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30 YEARS

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX 9.1

Geotechnical Assessment Report

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30 YEARS

CONSULTANTS IN ENGINEERING, ENVIRONMENTAL SCIENCE & PLANNING

COOM GREEN ENERGY PARK

GEOTECHNICAL ASSESSMENT REPORT

Prepared for: Coom Green Energy Park Ltd

Date: November 2020

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1. INTRODUCTION

1.1 General

Coom Green Energy Park Limited (CGEPL) is applying to An Bord Pleanála for consent for the proposed Coom Green Energy Park (CGEP) in County Cork. Subject to consent being granted the CGEP will be constructed by CGEP in partnership with Coillte Teoranta (Coillte). The proposed energy park is located approximately 12km to the south east of Mallow and approximately 13 km west of Fermoy in County Cork.

The proposed turbines are located in proximity to the Bottlehill Landfill site approximately 12km south east of Mallow, and at the Nagles Mountains, approximately 5km south west of Ballyhooly, County Cork. The proposed Coom Green Energy Park site includes lands contained within the following townlands: Glashaboy North, Coom (Hudson), Tooreen South, Killeagh, Coom (Fitzgerald), Slievedotia, Mullenaboree, Knoppoge, Carrig, Knuttery, Lackendarragh North, Knockacullata, Knockdoorty, and Glannasack, County Cork.

The general site layout of the site is shown in Figure 1.1 in Appendix 1.

1.1 Details of Proposed Works

The proposed project will primarily consist of a wind farm of up to 22 no. wind turbine generators (WTG's), up to 2 no. substation compounds and a battery energy storage system along with ancillary civil and electrical infrastructure.

The associated grid connection route (GCR) will consist entirely of underground cable and will connect the on-site substations to an existing 110kV substation at Barrymore, within the townland of Farran South near Rathcormac. The GCR will be ca.24.4km in length, with ca. 16.7km to be constructed within the existing road corridor. The 110kV grid connection cable will follow public roads and shall feature horizontal directional drilling (HDD) at up to 4 no. locations to cross existing watercourses and the M8 motorway.

1.2 Scope and Project Objectives

Fehily Timoney and Company (FT) were engaged by CGEP to undertake a geotechnical assessment of the proposed wind farm site with respect to slope and peat stability. An assessment of proposed borrow pit locations for the extraction of site won fill material was also required.

This study was carried out in accordance with Eurocode 7: Part 2 (NSAI, 2007). In addition to the Eurocode 7 guidance, the peat stability assessment was undertaken in accordance with the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRA, 2017).

The Peat Hazard and Risk Assessment is used in this report as it provides best practice methods to identify, mitigate and manage peat slide hazards and associated risks in respect of consent applications for electricity generation projects. The scope of this report included the investigation and reporting on the following information:

- Site details including location, present use, proposed use etc.
    - Site Geology (bedrock, superficial deposits and made ground)
    - Site Hydrogeology
    - Site Hydrology

- Any site-specific requirements
- A summary of the intrusive site investigations completed at the site

The study includes the following interpretative elements:

- Interpretation of the findings of the site walkovers, non-intrusive and intrusive site investigations
- Details of site constraints which may affect proposed site layout and engineering options.
- List of potential hazards at the site arranged into a Design Risk Register which will highlight any topographic, geological or man-made hazards in the area and potential mitigation measures to be taken during the next stages of the project.

2. DESK STUDY

Prior to undertaking the site walkover and intrusive site investigations, a desk study was undertaken to help determine the baseline conditions within the study area and planning boundary to provide relevant background information. The desk top study involved an examination of the following sources of information:

- OSI (2020), Current and historic Ordnance Survey Ireland mapping and ortho-photography.
- Taluntais (1980), General Soil Map of Ireland
- Geological Survey of Ireland (2020) GSI Public Data Viewer (www.spatial.dcenr.gov.ie)
- Environmental Protection Agency (2020) Review of the EPA online mapping (http://gis.epa.ie/Envision).
- Study of the proposed layout of the development.

To determine the existing hydrogeological regime within the study area the following EPA and GSI online datasets and mapping from the sources outlined above were reviewed:

- Catchment & Management Units;
- Groundwater Bodies Status and Risk;
- Drinking Water Protection Areas;
- Groundwater Resources (Aquifers);
- Groundwater Wells and Springs;
- Karst Features; and
- Groundwater Vulnerability

2.1 Geology

2.1.1 Quaternary Deposits

The Quaternary Geology underlying the proposed CGEP is discussed below and presented in Figure 2.1. The subsoils present within the development site and wider study area were taken from the Geological Survey of Ireland (GSI) online mapping - Quaternary Geology of Ireland (1:50,000 scale) and comprise:

- Till derived from Devonian Sandstones (TDSs);
- Bedrock outcrop or sub-crop (Rck);
- Limited extent of blanket peat (BktPt).

As shown in Figure 2.1 the majority of turbine location and associated infrastructure are located within areas classified as Glacial Till derived from Devonian Sandstones. Areas of bedrock outcrop or sub crop are identified at locations T2, T14, T20 and T21.

The majority of the proposed grid connection route is underlain by Till derived from Devonian Sandstones with limited areas of bedrock sub-crop or outcrop indicated along the proposed route.

During site walkovers areas of shallow Peat/Peaty Topsoil deposits were noted to be limited in extent and thin with typical thicknesses of between 0.1 – 0.4m. At proposed turbine location T4 Blanket Peat deposits were encountered with an average depth of 0.4m and a maximum depth of 0.5m.

2.1.2 Solid Geology

The Geological Survey of Ireland (GSI) 1:100,000 scale bedrock geology map shows that the proposed wind farm development site is underlain by the Devonian Ballytrasna Formation.

The Ballytrasna Formation is described as comprising dusky-red mudstone with subordinate pale-red sandstones occurring throughout the formation.

The bedrock geology that is within the proposed wind farm site forms an anticlinal feature as it is part of the regional folding in the Devonian rocks between the Mallow and Cork anticline. There is one main unnamed fault close to the proposed development site running in a northeast – southwest direction. Other faults in the surrounding area either follow this trend or run in a north – south direction.

The proposed grid connection route traverses the Ballytrasna Formation, as described above for the majority of the route. The eastern extent of the grid connection is underlain by the Gyleen and Waulsortian Formations. The Upper Devonian Gyleen Formation is described by the GSI as comprising of fining upwards sequences of red Sandstones with thinly bedded alternations of green and red Sandstones, Siltstones and Mudstones. The Carboniferous Waulsortian Formation is described by the GSI as comprising massive un-bedded lime-mudstone.

The bedrock geology of the proposed CGEP and surrounding area is presented in Figure 2.2.

During site investigations weathered bedrock was encountered at depths ranging from 1.3m to 2.8m BGL. Intact bedrock was encountered at between 3.4m to 10.8m BGL. Where intact bedrock was encountered it was generally described as medium strong to strong thinly bedded SILTSTONE.

2.2 Hydrogeology

2.2.1 Groundwater Vulnerability

The Groundwater Vulnerability within the proposed CGEP boundary is classified by the GSI as ranging from 'High' to 'Extreme' with areas of exposed bedrock (X – Rock Near Surface) also present within the proposed development site. At the eastern extent of the proposed grid connection the vulnerability classification is reduced to 'Moderate'. The GSI distribution of groundwater vulnerability for the site area is shown in Figure 2.3 in Appendix 1.

Based on the GSI aquifer vulnerability mapping, overburden deposits are generally between 3 and 10 m deep in the central portion of the site; generally, 3 to 5 m deep in the north, east and south-east of the site; and <3m deep in the extreme west and north east of the site.

A summary of the groundwater vulnerability for the site is presented in Table 2.1. This table outlines the standard ratings of vulnerability used by the GSI, with the existing site conditions highlighted based on the findings of the site investigations.

Table 2.1: Groundwater Vulnerability

	Hydrogeological Conditions

Vulnerability Rating	Subsoil Permeability (Type) and Thickness		
	High Permeability (sand/gravel)	Moderate Permeability (sandy soil)	Low Permeability (clayey subsoil, clay, peat)
Extreme (E)	0 - 3.0 m	0 - 3.0 m	0 - 3.0 m
High (H)	> 3.0 m	3.0 -10.0 m	3.0 - 5.0 m
Moderate (M)	N/A	>10.0 m	5.0 - 10.0 m
Low (L)	N/A	N/A	>10 m

2.2.2 Groundwater Bodies Description

The proposed wind farm site and the majority of the proposed gird connection of the CGEP is located within the Glenville Groundwater Body (GWB). The eastern extremity of the proposed grid connection route traverses the Tallow GWB as shown in Figure 2.4.

The descriptions of the GWBs within the study area have been taken from the 'Summary of Initial Characterisation' draft reports for each defined GWB published by the GSI in accordance with the Groundwater Working Group Publication: Guidance Document GW2 (2003). The GWB Characterisation Reports are available from the GSI Public Data Viewer. Site specific data including depth to bedrock and subsoil type encountered during intrusive investigations has been used to supplement and validate the published information.

Ballinhassig GWB

The Ballinhassig GWB which underlies the access road to the Bottlehill landfill site adjacent to the CGEP development covers the upland areas of the River Lee catchments and its tributaries.. This GWB is bounded to the north by the Glenville GWB which is discussed in the following section. The dominant bedrock units of this GWB comprise the Devonian Old Red Sandstones which includes the Ballytrasna Formation which underlies much of the study area.

The GSI indicate that permeability within the GWB generally decreases rapidly with depth in all aquifers within this GWB. Aquifer categories within the Ballinhassig GWB are either Locally Important or Poor Aquifers. General transmissivities are reported by the GSI to be 'Low'. However, 'Excellent' yielding wells known in some of the Old Red Sandstone units – these yields are usually associated with boreholes being situated on fault zones.

Diffuse recharge will occur via rainfall percolating through the subsoil or areas of outcropping rock. The generally Low permeability of the aquifer and the sloping topography in the north of the GWB indicate that a high proportion of recharge to the aquifer will discharge rapidly to surface water features. Groundwater flow paths to surface water within the GWB are relatively short (from 30-300 m), with groundwater discharging to springs, or to the streams that traverse the aquifer.

Glenview GWB

Due to the general absence of intergranular permeability within the underlying Ballytrasna Formation, groundwater flow generally occurs in faults and joints within this GWB. The majority of the groundwater flow generally occurs in an upper, shallow weathered zone. This is due to the lesser frequency and connectivity of water-bearing fractures and fissures at depth within the GWB.

The main recharge mechanism for the GWB is via diffuse recharge from rainwater percolating through the subsoils. According to the GSI, groundwater within this GWB is generally unconfined with local groundwater flow towards the rivers and streams, and flow paths will not usually exceed a few hundred metres in length.

Tallow GWB

The Tallow GWB is classified as a Regionally Important Karstified Aquifer (Rkd) dominated by diffuse flow, underlying the eastern extent of the proposed grid connection route. The main aquifer lithology in this GWB is Dinantian Pure Unbedded Limestones (Waulsortian Limestone Formation) as shown in Figure 2.4. The bedrock aquifer is generally devoid of intergranular permeability with groundwater flow occurring in faults and joints, enlarged by karstification. Due to the high frequency of fissures in this GWB, overall groundwater flow is thought to be of a diffuse nature.

Sandstone ridges within the adjacent Glenview GWB provide surface water runoff which recharges the aquifer lithologies within the Tallow GWB. According to the GSI a small volume of groundwater may cross as throughflow from the sandstones in the Glenview GWB. Recharge within the Tallow GWB is via point and diffuse recharge.

Karst features such as swallow holes and collapse features provide the means for point recharge to the underlying aquifer. Diffuse recharge occurs across the entire GWB via rainfall percolating through the subsoil.

The GSI classifications for the aquifer in the study area, including the principal aquifer characteristics are summarised in Table 2.2, and shown on Figure 2.5. All aquifers in the study area are bedrock aquifers; there are no gravel aquifers within the study area (i.e. a gravel deposit of greater than 1 km^2 with a saturated thickness of greater than 5 m).

Table 2-2: Summary of Aquifer Classifications & Characteristics

Groundwater Body	European Code	Aquifer Name	GSI Aquifer Classification	Status	Transmissivity (m^2/day)
Ballinhassig	! IE_SW_G_005	Unnamed	Locally important aquifer- bedrock which is moderately productive only in local zones	Good	Typically, 2- 20 m^2/d
Glenville	IE_SW_G_037	Unnamed	Locally important aquifer- bedrock which is moderately productive only in local zones	Good	2- 20 m^2/d
Tallow	IE_SW_G_074	Unnamed	Regionally Important Karstified Aquifer	Good	270 – 1820 m^2/d

According to interim classification work carried out as part of the Water Framework Directive and published by the EPA, the Ballinhassig, Glenville and Tallow GWBs are classified as having *'Good'* status in terms of quality and quantity. The overall risk for both GWBs is under review by the EPA with regards to groundwater quality.

3. SITE WALKOVER

As part of the geotechnical assessment and peat stability assessment site walkovers were carried out by FT during June and August 2019, and also during August 2020. The objective of the site walkovers was to determine the baseline characteristics of the proposed wind farm site with the CGEP development. This included the recording of salient geomorphological features with respect to the wind farm development and to investigate peat thickness and peat strength where peat deposits were encountered.

The survey covered the proposed locations for the turbine bases, substation, met mast, construction compounds, existing and proposed new access roads and all associated infrastructure.

The method adopted for carrying out the site walkover relied on practitioners carrying out a visual assessment of the site supplemented with measurement of slope inclinations.

3.1 General

As outlined above, site walkovers were carried out by FT during June and August 2019 and August 2020. The method adopted for carrying out the site walkovers relied on practitioners carrying out a visual assessment of the site supplemented with recording of slope inclinations.

The peat stability assessment included a series of hand-held probes proposed infrastructure locations to determine the presence/depth of peat within the proposed development site. Visual observations were also made to assess the stability of other soil slopes and rock exposures across the site.

The main findings of the site walkovers within the wind farm site are as follows:

The slopes of the southern portion of the proposed development site (Bottlehill) are characterised by elevated lands with typical elevations of between 270m to 290m AOD with steep to moderate slopes to the west of the site boundary. Slopes within the proposed development and at proposed infrastructure locations generally comprise gentle slopes of between 1.7 to 3.4 degrees.

The central portion of the site (Mullenaboree) is also characterised by elevated lands with gentle slopes within the proposed development boundary of between 1.7 to 3.4 degrees at turbine locations T11 to T16. Elevations at this portion of the proposed development are generally lower than those at the south with typical elevations of between 220m to 260m AOD.

The northern portion of the proposed development (Knockdoorty) which includes turbine locations T17 to T23, proposed borrow pit BP03 and the proposed Lackendarragh North sub-station comprises elevated lands generally sloping steeply to the south. A ridge feature at the extreme northern boundary of the proposed development trends east-west and reaches maximum elevations of between 424m and 428m AOD to the north of turbines T21 and T23 respectively.

Slopes at proposed turbine locations in this portion of the development range from gentle (3.4 degrees) to moderate where maximum slope angles of 10.2 degrees at turbines T20 and T22 to 14.5 degrees at T21. These turbines are located along the east-west ridge at the north of the proposed development. Slopes at the proposed borrow pit BP03 are typically in the order of 6 degrees sloping the south-east.

Soft Peaty Topsoil deposits were noted at other proposed infrastructure locations, but these were generally very thin (0.1 to 0.6m thick) and were not considered to constitute Peat Deposits but rather a highly organic Topsoil with Peaty appearance.

No evidence of past failures or any signs of peat instability were noted on site.

No evidence of slope instability in other soil or rock slopes was observed at the site and there are no historical records of landslide activity within or close to the site, on the GSI database.

The forested areas, which comprise the majority of the proposed development site have been planted predominantly with conifers with some deciduous regrowth in marginal areas of the forestry plantations. Ground conditions within the forested areas typically comprise thin cover of soft organic Topsoil or peaty Topsoil over Mineral Soil and Glacial Till.

The underlying Mineral Soils and Glacial Till were occasionally exposed at the ground surface in the felled and forested areas. In agricultural lands soil exposures indicated a dark brown mineral soil. Weathered bedrock exposures were noted in existing cuttings associated with forestry access tracks at the northern portion of the proposed development site (Knockdoorty). The weathered bedrock exposures encountered were generally described as *Moderately weathered, medium strong to strong, MUDSTONE/SHALE.*

From site walkovers completed by FT it was noted all existing Coillte access tracks on site have been constructed using a founded construction method based on observations made during site walkovers. The access tracks for the proposed development will comprise upgrading of existing founded access tracks and construction of new proposed access tracks using excavate and replace construction techniques.

A total of 3 no. proposed borrow pit locations were inspected during the site walkover. The location of the proposed borrow pits are shown on Figure 1.1 in Appendix A. The borrow pits will be used to provide suitable cohesive/granular Fill material during construction of the proposed development. On visual inspection of a limited number of exposed ground conditions on site, the site won Fill material is likely to be suitable for re-use within the lower layers of access roads, hardstands and soil Fill to turbine foundations.

A summary of the information obtained during the field assessments is provided below in Table 3.1 over.

Table 3.1: Site Walkover Summary

Proposed Infrastructure	Land use	Quaternary Deposits (GSI Online Mapping)	Ground conditions encountered	Average Peat Depth (m)	Slope (degrees)	Depth to Bedrock (m) from Site Investigations	Groundwater Vulnerability (GSI Online Mapping
T02	Mature Forestry	Bedrock outcrop or sub-crop	Soft Peaty Topsoil with gentle to level topography	0.3 (Peaty Topsoil)	2	4.5m	X – Rock Near Surface
T03	Immature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	0.3 (Peaty Topsoil)	4	2.5m	High to Extreme
T04	Mature Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle topography	0.3m	2	6.4 - 12.5m	Extreme
T05	Mature Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.4m (Peaty Topsoil)	3	5.0 - 7.5m	High to Extreme
T06	Mature Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.3m (Peaty Topsoil)	4	3.5 - 4.5m	High
T07	Mature Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.6m (Amorphous Peat with silt laminations)	2	3.0m	Extreme
T08	Agricultural Land (Grassland)	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to level topography	None Present	2.2	6.0m	High to Extreme
T09	Felled forestry lands	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	None Present	3.4	2.5m	High
T10	Edge of mature forestry and agricultural land	Till derived from Devonian sandstones	Grassland with Loamy Topsoil, level topography	None Present	1.7	3.4 - 7.0m	High
T11	Agricultural Land (Grassland)	Till derived from Devonian sandstones	Grassland with Loamy Topsoil, level topography	None Present	1.7	2.4m	High
T12	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	None Present	1.1	5.0m	High
T13	Felled forestry lands	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.2m (Peaty Topsoil)	1.7	2.7m	High
T14	Mature Forestry	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle topography	None Present	2.2	4.8m	X – Rock Near Surface
T15	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	None Present	3.4	4.0 - 10.0m	High
T16	Mature Forestry	Till derived from	Soft Organic Topsoil with	None Present	3.4	4.5	High

		Devonian sandstones	gentle topography				
T17	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	None Present	3.4	2.0 - 4.5m	High
T18	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	None Present	4	8.0m	High
T19	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	None Present	5	5.6m	High
T20	Mature Forestry	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderately sloping topography	None Present	10.2	3.4 - 10.0m	X – Rock Near Surface
T21	Mature Forestry	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderate to steep slopes	None Present	14.5	10.0m	X – Rock Near Surface
T22	Mature Forestry	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderate to steep slopes	None Present	10.2	4.0m	Extreme to X – Rock Near Surface
T23	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderate slopes	None Present	5	8.6m	Extreme
BP1	Young Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle slopes	None Present	3	2.5-2.7m	Extreme
BP2	Mature Forestry	Till derived from Devonian sandstones	Exposed Mineral Soil with gentle slopes	None Present	3	2.0 – 2.8m	High
BP3	Mature Forestry	Bedrock outcrop or sub-crop	Exposed Mineral Soil with moderate slopes	None Present	6	NP	Extreme
Lackendarragh North Substation	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle slopes	-	3	-	High
Temporary Compound (South)	Young Forestry	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle slopes	0.2m (Peaty Topsoil)	3	-	Extreme
Temporary Compound (North)	Mature Forestry	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle slopes	-	3	-	Extreme

4. GROUND INVESTIGATIONS

Intrusive and non-intrusive site investigations were undertaken by Irish Drilling Ltd (IDL) and Minerex Environmental Ltd under the supervision of an Engineering Geologist from FT in June to October 2019 with additional works undertaken in October and November 2020.

The scope of the site investigations is summarised below with the information obtained referenced in this chapter:

- Advancement of 18 No. trial pits to a maximum depth of 4.4m below ground level (BGL) at proposed borrow pit locations and selected turbine locations.
- Advancement of 3 No. cable percussive/rotary boreholes to a maximum depth of 15m BGL at proposed horizontal directional drilling (HDD) locations at water crossings locations W06, W08 and W19 along the proposed grid connection route.
- Collection of samples for environmental and geotechnical testing.
- Seismic Refraction Profiling, 2D Electrical Resistivity (ERT) surveying and Seismic Refraction (P-Wave) along pre-designated transects at proposed turbine locations.

The ground investigation was carried out in accordance with the principles in BS 5930:2015 and Eurocode 7 Part 2. A ground investigation location plan showing all trial pit and borehole locations is included as Figure 4.1 in Appendix A of this report.

4.1 Summary of Ground Conditions Encountered

The following section describes the ground conditions encountered during ground investigation completed at the proposed watercourse crossing locations, selected proposed turbine locations and proposed borrow pit locations. A summary of the findings of the geophysical surveys completed at each of the proposed turbine locations is also included below.

4.1.1 Proposed HDD Watercourse crossing Locations

At the proposed water crossing WC006, borehole RC01 encountered Made Ground below the asphalt layer within the existing public road to a maximum depth of 2.0m BGL. This was described as comprising *Subangular fine Limestone GRAVEL*. This was underlain by a thin layer of overburden described as comprising Clay & Gravel to a maximum depth of 2.6m BGL.

Underlying the Made Ground and overburden deposits Weathered Bedrock was encountered between 2.6m and 3.4m BGL and was described as Weathered SILTSTONE. This was recovered in the borehole arising as *Angular fine to coarse gravel sized clasts of purple SILTSTONE with purple SILT.*

Competent bedrock was encountered at 3.4m BGL to the maximum depth of RC01 at 7.5m BGL. The bedrock recovered in RC01 comprised *Strong locally medium strong thinly bedded purple fine-grained SILTSTONE.* Between 3.80m to 3.90m BGL and 4.50m to 4.60m BGL weathered infill material comprising Firm *purple SILT* was noted in recovered core.

Borehole RC02 was advanced at HDD crossing WC007 to a maximum depth of 14.2m BGL. Overburden deposits were encountered below the thin asphalt layer (0.03m) within the existing public road. These deposits

comprised *Sub-rounded to sub-angular fine to coarse assorted grey limestone and grey purple and dark brown sandstone GRAVEL* to 10.8m BGL. The Gravel deposits were underlain by bedrock described as *Medium strong thinly bedded greenish brown slightly sandy fine-grained SILTSTONE.*

Weathered infill material was noted between 12.50m to 12.60m BGL and 13.60m to 14.20m BGL. This infill material was described as *greyish green slightly gravelly SILT* and *grey/green SAND* respectively.

Borehole RC03 was advanced at proposed HDD crossing location WC019 to a maximum depth of 15.0m BGL. Made Ground was encountered to 0.8m BGL and comprised Asphalt (0.2m) underlain by *Angular fine and medium purple siltstone GRAVEL with purple SILT.* This was underlain by a gravel horizon at 7.3m BGL which was described as *Subangular to sub-rounded fine to coarse assorted grey limestone and assorted grey and brown sandstone GRAVEL with pink brown SILT*. This horizon was encountered the maximum depth of exploration at 15.0m BGL. Gravel deposits were generally Medium Dense becoming Dense at 12.5m BGL.

4.1.2 Proposed Borrow Pit Locations

Exploratory trial pits were advanced at proposed borrow pit locations BP01, BP02 and BP03 to assess potential for use of site won materials as general Fill material for the construction of elements of the proposed development. Geotechnical and environmental samples were also collected from trial pits with the results discussed in Section 4.2 of this report.

A total of 2 No. trial pits (BP-TP01 and BP-TP02) were advanced at BP01 to a maximum depth of 2.7m BGL where bedrock obstruction was encountered.

The ground profile at BP01 generally comprised granular overburden deposits typically comprising slightly sandy silty gravelly Cobbles. Bedrock was encountered in each trial pit advanced at BP01 at depths of 2.5m to 2.7m BGL.

A total of 4 No. trial pits (BP2-TP01, BP2-TP02, BP2-TP03 and BP2-TP04) were advanced at BP02 to a maximum depth of 2.9m BGL where bedrock obstruction was encountered. The ground profile at BP02 generally comprised thin cover deposits comprising thin Peat cover at BP2-TP03 (0.3m thick), firm orange and purplish brown SILT with cobbles and Made Ground to a maximum depth of 1.1m BGL.

These deposits were underlain by granular overburden deposits typically *clayey sandy subangular medium to coarse GRAVEL with high Cobble content* and *slightly silty sandy gravelly subangular siltstone COBBLES*.

SILTSTONE bedrock was encountered in each trial pit advanced at BP02 at depths of between 2.0m to 2.8m BGL. Where the SILTSTONE encountered was weathered it was typically recovered from the trial pits as *angular and blocky Cobble and Boulder sized clasts of SILTSTONE.*

A total of 2 No. trial pits (BP3-TP01 and BP3-TP03) were advanced at BP03 to a maximum depth of 3.9m BGL. At trial pit BP3-TP01 *peaty silty TOPSOIL* was encountered to 0.6m BGL where it overlies *Firm yellow/brown slightly sandy SILT with rootlets* to 1.1m BGL. Below 1.0m BGL a *Stiff purplish brown slightly gravelly sandy CLAY with high Cobble content and medium Boulder content* was encountered to 3.8m BGL where obstruction from Boulders was encountered.

