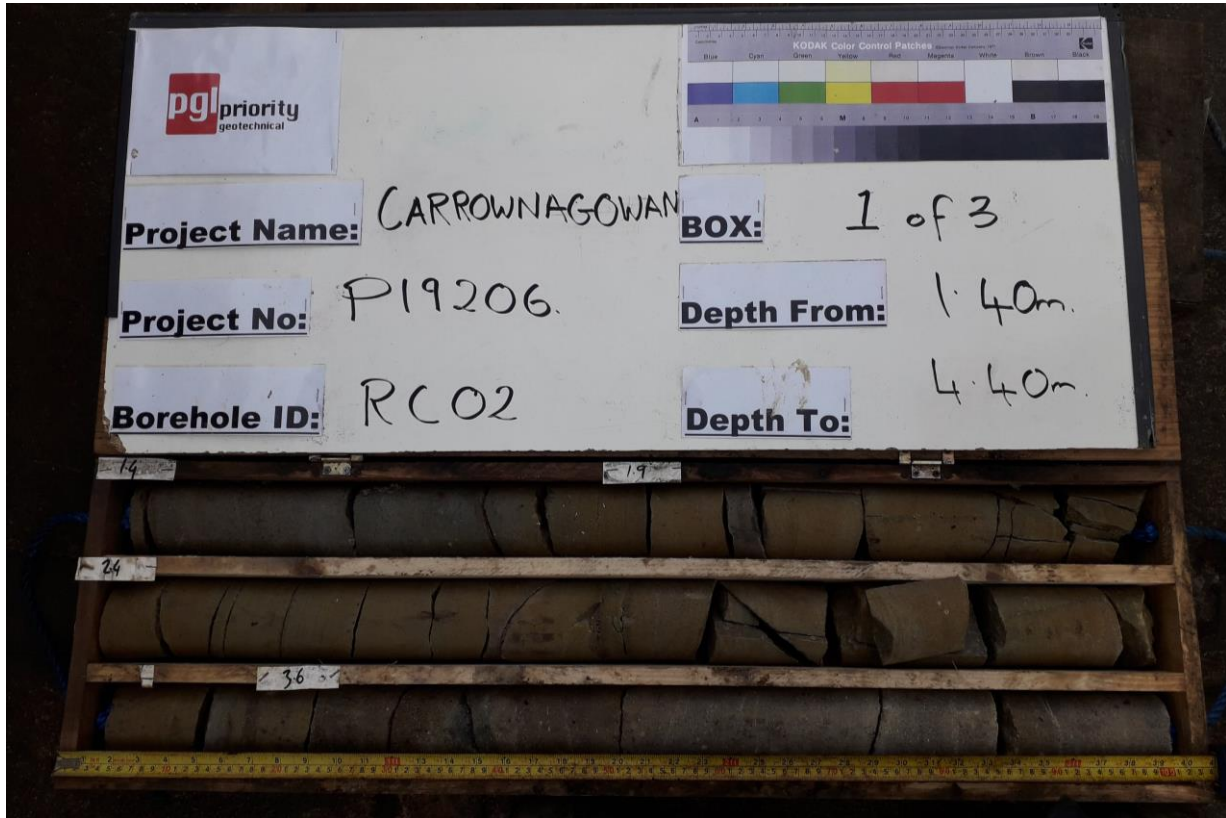
<b>Location:</b> Co. Clare	<b>Level:</b>	<b>Scale:</b> 1:50
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<b>Client:</b> Coillte	<b>Dates:</b> 22/11/2019 22/11/2019
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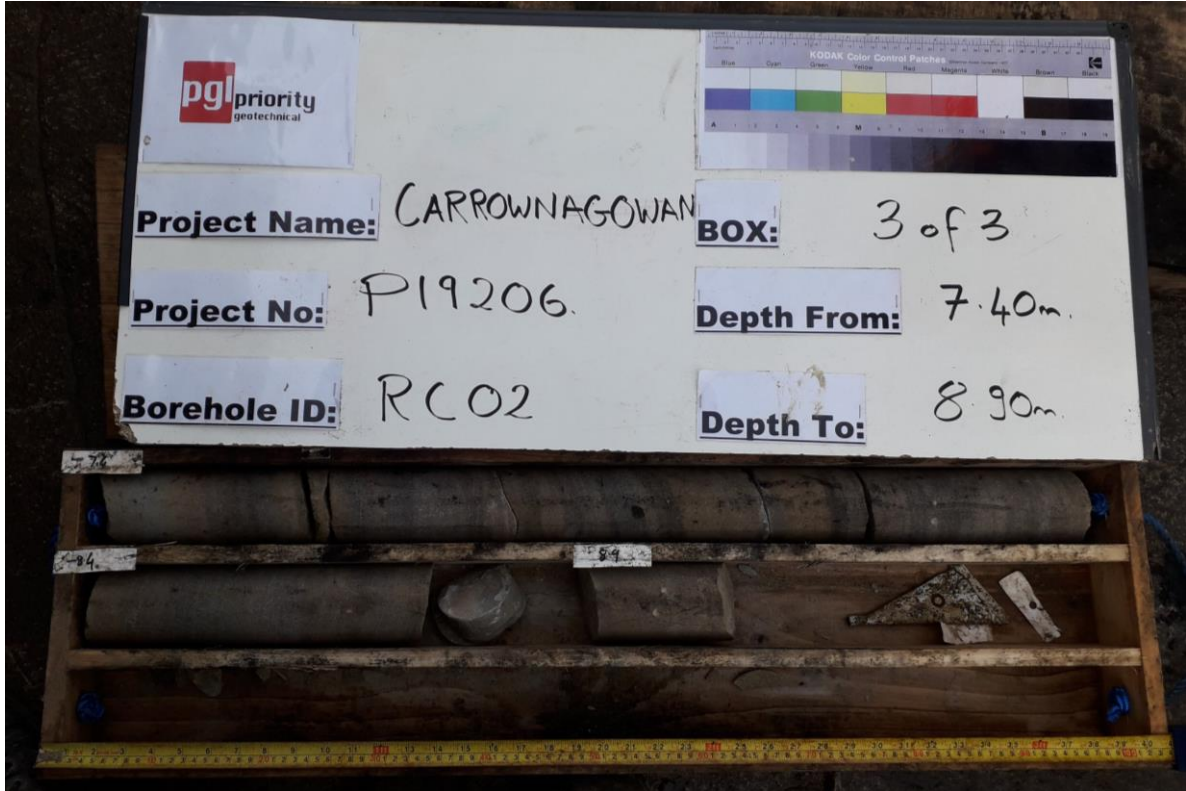
Well	Water Strike (m)	Depth (m)	Type /Fs (min, max, avg)	Coring (%)			Depth (m) / Fl (/m)	Level (mOD)	Legend	Stratum Description	
				TCR	SCR	RQD					
	▼	0 (25 for 0mm/0 for 0mm) 1.40(C) 1.90	50mm 190mm 150mm	100	100	58	1.40 4/m			Open hole boring. Driller described: MADE GROUND onto bedrock.	1
		1.90 - 2.40	10mm 70mm 50mm	100	60	0	10/m			Lithology: 1.40m to 3.60m fine to medium yellow grey SANDSTONE. 3.60m to 8.90m coarse grey SANDSTONE.  Weathering: Slight oxidation discolouration from 1.40m to 3.60m.	2
		2.40 - 3.60	10mm 70mm 60mm	100	83	83	19/m			Fractures: Set 1 dipping 0 to 10 degrees, close to medium spacing, planar rough. Set 2 dipping 30 to 45 degrees, planar rough fracture surfaces, medium spacing. Set 3 dipping 80 to 90 degrees, planar smooth fracture surfaces, medium spacing.	3
		3.60 - 5.20	100mm 220mm 100mm	100	100	75	10/m			Detail: Clay infill from 3.60m to 3.80m.	4
		5.20 - 6.40	30mm 200mm 200mm	100	100	83	8/m				5
		6.40 - 7.40	50mm 380mm 300mm	100	100	80	4/m				6
		7.40 - 8.40	50mm 350mm 300mm	100	100	82	5/m				7
		8.40 - 8.90	20mm 320mm 320mm	100	100	90	2/m				8
								8.90			End of Borehole at 8.900m

<b>Groundwater:</b>	<b>Hole Information:</b>			<b>Equipment:</b>	Deltabase 520
Struck (m bgl) 1.00	Rose to	After (min)	Sealed	Comment	See shift data.
	Hole Depth (m bgl) 8.90	Hole Dia (mm) 76	Casing Dia (mm) 131	<b>Method:</b>	Compressed air

<b>Remarks:</b> Borrow pit #2. Borehole terminated at 8.90m bgl, required depth.	<b>Shift Data:</b>	Groundwater (m bgl)	Shift	Hole Depth (m bgl)	Remarks
		3.6	22/11/2019 08:00 22/11/2019 18:00	0.00 8.90	Start of shift. End of borehole.



<p><b>Number:</b> RC BP02</p>	<p><b>Project</b> Carrownagowan WF, Co. Clare  <b>Project No</b> P19206  <b>Engineer</b> Malachy Walsh &amp; Partners</p>	<p><b>Borrow Pit #</b></p>
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<p>Number: RC BP02</p>	<p>Project Carrownagowan WF, Co. Clare Project No P19206 Engineer Malachy Walsh &amp; Partners</p>	<p>Borrow Pit #</p>
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**Drilled By:**  
 KM  
**Logged By:**  
 PK

Borehole No.  
**RC SS**  
 Sheet 1 of 2

**Project Name:** Carrowmagowan Wind Farm  
**Project No.:** P19206  
**Co-ords:** 561975E - 678293N  
**Hole Type:** Rotary cored

**Location:** Co. Clare  
**Level:**  
**Scale:** 1:50

**Client:** Coillte  
**Dates:** 19/11/2019 20/11/2019

Well	Water Strike (m)	Depth (m)	Type /Fs (min, max, avg)	Coring (%)			Depth (m) / Fl (/m)	Level (mOD)	Legend	Stratum Description	
				TCR	SCR	RQD					
		N=36 (8,9/7,8,9,12) (C)	180mm 180mm 180mm				1.50		Open hole boring. Driller described (MADE GROUND): CLAY.	1	
		0 (25 for 0mm/0 for 0mm) 2.20 (C)		100	75	75	2.20 1/m		Open hole boring. Driller described: CLAY.	2	
		N=48 (12,13/13,12,11,12) (C)							Sandy gravelly CLAY with Cobble and BOulder content. Boulders, 2.20m to 2.60m, lithology: strong medium grained SANDSTONE with manganese oxide dendrites.	3	
		N=41 (7,10/10,9,11,11) (C)								4	
		N=42 (8,6/8,10,12,12) (C)								5	
	N=37 (11,12/12,9,8,8) (C)								6		
	▼								7		
									8		
									9		

<b>Groundwater:</b>				<b>Hole Information:</b>			<b>Equipment:</b>	Deltabase 520
Struck (m bgl)	Rose to	After (min)	Sealed	Comment	Hole Depth (m bgl)	Hole Dia (mm)	Casing Dia (mm)	<b>Method:</b>
8.00					12.30	76	131	Compressed air

<b>Remarks:</b> Borehole terminated at 12.30m bgl, required depth.	<b>Shift Data:</b>	Groundwater (m bgl)	Shift	Hole Depth (m bgl)	Remarks
		Dry	19/11/2019 08:00	0.00	Start of shift.
		Dry	19/11/2019 18:00	4.50	End of borehole.
		8.0	20/11/2019 08:00	4.50	Start of shift.
			20/11/2019 18:00	12.30	End of borehole.



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**Drilled By:**  
 KM  
**Logged By:**  
 PK

Borehole No.  
**RC SS**  
 Sheet 2 of 2

**Project Name:** Carrowmagowan Wind Farm  
**Project No.:** P19206  
**Co-ords:** 561975E - 678293N  
**Hole Type:** Rotary cored

**Location:** Co. Clare  
**Level:**  
**Scale:** 1:50

**Client:** Coillte  
**Dates:** 19/11/2019 20/11/2019

Well	Water Strike (m)	Depth (m)	Type /Fs (min, max, avg)	Coring (%)			Depth (m) / Fl (/m)	Level (mOD)	Legend	Stratum Description	
				TCR	SCR	RQD					
		N=45 (8,8/10,11,11,13) (C)									10
		0 (25 for 0mm/0 1000mm/0) (C)		83	0	0					11
		10.80 - 12.00		8	0	0					12
		0 (50 for 0mm/0 1200mm/0) (C)		100	0	0					13
							12.30			End of Borehole at 12.300m	14
											15
											16
											17
											18