Trial pit BP3-TP03 was advanced to a depth of 3.9m BGL. Here a *Stiff orange/brown and purple/brown gravelly SILT with high Cobble content and medium Boulder content* was encountered between 0.9m to 3.9m BGL. These SILT deposits were overlain by a *Stiff orangish brown CLAY with low Cobble content* was encountered from ground level to 0.9m BGL.

comprised *Sub-rounded to sub-angular fine to coarse assorted grey limestone and grey purple and dark brown sandstone GRAVEL* to 10.8m BGL. The Gravel deposits were underlain by bedrock described as *Medium strong thinly bedded greenish brown slightly sandy fine-grained SILTSTONE.*

Weathered infill material was noted between 12.50m to 12.60m BGL and 13.60m to 14.20m BGL. This infill material was described as *greyish green slightly gravelly SILT* and *grey/green SAND* respectively.

Borehole RC03 was advanced at proposed HDD crossing location WC019 to a maximum depth of 15.0m BGL. Made Ground was encountered to 0.8m BGL and comprised Asphalt (0.2m) underlain by *Angular fine and medium purple siltstone GRAVEL with purple SILT.* This was underlain by a gravel horizon at 7.3m BGL which was described as *Subangular to sub-rounded fine to coarse assorted grey limestone and assorted grey and brown sandstone GRAVEL with pink brown SILT*. This horizon was encountered the maximum depth of exploration at 15.0m BGL. Gravel deposits were generally Medium Dense becoming Dense at 12.5m BGL.

4.1.2 Proposed Borrow Pit Locations

Exploratory trial pits were advanced at proposed borrow pit locations BP01, BP02 and BP03 to assess potential for use of site won materials as general Fill material for the construction of elements of the proposed development. Geotechnical and environmental samples were also collected from trial pits with the results discussed in Section 4.2 of this report.

A total of 2 No. trial pits (BP-TP01and BP-TP02) were advanced at BP01 to a maximum depth of 2.7m BGL where bedrock obstruction was encountered.

The ground profile at BP01 generally comprised granular overburden deposits typically comprising slightly sandy silty gravelly Cobbles. Bedrock was encountered in each trial pit advanced at BP01 at depths of 2.5m to 2.7m BGL.

A total of 4 No. trial pits (BP2-TP01, BP2-TP02, BP2-TP03 and BP2-TP04) were advanced at BP02 to a maximum depth of 2.9m BGL where bedrock obstruction was encountered. The ground profile at BP02 generally comprised thin cover deposits comprising thin Peat cover at BP2-TP03 (0.3m thick), firm orange and purplish brown SILT with cobbles and Made Ground to a maximum depth of 1.1m BGL.

These deposits were underlain by granular overburden deposits typically *clayey sandy subangular medium to coarse GRAVEL with high Cobble content* and *slightly silty sandy gravelly subangular siltstone COBBLES*.

SILTSTONE bedrock was encountered in each trial pit advanced at BP02 at depths of between 2.0m to 2.8m BGL. Where the SILTSTONE encountered was weathered it was typically recovered from the trial pits as *angular and blocky Cobble and Boulder sized clasts of SILTSTONE.*

A total of 2 No. trial pits (BP3-TP01 and BP3-TP03) were advanced at BP03 to a maximum depth of 3.9m BGL. At trial pit BP3-TP01 *peaty silty TOPSOIL* was encountered to 0.6m BGL where it overlies *Firm yellow/brown slightly sandy SILT with rootlets* to 1.1m BGL. Below 1.0m BGL a *Stiff purplish brown slightly gravelly sandy CLAY with high Cobble content and medium Boulder content* was encountered to 3.8m BGL where obstruction from Boulders was encountered.

Trial pit BP3-TP03 was advanced to a depth of 3.9m BGL. Here a *Stiff orange/brown and purple/brown gravelly SILT with high Cobble content and medium Boulder content* was encountered between 0.9m to 3.9m BGL. These SILT deposits were overlain by a *Stiff orangish brown CLAY with low Cobble content* was encountered from ground level to 0.9m BGL.

4.1.3 Proposed Turbine Locations

Exploratory trial pits were advanced at selected proposed turbine locations T13, T20, T22 and T23 based on potential ground risks from moderate slopes noted during site walkovers. Trial pits were also excavated at T3, T6 and T7. Geotechnical and environmental samples were also collected from trial pits with the results discussed in Section 4.2 of this report.

At proposed turbine location T3 trial pit TP-T03 was advanced to a maximum depth of 4.4m. The ground conditions comprised thin peaty topsoil (0.3m thick) overlying a *stiff grey slightly gravelly sandy Silt* to 4.0m BGL. Between 4.0m and 4.4m BGL a *light grey slightly gravelly silty SAND* was recorded.

At proposed turbine location T6 trial pit TP-T06 was advanced to a maximum depth of 3.0m where an obstruction was encountered, recorded as *angular to tabular clay smeared cobbles of SILTSTONE*. The ground conditions comprised Made Ground, described as a *black peaty silt mixed with stiff orange brown sandy gravelly silt* to a depth of 2.0m BGL. Between 2.0m and 2.4m BGL a *stiff orange brown slightly sandy slightly gravelly SILT* was recorded. This overlay weathered bedrock at 2.4m BGL which was described as *angular to tabular clay smeared cobbles of SILTSTONE.*

At proposed turbine T7 trial pit TP-T07 was advanced to a maximum depth of 4.0m BGL. The ground conditions encountered comprised thin peaty topsoil (0.6m thick) overlying a stiff brown sandy SILT to a depth of 1.3m BGL. This was underlain by a *grey silty gravelly SAND* to 4.0m BGL.

At proposed turbine location T13 trial pit TP-T13 was advanced to a maximum depth of 2.7m BGL where an obstruction was encountered from the presence of SHALE/MUDSTONE bedrock at 2.7m BGL. The ground conditions encountered at T13 comprised thin Peat cover (0.2m thick) overlying a *Firm brown slightly sandy SILT* to 0.6m BGL.

Between 0.6m to 2.0m BGL SAND and GRAVEL deposits were encountered which in turn overlaid Weathered Bedrock at 2.0m BGL which was described as SHALE/MUDSTONE and recovered from the trial pit as angular Cobbles of SHALE/MUDSTONE with Clay.

At proposed turbine T20 Weathered Bedrock was encountered at 1.3m BGL which was described as angular flat and tabular gravel and cobbles of SHALE/MUDSTONE. The trial pit was terminated at 4.0m BGL where obstruction due to competent bedrock was encountered. The Weathered Bedrock was overlain by a *Stiff purple CLAY with high Cobble content* between 0.6m to 1.3m BGL. This was overlain by a *Firm purple/brown slightly gravelly SILT* encountered from ground level to 0.6m BGL.

At proposed turbine location T22 trial pit TP-T22 was advanced to a maximum depth of 4.0m BGL where an obstruction was encountered from the presence of SHALE/MUDSTONE Bedrock at this depth. The ground conditions encountered at T22 comprised thin Peat cover (0.3m thick) overlying a *Soft orange/brown sandy SILT* to 1.2m BGL. Between 1.2m and 1.9m BGL GRAVEL deposits were encountered which in turnover laid Weathered Bedrock at 1.9m BGL which was described as SHALE/MUDSTONE and recovered from the trial pit as flat and angular cobbles of SHALE/MUDSTONE.

At proposed turbine location T23 trial pit TP-T23 was advanced to a maximum depth of 4.3m BGL. The ground conditions encountered at T23 comprised a *Stiff purple slightly sandy CLAY with low Cobble content* to 0.35m BGL. This was underlain by a *Purple/orange silty gravelly fine to coarse SAND with low Cobble content* to 0.9m BGL. Between 0.9m to 3.2m BGL SAND and GRAVEL deposits described as *Purple silty fine to medium SAND and sub-rounded fine to medium GRAVEL with low Cobble content* were encountered. These were underlain by a *Stiff purple slightly sandy slightly gravelly CLAY with medium Cobble content and low Boulder* content to the maximum depth of excavation at 4.3m BGL.

4.1.4 Geophysical Surveys

Geophysical survey works consisting of a 2D-Resistivity and Seismic Refraction Profile centred on the proposed turbine locations was completed by Minerex Geophysics Ltd (MXL). At the proposed turbine locations a 2D-Resistivity and a seismic refraction profile was completed. At the majority of the turbines the survey transect was centred with the proposed turbine location completed.

Each 2D-Resisitivity profile had 32 electrodes with a 3m spacing to give 93m length per profile while each seismic refraction profile was carried out using a 2m spacing and 24 geophones, giving a 46m long profile. The findings of the geophysical survey are presented in Appendix 4 of this document. A summary of the findings is presented below with the interpreted depth to bedrock outlined above in Table 3.1 at locations where no intrusive investigations were completed.

The findings of the 2D-Resistivity survey identified a range of typical resistivity values for materials at all proposed turbine locations. These ranged from clay rich overburden or peat (low resistivities) to fresh strong un-weathered bedrock (high resistivities). Within overburden layers, low resistivity values (<250 Ohmm) typically indicates sandy gravelly clay and silt. Medium values (250 to 1000 Ohmm) show a clayey silty Sand and Gravel. High resistivities (>1000 Ohmm) indicate a clean sand and gravel overburden. Within bedrock layers, low resistivities indicate Mudstone, medium resistivities are interpreted as interbedded Mudstone and Sandstone while high resistivities indicate Sandstone bedrock.

The seismic refraction survey was also used to estimate the density of subsurface materials. The higher the density of the subsurface materials, the higher the seismic velocity. A total of 7 no. seismic layers have been determined by analysing the seismic traces. The resulting seismic layer boundaries are then overlain on the 2D-Resistivity cross sections to give a profile of estimated material density at each turbine location. A full interpretation of the geophysical survey results and associated cross sections and profiles is presented in Appendix C.

4.1.5 Groundwater Encountered

Groundwater was encountered in all boreholes advanced at the proposed HDD water crossing locations. Groundwater strikes in boreholes RC02 and RC03 during drilling works were encountered within the Gravel or Silt deposits encountered at these locations. In borehole RC01 groundwater was encountered at the intersection with Weathered Bedrock at approximately 2.5m BGL.

During trial pit excavations minor shallow (perched) groundwater seepage to moderate ingress was noted in certain trial pits. Table 4.1 shows the groundwater strikes encountered during the intrusive site investigations. The remainder of site investigation location were noted as being dry during the works.

At proposed turbines T13 and T20 groundwater seepage was noted in trial pits at 2.0m and 3.5m BGL respectively. At turbine location T22 a moderate ingress of groundwater into the trial pit was observed at 2.0m BGL.

Table 4.1: Summary of Groundwater Encountered

Borehole/Trial Pit ID	Groundwater Strike (m bgl)
RC01	6.0m
RC02	4.0m
RC03	2.5m

BP-TP01 (at BP01)	Seepage at 2.0m
BP-TP02 (at BP01)	None Encountered
BP2-TP01	None Encountered
BP2-TP02	None Encountered
BP2-TP03	None Encountered
BP2-TP04	Seepage at 3.0m
BP2-TP01	None Encountered
BP3-TP03	Seepage at 0.6m
TP-T03	Seepage at 1.2m
TP-T06	None Encountered
TP-T07	Slight inflow at 3.0m
TP-T13	Seepage at 2.0m
TP-T20	Seepage at 3.5m
TP-T21	None Encountered
TP-T22	Moderate Ingress at 2.0m

4.2 Geotechnical Laboratory Testing

Following completion of intrusive site investigations by IDL laboratory testing was scheduled by FT. Soil and Rock testing was carried out in accordance with BS1377 (1990) - *Methods of Test for Soils for Civil Engineering Purposes* in their own designated Materials Laboratory, accredited in accordance with the Irish National Accreditation Board (INAB).

The samples of the overburden material (Glacial Till) were analysed for a range of parameters which included Particle Size Distribution (PSD), moisture content and Atterberg Limits. Chemical testing was also undertaken to determine Concrete Classification from the derived Sulphate Class for buried concrete. Testing was also completed on rock samples obtained from cores retrieved during rotary drilling works. These included Point Load Index and Uniaxial Compressive Strength testing.

The analysis results are summarised in Table 4.2 over.

Table 4.2: Laboratory Testing

Type	N	Min	Max	Remarks
Natural Moisture Content (%)	29	0.6	31	Typical moisture content values for Gravel Deposits were between 0.6% to 22%. For cohesive deposits moisture content values ranged from between 11% to 26%
Atterberg Limits	11	PI: 6	PI: 21	Liquid Limit, LL 24% to 39% Plastic Limit, PL 15% to 29% Plasticity Index, PI 1 to 30
Particle Size Distribution	29	-	-	Material encountered ranges from sandy gravelly SILT/CLAY to sandy clayey GRAVEL PSD test results from proposed borrow pits confirm indicate material to be Class 1 (granular fill) or Class 2 (cohesive fill)
California Bearing Ratio Test (%)	3	0.2	1.7	

Moisture Condition Value (MCV)	8	3.4	12.5	
Point Load Index (MPa)	3	0.4	0.8	
Uniaxial Compressive Strength (MPa)	1	4.9	4.9	
pH	12	5.46	8.58	
Chloride (Water Soluble) (mg/l)	9	7.19	13.8	
Sulphate as SO_4 (Total)	9	ND	ND	

5. GROUND MODEL

The site walkover and ground investigations have generally confirmed the anticipated geology described in the Desk Study. A summary of the geological strata encountered during the ground investigations is summarised in Table 5.1 below.

Table 5.1: Summary of Geology Encountered

Strata	General Description	Depth to Top Range (m bgl)	Depth to Bottom Range (m bgl)
Peaty Topsoil	*Black amorphous Peat*	0.0 – 0.3	0.1 – 0.6*
Made Ground	*Slightly gravelly silty medium to coarse Sand* *or* *Sub-angular fine Limestone Gravel* *Or* *Firm brown gravelly Clay* *Or* *Orange brown sandy gravelly Silt*	0.0	0.3 – 2.0
Glacial Till (SILT)	*Soft to Stiff sandy gravelly SILT*	0.0 – 0.9	0.4 – 7.3
Glacial Till (CLAY)	*Firm to stiff slightly sandy slightly gravelly CLAY*	0.0 – 3.2	0.35 – 4.3 (ND)
Glacial Till (SANDS & GRAVELS)	*Clayey gravelly fine to coarse SAND with Cobbles* *Or* *Silty sandy fine to coarse sub-angular to angular GRAVEL with Cobbles and/or Boulders*	0.4 – 7.3	2.0 - 15.0 (ND)
Weathered Bedrock (Ballytrasna Formation)	*Angular and blocky Cobble and Boulder sized clasts of SILTSTONE/MUDSTONE*	1.3 – 2.8	2.7 – 4.0
Bedrock (Ballytrasna Formation)	*Medium strong thinly bedded greenish brown slightly sandy fine-grained SILTSTONE/MUDSTONE.*	2.7 – 10.8	>14.2 (limit of borehole)

*From peat probing and intrusive investigation.

6. SLOPE STABILITY ASSESSMENT

6.1 Factors Controlling the Stability of Slopes

The factors controlling the stability of slopes are:

- Slope geometry
- Geology
- Properties of the slope material
- Groundwater levels
- Surcharge.

From a review of the GSI Landslide Susceptibility database the proposed development and proposed infrastructure locations are generally located within areas of 'Low' susceptibility. The exceptions are T20 and T21 (Moderately High) and T22 (Low to Moderately Low). These turbines are all located in the northern portion of the proposed development.

Slopes at these proposed turbine locations were recorded during site walkover to be moderate/steep with maximum slope angles of 10.2 degrees at turbines T20 and T22 to 14.5 degrees at T21. These turbines are located along the east-west ridge at the north of the proposed development. Since these are the worst-case slopes within the development where the landslide susceptibility is greater that 'Low' these locations were selected for slope stability assessment in accordance with the principles of Eurocode 7 (IS EN 1997-1).

6.2 Eurocode 7 and Partial Factors

In accordance with the principles of Eurocode 7 (IS EN 1997-1), rather than using a global factor of safety as per previous design codes, the factors of safety (termed partial factors) are applied to the chosen characteristic values to obtain design values. Actions (influences) are multiplied by the safety factor, while resistances are divided by the safety factor.

In accordance with Eurocode 7 (IS EN 1997-1), geotechnical checks must be carried out to ensure that the resistance preventing a slide are greater than or equal to the actions which cause a slide, i.e.:

$$E_d <= R_d$$

Where:

E_d = Sum of design actions
R_d = Sum of design resistances

By adopting the methods of analysis given in Eurocode 7 (IS EN 1997-1), the factor of safety against failure is ***included*** in the partial factors (ranging from 1.0 to 1.3 for various parameters) applied to the analysis rather than to the end result. In order to verify that this condition is met, the resulting "safety ratio" must be equal or greater than 1.0 in order to verify that the above condition is met. i.e.: An in-situ "safety ratio" of less than 1.0 indicates that the slope currently has an inadequate factor of safety against failure and therefore is potentially unstable. Ratios greater than 1.0 indicate an adequate factor of safety against failure and are considered stable in both short and long term.

Table 6.1: Partial Factors used to Derive Design Parameters

Partial Factor		Parameter
$\gamma_{c'}$	1.25	Effective cohesion
$\gamma_{\phi'}$	1.25	Effective angle of friction
γ_{γ}	1	Soil density
γ_{Q}	1.3	Loading (unfavourable)
$\gamma_{R;e}$	1	Earth resistance

Table 6.1 shows the partial factors which have been applied to the characteristic values to give the derived parameters in Table 6.2 and 6.3 used during the slope stability analyses. The design parameter is derived by multiplying or dividing the characteristic values by the associated partial factor, i.e. tan 15(ϕ') / 1.25($\gamma_{\phi'}$) = 12.1°.

6.3 Slope Stability Analysis Method

SLOPE/W software of GEO-SLOPE International Ltd. was used to assess the stability of proposed slopes at turbine locations T20, T21 and T22. SLOPE/W is a general software tool for the slope stability analysis of earth structures.

It uses the limit equilibrium method of analysis by using the idea of dissecting a potential sliding mass into vertical slices. It assesses the factor of safety for both moment and force equilibrium based on various methods, including Bishop, Janbu and Morgenstern-Price.

Using this software, it is possible to deal with complex stratigraphy, highly irregular pore-water pressure conditions, a variety of linear and nonlinear shear strength models, virtually any kind of slip surface shape, concentrated loads and pressure lines. Limit equilibrium formulations based on the method of slices are also being applied more and more to the stability analysis of structures such as tieback walls, nail or fabric reinforced slopes, and even the sliding stability of structures subjected to high horizontal loading arising.

Traditionally, the factor of safety is defined as that factor by which the shear strength of the soil must be reduced in order to bring the mass of soil into a state of limiting equilibrium along a selected slip surface. The results of the analysis show the overall stability of the embankment expressed as a factor of safety.

The definition of factor of safety used within SLOPE/W is:

$$F = \frac{\text{Available restoring moment (or forces)}}{\text{Total disturbing moment (or forces)}}$$

Design values for use in the slope stability analysis have been derived using Eurocode 7 (IS EN 1997-1) Design Approach 3. This design approach is considered to be the most logical approach for slope stability analysis as it includes partial factors for both material properties and variable loads (for example traffic loads).

6.4 Limitations of Slope Stability Analysis

The application of traditional stability analysis such as this can be misleading as they assume a circular slip surface is the ultimate limit state. In reality, the ultimate limit state is likely to be non-circular in nature and as such these models may not be strictly modelling the critical limit state. Slope/W allows for some optimisation of the slip surface within its analysis which reduces this limitation to some extent.

Despite the limitations outlined above, this method of slope analysis is still considered to provide a conservative analysis of the ultimate limit state and its use is in accordance with current industry best practice.

6.5 Material Properties

Table 6.2 below shows the typical parameters used for the Glacial Till and bedrock encountered beneath the turbine locations T20, T21 and T22 in the Drained conditions.

Table 6.2: Characteristic Parameters for Materials

Material	Glacial Till (Granular)	Glacial Till (Cohesive)	Bedrock (Weathered)	Bedrock (Intact)
Cohesion, c', kN/m^2	0	5	0	4000
Effective Friction angle, ϕ',	35	30	35	30
Bulk unit weight, γ, kN/m^3	21	20	21	22

Table 6.3 below shows the design parameters which have been derived using the partial factors given in Table 6.1.

Table 6.3: Design Parameters for Materials

Material	Glacial Till (Granular)	Glacial Till (Cohesive)	Bedrock (Weathered)	Bedrock (Intact)
Cohesion, c', kN/m^2	0	4	0	3200
Effective Friction angle, ϕ',	28.1	21.3	28.1	21.3
Bulk unit weight, γ, kN/m^3	21	20	21	22

6.6 Loading

A modelled foundation loading of $280kN/m^2$ was conservatively applied to the slopes during the analyses to simulate the turbine foundation on the slopes. After applying a partial factor of 1.3 as per IS EN 1997-1 Design Approach 3 (variable, unfavourable action), a design load of $364kN/m^2$ has been applied to the models.

For the purposes of the slope stability modelling all shallow soft deposits have been removed from the proposed location of the turbine foundation.

6.7 Slope Stability Analysis Models

Three Slope/W models have been presented to reflect the proposed slopes at the turbine locations as outlined below:

- Model 1- Turbine T20
- Model 2 – Turbine T21
- Model 3 – Turbine T22

The results of those analyses are summarised in Table 6.4 with safety ratios calculated for the Morgenstern-Price method. The critical slope analysis is presented graphically for the turbine locations in Figures 6.1, 6.2 and 6.3 using the Morgernstern-Price method of analysis and in Appendix B of this report.

6.8 Slope Stability Analysis Results

Safety ratios for potential slope failures (Table 6.4) ranged from 1.528 to 2.822. Analyses were undertaken for both deep-seated (rotational) type slips and shallow (translational) type although the shallow translations failures within the overburden deposits gave the lower safety ratios.

Table 6.4: Slope Analysis Results

Model Name	Turbine Location	Morgenstern-Price FoS
Model 1	T20	2.822
Model 2	T21	1.528
Model 3	T22	2.822

Safety ratios for potential slope failures for drained conditions ranged from 1.528 to 2.822 at proposed turbine locations T20, T21 and T22. By adopting the methods of analysis given in IS EN 1997-1, the factor of safety (FoS) against failure is included in the partial factors applied to the analysis rather than to the end result. A safety ratio of greater than 1.0 indicates that the slope is considered stable in the long-term drained conditions.

In order to maintain the safety of the slopes during the foundation and hardstands excavation works and associated cut and fill activities groundwater and surface water drainage should be maintained to mitigate the potential instability of the slopes. It is also recommended that surcharging loads i.e. construction traffic is limited to 10kN/m^2 and a 0.5m exclusion zone from the edge of the crest of constructed slopes is maintained to prevent surface failures or shoulder failure at the crest of the slope.

In addition, it is recommended that the slopes are inspected after extended periods of heavy rain for any signs of instability such as tension cracks at the top of the slopes or bulging near the toe of slopes.

7. GEOTECHNICAL CONSIDERATIONS

7.1 Turbine Foundations

Based on the findings of the site investigations undertaken to date, a preliminary assessment of the likely foundation types found that a gravity foundation construction (founded) would be suitable for all of the proposed turbine foundations.

At the underside of the turbine foundation, a layer of structural up-fill (class 6N/6P - in accordance with TII requirements) will be required.

It should be noted that at detailed design stage a detailed ground investigation will be carried out at each proposed turbine locations to confirm the turbine foundation type. The ground investigation will be in the form of a borehole with in-situ SPT testing at 1.0m intervals in the overburden and follow-on rotary core through bedrock.

A summary of turbine foundations type, estimated depth and founding stratum is provided below in Table 7.1.

Table 7.1: Turbine Foundation Summary

Proposed Infrastructure	Quaternary Deposits (GSI)	Ground Conditions Encountered	Average Peat Depth (m)	Slope (degrees)	Depth to Bedrock	Foundation Recommendation
T02	Bedrock outcrop or sub-crop	Soft Peaty Topsoil with gentle to level topography	0.3 (Peaty Topsoil)	2	4.5m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T03	Till derived from Devonian sandstones	Soft Organic Topsoil overlying stiff cohesive glacial deposits, with gentle topography	0.3 (Peaty Topsoil)	4	0.6 - 2.5m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T04	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	0.3m	2	6.4 -12.5m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T05	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.4m (Peaty Topsoil)	3	5.0m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T06	Till derived from Devonian sandstones	Made Ground overlying stiff cohesive glacial deposits, with gentle to level topography	0.3m (Peaty Topsoil)	4	2.4m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T07	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.6m (Amorphous peat with silt laminations)	2	3.5m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T08	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to level topography	-	2.2	6.0m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T09	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	-	3.4	2.5m	Gravity foundation up to 3.0m BGL. Groundwater control may be required.
T10	Till derived from Devonian sandstones	Grassland with Loamy Topsoil, level topography	-	1.7	3.4 - 7.0m	Gravity foundation up to 3.0m BGL It is recommended to excavate to weathered bedrock level. Groundwater control may be required.