**Groundwater:**  
 Struck (m bgl) 8.00  
 Rose to After (min) Sealed Comment

**Hole Information:**  
 Hole Depth (m bgl) 12.30  
 Hole Dia (mm) 76  
 Casing Dia (mm) 131

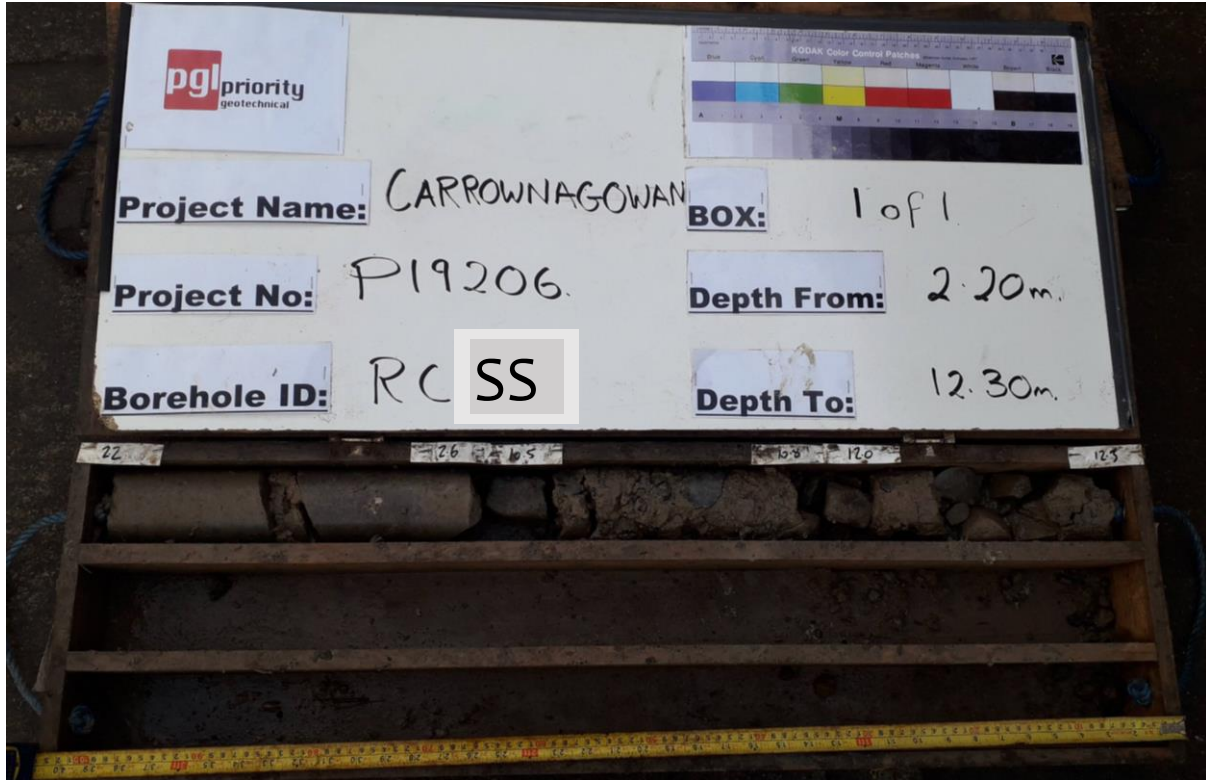
**Equipment:** Deltabase 520  
**Method:** Compressed air

**Remarks:**  
 Borehole terminated at 12.30m bgl, required depth.

**Shift Data:**

Groundwater (m bgl)	Shift	Hole Depth (m bgl)	Remarks
Dry	19/11/2019 08:00	0.00	Start of shift.
Dry	19/11/2019 18:00	4.50	End of borehole.
Dry	20/11/2019 08:00	4.50	Start of shift.
8.0	20/11/2019 18:00	12.30	End of borehole.





<b>Number:</b>	RC SS	<b>Project</b> <b>Project No</b> <b>Engineer</b>	Carrownagowan WF, Co. Clare P19206 Malachy Walsh & Partners	<b>Sub-station</b>
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