T11	Till derived from Devonian sandstones	Grassland with Loamy Topsoil, level topography	-	1.7	2.4m	Gravity foundation up to 4.0 m BGL to be filled with compacted structural fill
T12	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	-	1.1	5.0m	Gravity foundation up to 3.0 m BGL. Deeper excavation is required due to differences in the topographical elevation. Lateral change to cohesive is probable.
T13	Till derived from Devonian sandstones	Soft Peaty Topsoil with gentle to level topography	0.2m (Peaty Topsoil)	1.7	2.7m	Gravity foundation up to 5.0 m BGL to be filled with compacted structural fill. It is recommended to bench the excavation. Groundwater control may be required
T14	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle topography	-	2.2	4.8m	Gravity foundation up to 3.0 m BGL. Sub-formation should be compacted. Groundwater control may be required
T15	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	-	3.4	4.0 - 10.0m	Gravity foundation up to 3.0 m BGL. Sub-formation should be compacted. Groundwater control may be required
T16	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle topography	-	3.4	4.5	Gravity foundation up to 3.0 m BGL. Lateral variability is expected. Sub-formation should be compacted. Groundwater control may be required
T17	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	-	3.4	2.0 - 4.5m	Gravity foundation up to 3.0 m BGL. Sub-formation should be compacted. Groundwater control may be required
T18	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	-	4	8.0m	Gravity foundation up to 3.0 m BGL. Sub-formation should be compacted. Groundwater control may be required
T19	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderately sloping topography	-	5	5.6m	Gravity foundation up to 4.0 m BGL to be filled with compacted structural fill. Sub-formation should be compacted. The excavation must be benched. Groundwater control may be required
T20	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderately sloping topography	-	10.2	3.4 - 10.0m	Gravity foundation up to 5.0 m BGL to be filled with compacted structural fill. Groundwater control may be required
T21	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderate to steep slopes	-	14.5	10.0m	Gravity foundation up to 3.0 m BGL. Sub-formation must be compacted. Groundwater control may be required
T22	Bedrock outcrop or sub-crop	Soft Organic Topsoil with gentle to moderate to steep slopes	-	10.2	4.0m	Gravity foundation up to 4.0 m BGL to be filled with compacted structural fill. Sub-formation must be compacted. Groundwater control may be required
T23	Till derived from Devonian sandstones	Soft Organic Topsoil with gentle to moderate slopes	-	5	8.6m	Gravity foundation up to 4.0 m BGL to be filled with compacted structural fill. Groundwater control may be required

7.2 Access Tracks

It is considered all newly constructed access road will be of the founded type. Existing access road infrastructure will be incorporated into the design or improved upon through the use of widening and strengthening.

Founded roads are used in areas where competent ground is encountered at shallow depth. These roads are constructed by excavating until competent strata is encountered and then filling with a compacted 6F2 granular fill to road level. A layer of Class 804 material (in accordance with 800 Series of the Specification for Road Works) is then used as a surfacing layer.

Tracks shall be observed during earthworks operations, if excessive rutting occurs, the pavement depth shall be increased.

Stone fill of suitable Class 6F2 material will be placed and compacted in accordance with the TII Specification for Road Works.

Where bearing stratum has slope greater than 1:5, benching should be carried out. Benches to be 0.5m Vertical & 1.0m Horizontal, with maximum crossfall of 2% on Horizontal section.

7.3 Crane Hardstands

Crane hardstands will all be founded. Crane hardstands are generally constructed using compacted Class 1/6F material on a suitable sub-formation to achieve the required bearing resistance. The hardstands will be designed for the most critical loading combinations from the crane. The founding levels for the hardstands may be variable across the site and will be determined during detailed ground investigation/design stage.

The typical make-up of the hardstands would include up to 1,000mm of compacted Class 1/6F material with geotextile and/or geogrid layers incorporated as required during detailed design stage.

7.4 Substation Foundations and Platforms

The substation platforms will be constructed using the founded technique. The substation foundations may comprise strip/raft foundations under the main footprint of the building with possibly a basement/pit for cable connections. Substation platforms are generally constructed using compacted Class 1/6F material with a suitable sub-formation to achieve the required bearing resistance.

Given the ground conditions present at the proposed substations, it is envisaged that the foundations will require to be founded on Glacial Till deposits. The typical make-up of the substation platform may include up to 750mm of granular stone fill with possibly a layer of geotextile and/or geogrid. At the underside of the substation foundations, a layer of structural up-fill (class 6N/6P) will likely be required.

7.5 Temporary Construction Compound Platforms

The construction compound platforms will be constructed using founded techniques. The construction compound platforms are generally constructed using compacted Class 1/6F material on a suitable sub-formation to achieve the required bearing resistance.

The typical make-up of the construction compound platform would include up to 500mm compacted Class 1/6F material with a suitable sub-formation to achieve the required bearing resistance. Geotextile and/or geogrid layers will be incorporated as required during detailed design stage.

7.6 Borrow Pit

As outlined in Section 3.1.3 Exploratory trial pits were advanced at proposed borrow pit locations BP01, BP02 and BP03 to assess potential for use of site won materials as general Fill material for the construction of elements of the proposed development. Geotechnical and environmental samples were also collected from trial pits with the results discussed in Section 4.2 of this report.

From a preliminary assessment of the overburden and weathered bedrock encountered at the proposed borrow pit locations, it is considered that site won material is likely suitable for use as General Fill material. Imported stone fill is likely to be required to form the upper layers of the infrastructure elements.

The findings of the geotechnical testing completed on samples submitted from the proposed borrow pit locations indicates that where cohesive (clay) deposits are encountered this material would be suitable for use as Class 2 (Cohesive Fill) material in accordance with Series 600 of the Specification for Road Works (SPW). Where granular (gravel) deposits are encountered grading carried out on these samples indicates this material would be suitable as Class 1 (Granular Fill) in accordance with Series 600.

Further ground investigation in the form of rotary cores and laboratory testing will be required to assess to the usability and excavatability of the bedrock encountered at the base of the exploratory trial pits.

Groundwater seepages were recorded in the trial pits at depths ranging from 0.6m to 3.0m BGL. It is likely that groundwater levels will require the use of dewatering plant during the development of the proposed borrow pits.

7.7 HDD Watercourse Crossing

From the findings of the site investigations the locations of the proposed HDD cable installation are underlain by Glacial Till deposits which were encountered during intrusive site investigations. The Glacial Till deposits generally comprised medium dense to dense GRAVEL and medium dense SAND to the maximum depth of investigation at 15m BGL at WS017.

At WS006 Weathered Bedrock was encountered between 2.6m and 3.4m BGL and was described as Weathered SILTSTONE. This was recovered in the borehole arising as *Angular fine to coarse gravel sized clasts of purple SILTSTONE with purple SILT.* Competent Bedrock was encountered at WS007 at 10.8m BGL.

Given the presence of Alluvial deposits at the site it is likely that Directional Drilling will be advanced through granular material comprising medium dense to dense gravel deposits. As such the potential borehole collapse and loosening of bore spoil should be addressed at design stage. To mitigate the risks posed to the integrity of the borehole and for the successful completion of the HDD cable installation appropriate drilling fluids should be selected for use in granular conditions to ensure the HDD hole is stabilised during drilling works.

Typically, drilling fluids containing Bentonite Clay which consist of natural clay material with swelling properties can be applied to support the open bore during drilling works. To minimise the volumes of drilling fluid used during the works a suitable recycling method could be employed so it can be used again and reduce fluid loss to groundwater.

Based on the findings of the investigations existing ground conditions are suitable for HDD cable installation works at the locations investigated subject to the mitigation of risks outlined above.

8. CONCLUSIONS AND RECOMMENDATIONS

Fehily Timoney & Company (FT) were retained by Coom Green Energy Park (GCEP) Ltd in partnership with Coillte to undertake geotechnical site assessments at the proposed Coom Green Energy Park (CGEP) located in north County Cork.

The site spans across the southern and southwestern extents of the Nagle Mountains, south of the Blackwater River Valley. Both the Nagle mountains and the Blackwater River valley are the most prominent landscape features within the central study area and its wider surrounds. Reaching a height of approximately 420m AOD.

The slopes of the southern portion of the proposed development site (Bottlehill) is characterised by elevated lands with typical elevations of between 270m to 290m AOD. The central portion of the site (Mullenaboree) is also characterised by elevated lands with gentle slopes. Elevations at this portion of the proposed development are generally lower than those at the south with typical elevations of between 220m to 260m AOD. The northern portion of the proposed development (Knockdoorty) comprises a ridge feature at the extreme northern boundary of the proposed development trends east-west and reaches maximum elevations of between 424m and 428m AOD to the north of turbines T21 and T23 respectively.

A review of the published GSI datasets for the site indicated that the site is underlain by Glacial Till deposits underlain by the Devonian Ballytrasna Formation. The Ballytrasna Formation is described as comprising dusky-red mudstone with subordinate pale-red sandstones occurring throughout the formation. The findings of the intrusive site investigations confirm the geological profiles outlined by the GSI mapping and datasets.

Maximum slope angles of 10.2 degrees at turbines T20 and T22 to 14.5 degrees at T21 were recorded. Since these are the worst-case slopes within the development these locations were selected for slope stability assessment. Safety ratios for potential slope failures for drained conditions ranged from 1.528 to 2.822 at proposed turbine locations T20, T21 and T22. A safety ratio of greater than 1.0 indicates that the slope is considered stable in the long-term drained conditions.

Based on the analyses presented, no data points were recorded to have a FoS of less than 1.0 with the lowest in-situ FoS of 30.6 recorded. The results give rise to in-situ safety ratios for translational slides which are above the minimum required value for all infrastructure locations analysed.

Despite the development site having an acceptable margin of safety with respect to slope stability a number of mitigation/control measures are proposed to ensure that all works adhere to an acceptable standard of safety for work in upland site conditions. Mitigation/control measures identified for each of the infrastructure elements in the risk assessment should be taken into account and implemented throughout design and construction works (Appendix D).

Based on the findings of the intrusive site investigations it is likely that Directional Drilling will be advanced through granular deposits at the site. This should be taken into account by the Drilling Contractor in completing Method Statements for the works. Appropriate drilling fluids should be selected for use in granular conditions to ensure the HDD hole is stabilised during drilling works. During drilling works sufficient thickness of alluvial deposits (3m) should be maintained between the HDD bore and the bed of each of the watercourses at the proposed HDD locations.

Best practice should be implemented for HDD activities. Locations for drill rig positioning and pipeline pull areas shall be chosen or engineered such that the fall is away from the waters in question, thereby facilitating installation of pollution containment and control facilities. Where drilling fluids are being returned for cleaning and re-use or recirculation through a temporary fluid return line, pneumatic leak testing shall be carried out to

confirm the integrity of the return line. Spent drilling fluids including separated drill materials shall be contained in secure bunded areas for off-site disposal at a licensed disposal facility.

There is a risk of water ingress during excavation for the footings above the level of bedrock at the site. As such, provisions should be made for sump pumping should water ingress occur. Should foundations be required to advance below bedrock dewatering infrastructure should be considered during detailed design stage.

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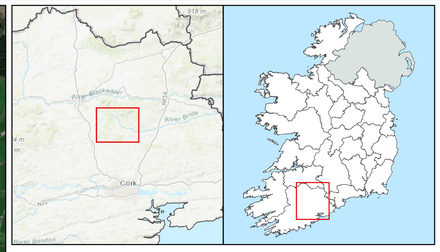
APPENDIX A

Figures

Map Path: R:\Map Production\2020\P20-099\Workspace\Community Engagement Information\P20-099_GIS_SiteLayout_A1.mxd



- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Underground Cable Route
- Proposed Development Boundary
- Existing Road
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Turbine Hardstanding Area
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation

N W E S

0 0.5 1 2 Kilometers

TITLE: Site Layout			
PROJECT: Coom Green Energy Park, Co. Cork			
FIGURE NO:	1.1		
CLIENT:	Coom Green Energy Park Ltd.		
SCALE:	1:20000	**REVISION:**	0
DATE:	06/11/2020	**PAGE SIZE:**	A1

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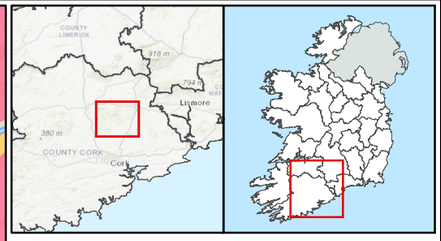

- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Cable Route
- Proposed Development Boundary
- Proposed Internal Roads
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation
- Existing Barrymore 110kV Substation

Quaternary Sediments

- A, Alluvium
- BktPt, Blanket Peat
- Cut, Cut over raised peat
- GDSs, Gravels derived from Devonian sandstones
- KaRck, Kartsified bedrock outcrop or subcrop
- L, Lacustrine sediments
- Rck, Bedrock outcrop or subcrop
- TDSs, Till derived from Devonian sandstones
- TNSSs, Till derived from Namurian sandstones and shales
- Urban
- Water

N W E S

0 1 2 4 Kilometers

TITLE:	Quaternary Geology		
PROJECT:	Coom Green Energy Park, Co. Cork		
FIGURE NO:	2.1		
CLIENT:	Coom Green Energy Park Ltd.		
SCALE:	1:70000	**REVISION:**	0
DATE:	28/09/2020	**PAGE SIZE:**	A3

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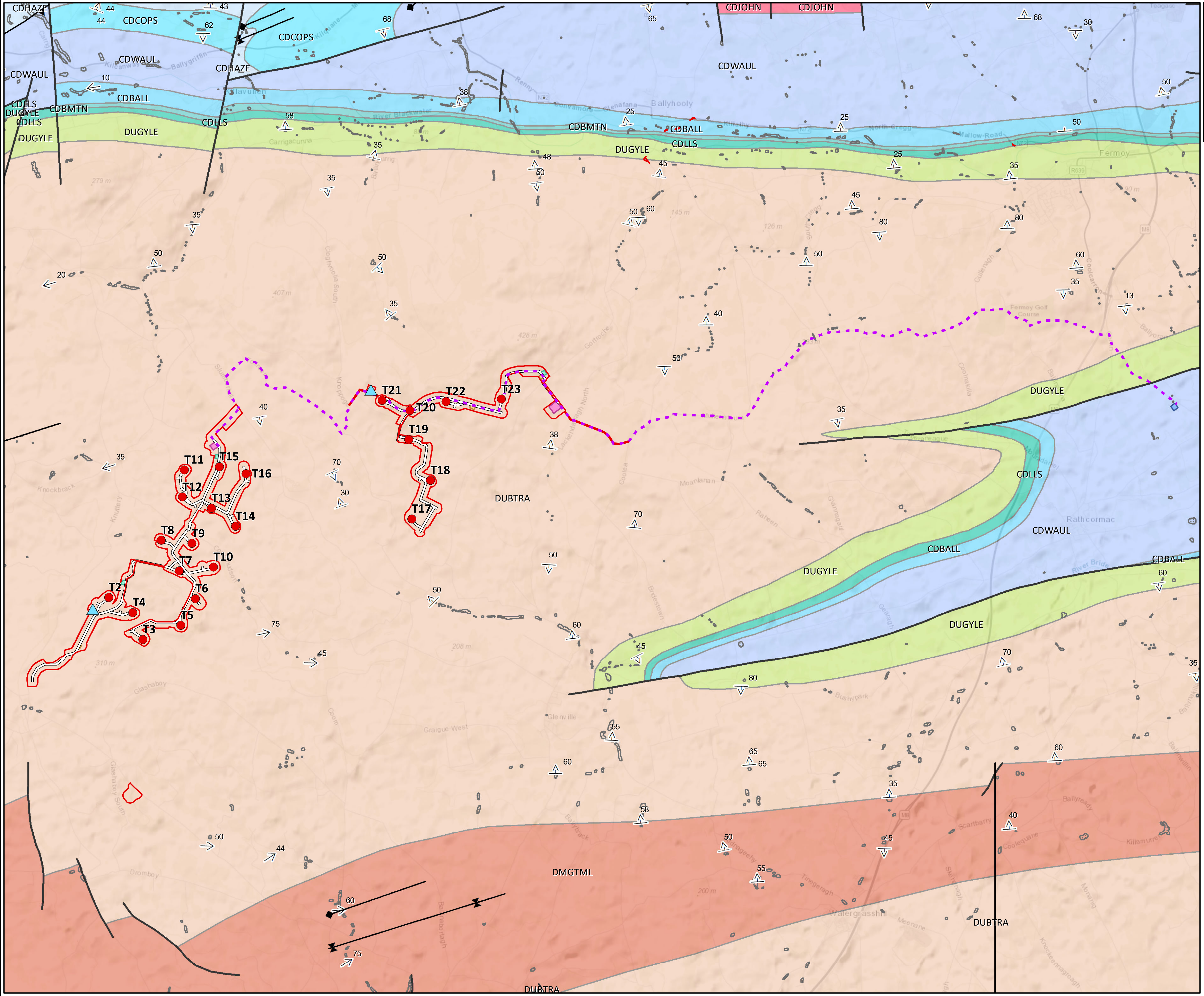
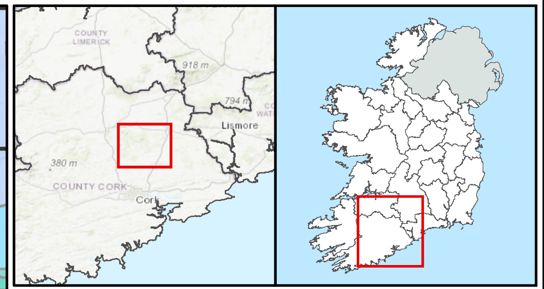
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community
Mapping Reproduced Under Licence from the Ordnance Survey Ireland Licence No. EN 0001219 © Government of Ireland





- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Cable Route
- Proposed Development Boundary
- Proposed Internal Roads
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation
- Existing Barrymore 110kV Substation
- Anticlinal Axis
- Fault
- Synclinal Axis
- Thrust, barbs on hanging-wall side
- X-Section
- Dip of bedding or main foliation, old GSI data
- Strike and dip of bedding, right way up
- Strike and dip of bedding, way up unknown
- Bedrock Outcrop
- Ballysteen Formation
- Ballymartin Formation
- Copstown Limestone Formation
- Hazelwood Limestone Formation
- Johnstown Red Marble Formation
- Lower Limestone Shale
- Waulsortian Limestones
- Gortanimill Formation
- Ballytrasna Formation
- Gyleen Formation

TITLE: Bedrock Geology	
PROJECT: Coom Green Energy Park, Co. Cork	
FIGURE NO: 2.2	
CLIENT: Coom Green Energy Park Ltd.	
SCALE: 1:70000	**REVISION:** 0
DATE: 28/09/2020	**PAGE SIZE:** A3

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0 1 2 4 Kilometers

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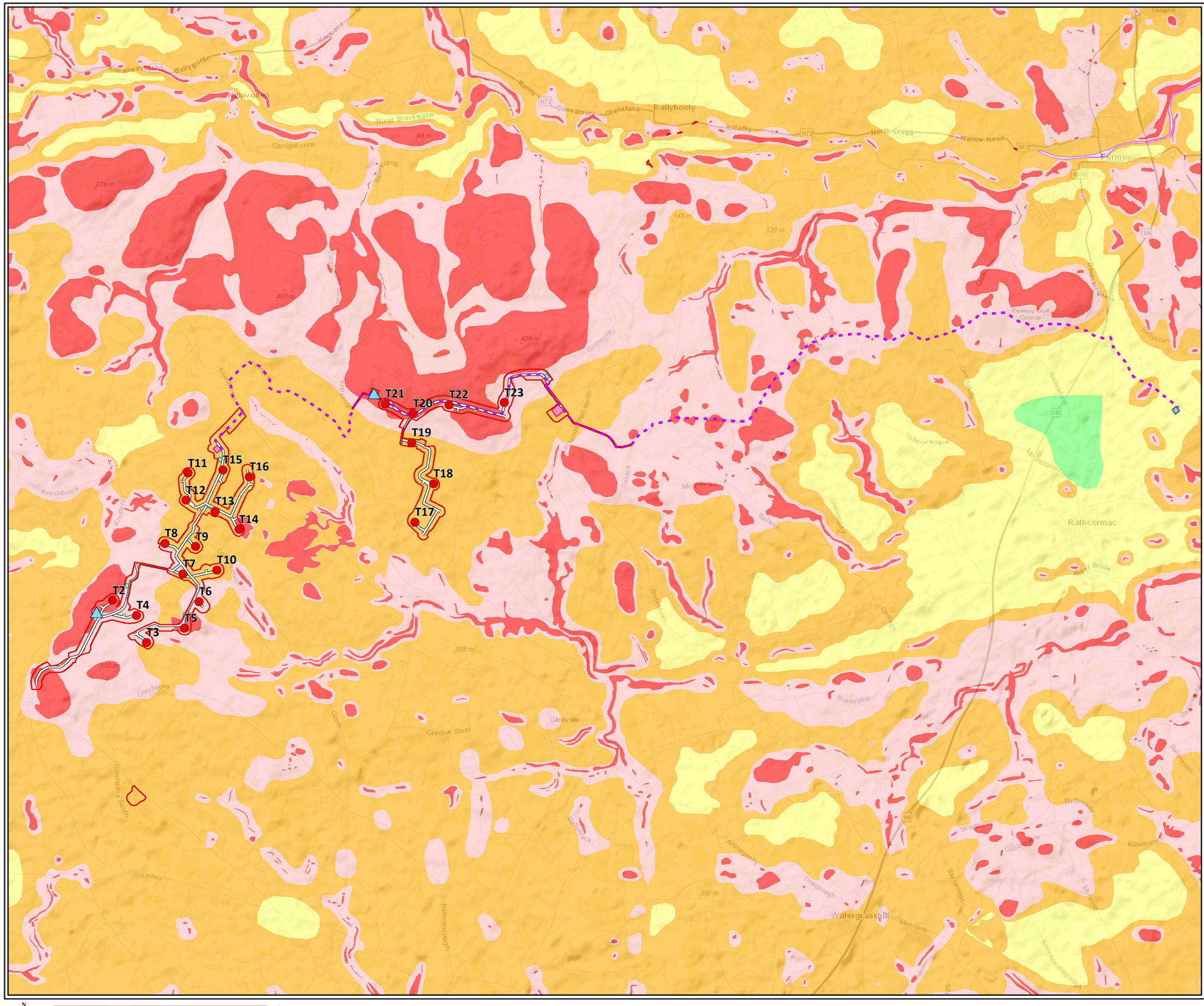

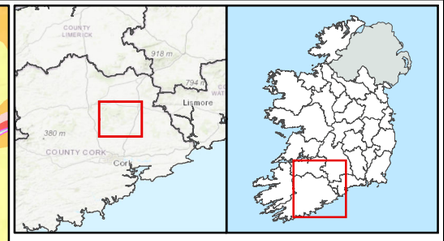

- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Cable Route
- Proposed Development Boundary
- Proposed Internal Roads
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation
- Existing Barrymore 110kV Substation

Groundwater Vulnerability

- E - Extreme
- H - High
- M - Moderate
- L - Low
- Water
- X - Rock Near Surface or Karst

TITLE:	Groundwater Vulnerability		
PROJECT:	Coom Green Energy Park, Co. Cork		
FIGURE NO:	2.3		
CLIENT:	Coom Green Energy Park Ltd.		
SCALE:	1:70000	**REVISION:**	0
DATE:	28/09/2020	**PAGE SIZE:**	A3

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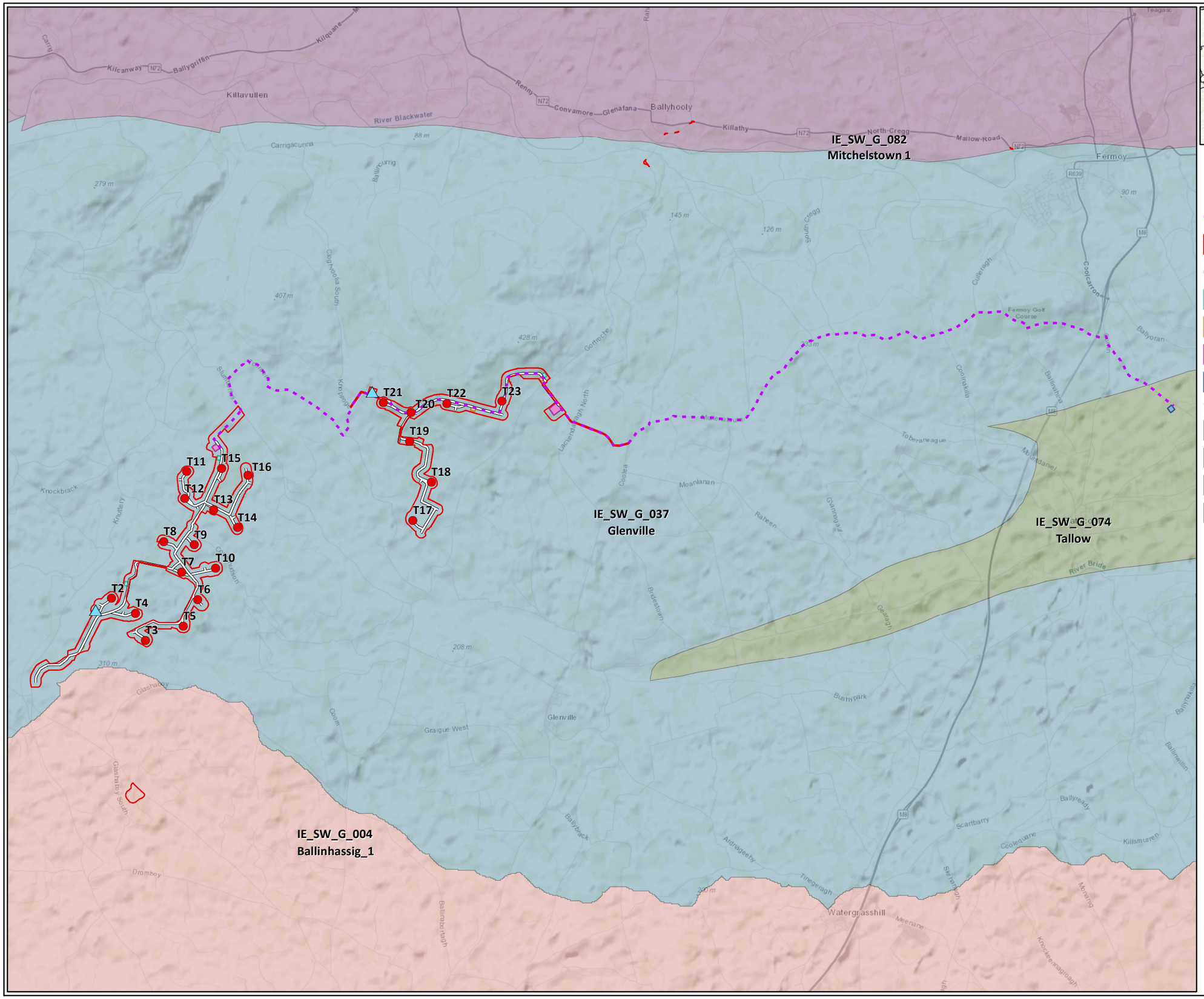

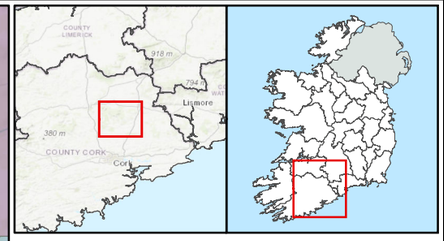

- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Cable Route
- Proposed Development Boundary
- Proposed Internal Roads
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation
- Existing Barrymore 110kV Substation

WFD Ground Water Bodies

- IE_SW_G_004, Ballinhassig_1
- IE_SW_G_037, Glenville
- IE_SW_G_074, Tallow
- IE_SW_G_082, Mitchelstown 1

TITLE:	Groundwater Bodies		
PROJECT:	Coom Green Energy Park, Co. Cork		
FIGURE NO:	2.4		
CLIENT:	Coom Green Energy Park Ltd.		
SCALE:	1:70000	**REVISION:**	0
DATE:	28/09/2020	**PAGE SIZE:**	A3

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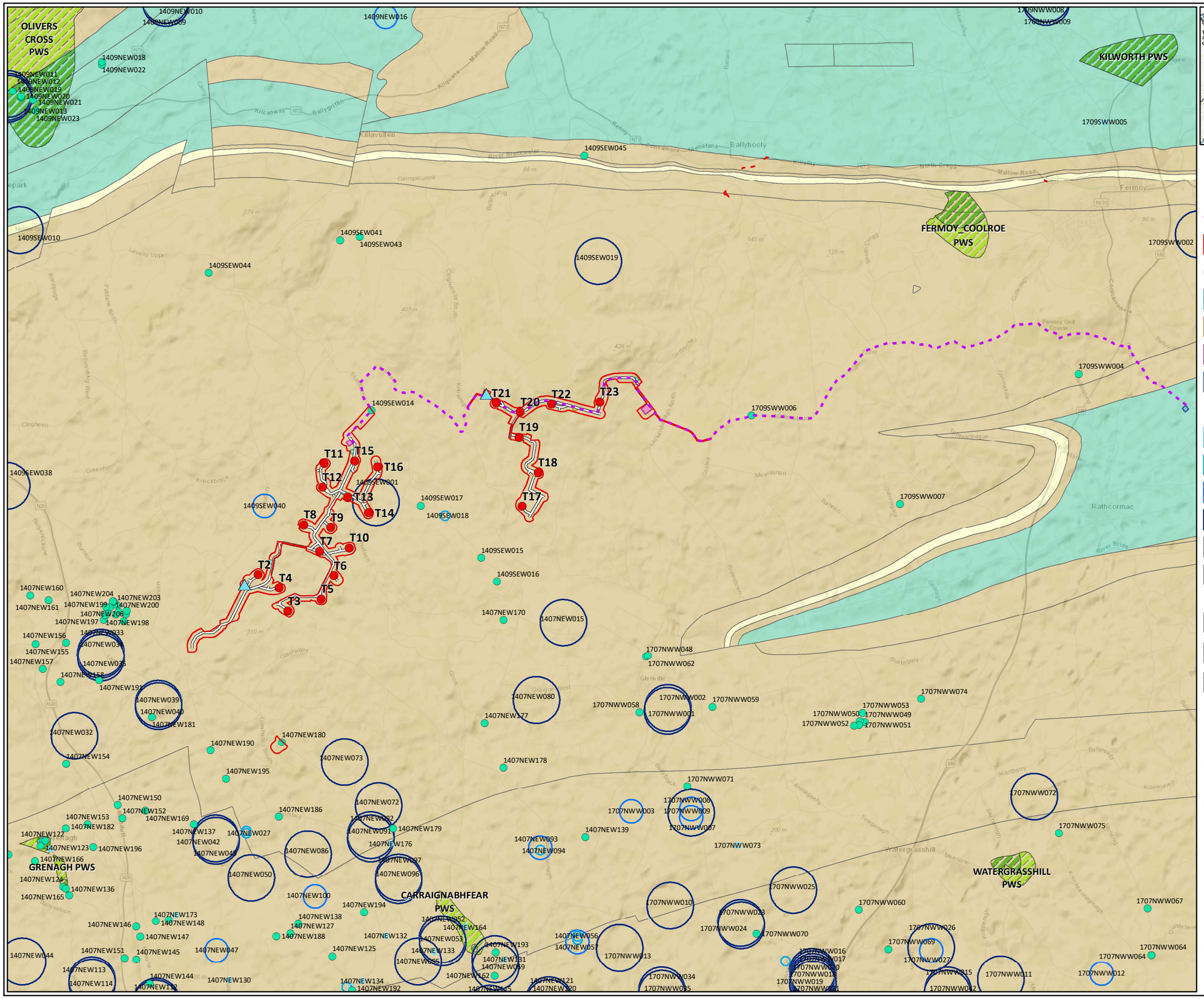

TITLE:	Aquifer Classification
PROJECT:	Coom Green Energy Park, Co. Cork
FIGURE NO:	2.5
CLIENT:	Coom Green Energy Park Ltd.
SCALE:	1:80000
REVISION:	0
DATE:	28/09/2020
PAGE SIZE:	A3

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N W E S

0 1 2 4 Kilometers

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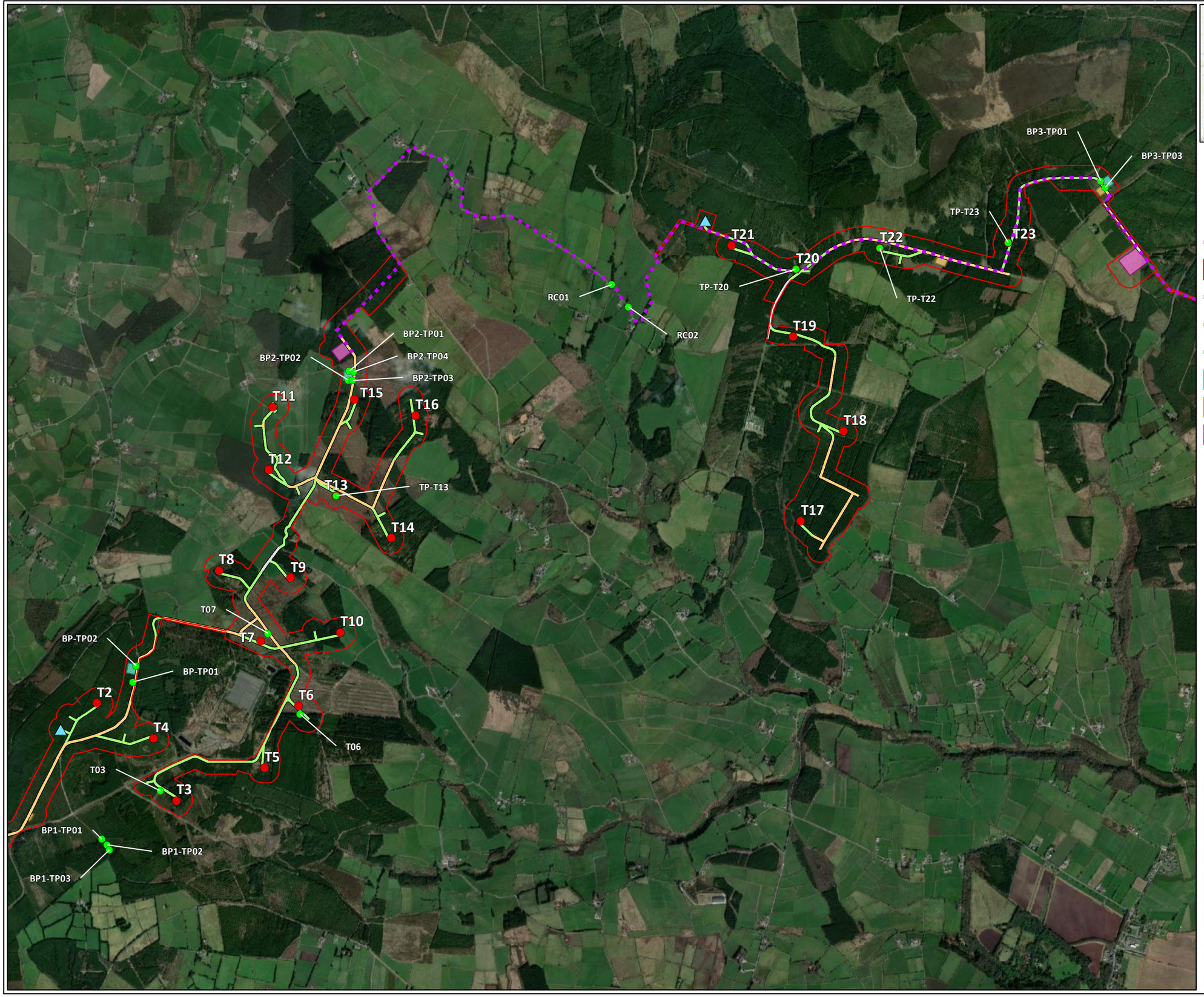

- Site Investigation Locations
- Proposed Turbine Layout
- Proposed Permanent Met Masts
- Proposed Cable Route
- Proposed Development Boundary
- Existing Road
- Proposed Existing Road Upgrade
- Proposed New Road
- Proposed Borrow Pit
- Proposed Temporary Compound
- Proposed Substation

N W E S

Kilometers
0 0.25 0.5 1

TITLE:	Site Investigation Locations		
PROJECT:	Coom Green Energy Park, Co. Cork		
FIGURE NO:	4.1		
CLIENT:	Coom Green Energy Park Ltd.		
SCALE:	1:30000	**REVISION:**	0
DATE:	16/11/2020	**PAGE SIZE:**	A3

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APPENDIX B

Slope Stability Assessment

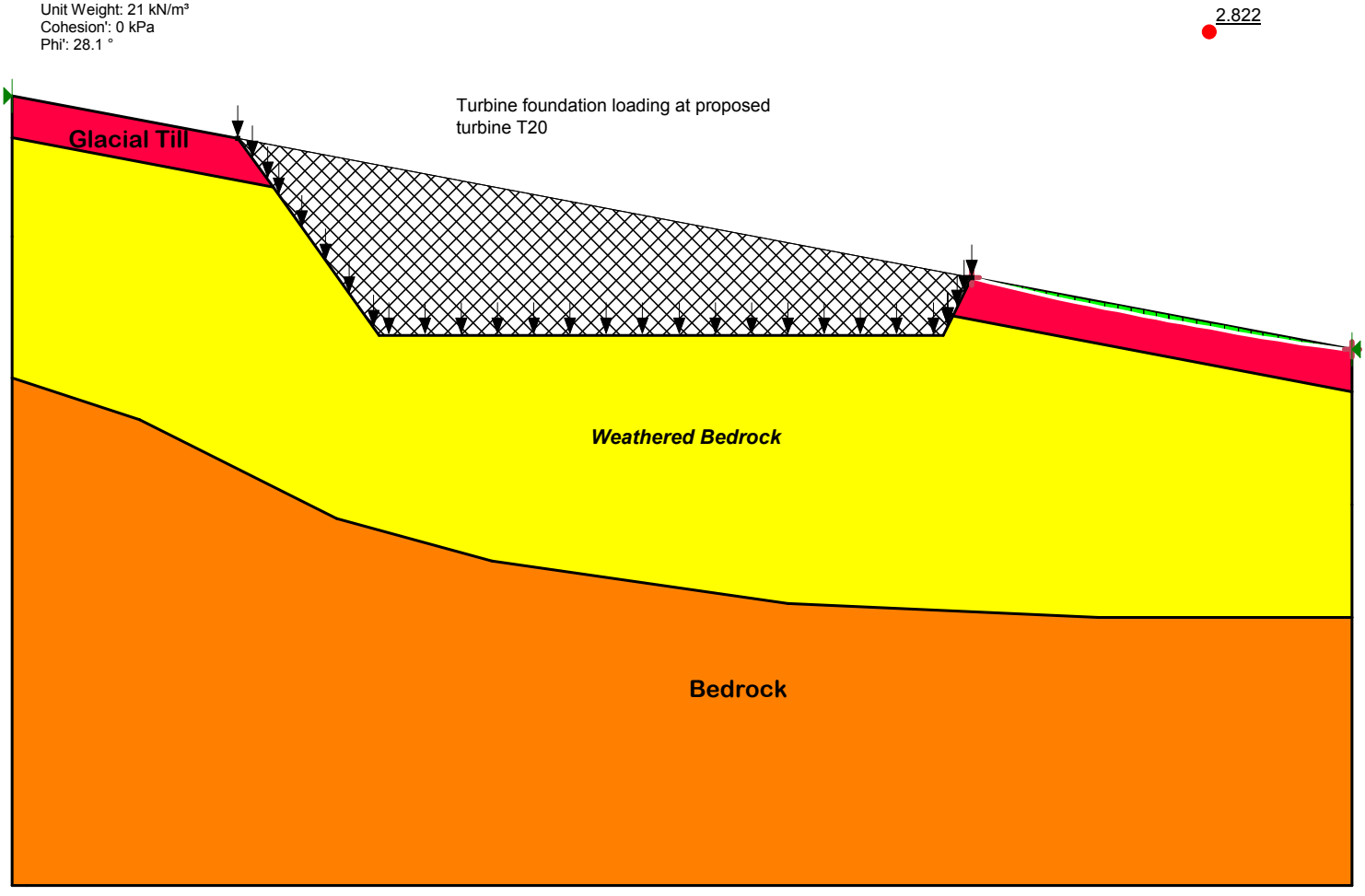
Slope Stability Analysis - Proposed Turbine T20

Design Approach 3 Eurocode 7

Name: Weathered Bedrock
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 28.1 °

Name: Bedrock: Shale/Mudstone
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion': 3,200 kPa
Phi': 21.3 °

Name: Glacial Till (Granular)
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 28.1 °

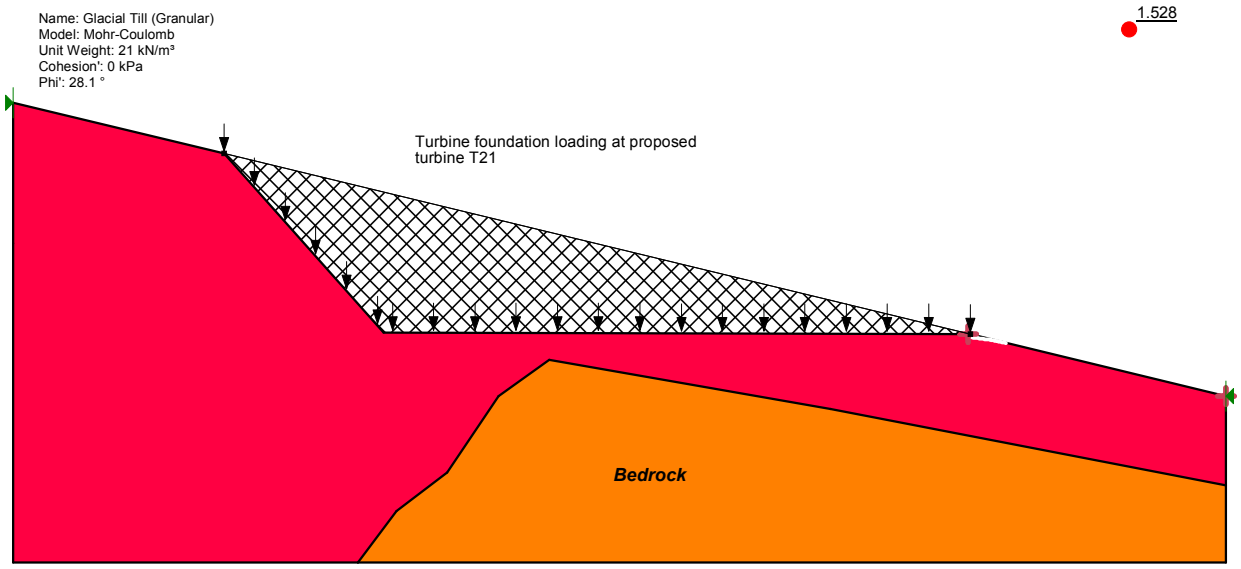


Slope Stability Analysis - Proposed Turbine T21

Design Approach 3 Eurocode 7

Name: Bedrock: Shale/Mudstone
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion': 3,200 kPa
Phi': 21.3 °

Name: Glacial Till (Granular)
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 28.1 °



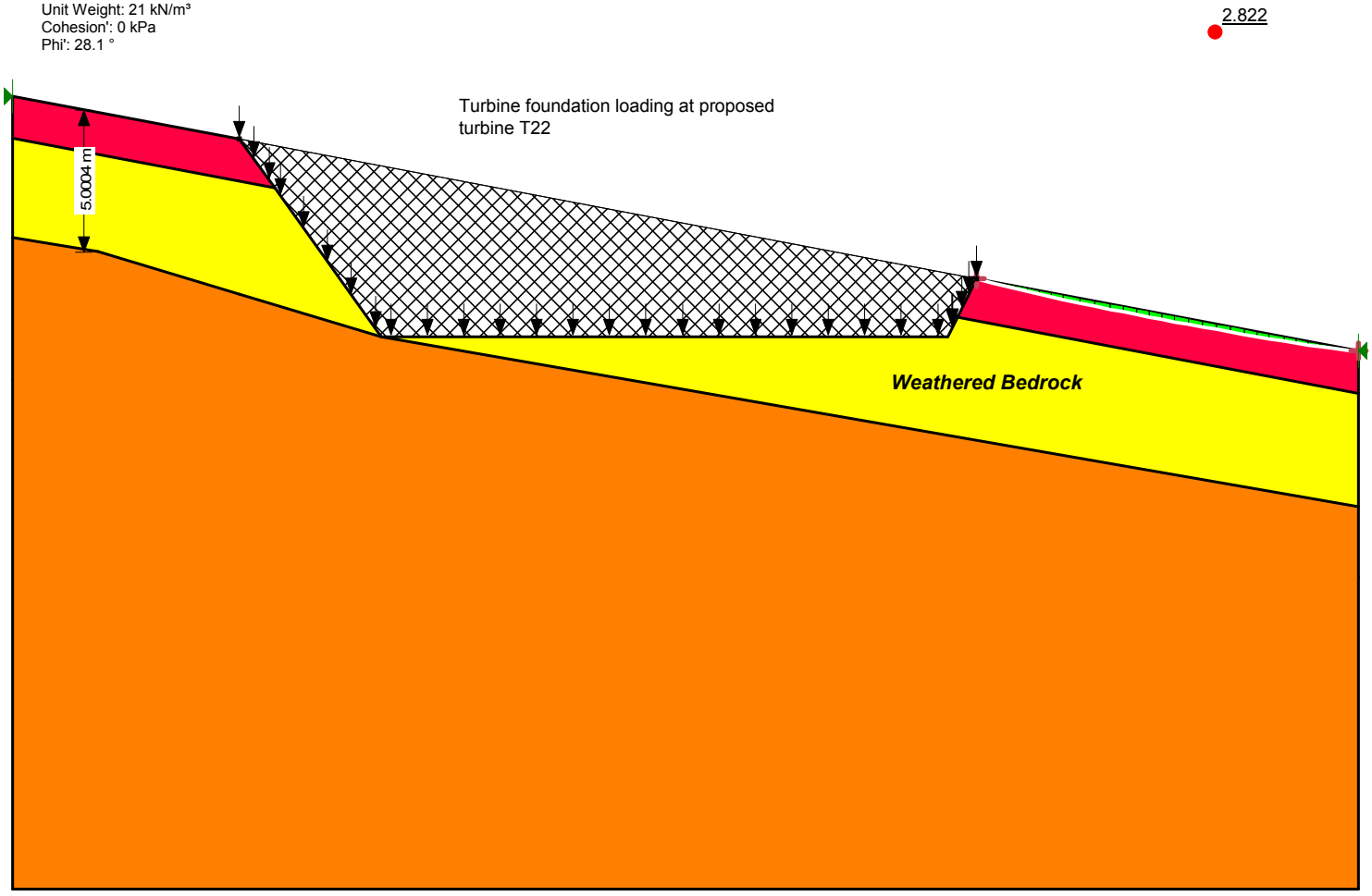
Slope Stability Analysis - Proposed Turbine T22

Design Approach 3 Eurocode 7

Name: Weathered Bedrock
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 28.1 °

Name: Bedrock: Shale/Mudstone
Model: Mohr-Coulomb
Unit Weight: 22 kN/m³
Cohesion': 3,200 kPa
Phi': 21.3 °

Name: Glacial Till (Granular)
Model: Mohr-Coulomb
Unit Weight: 21 kN/m³
Cohesion': 0 kPa
Phi': 28.1 °



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APPENDIX C

Ground Investigation Factual Report

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

Phone: (091) 841 274
Fax: (091) 847 687

email: info@irishdrilling.ie

COOM WIND FARM

SITE INVESTIGATION FACTUAL REPORT

Coillte,
Moneen Road,
Castlebar,
Co. Mayo.

Fehily Timoney & Company,
Consulting Engineers,
Core House,
Pouladuff Road,
Cork.

	Prepared by	Approved by	Rev. Issue Date:	Revision No.
	Ronan Killeen	Declan Joyce	14th November 2019	19 _C_106/001
Signature				

FOREWORD

The borehole and trial pit records have been compiled from an examination of the samples by a Geotechnical Engineer and from the Drillers' descriptions.

The report presents an opinion on the configuration of the strata within the site based on the borehole and trial pit results. The assumptions, though reasonable, are given for guidance only and no liability can be accepted for changes in conditions not revealed by the boreholes.

The fieldwork was carried out in accordance with IS EN 1997-2 and BS5930, 2015 Code of Practice for Site Investigations with precedence given to IS EN 1997-2 where applicable.

Contents:

1.0 Introduction.

Irish Drilling Ltd. (IDL) was instructed by Fehily Timoney & Company, Consulting Engineers, on behalf of Coillte, to carry out a site investigation at the site of the proposed Coom Wind Farm.

This site investigation was carried out to provide detailed factual geotechnical information of the underlying ground conditions at the proposed wastewater treatment works site.

The fieldwork commenced on June 17th 2019 and was completed on October 8th 2019.

2.0 Site & Geology

The site is located in and around the environs of Bottlehill, County Cork.

The fieldwork was carried out predominantly on agricultural lands, Coillte forestry lands and national primary and/or secondary road verges.

Site Plans, prepared by the client's representatives and amended by IDL to show 'as-built' locations, are included with this report.

3.0 Fieldwork.

The following plant was mobilised to site to carry out fieldwork operations:

DeltaBase 520 Rotary Core Drilling Rig.
Hitachi ex135 Excavator.

Fieldwork carried out to date has included the following:

Thirteen trial pits were excavated on site using a tracked excavator. The pits were logged and photographed by an Engineer with observations made on ground conditions, pit stability and water ingress.

Small and bulk disturbed soil samples were recovered at each change in strata and the samples were returned to the laboratory and presented for testing.

Three rotary core boreholes were carried out along the proposed cable route and at potential water course crossings. The boreholes were carried out to establish overburden conditions and rockhead and to establish the nature and integrity of the underlying rock.

Wireline drilling techniques, using HQ size drill strings, were carried out to recover soil and rock core samples. The core samples recovered consisted of the following core diameters: 64mm (HQ).

The samples were stored in wooden boxes and returned to the laboratory where there were logged and photographed by a Geotechnical Engineer and presented for testing.

In–Situ testing consisting of Standard Penetration Tests were carried out at regular intervals in the overburden or as instructed by the client's representatives.

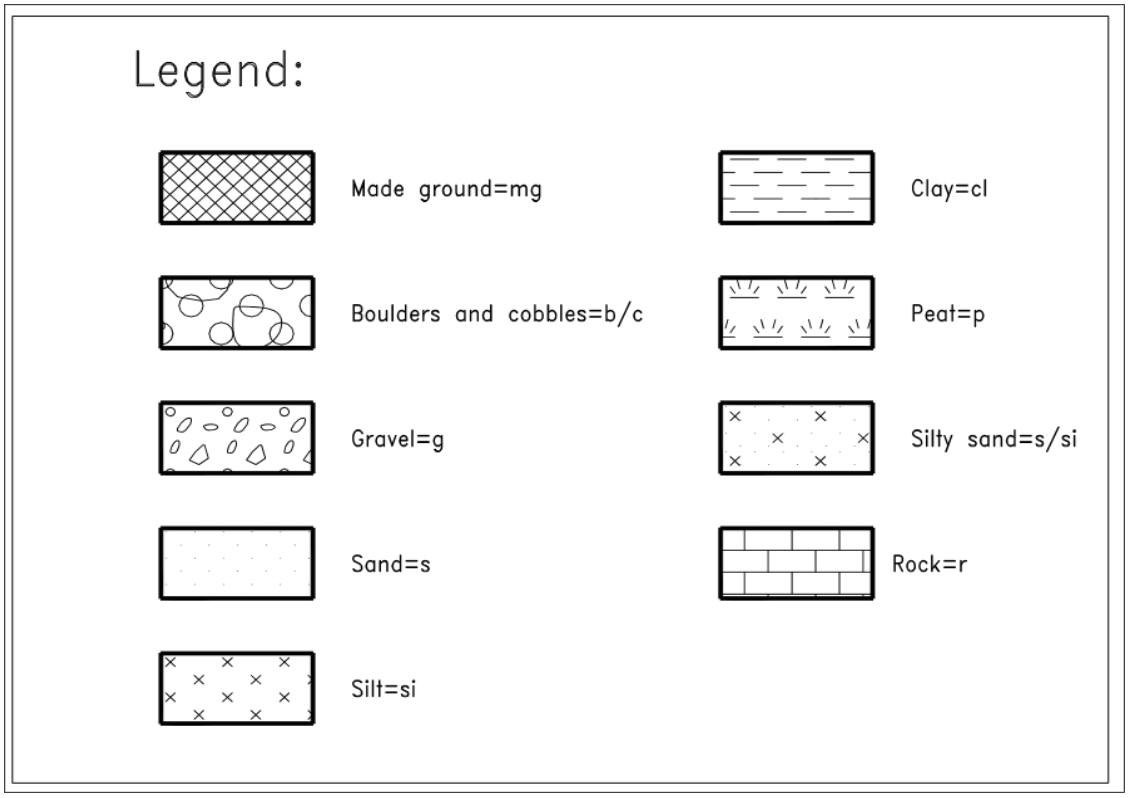
Bedding planes are defined as the surface that separates one stratum, layer or bed stratified rock from another. Discontinuity is defined as the plane of physical weakness where the tensile strength perpendicular to the discontinuity or the shear strength along the discontinuity is lower than that of the surrounding soil or rock material.

The rotary core boreholes were carried out to depths ranging from 7.50m to 15.00m below ground level.

A geophysical survey was carried out by Minerex Geophysics Limited at proposed turbine locations.

The geophysical survey consisted of 2-D Resistivity and Seismic Refraction and the records of their findings are included as a 'stand-alone' report in appendix 3 of this report.

The following Key Legend Table details the symbology used on the engineering logs to describe ground conditions encountered:



Ground conditions encountered during the completion of the fieldwork were typical and as expected for this region and predominantly consisted of Peat and/or Made Ground overlying Glacial Tills overlying possible weathered bedrock.

The Glacial Tills in general consisted of slightly sandy slightly gravelly silt/clay and/or silty clayey sands and gravels with occasional, some or many cobbles and boulders.

Made Ground was also encountered in a number of the trial pits to depths ranging from 0.20m to 3.10m below ground level.

Peat and/or peaty silt was encountered at a number of trial pits at a depth ranging from 0.10m to 0.65m below ground level.

Possible weathered bedrock was also encountered in many of the trial pits at depths ranging from 1.30m to 2.80m below ground level.

Intact bedrock was encountered in the following rotary boreholes at depths ranging from 3.40m to 10.80m below ground level: RC 01 and RC 02.

Intact bedrock in general is predominantly described as medium strong to strong thinly bedded siltstone.

Bedrock was not encountered in rotary borehole RC 03 to a depth of 15.00m below ground level before termination.

For detailed descriptions of bedrock and ground conditions encountered please refer to the engineering logs included in appendix 1 and 2 of this report.

The fieldwork was carried out in accordance with IS EN 1997-2 and BS5930, 2015 Code of Practice for Site Investigations with precedence given to IS EN 1997-2 where applicable.

The fieldwork locations were set out on site using a Trimble CU Bluetooth GPS Surveying Unit and the co-ordinates are included on the logs presented in the appendices. All fieldwork co-ordinates are reported to Irish Transverse Mercator (ITM) with Reduced Levels recorded relative to Malin Head Datum and with an accuracy level of + or – 0.10m.

4.0 Laboratory Testing

Representative samples recovered from the boreholes and trial pits were scheduled for testing in the laboratory.

The test schedules were prepared by the Client's Engineer and included some or all of the following tests on disturbed soil samples and soil core samples:

* Natural Moisture Content.
* Atterberg Limits.
* Particle Size Distribution.
* Compaction (MCV, CBR).
* Chemical (pH, Sulphate, Chloride, Carbonate).

The test schedules also included some or all of the following tests on rock core samples:

* Point Load.
* UCS.

The soil and rock descriptions as noted on the borehole and trial pit logs are in general visual descriptions as observed and logged by our Engineers and are described in accordance with IS EN 1997-2 and BS5930, 2015 Code of Practice for Site Investigations.

Soils descriptions (cohesive or otherwise) are also initially assessed based on the texture and 'feel' of the soil materials as witnessed by our Geotechnical Engineers and in accordance with IS EN 1997-2 and BS5930.

Where laboratory classification tests have been carried out on soil or rock samples then these visual descriptions have been amended accordingly to take into account the results of these classification tests.

The records of all fieldwork, laboratory test results and photographs are included in the appendices of this Factual Report.

Ronan Killeen
Chartered Engineer
Irish Drilling Limited
November 14th 2019

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

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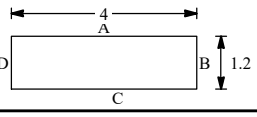
COOM WIND FARM

APPENDIX 1

PROJECT: Coom Energy Park		**TRIALPIT: BP -TP01**
LOCATION: Bottlehill, Co Cork		**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**	**Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 562,872.0 N 590,406.0**	**Rev: 1**
Ground level: m O.D.		**DATE: 22.10.20**

GROUNDWATER
Water strikes: Rose to after:
1st: 2.00m
2nd:
3rd:

PIT DIRECTION: 0-180
PIT DIMENSION: 1.20 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable during excavation.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0								0.50	Firm light grey gravelly SILT. Gravel is fine, angular to subangular.
								0.70	Black silty GRAVEL with medium cobble content. Gravel is angular.Cobbles are flat and angular.
			B 1	0.70-0.90				1.50	Stiff light brown slightly sandy gravelly SILT with high cobble content. Cobbles are subangular to angular and tabular. Gravel is subangular to angular.
1									
			B 2	1.60-1.80				2.50	Orangish brownish grey slightly sandy silty gravelly COBBLES. Cobbles are angular and tabular of siltstone. Gravel is angular.
2		1							
						END			TP terminated at 2.50m bgl. Obstruction as possible rock.
3									
4									
5									

Remarks: Slight inflow of water at 2.0m depth. TP backfilled with arisings.

Scale: 1:25

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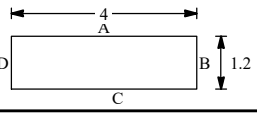
TRIAL PIT VANE & WL RISES COOM EP TPS.GPJ IRISHDRL.GDT 5/11/20

PROJECT: Coom Energy Park	**TRIALPIT: BP -TP02**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** E 562,899.0 N 590,538.0
ENGINEER: Fehily Timoney & Co	**Rig: Hitachi ex170**
	Rev: 1
Ground level: m O.D.	**DATE: 22.10.20**

GROUNDWATER

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

PIT DIRECTION: 0-180
PIT DIMENSION: 1.20 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable during excavation.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									
			B 1	0.20-0.40				0.50	Grey silty SAND and GRAVEL. Gravel is fine, angular to subangular. Sand is coarse.
								0.70	Black silty peaty gravelly COBBLES. Gravel is angular.Cobbles are flat, tabular and angular.
1			B 2	1.20-1.40				1.30	Orange brown slightly sandy silty gravelly COBBLES. Cobbles are subangular to angular and tabular. Gravel is subangular to angular, medium. 1.20m: with low boulder content. Boulders are tabular.
2								2.70	Orangish brownish grey slightly sandy silty gravelly COBBLES and BOULDERS. Cobbles and boulders are angular.
						END			TP terminated at 2.70m bgl. Obstruction as possible rock.
3									
4									
5									

Remarks: Pit dry during excavation.TP backfilled with arisings.

Scale: 1:25

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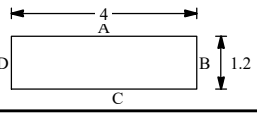
TRIAL PIT VANE & WL RISES COOM EP TPS.GPJ IRISHDRL.GDT 5/11/20

PROJECT: Coom Energy Park	**TRIALPIT: T 03**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** E 563,096.0 N 589,527.0
ENGINEER: Fehily Timoney & Co	**Rig: Hitachi ex170**
Ground level: m O.D.	**Rev: 1**
	DATE: 22.10.20

GROUNDWATER

Water strikes: Rose to after:
1st: 1.20m
2nd:
3rd:

PIT DIRECTION: 90-270
PIT DIMENSION: 1.20 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable during excavation.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0								0.30	Grass over soft black amorphous PEAT.
			B 1 J 2	0.60-0.80 0.60-0.80				1.20	Stiff light grey slightly sandy SILT.
1		▼							
			B 3 J 4	1.50-1.70 1.50-1.70				2.70	Stiff damp purple grey slightly gravelly sandy SILT with medium cobble content. Gravel is subrounded. Cobbles are subangular to subrounded.
2									
			B 5 J 6	2.80-3.00 2.80-3.00				4.00	Stiff grey slightly gravelly sandy SILT with low cobble content. Cobbles are angular.
3									
4			B 7	4.00-4.20				4.40	Light grey slightly gravelly silty SAND. Sand is fine to medium. Gravel is fine to coarse, subangular to subrounded.
						END			TP terminated at 4.40m bgl.
5									

Remarks: Slight inflow of water at 1.2m depth. TP backfilled with arisings.

Scale: 1:25

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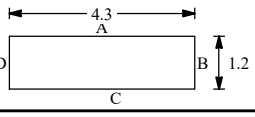
TRIAL PIT VANE & WL RISES COOM EP TPS.GPJ IRISHDRL.GDT 5/11/20

PROJECT: Coom Energy Park	**TRIALPIT: T 06**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** **Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 564,224.0 N 590,148.0** **Rev: 1**
Ground level: m O.D.	**DATE: 22.10.20**

GROUNDWATER

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

PIT DIRECTION: 0-180
PIT DIMENSION: 1.20 * 4.30m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable during excavation.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									MADE GROUND - Reeds over black peaty silt mixed with stiff orange brown sandy gravelly silt. Made ground encountered to 0.85m depth at northern section of pit down to 2.00m depth at southern section of pit.
			B 1	0.50-0.70					
1									
			B 2	1.30-1.50					
2								2.00	
								2.40	Stiff orange brown slightly sandy slightly gravelly SILT with high cobble content. Cobbles are angular to subangular. Gravel is fine, angular to subangular.
			B 3	2.70-3.00				3.00	Possible weathered bedrock - rcovered as angular to tabular clay smeared COBBLES of siltstone.
3									**END** TP terminated at 3.00m bgl. Obstruction as possible rock.
4									
5									

Remarks: Pit dry during excavation.TP backfilled with arisings.

Scale: 1:25

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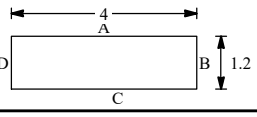
TRIAL PIT VANE & WL RISES COOM EP TPS.GPJ IRISHDRL.GDT 5/11/20

PROJECT: Coom Energy Park	**TRIALPIT: T 07**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** E 563,964.0 N 590,800.0
ENGINEER: Fehily Timoney & Co	**Rig: Hitachi ex170**
Ground level: m O.D.	**Rev: 1**
	DATE: 22.10.20

GROUNDWATER

Water strikes: Rose to after:
1st: 3.00m
2nd:
3rd:

PIT DIRECTION: 90-270
PIT DIMENSION: 1.20 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable during excavation.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0								0.60	Soft brown amorphous PEAT with laminations of soft light grey silt.
			B 1 J 2	0.70-0.90 0.70-0.90				1.30	Stiff brown sandy SILT. Sand is fine to medium.
			B 3	1.50-1.70					Grey silty gravelly SAND with medium cobble content. Gravel is fine to coarse, angular to subangular. Cobbles are subangular.
			B 4	2.50-2.70					2.60m: with medium boulder content.
								4.00	
						END			TP terminated at 4.00m bgl.

Remarks: Slight inflow of water at 3.0m depth. TP backfilled with arisings.

Scale: 1:25

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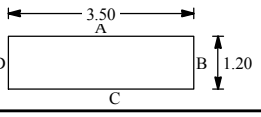
TRIAL PIT VANE & WL RISES COOM EP TPS.GPJ IRISHDRL.GDT 5/11/20

PROJECT: Coom Wind Farm	**TRIALPIT: BP2-TP01**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates: E 564,627.2 N 592,916.3**
ENGINEER: Fehily Timoney & Co	**Rig: Hitachi ex170**
Ground level: 246.06m O.D.	**Rev: 1**
	DATE: 17.6.19

GROUNDWATER

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

PIT DIRECTION: 000-180
PIT DIMENSION: 1.20 * 3.50m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									
									Grass over firm orange and purplish brown SILT with cobbles. Cobbles are subangular to subrounded.
							245.26	0.80	
			B 1	0.80-1.00					Purplish brown sandy silty subangular to subrounded fine to coarse GRAVEL with high cobble content. Cobbles are tabular and flat subangular to subrounded. Cobble content increasing with depth.
1									
			B 2	1.80-2.00			244.06	2.00	
2									Possible SILTSTONE rock. Recovered as purplish brown silty gravelly flat and subangular siltstone COBBLES and flat siltstone BOULDERS. Gravel is angular to subangular medium to coarse.
			B 3	2.20-2.40			243.56	2.50	
						END			TP terminated at 2.50m bgl. Obstruction as siltstone rock.
3									
4									
5									

Remarks: TP dry on excavation. TP backfilled with arisings.

Scale: 1:25

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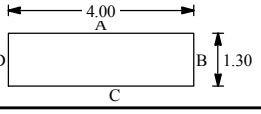
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm		**TRIALPIT: BP2-TP02**
LOCATION: Bottlehill, Co Cork		**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**	**Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 564,634.8 N 592,897.6**	**Rev: 1**
Ground level: 245.76m O.D.		**DATE: 17.6.19**

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.30 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									
									MADE GROUND: Grass over orangish brown gravelly cobbly SILT mixed with plastic black amorphous PEAT.
1							244.66	1.10	
			B 1	1.10-1.30					Purple and orangish brown very sandy very silty subangular fine to coarse GRAVEL with high cobble content.
							243.76	2.00	
2			B 2	2.00-2.20					Purplish brown sandy silty gravelly angular to subangular COBBLES. Gravel is coarse.
							243.06	2.70	
			B 3	2.80-3.00					Weathered SILTSTONE rock. Recovered as flat and angular cobble and boulder sized clasts of siltstone.
3							242.26	3.50	
						END			TP terminated at 3.50m bgl. Obstruction as siltstone rock.
4									
5									

Remarks: TP dry on excavation. TP backfilled with arisings.

Scale: 1:25

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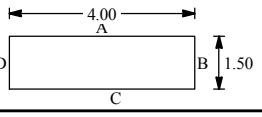
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm		**TRIALPIT: BP2-TP03**
LOCATION: Bottlehill, Co Cork		**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**	**Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 564,649.4 N 592,837.2**	**Rev: 1**
Ground level: 244.95m O.D.		**DATE: 17.6.19**

GROUNDWATER

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.50 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0							244.65	0.30	Plastic black silty amorphous PEAT.
			B 1	0.50-0.70			244.15	0.80	Purplish brown very silty very sandy medium and fine GRAVEL with high cobble content. Cobbles are subangular and flat of siltstone.
1									Purplish brown slightly silty sandy gravelly subangular siltstone COBBLES. Gravel is angular to subangular medium.
			B 2	1.60-1.80					
2							242.45	2.50	
			B 3	2.50-2.70					Weathered SILTSTONE rock. Recovered as flat tabular blocky and angular gravel cobble and boulder sized clasts of siltstone with some grey slightly sandy slightly silty gravel.
3			B 4	3.30-3.50			241.45	3.50	
						END			TP terminated at 3.50m bgl. Obstruction as siltstone rock.
4									
5									

Remarks: TP dry on excavation. TP backfilled with arisings.

Scale: 1:25

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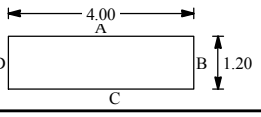
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm	**TRIALPIT: BP2-TP04**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** E 564,655.2 N 592,907.9 — **Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**Rev: 1**
Ground level: 244.52m O.D.	**DATE: 17.6.19**

GROUNDWATER
Water strikes: Rose to after:
1st: 3.00m
2nd:
3rd:

PIT DIRECTION: 000-180
PIT DIMENSION: 1.20 * 4.00m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									
							244.22	0.30	MADE GROUND: Firm brown gravelly CLAY with high cobble content. Cobbles are angular to subangular.
							244.07	0.45	Plastic black amorphous PEAT.
							243.52	1.00	Purplish brown slightly sandy gravelly SILT with high cobble content. Cobbles are subangular and flat of siltstone.
1			B 1	1.00-1.20					
									Purplish grey sandy very silty subangular to angular fine to coarse GRAVEL with high cobble content. Cobbles are angular.
2			B 2	2.00-2.20					
							241.72	2.80	
			B 3	2.80-3.00					Weathered SILTSTONE rock. Recovered as angular cobble sized clasts of purple siltstone.
3		▼					240.62	3.90	
						END			TP terminated at 3.90m bgl. Obstruction as siltstone rock.
4									
5									

Remarks: Seepage of water at 3.00m bgl. TP backfilled with arisings.

Scale: 1:25

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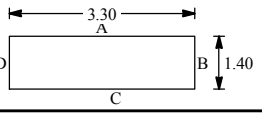
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm		**TRIALPIT: BP3-TP01**
LOCATION: Bottlehill, Co Cork		**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**	**Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 570,685.1 N 594,443.1**	**Rev: 1**
Ground level: 289.66m O.D.		**DATE: 18.6.19**

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.40 * 3.30m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0							289.06	0.60	TOPSOIL: Grass over dark brown peaty SILT.
			B 1 D 2	0.70-0.90 0.70-0.90			288.56	1.10	Firm damp yellowish brown slightly gravelly sandy CLAY with rootlets.
1			B 3 D 4	1.30-1.50 1.30-1.50			287.26	2.40	Stiff purplish brown slightly gravelly sandy SILT with high cobble content. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular of siltstone.
2			B 5	2.50-2.70			285.86	3.80	Stiff purplish brown slightly gravelly sandy SILT with high cobble content and medium boulder content. Gravel is subangular to subrounded fine to coarse. Cobbles are subangular of siltstone. Boulders are of siltstone. Boulders are up to 800mm in length.
3			B 6	3.30-3.50					
						END			TP terminated at 3.80m bgl. Obstruction as boulders.
4									
5									

Remarks: TP damp from 0.60m to 1.10m bgl. TP backfilled with arisings.

Scale: 1:25

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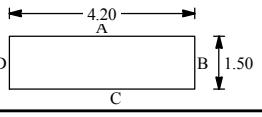
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm	**TRIALPIT: BP3-TP03**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**
ENGINEER: Fehily Timoney & Co	**E 570,726.5 N 594,401.4**
Ground level: 282.24m O.D.	**Rig: Hitachi ex170**
	Rev: 1
	DATE: 17.6.19

GROUNDWATER

Water strikes: **Rose to after:**
1st: 0.60m
2nd:
3rd:

PIT DIRECTION: 090-270
PIT DIMENSION: 1.50 * 4.20m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0			B 1 D 2	0.40-0.60 0.40-0.60			281.34	0.90	Stiff orangish brown CLAY with low cobble content. Cobbles are subangular to subrounded. 0.00m to 0.30m: with plastic and grass on eastern side of TP.
1			B 3	1.40-1.60			278.34	3.90	Stiff orangish brown and purplish brown slightly gravelly sandy CLAY with high cobble content and medium boulder content. Gravel is subangular to subrounded medium to coarse. Cobbles are angular to subangular. Boulders are subangular. Boulders are up to 600mm in length. Boulder content increasing with depth.
2			B 4 D 5	2.60-2.80 2.60-2.80					
3			B 6	3.30-3.50					
4						END			TP terminated at 3.90m bgl. Obstruction as boulders.
5									

Remarks: Seepage of water at 0.60m bgl. TP backfilled with arisings.

Scale: 1:25

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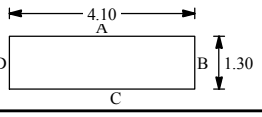
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm	**TRIALPIT: TP-T13**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** E 564,526.7 N 591,912.4 — **Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**Rev: 1**
Ground level: 234.53m O.D.	**DATE: 19.6.19**

GROUNDWATER

Water strikes: Rose to after:
1st: 2.00m
2nd:
3rd:

PIT DIRECTION: 090-270
PIT DIMENSION: 1.30 * 4.10m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0							234.33	0.20	Grass over plastic blackish brown amorphous PEAT.
			B 1	0.30-0.50			233.93	0.60	Firm brown slightly sandy SILT with medium cobble content. Cobbles are subangular.
1			B 2	1.00-1.20					Purplish brown very silty very sandy angular to subangular fine to coarse GRAVEL with high cobble content. Cobbles are subangular to subrounded. 1.50m: with medium boulder content. Boulders are subangular.
2		▼1	B 3	2.20-2.40			232.53	2.00	Weathered SHALE/MUDSTONE rock. Recovered as angular cobble sized clasts of shale/mudstone with clay smear.
						END	231.83	2.70	TP terminated at 2.70m bgl. Obstruction as rock.
3									
4									
5									

Remarks: Seepage of water at 2.00m bgl. TP backfilled with arisings.

Scale: 1:25

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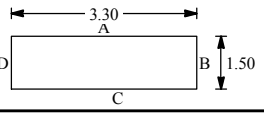
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm	**TRIALPIT: TP-T20**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**
ENGINEER: Fehily Timoney & Co	**E 568,245.6 N 593,744.3**
Rig: Hitachi ex170	
Rev: 1	
Ground level: 328.92m O.D.	**DATE: 18.6.19**

GROUNDWATER

Water strikes: Rose to after:
1st: 3.50m
2nd:
3rd:

PIT DIRECTION: 090-270
PIT DIMENSION: 1.50 * 3.30m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0			B 1	0.20-0.40			328.32	0.60	Firm purplish brown very gravelly very silty SAND.
1							327.62	1.30	Stiff purple CLAY with high cobble content. Cobbles are subangular.
2			B 2	1.30-1.50					Weathered SHALE/MUDSTONE rock. Recovered as angular flat and tabular gravel and cobble sized clasts of purplish brown shale/mudstone. 2.30m to 4.00m: as cobble and boulder sized clasts.
3			B 3	3.00-3.20					
4							324.92	4.00	
5						END			TP terminated at 4.00m bgl. Obstruction as rock.

Remarks: Seepage of water at 3.50m bgl. TP backfilled with arisings.

Scale: 1:25

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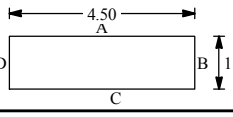
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm		**TRIALPIT: TP-T22**
LOCATION: Bottlehill, Co Cork		**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:**	**Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 568,917.9 N 593,935.8**	**Rev: 1**
Ground level: 377.71m O.D.		**DATE: 18.6.19**

GROUNDWATER
Water strikes: Rose to after:
1st: 2.00m
2nd:
3rd:

PIT DIRECTION: 000-180
PIT DIMENSION: 1.50 * 4.50m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit unstable. Sidewall collapse from 2.00m bgl.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0							377.41	0.30	Plastic black amorphous PEAT.
			B 1	0.50-0.70			376.51	1.20	Soft orangish brown slightly gravelly very silty fine and medium SAND.
			B 2	1.50-1.70			375.81	1.90	Purplish brown very silty very sandy GRAVEL with high cobble content. Cobbles are subangular to subrounded.
2		1							Weathered SHALE/MUDSTONE rock. Recovered as flat and angular cobble sized clasts of purple mudstone/shale.
			B 3	2.40-2.60					
3									
			B 4	3.40-3.60			373.71	4.00	
4									TP terminated at 4.00m bgl. Unable to keep TP open - sidewall collapse.
						END			
5									

Remarks: Moderate ingress of water at 2.00m bgl. TP backfilled with arisings.

Scale: 1:25

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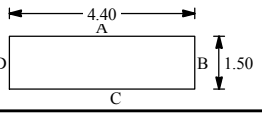
TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

PROJECT: Coom Wind Farm	**TRIALPIT: TP-T23**
LOCATION: Bottlehill, Co Cork	**Sheet 1 of 1**
CLIENT: Coillte	**Co-ordinates:** **Rig: Hitachi ex170**
ENGINEER: Fehily Timoney & Co	**E 569,779.9 N 593,923.6** **Rev: 1**
Ground level: 311.43m O.D.	**DATE: 18.6.19**

GROUNDWATER

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.50 * 4.40m
LOGGED BY: DF



Shoring/Support: N/A
Stability: Pit stable.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									
							311.08	0.35	Stiff purple slightly sandy CLAY with low cobble content.
			B 1	0.40-0.60					Purple and orange silty gravelly fine to coarse SAND with low cobble content. Gravel is subangular to subrounded fine to coarse. Cobbles are subrounded.
							310.53	0.90	
1									Purple very silty fine to medium SAND and subrounded fine to medium GRAVEL with low cobble content. Cobbles are subangular to subrounded of siltstone.
			B 2	1.20-1.40					
2									
			B 3	2.20-2.40					
3							308.23	3.20	
			B 4	3.20-3.40					Stiff purple slightly gravelly sandy CLAY with medium cobble content and low boulder content. Gravel is subangular to subrounded fine to coarse. Cobbles are angular to rounded. Boulders are angular.
			D 5	3.20-3.40					
4							307.13	4.30	
						END			TP terminated at 4.30m bgl.
5									

Remarks: TP dry on excavation. TP backfilled with arisings.

Scale: 1:25

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TRIAL PIT VANE & WL RISES COOM WF TPS FILE 1 W LAB SEPT 24 2019.GPJ IRISHDRL.GDT 15/11/19

IRISH DRILLING LIMITED

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COOM WIND FARM

APPENDIX 2

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Coom Wind Farm	Bottlehill, Co Cork	**RC01**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019C106	07-10-19 07-10-19	226.46	E 566,741.3 N 593,612.6

Engineer: Fehily Timoney & Co

Sheet 1 of 1

Rev. DRAFT

RUN DETAILS					STRATA				
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument/ Backfill
0.00	15 (-) -	NA	226.41		0.05	0.00 - 2.60 : overburden.	ASPHALT.		
					(1.95)		MADE GROUND: Subangular fine limestone GRAVEL. (0.30m recovered).		
2.00			224.46		2.00				
	67 (8) 0	2.00(38/75mm)	223.86		(0.60) 2.60		No recovery. Drillers comment: clay and gravel.		
3.20		NI	223.06		(0.80) 3.40	2.60 - 3.40 Non-intact as weathered rock.	Weathered SILTSTONE rock. Recovered as angular fine to coarse gravel sized clasts of purple siltstone with much purple silt.		
4.50	100 (52) 36					3.40 - 7.50 Discontinuities, medium spaced, locally very closely spaced, dipping 16 to 18 and 82 to 84°, planar, smooth, with 0.5 to 30mm thick purple silt smear.	Strong locally medium strong thinly bedded purple fine grained SILTSTONE. 3.80m to 3.90m: firm purple silt.		
6.10	100 (52) 0	NI			(4.10)		4.50m to 4.60m: firm purple gravelly silt. Gravel is angular fine of siltstone.		
07.10 7.50	100 (60) 41	9	218.96		7.50				
							BH terminated at 7.50m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing
07-10-19	15.00	7.50	3.00	99	63		3.00

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	7.50	water	100

GENERAL REMARKS

BH reinstated.

All dimensions in metres Scale 1:62.5	Client: Coillte	Method/ Plant Used: Hydreq	Bit Design: HQ	Driller: DK	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Coom Wind Farm	Bottlehill, Co Cork	**RC02**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019C106	08-10-19 08-10-19	226.05	E 566,876.1 N 593,433.7

Engineer: Fehily Timoney & Co

Sheet 1 of 2

Rev. DRAFT

RUN DETAILS					STRATA				
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities	Detail	Main	Geology / Instrument/ Backfill
0.00	10 (-) -		226.02		0.03	0.00 - 10.80 : overburden.		ASPHALT. Subrounded to subangular fine to coarse assorted grey limestone and grey purple and dark brown sandstone GRAVEL.	
2.00	13 (-) -	2.00 (29)						2.00m: dense.	
3.50	13 (-) -	3.50 (25/0mm)							
5.00	13 (-) -	5.00 (0/0mm) NA			(10.77)				
6.50	13 (-) -	6.50 (49)						6.50m: dense.	
8.00	13 (-) -	8.00 (25/0mm)							
9.50		9.50 (0/0mm)							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	14.20	polymer	100

GENERAL REMARKS

5 litres of polydrill used. BH reinstated.

All dimensions in metres Scale 1:62.5	Client: Coillte	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: DK	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Coom Wind Farm	Bottlehill, Co Cork	**RC02**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019C106	08-10-19 08-10-19	226.05	E 566,876.1 N 593,433.7

Engineer	Sheet	Rev.
Fehily Timoney & Co	2 of 2	DRAFT

RUN DETAILS					STRATA				
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument/ Backfill
	27 (0) 0		215.25		10.80		Subrounded to subangular fine to coarse assorted grey limestone and grey purple and dark brown sandstone GRAVEL. *(continued)*		
11.00		12				10.80 - 14.20 Discontinuities, closely spaced, locally very closely spaced, dipping 16 to 18°, stepped, smooth, with 0.5 to 16mm thick brownish pink silt smear. 11.90 - 13.60 Possible joint, subvertical dip, planar, smooth, with black smear and minor dark orange brown iron stain, open, non-intact.	Medium strong thinly bedded greenish brown slightly sandy fine grained SILTSTONE.		
12.50	100 (68) 39	NI			(3.40)		12.50m to 12.60m: greyish green slightly gravelly silt. Gravel is subangular fine to coarse of siltstone.		
13.60	100 (26) 0						13.60m to 14.20m: becoming greenish grey sandy.		
08.10 14.20	100 (72) 52	5	211.85		14.20		BH terminated at 14.20m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing
08-10-19	16.00	14.20	5.00	99	63		4.00

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

5 litres of polydrill used. BH reinstated.

All dimensions in metres Scale 1:62.5	Client: Coillte	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: DK	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Coom Wind Farm	Bottlehill, Co Cork	**RC03**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019C106	04-10-19 04-10-19	51.87	E 582,096.2 N 594,256.2

Engineer: Fehily Timoney & Co

Sheet 1 of 2

Rev. DRAFT

RUN DETAILS					STRATA				
Depth / Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick-ness)	DESCRIPTION: Discontinuities / Detail	DESCRIPTION: Main	Geology	Instrument/ Backfill
0.00			51.67		0.20	0.00 - 15.00 : overburden.	ASPHALT.		
					(0.60)		Angular fine and medium purple siltstone GRAVEL with a little purple silt.		
	70 (-) -		51.07		0.80		Firm slightly sandy slightly gravelly clayey SILT. Sand is fine. Gravel is subrounded fine and medium of assorted brown sandstone and assorted grey limestone.		
2.00		2.00 (30)							
	73 (-) -								
3.50		3.50 (33)							
	13 (-) -				(6.50)				
5.00		5.00 NA (42)							
	27 (-) -								
6.50		6.50 (31)							
	33 (-) -		44.57		7.30		Subangular to subrounded fine to coarse assorted grey limestone and assorted grey and brown sandstone GRAVEL with a little pinkish brown silt.		
8.00									
	67 (-) -	8.00 (25/0mm)							
8.60									
	56 (-) -								
9.50		9.50 (38/75mm)							

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing

Rotary Flush

From (m)	To (m)	Type	Return (%)
0	15.00	polymer	100

GENERAL REMARKS

5 litres of polydrill used. BH reinstated.

All dimensions in metres Scale 1:62.5	Client: Coillte	Method/ Plant Used: Hydreq	Bit Design: HQ	Driller: DK	Logged By: EAT

IDL AGS UK DH (SPTS) COOM WF RC FILE 1 OCT 10 2019.GPJ IDL TP TEMPLATE.GDT 10/10/19

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Coom Wind Farm	Bottlehill, Co Cork	**RC03**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019C106	04-10-19 04-10-19	51.87	E 582,096.2 N 594,256.2

Engineer	Sheet	Rev.
Fehily Timoney & Co	2 of 2	DRAFT

RUN DETAILS					STRATA				
Depth Date	TCR (SCR) RQD	(SPT) Fracture Spacing	Red'cd Level	Legend	Depth (Thick- ness)	DESCRIPTION Discontinuities	Detail	Main	Geology	Instrument/ Backfill
11.00	33 (-) -							Subangular to subrounded fine to coarse assorted grey limestone and assorted grey and brown sandstone GRAVEL with a little pinkish brown silt. *(continued)*		
		11.00 (0/0mm)			(7.70)					
12.50	27 (-) -									
		12.50 NA (49)						12.50m: dense.		
14.00	20 (-) -									
		14.00 (25/0mm)								
04.10 15.00	40 (-) -		36.87		15.00					
		15.00 (55/150mm)						BH terminated at 15.00m bgl on REs instruction.		

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing
04-10-19	15.30	15.00	6.00	99	63		2.50

Rotary Flush

From (m)	To (m)	Type	Return (%)

GENERAL REMARKS

5 litres of polydrill used. BH reinstated.

All dimensions in metres Scale 1:62.5	Client: Coillte	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: DK	Logged By: EAT

IDL AGS UK DH (SPTS) COOM WF RC FILE 1 OCT 10 2019.GPJ IDL TP TEMPLATE.GDT 10/10/19

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COOM WIND FARM

APPENDIX 3

Coom Windfarm

Bottle Hill, Co. Cork

Geophysical Survey

Report Status: Draft

MGX Project Number: 6529

MGX File Ref: 6529d-005.doc

11th November 2020

Confidential Report To:

Irish Drilling Ltd
Old Galway Road
Pollroebuck
Loughrea
Co. Galway

Fehily Timoney & Company
Core House
Pouladuff Road
Cork

Report submitted by:
Minerex Geophysics Limited

Unit F4, Maynooth Business Campus
Maynooth, Co. Kildare
Ireland
Tel.: 01-6510030
Fax.: 01-6510033
Email: info@mgx.ie

Issued by:

Author: John Connaughton (Geophysicist)

Reviewer: Hartmut Krahn (Senior Geophysicist)

Minerex
Geophysics Limited

Subsurface Geophysical Investigations

EXECUTIVE SUMMARY

1. Minerex Geophysics Ltd. (MGX) carried out a geophysical survey consisting 2D-Resistivity and seismic refraction (p-wave) profiles at 22 Turbine locations for the Coom Windfarm Project, Bottlehill, Co. Cork.
2. The main objectives of the survey were to determine the ground conditions under the site, determine the depth to rock and the overburden thickness, to estimate the strength/stiffness/compaction of overburden and the rock quality.
3. After the initial survey was carried out in 2019, six turbine locations (T2 – T7) were changed. 5 out of 6 of these new locations were surveyed in November 2020 but the new T4 location was flooded and could not be surveyed at the time.
4. The locations in 2020 were cleared by Fehily Timoney & Co. prior to Minerex arrival on site and profiles were carried out where clearance was available. T2 is 30 m from the profile location while T5 is 67 m away from the profiles.
5. The survey was spread over an area covering roughly 1500 Ha. It resulted in a wide range of electrical resistivities and seismic refraction velocities characterising the turbine locations.
6. The seismic refraction data was divided into 7 distinct layers while the 2D-Resistivitity data provided three generalised overburden and rock types.
7. Seismic Layer 1 is interpreted as very soft or very loose topsoil and is no deeper than 1.5 m at its thickest.
8. Layer 2 is described as soft or loose topsoil while layers 3 and 4 are described as firm or medium dense and stiff or dense overburden respectively.
9. Layer 5 may contain poor weathered rock or very stiff or very dense overburden within it.
10. Layer 6 is the deepest layer within the survey constraints at most locations and is interpreted as fair to good rock.
11. Layer 7 is the deepest layer, occurring at 2 turbine locations, and is interpreted as good Sandstone.
12. The 2D-Resistvity data allowed three general types of overburden to be interpreted which are described as sandy gravelly clay and silt, clayey silty sand and gravel and as the third clean sand and gravel.
13. Within the rock layers, the 2D-Resistivity results allowed for three generalised rock types described as mudstone, interbedded mudstone and sandstone, and sandstone within layers 5 and 6 and sandstone within layer 7.
14. Layers 1 and 2 which represent very soft or very loose and soft or loose overburden are greater than 3 m thick at T2, T10, T18, T19. The soft or loose layer reaches a depth of up to 4.5m bgl at T5 and T21.
15. The shallowest rock at less than 3 m deep occurs at T7, T8 and T9.

16. Deepest rock at more than 10 m deep occurs at T5, T15, T20 and T21.
17. Along the profiles at Turbines T15 and T23 the geophysics indicate significant lateral change across the length of the profiles.
18. This report will be reviewed and finalised after the complete direct ground investigation data has been received.

CONTENTS

List of Tables, Maps and Figures:

1. INTRODUCTION

1.1 Background

Minerex Geophysics Ltd. (MGX) carried out a geophysical survey for the Coom Windfarm Project. The survey consisted of a 2D-Resistivity and seismic refraction (p-wave) profile at each of the turbine locations. The survey was commissioned by Irish Drilling Ltd.

22 locations were initially surveyed in 2019. Six turbine locations (T2 – T7) were subsequently moved and five of these new locations were surveyed in 2020. T4 was flooded at this time and no survey was carried out at the new proposed T4 turbine location. The results from the old turbine location have been replaced in this report.

The survey employed two geophysical methods that complement each other and improve the interpretation. The role of geophysics as a non-destructive fast method is to allow later targeted direct investigations. Those results can be used to improve the initial results and interpretation.

The proposed development consists of 22 Wind Turbines (T2 to T23), 2 substations and three borrow pits across an area covering 1500 ha and stretches a distance of 10 km between the furthest turbines.

The survey was aimed both at investigating the ground stability and to determine the ground conditions under the site.

1.2 Objectives

The main objectives of the geophysical survey were:

- To determine the ground conditions under the site
- To determine the depth to rock and the overburden thickness
- To estimate the strength/stiffness/compaction of overburden materials and the rock quality
- To determine the type of overburden and rock
- To detect lateral changes within the geological layers
- To determine the presence of possible faults and fracture zones

1.3 Site Description

The site is located in Co. Cork between Mallow and Fermoy around Bottlehill and Knocknaskagh. The site stretches for a distance of 10 km and covers an area of roughly 1500 Ha, with 22 turbine locations proposed. Most of the locations are within conifer forestry while some are located in farm land. The turbines are located in upland areas across two separate hills. Most locations required forest clearance for access and to set out the profiles.

1.4 Geology

Table 1 describes the conditions at all the turbine locations including information on the bedrock, overburden, landslide susceptibility and ground water. This table was part of Fehily Timoney's desktop study of the site.

The online geological map of Ireland (GSI, 2019) indicates that the whole survey area is underlain by the Ballytrasna Formation, described as purple mudstone and sandstone while the subsoil varies but is primarily till derived from Devonian sandstones. The rock formation is heavily folded along east – west axes.

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). For ease of reference, the figure numbers are related to the Turbine numbers which means there is no figure 1.

Elevations were surveyed on site where possible and are used in the vertical sections. In locations where the tree cover was too dense to obtain good elevations with a RTK-GPS system the reference elevation in the drawings is 'zero'.

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 carrying out a 2D-Resistivity and Seismic Refraction Profile centred on the proposed turbine location. The orientation of the profiles was primarily based on the most accessible line which could be cleared, avoiding steep embankments and dense vegetation which might affect the results of the survey.

All 21 locations had one 2D-Resistivity and one seismic refraction profile centred at the proposed turbine. Each 2D-Resisitivity profile had 32 electrodes with a 3 m spacing to give 93 m length per profile while each seismic refraction profile was carried out using a 2 m spacing and 24 geophones, giving a 46 m long profile. The survey locations are indicated on Map 1 while the orientations are better illustrated on Maps 2a and 2b.

During the revisit in 2020 for the new T2 – T7 location, profiles were carried out where clearance had been undertaken. No clearance had been completed at T4 as it was flooded. The clearance at T2 was 30 m SW of the turbine location and T5 was located 67 m west of where the profiles were undertaken.

All geophysical surveys are acquired, processed and reported in accordance with British Standards BS 5930:1999 +A2:2010 'Code of Practice for Site Investigations'.

2.2 2D-Resistivity

2D-Resistivity profiles were surveyed with electrode spacing of 3 m, 32 electrodes per set-up and a length of 93 m per profile. The readings were taken with a Tigre Resistivity Meter, Imager Cables, stainless steel electrodes, laptop and ImagerPro acquisition software.

During 2D-Resistivity surveying data is acquired in the form of linear profiles using a suite of metal electrodes. A current is injected into the ground via a pair of electrodes while a potential difference is measured across a second pair of electrodes. This allows for the recording of the apparent resistivity in a two-dimensional arrangement below the profile. The data is inverted after the survey to obtain a model of subsurface resistivities. The generated model resistivity values and their spatial distribution can then be related to typical values for different geological materials.

The penetration depth of a resistivity profile increases towards the centre where it reaches an approx. value of $1/6^{th}$ of the layout length.

2.3 Seismic Refraction

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

In the seismic refraction survey method, a p-wave is generated by a source at the surface resulting in energy travelling through surface layers directly and along boundaries between layers of differing seismic wave velocities. Processing of the seismic data allows geological layer thicknesses and boundaries to be established.

Seismic Refraction generally determines the depth to horizontal or near horizontal layers where the compaction/strength/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 degrees angle the accuracy becomes much less.

The seismic refraction profiles with 46 m individual length and 12 m offshots have a reasonable penetration depth of around 12m. The depth penetration varies according to the velocity structure of the subsurface.

2.4 Site Work

The data acquisition was carried out between the 4th and 19th of June 2019 and the 25th and 26th of September 2019. The site was revisited on the 3rd and 4th of November 2020 as the locations for Turbines T2 – T7 were changed and new surveys were required at the new locations. At the time of the revisit T4 was flooded and could not be surveyed. There are therefore no results provided for T4 in this report. The weather conditions were variable throughout the acquisition period. Health and safety standards were adhered to at all times. The locations and elevations were surveyed with a TRIMBLE RTK-GPS to accuracy < 0.05 m where possible. High trees and dense tree cover in many locations affected the accuracy of the GPS. In these locations, the profile locations are accurate to ~2m and no elevations are provided. The figures are then drawn at a ‘zero’ elevation (T2, 3, 5, 8, 10, 12, 14, 16, 17, 19, 20, 21, 22, 23).

3. RESULTS AND INTERPRETATION

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

The interpretation is made as a layered ground model based on seismic velocities. The 2D-Resistivity results provide information on overburden and rock types as well as horizontal variations within the seismic layers.

3.1 2D-Resistivity

The 2D-Resistivity data was positioned and inverted with the RES2DINV inversion package. The programme uses a smoothness constrained least-squares inversion method to produce a 2D model of the subsurface model resistivities from the recorded apparent resistivity values. Three variations of the least squares method are available and for this project the Jacobian Matrix was recalculated for the first three iterations, then a Quasi-Newton approximation was used for subsequent iterations. Each dataset was inverted using seven iterations resulting in a typical RMS error of <3.0%. The resulting models were colour contoured with the same resistivity scale for all profiles and they are displayed as cross sections (Figures 2 - 23).

Resistivities are characteristic for certain overburden and rock types. If there is a high content of clay minerals (which are electrically conductive) then the overburden resistivity will be lower than as if there is a high content of clastic grains like sand or gravel. The purer the clay and the lower the sand/gravel content the lower the resistivity. The water content in the overburden also influences the resistivities but generally the clay content has a larger effect.

The resistivities cover a range typical for materials from clay rich overburden or peat (low resistivities) to fresh strong unweathered bedrock (high resistivities). The ranges have been taken into the consideration for the interpretation. Within overburden layers, low resistivity values (<250 Ohmm) typically indicates sandy gravelly clay and silt. Medium values (250 to 1000 Ohmm) show a clayey silty sand and gravel, while high resistivities (>1000 Ohmm) indicates a clean sand and gravel overburden. Within bedrock layers, low resistivities indicate mudstone, medium resistivities are interpreted as interbedded mudstone and sandstone while high resistivities indicate sandstone.

3.2 Seismic Refraction

The seismic refraction data was positioned and processed with the SEISIMAGER software package to give a layered model of the subsurface. A total of 7 seismic layers have been determined by analysing the seismic traces and between 3 and 4 layers were used in each individual model. All seismic profiles were subject to a standardised processing sequence which consisted of a topographic correction which was based on

integrated elevation data where available, first break picking, tomographic inversion, travel-time computation via ray-tracing and velocity modelling. Residual deviations of typically 0.4 to 1.8 msec RMS have been obtained for each profile. Following each processing stage QC procedures were adhered to. The resulting layer boundaries are shown as thick lines overlaid on the 2D-Resistivity cross sections (Figures 2 -23). 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. Similarly, for the other parameters, it is generally valid that a more compacted, stiffer 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, fissured or karstified 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 weathered rock can have the same seismic velocity range (as is the case in the layer 5 below).

The modelled seismic data has created the following layered ground model:

Layer 1 is found at locations turbine locations 3, 8, 11 – 13 and 17 -23. It has seismic velocities of 170 - 200 m/s and is interpreted as very soft of very loose topsoil. This layer may include peat but is not very thick with a maximum thickness of under 1.5 m.

Layer 2 was modelled with a velocity range of 300 - 600 m/s and is the top layer at all other turbine locations (2, 5 – 7, 9, 10, 14 - 16) and is found at T12, 18, 19 and 21 below layer 1. The velocity indicates soft or loose topsoil.

Layer 3 velocities of 800 - 1100 m/s indicate overburden with firm or medium dense strength or compaction. This layer is identified at locations T3, 6, 11 - 18, 20 and 22.

Layer 4 has velocities of 1400 - 1500 m/s which indicate a stiff or dense overburden and this is interpreted at T2, 5, 8, 9, 11, 19, 21, 23. This is the deepest layer modelled at T5.

Layer 5 has a velocity range between 1700 – 2000 m/s. This layer is interpreted predominantly as poor weathered rock or very stiff or very dense overburden. This layer is found at T3, 10, 15, 17, 20 and 22.

Layer 6 has a velocity range of 2600 – 3200 m/s and is interpreted as fair to good rock. T6 is the deepest layer in all locations except T2 and T5

Layer 7 is interpreted as good rock with velocities of between 3700 – 4000 m/s. This layer if the found as the deepest layer at T2.

3.3 Interpretation of Resistivity and Seismic Refraction

Table 2 summarises the interpretation. 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.

Interpreted cross sections are shown in the right panel of Figures 2 - 23. The interpretation has been made from all available information. For overburden layers and the top of the rock the seismic refraction data has been used as seismic refraction is the best method to delineate layer boundaries (Layers 1 - 7). The resistivity models have been used to delineate three generalised types of overburden and rock (a, b and c). Resistivity data is better suited to show rock types and features within the rock while seismic refraction velocities are indicating the change of compaction, stiffness or rock quality with depth. Along short profile parts where only one data type is available an interpolation for the interpreted layers was made.

Table 2: Summary of Results and Interpretation

Layer	**General Seismic Velocity Range (m/sec)**	**General Resistivity Range (Ohmm)**	**Stiffness/ Compaction or Rock Strength/ Quality**	**Interpretation**	**Estimated Excavation Method**
1	170 – 200	Any	Very Soft or very loose	Topsoil	Diggable
2	300 – 600	Any	Soft or Loose	Topsoil	Diggable
3a	800 - 1100	<250	Firm	Sandy gravelly Clay and Silt	Diggable
3b	800 - 1100	250 - 1000	Medium Dense	Clayey silty Sand and Gravel	Diggable
3c	800 - 1100	>1000	Medium Dense	Sand and Gravel	Diggable
4a	1400 - 1500	<250	Stiff	Sandy gravelly Clay and Silt	Diggable
4b	1400 - 1500	250 - 1000	Dense	Clayey silty Sand and Gravel	Diggable
4c	1400 - 1500	>1000	Dense	Sand and Gravel	Diggable
5a	1700 - 2000	<250	Poor or Very stiff	Weathered Mudstone or sandy gravelly Clay and Silt	Diggable or rippable to marginal rippable
5b	1700 - 2000	250 - 1000	Poor or Very dense	Weathered Interbedded Mudstone and Sandstone or clayey silty Sand and Gravel	Diggable or rippable to marginal rippable
6a	2600 - 3200	<250	Fair to Good	Mudstone	Breaking & Blasting
6b	2600 - 3200	250 - 1000	Fair to Good	Interbedded Mudstone and Sandstone	Breaking & Blasting
6c	2600 - 3200	>1000	Fair to Good	Sandstone	Breaking & Blasting
7	3700 - 4000	>1000	Good	Sandstone	Breaking & Blasting

4. CONCLUSIONS

4.1 General Conclusions

- Minerex Geophysics carried out a survey consisting of a 2D-Resistivity and seismic refraction profile at 22 proposed turbine location for the Coom Windfarm project.
- Six Turbine locations (T2 – T7) were subsequently changed and 5 of these (T2, T3, T5 – T7) were resurveyed in 2020.
- The survey was carried out over a large area which is indicated by the wide range of resistivities and seismic refraction velocities found throughout the survey.
- There are 7 seismic layers modelled where the strength, stiffness, compaction and rock quality increases with depth. These have been subdivided by resistivities into overburden and rock type.
- Layer 2 is interpreted as soft or loose topsoil while layers 3 and 4 are described as firm or medium dense and stiff or dense overburden.
- Layer 5 is described as poor weathered rock or very stiff or very dense overburden.
- Layer 6 is interpreted as fair to good rock while layer 7 which is only found at T2 has higher velocities and is interpreted as good rock.
- The overburden layers were subdivided into three general types using the 2D-Reistivity results described as sandy gravelly clay and silt, clayey silty sand and gravel and clean sand and gravel.
- Layers 5 is both divided into two generalised rock types described as mudstone and interbedded mudstone and sandstone.
- Layer 6 is divided into three generalised rock types described as mudstone and interbedded mudstone and sandstone and sandstone.
- Where seismic layer 7 is present the resistivities are also higher than in layers 5 and 6 which give an interpretation of the bedrock as sandstone.

4.2 Conclusions by Turbine

Turbine 2 has the highest resistivity and seismic velocities of all the turbine locations. The resistivities remain high from the surface to depth and are interpreted as sand and gravel overburden over good sandstone. There is a think soft and loose topsoil layer with good sandstone layer between 4.5 and 7 m below ground level (bgl). The overburden could be derived by complete weathering of the rock.

Turbine 3 has a shallow topsoil layer underlain by 1.5 – 3 m of medium dense clayey silty sand and gravel. The poor weathered interbedded mudstone and sandstone or very dense clayey silty sand and gravel layer is between 2 – 3.5 m thick.. Fair to good interbedded mudstone and sandstone is between 2.5 and 4 m bgl.

Turbine 4 was not surveyed as the location was flooded when surveying was taking place.

Turbine 5 has a layer of soft or loose topsoil that is between 3.5 – 4.5 m thick. This layer us underlain by thick overburden primarily described as dense sand and gravel with some dense clayey silty sand and gravel near the top of the layer. It is likely that rock is found at a depth of 10 m as the resistivities increase around this depth.

Turbine 6 has uniform high resistivity with depth along the profile. The seismic refraction data shows soft or loose overburden over medium dense sand and gravel to a depth of 3.5 – 4.5 m underlain by fair to good sandstone.

Turbine 7 shows high seismic velocities close to the surface with primarily medium resistivities at all depths. The location is underlain by 1 – 2 m of soft or loose topsoil with fair to good interbedded mudstone and sandstone below this.

Turbine 8 has predominantly dense clayey silty sand and gravel overburden under a shallow layer of very soft or very loose topsoil. The bedrock is described as fair to good interbedded mudstone and sandstone at a depth of between 2.75 m in the SE to 6 m below the Turbine and towards the NW.

Turbine 9 has a more clay and silt rich overburden while the bedrock is shallow at a depth of between 2 m in the SE and 4 m in the NW. It is interpreted as fair to good mudstone.

Turbine 10 has a relatively deep layer of soft or loose topsoil up to 3.5 m thick, underlain predominantly by poor weathered mudstone or very stiff sandy gravelly clay and silt. The top of the fair to good mudstone layer is between than 5.5 and 9 m bgl.

At **Turbine 11**, the overburden is described as a thin layer of very soft or very loose topsoil over medium dense to dense predominantly clayey silty sand and gravel to a depth of 5 – 6.5 m bgl underlain by fair to good mudstone.

Along **Turbine 12**, the resistivities decrease with depth which indicates a sandier gravelly overburden at the surface with greater clay content below it. The low resistivities at depth indicate a mudstone which is at depths of 3.5 and 5.5 bgl.

Turbine 13 shows a sudden decrease in resistivities between the overburden and rock layers. This is interpreted as a very loose to medium dense sand and gravel overburden to a depth of 4 – 5 m bgl over mudstone in the east and interbedded mudstone and sandstone towards the west.

Turbine 14 similarly shows a rapid decrease in resistivities with depth which is also interpreted as loose to medium dense sand and gravel overburden over fair to poor mudstone at a depth of 4 – 5 m bgl.

At **Turbine 15** the resistivities generally decrease with depth as well as decreasing towards the SW. This indicates greater clay content in the overburden and mudstone towards the SW. Soft or loose topsoil is up to 2.5 m thick. This is underlain by a slightly thinner layer of medium dense sand and gravel. Poor weathered interbedded mudstone and sandstone or very dense clayey silty sand and gravel begins at 4 m

bgl while the fair to good rock layer begins between 6 and 10 m bgl, becoming deeper towards the NE. This location shows a lateral change in overburden and bedrock type and also in the depth to rock. This could indicate a fault or fracture zone under the proposed turbine.

Turbine 16 has a thin layer of soft or loose topsoil over medium dense clayey silty sand and gravel. Low resistivities and high seismic refraction at depth indicates fair to good mudstone at a depth of 4.5 m bgl

Turbine 17 has a relatively uniform resistivity throughout the survey area. The seismic refraction velocities increase rapidly with depth which gives a four-layer model ranging from very soft or very loose topsoil to fair to good interbedded mudstone and sandstone at a depth of 4 – 4.5 m bgl.

Turbine 18 shows a slight decrease in resistivities with depth and towards the west. The overburden consists of thin layers of very soft to soft or very loose to loose topsoil over a thicker layer of medium dense clayey silty sand and gravel. The bedrock is interpreted as fair to good interbedded mudstone and sandstone at a depth of between 8.5 and 9 m bgl. The rock is relatively deep at this location.

Turbine 19 has a decrease in resistivities with depth in the overburden and an increase within the rock layer. This indicates an increase in clay content in the overburden and an increase in sandstone layering within the bedrock with depth. The overburden is interpreted as 1.5 to 3 m of very soft to soft or very loose to loose topsoil over stiff or dense overburden. The fair to good rock layer begins at a depth of 5 – 6.5 m bgl.

Turbine 20 shows a higher resistivities near the surface before decreasing and becoming more homogenous with depth. There is a thick layer between 3 – 5 and 8 – 11 m bgl which is interpreted as poor weathered interbedded mudstone and sandstone or very dense clayey silty sand and gravel with fair to good rock below it. The fair to good rock is relatively deep at this location.

The geophysical results at **Turbine 21** are interpreted as a 2 – 4.5 m of very loose to loose topsoil over a layer of dense sand and gravel with increased clay and silt content with depth. The fair to good rock drops off sharply below the turbine location from 7 m bgl in the SE to over 15 m in towards the NW. This location shows a lateral change in overburden and bedrock type and also in the depth to rock. This could indicate a fault or fracture zone under the proposed turbine.

Turbine 22 has a four-layer seismic refraction model which is interpreted as thin layers of very soft or very loose overburden and medium dense clayey silty sand and gravel over a layer interpreted primarily as poor weathered interbedded mudstone and sandstone or very dense clayey silty sand and gravel starting at a depth of 1.5 – 3.5 m bgl. Fair to good rock begins at a depth of 4.5 – 5 m.

Turbine 23 has a thin layer of very soft or very loose topsoil over a thick layer of dense clayey silty sand and gravel. Fair to good interbedded mudstone and sandstone is interpreted as a depth of 5 m in the SE dropping to 8.5 m in the NW.

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3. **Milsom, 1989.** Field Geophysics. John Wiley and Sons.

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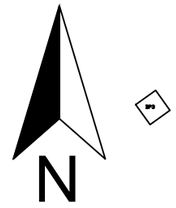

T21
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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Map 1: Overview Map of Geophysical Survey Locations

SCALE:	1:20,000 @ A3
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

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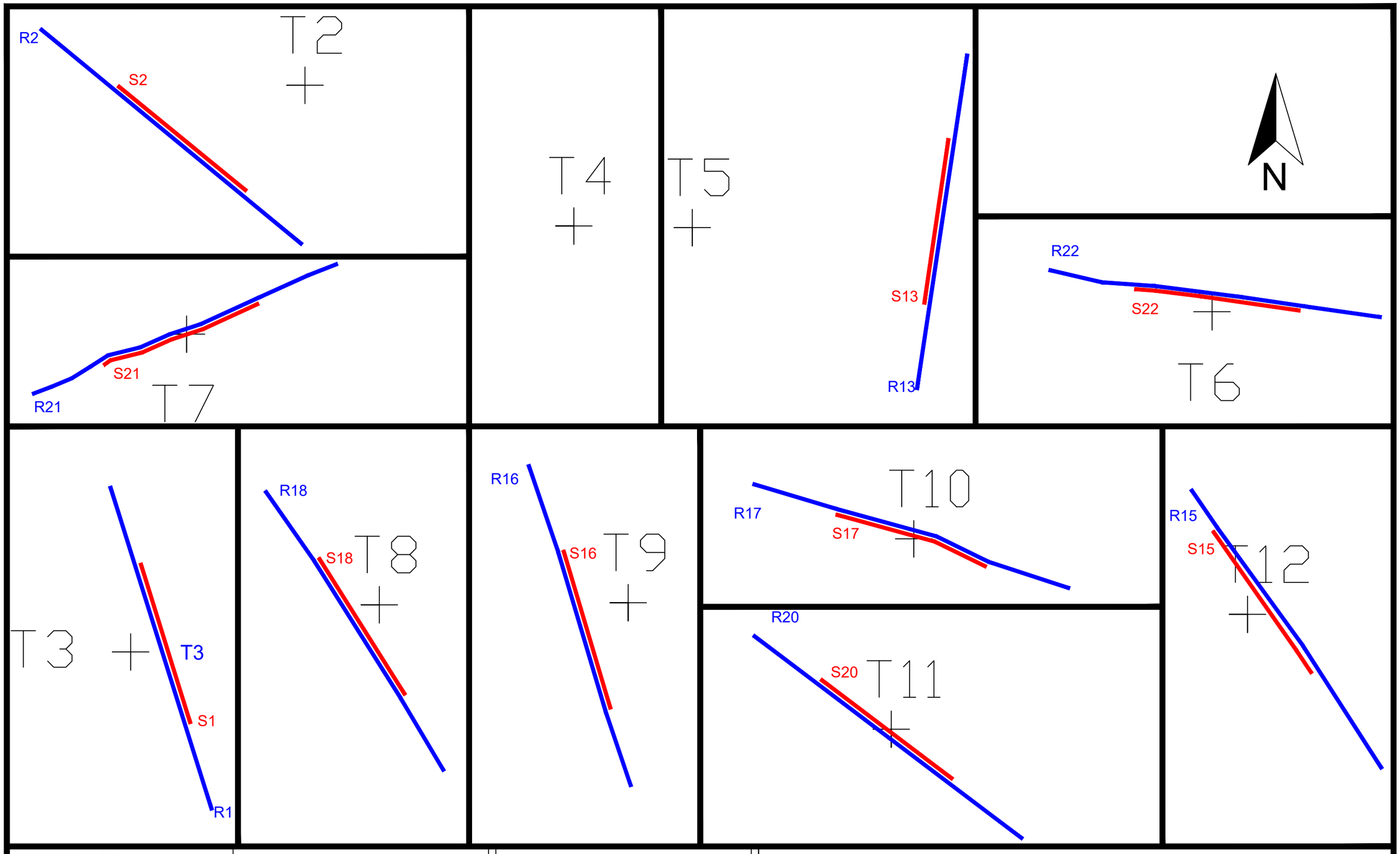
R2	2D-Resistivity Profile
S1	Seismic Refraction Profile
T1	Turbine Name

Direct Ground Investigation Locations:

TP1	Trial Pit



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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Map 2a: Geophysical Survey Location Maps

SCALE:	1:1000 @ A3
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

LEGEND:

Geophysical Survey Locations:

R2	2D-Resistivity Profile
S1	Seismic Refraction Profile
T1	Turbine Name

Direct Ground Investigation Locations:

TP1	Trial Pit

T13
S4
TP13
R4
T15
R5
S5
T17
S11
R11
N
T14
R3
S3
T16
S23
R23
R10
T18
S10
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R6
T23
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T19
S9
TP22
T22
R8
S8

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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Map 2b: Geophysical Survey Location Maps

SCALE:	1:1000 @ A3
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

LEGEND:

Geophysical Survey Locations:

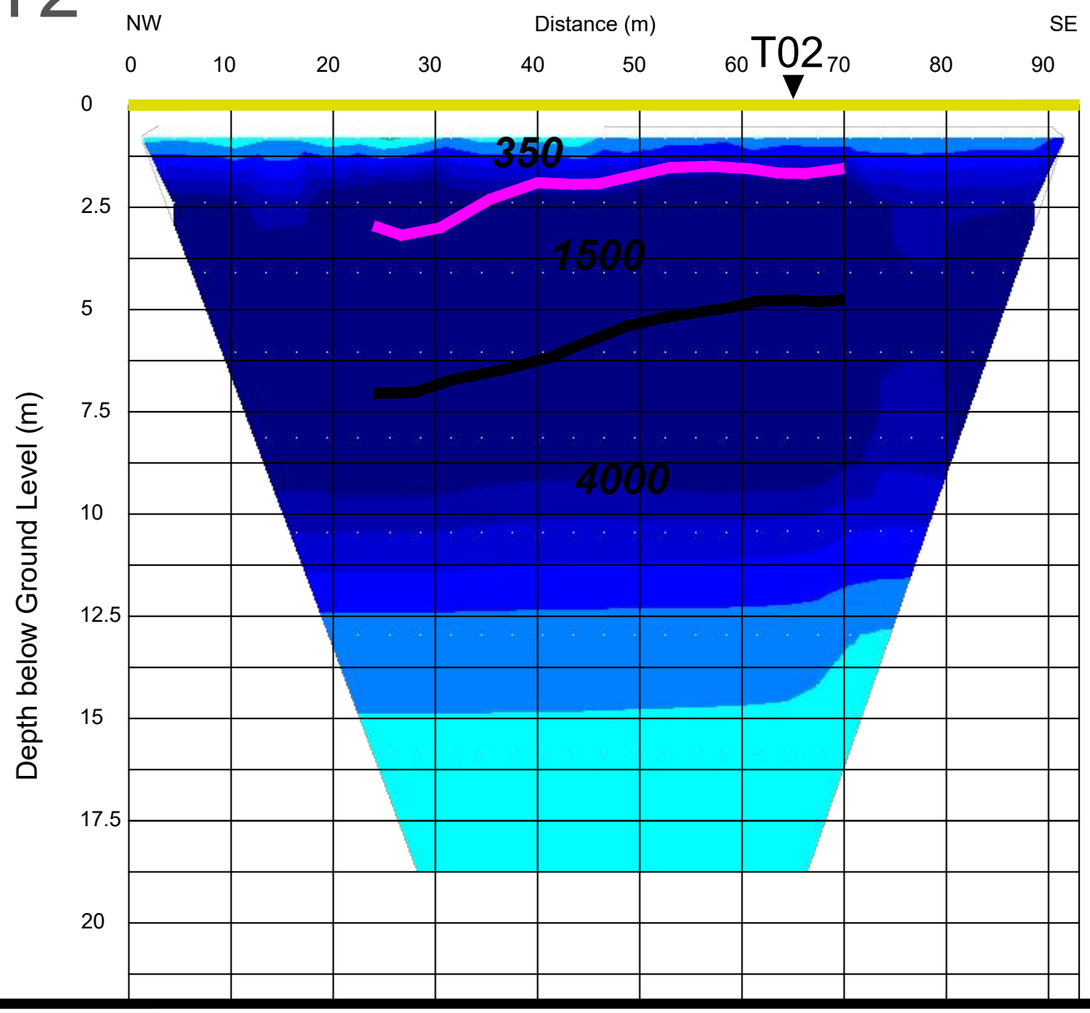
R2	2D-Resistivity Profile
S1	Seismic Refraction Profile
T1	Turbine Name

Direct Ground Investigation Locations:

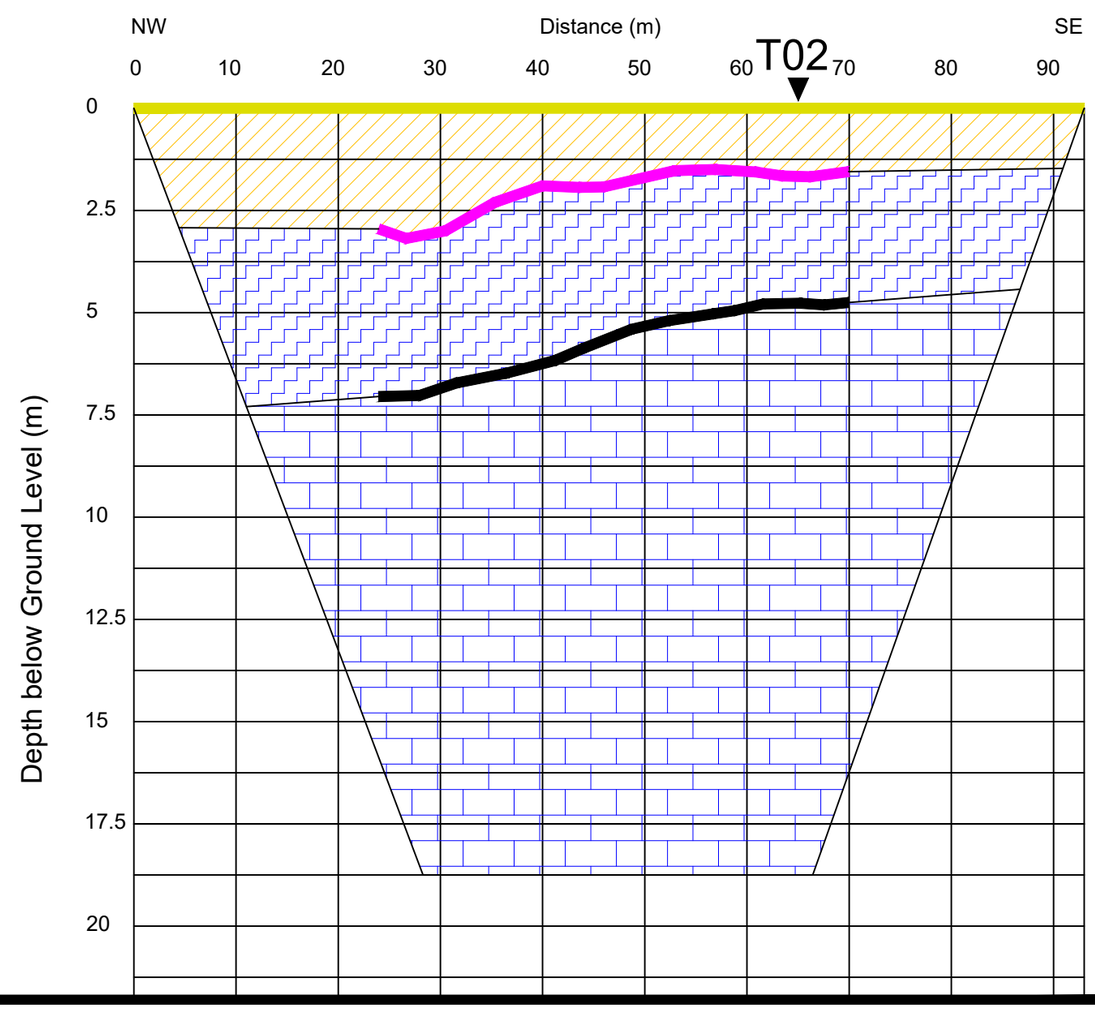
TP1	Trial Pit

T2

2D-Resistivity Profile R2 and Seismic Refraction Profile S2 Model



2D-Resistivity Profile R2 and Seismic Refraction Profile S2 Interpretation



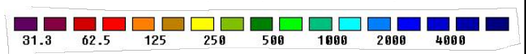
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 2: Models and Interpretation of Geophysical Survey for T2

SCALE:	1:600 @ A3, VE x 4
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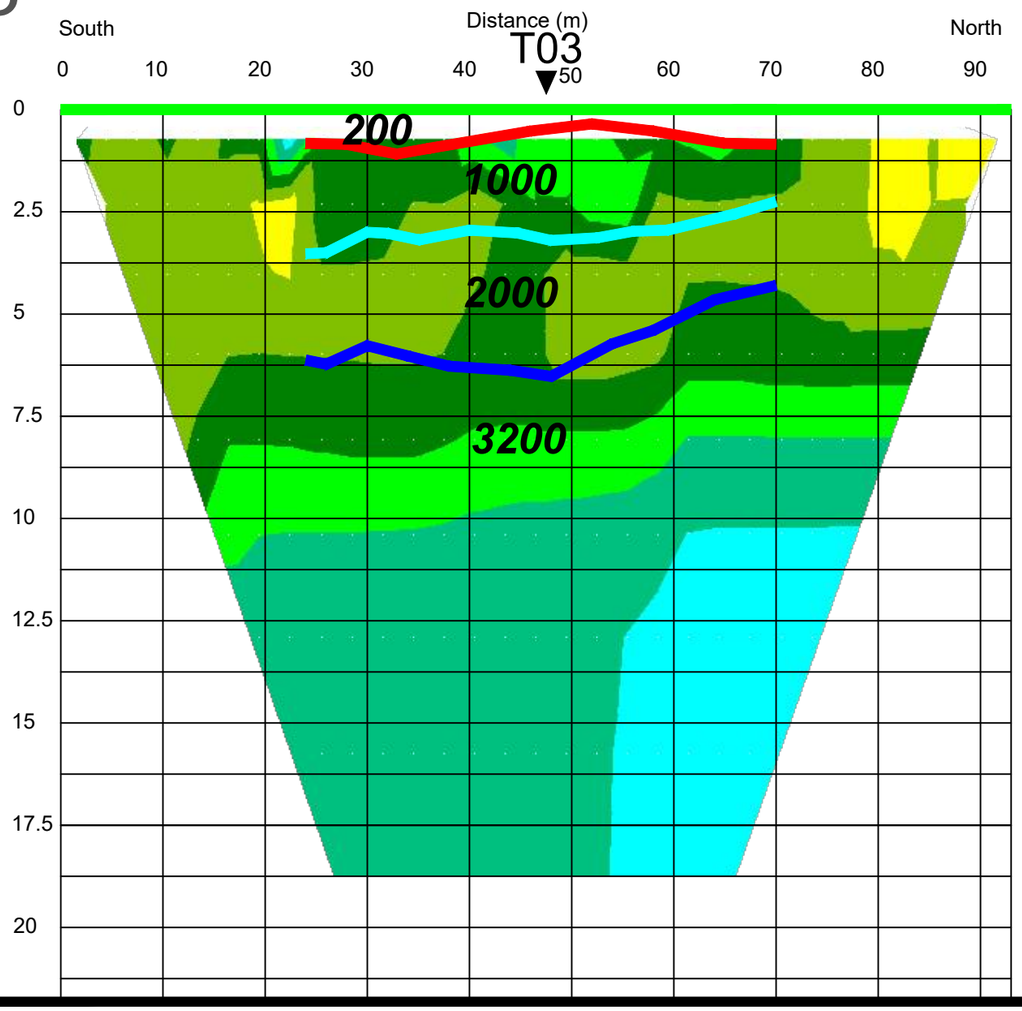
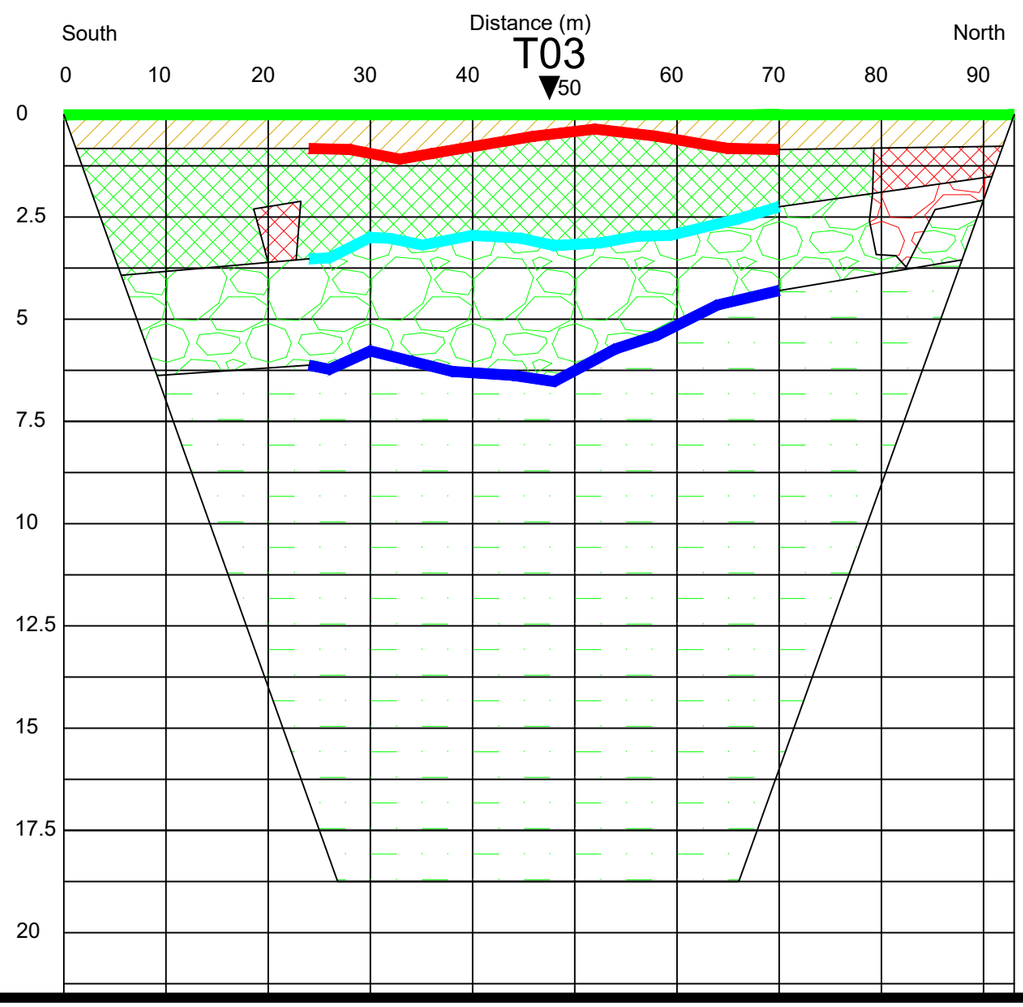
DATE:	06/11/2020
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T3

2D-Resistivity Profile R1 and Seismic Refraction Profile S1 Model



2D-Resistivity Profile R1 and Seismic Refraction Profile S1 Interpretation

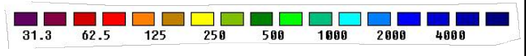


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 3: Models and Interpretation of Geophysical Survey for T3

SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	06/11/2020
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T4

Site flooded during revisit 2020

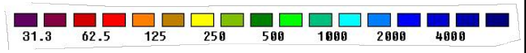
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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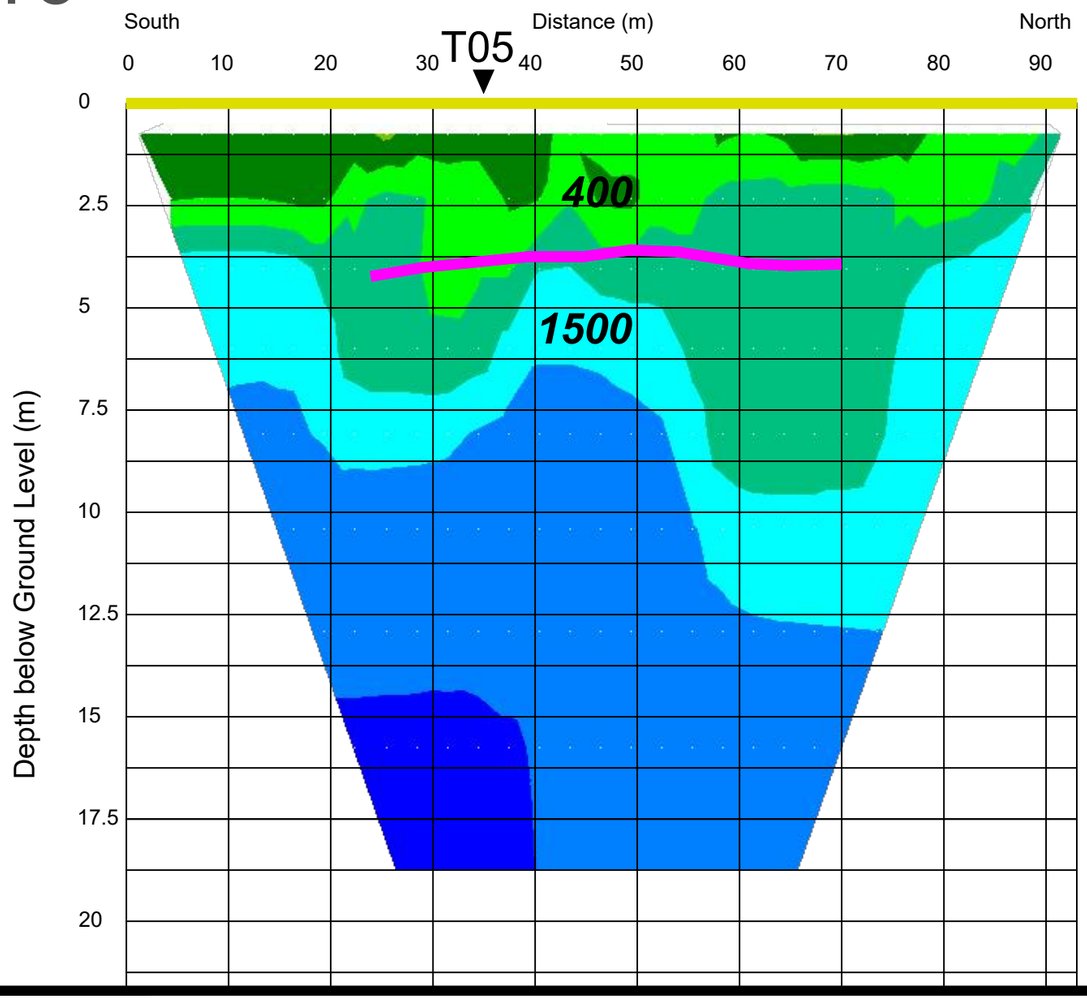
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 4: Models and Interpretation of Geophysical Survey for T4

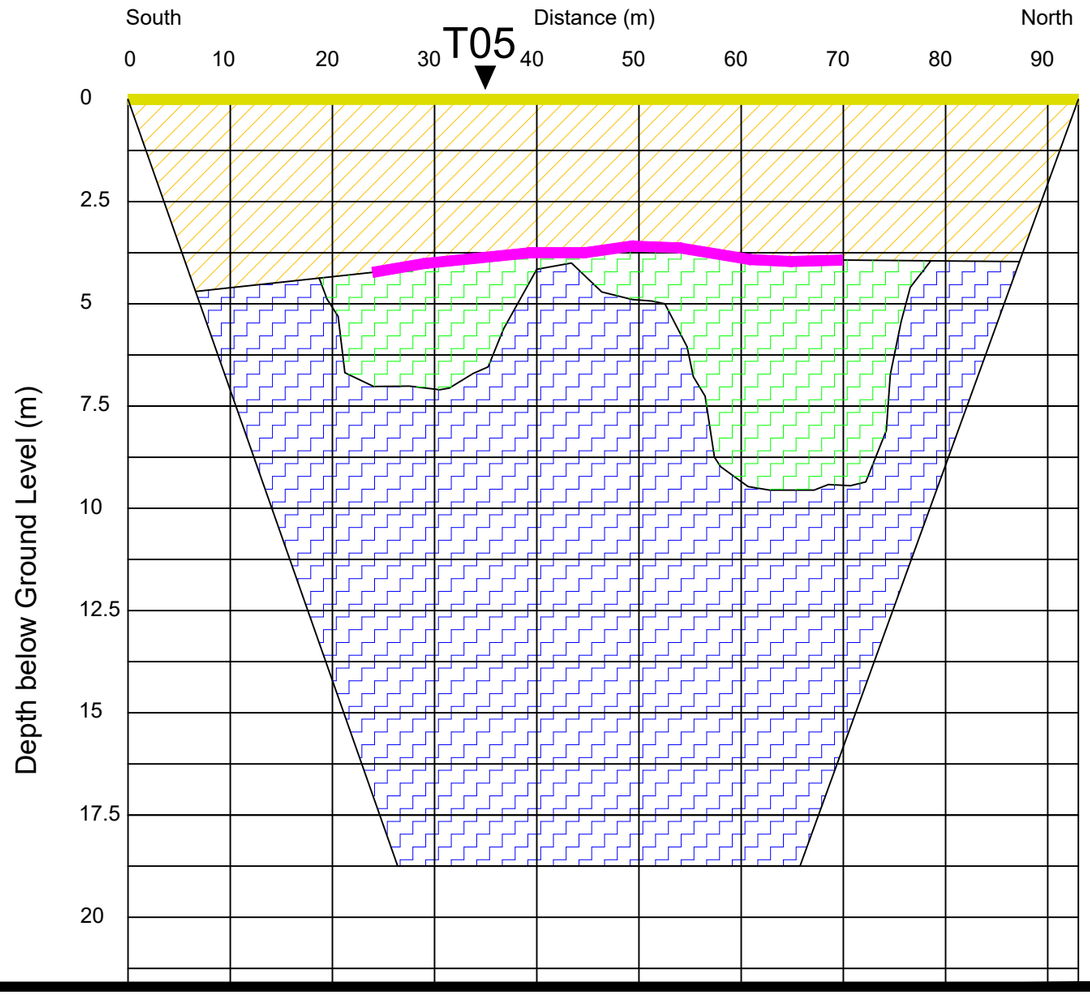
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6446d_MapsFigs.dwg
STATUS:	Draft

T5

2D-Resistivity Profile R13 and Seismic Refraction Profile S13 Model



2D-Resistivity Profile R13 and Seismic Refraction Profile S13 Interpretation



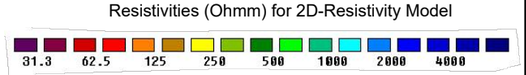
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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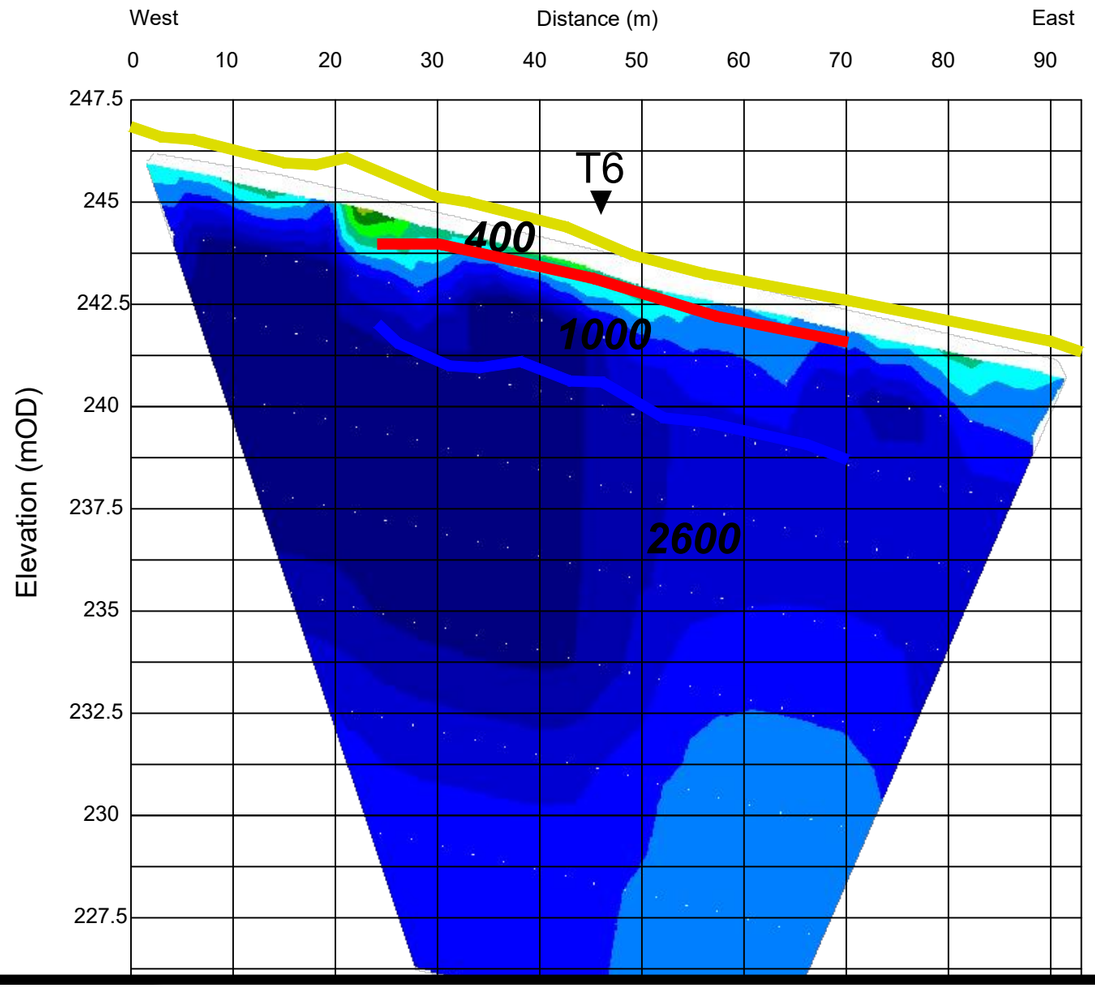
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 5: Models and Interpretation of Geophysical Survey for T5

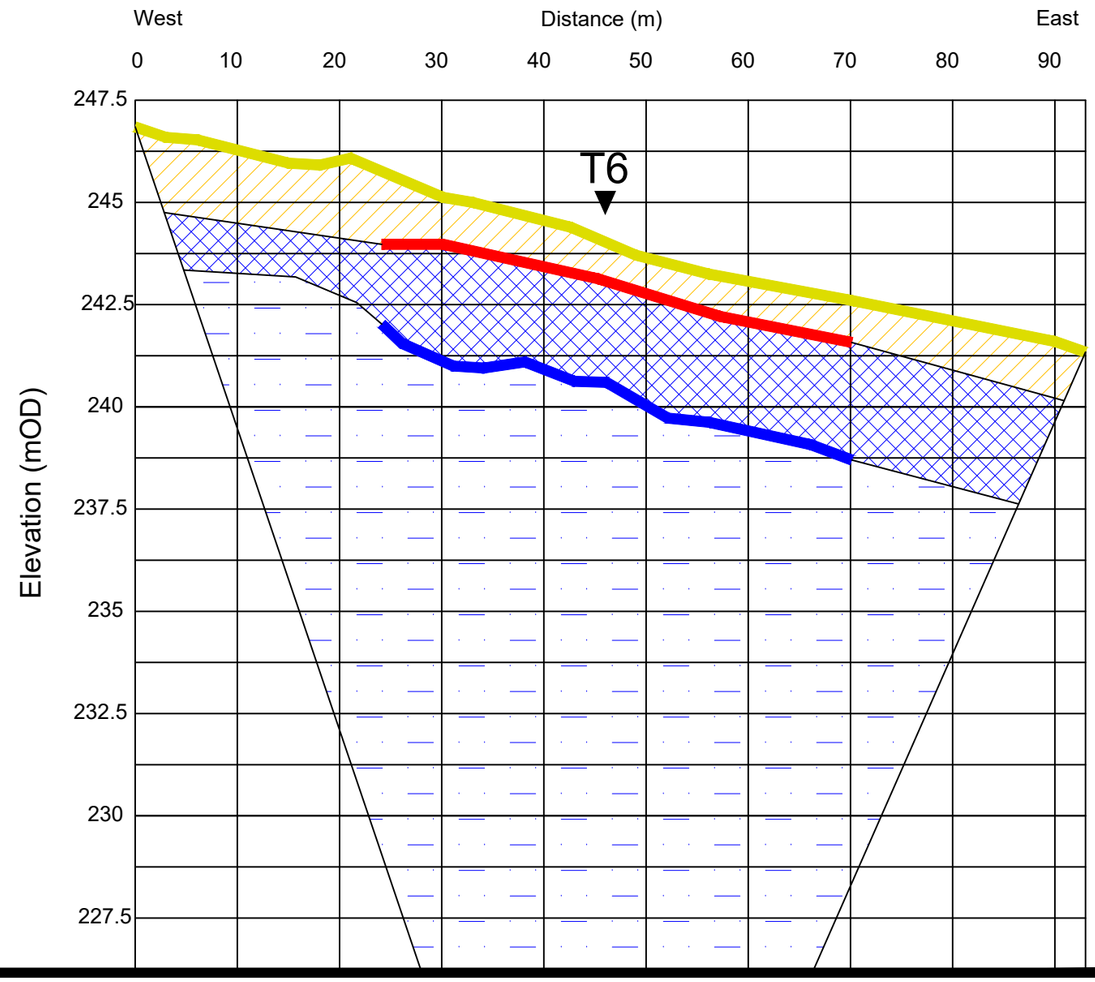
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	06/11/2020
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T6

2D-Resistivity Profile R22 and Seismic Refraction Profile S22 Model



2D-Resistivity Profile R22 and Seismic Refraction Profile S22 Interpretation



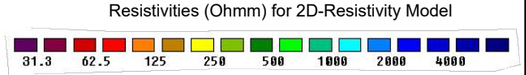
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone
6c Fair to good Sandstone

7 Good Sandstone

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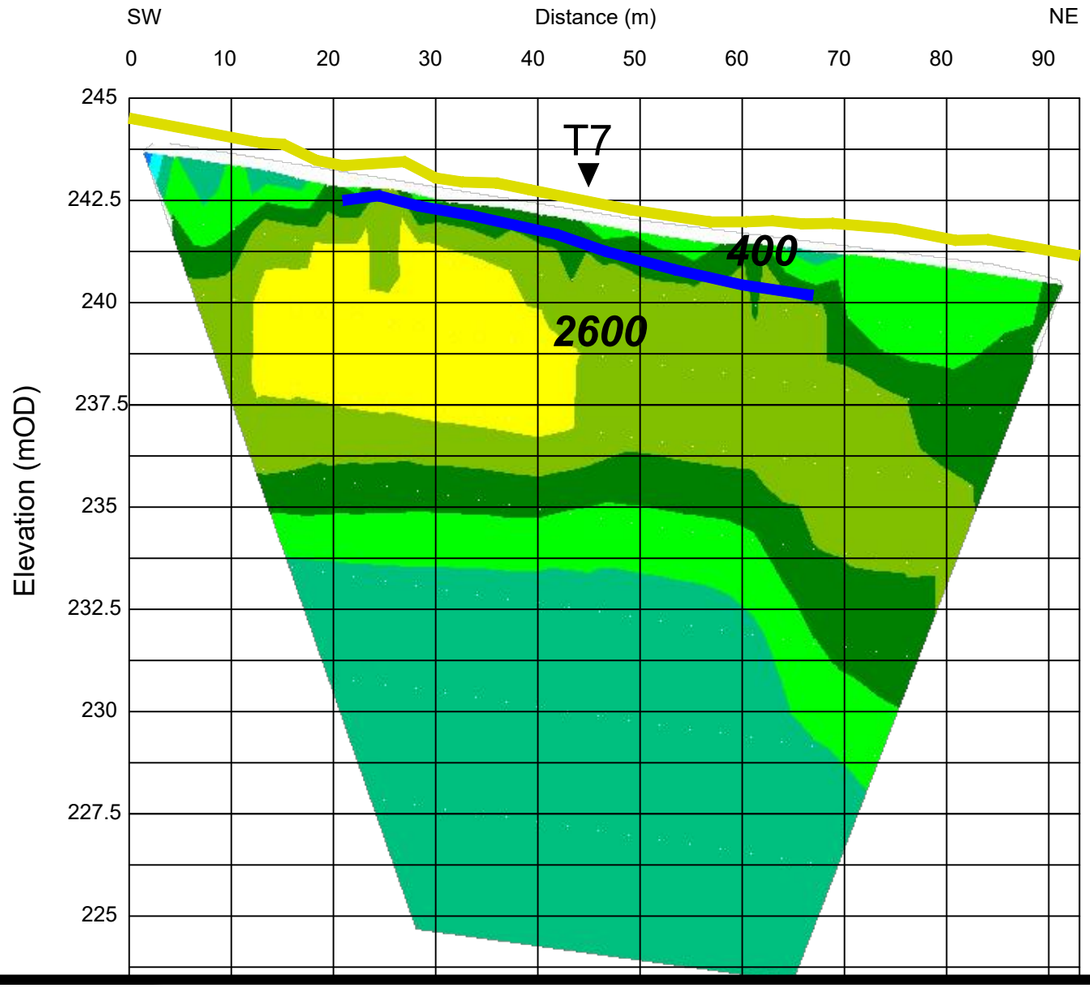
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 6: Models and Interpretation of Geophysical Survey for T6

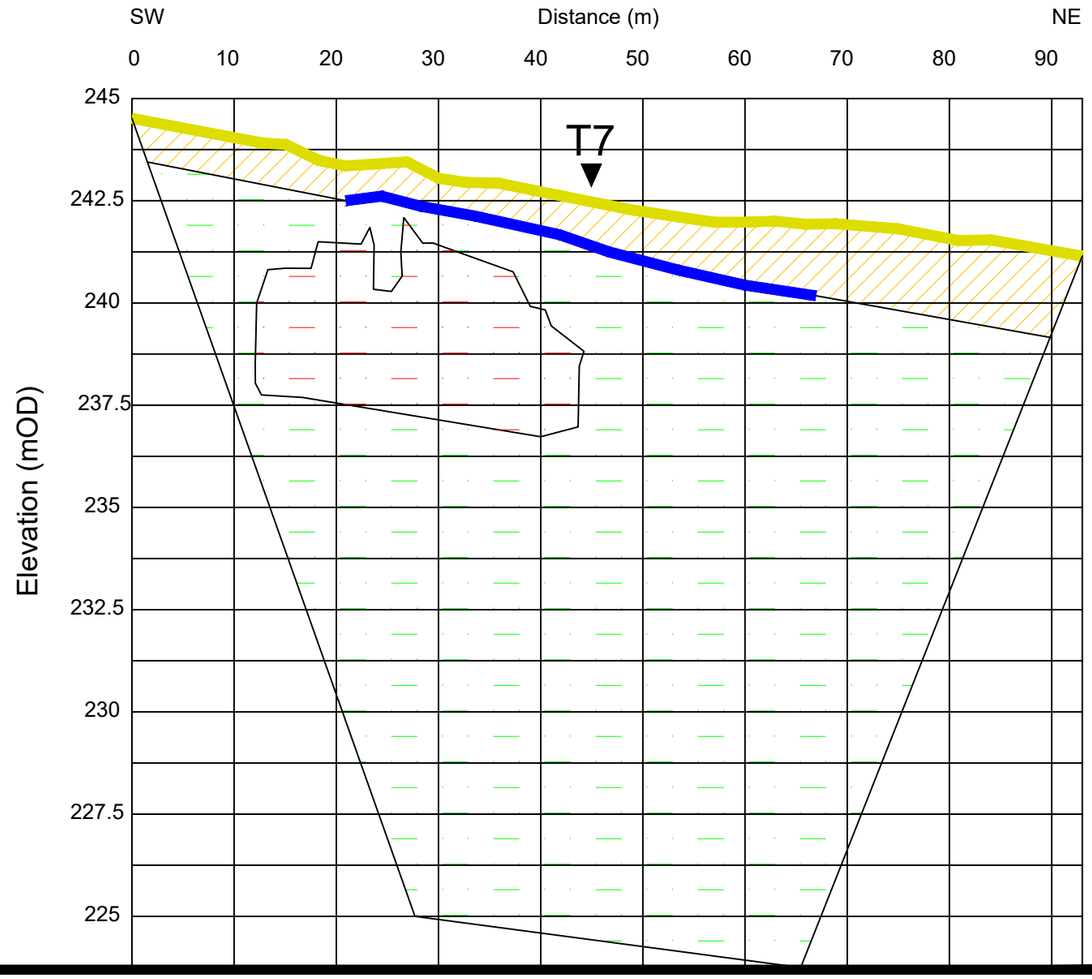
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	06/11/2020
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T7

2D-Resistivity Profile R21 and Seismic Refraction Profile S21 Model



2D-Resistivity Profile R21 and Seismic Refraction Profile S21 Interpretation



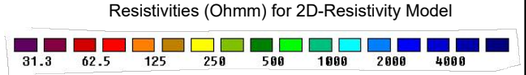
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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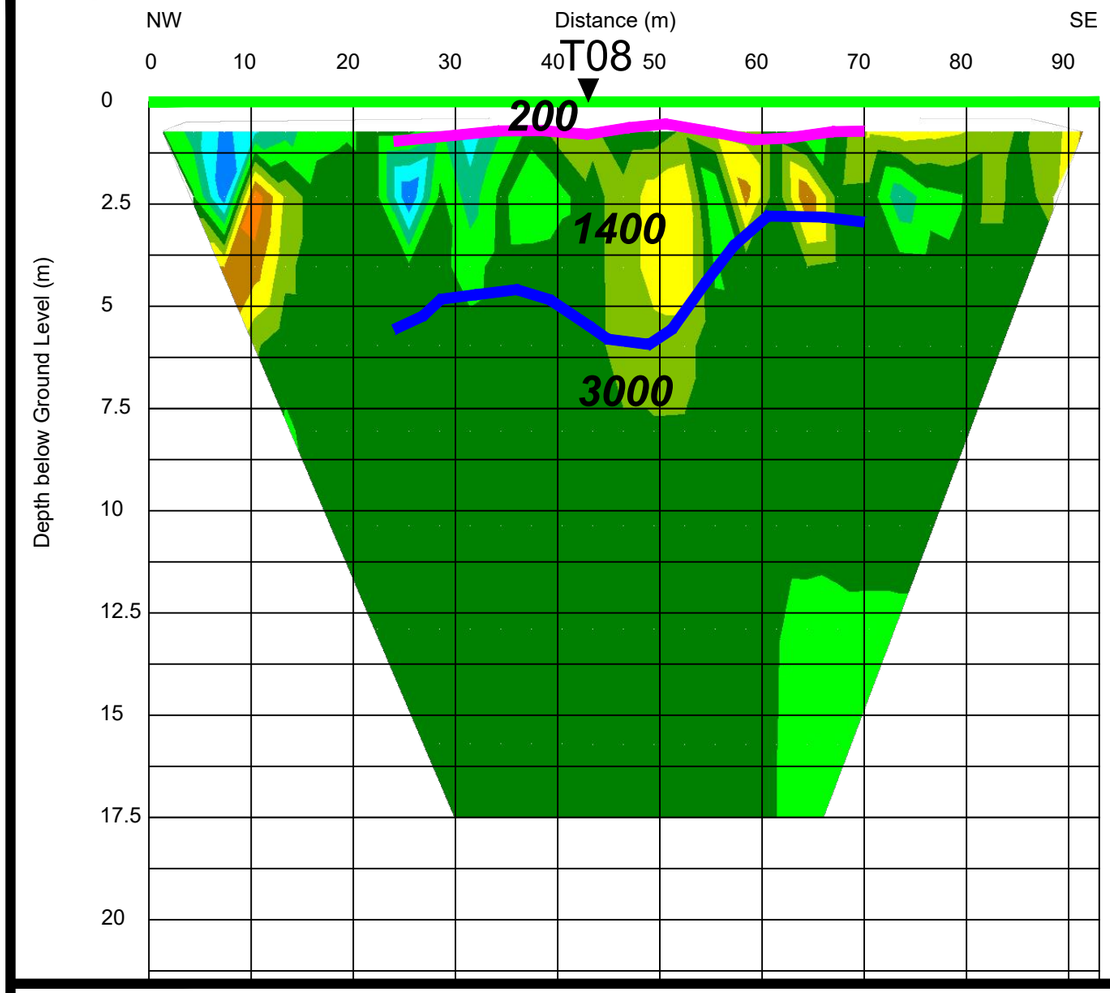
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 7: Models and Interpretation of Geophysical Survey for T7

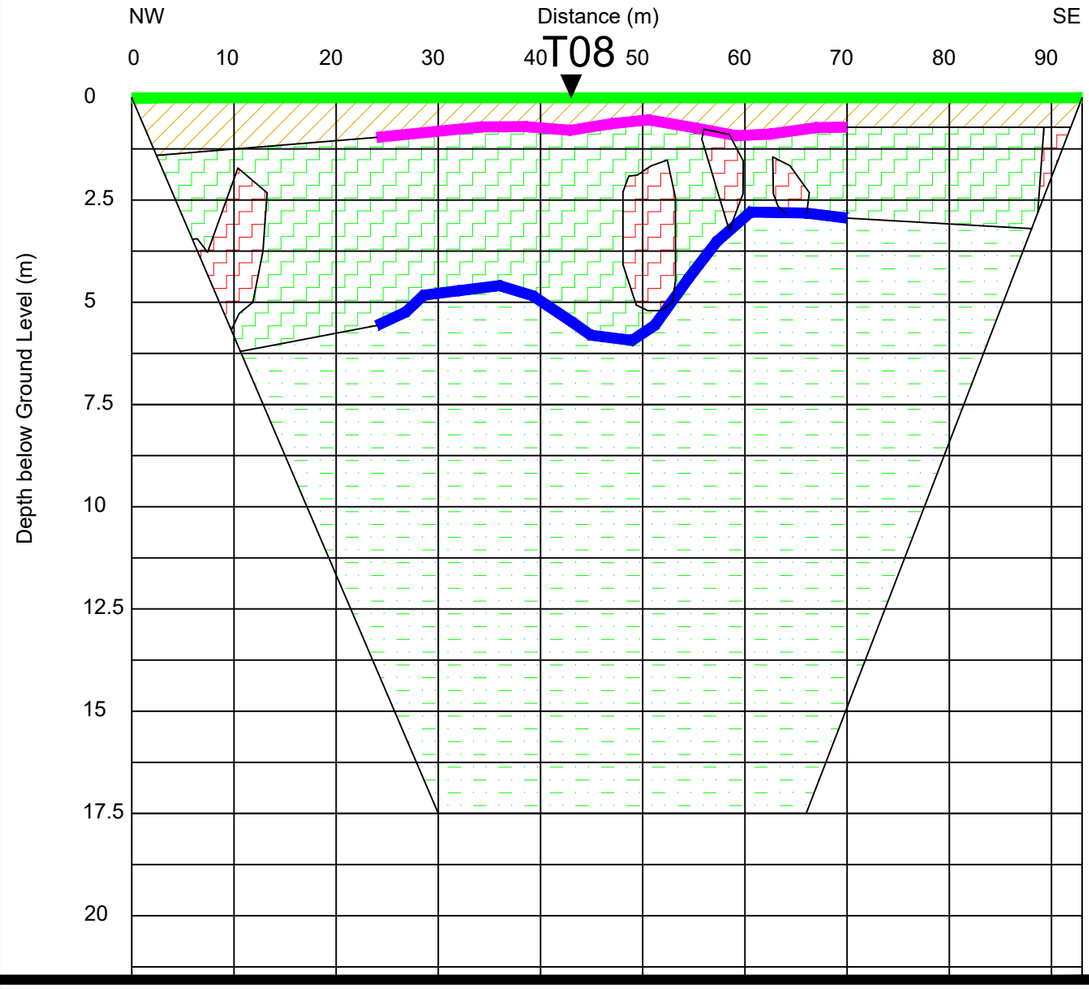
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	06/11/2020
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T8

2D-Resistivity Profile R18 and Seismic Refraction Profile S18 Model



2D-Resistivity Profile R18 and Seismic Refraction Profile S18 Interpretation

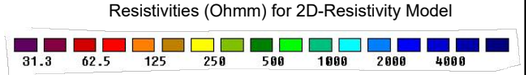


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- **1800** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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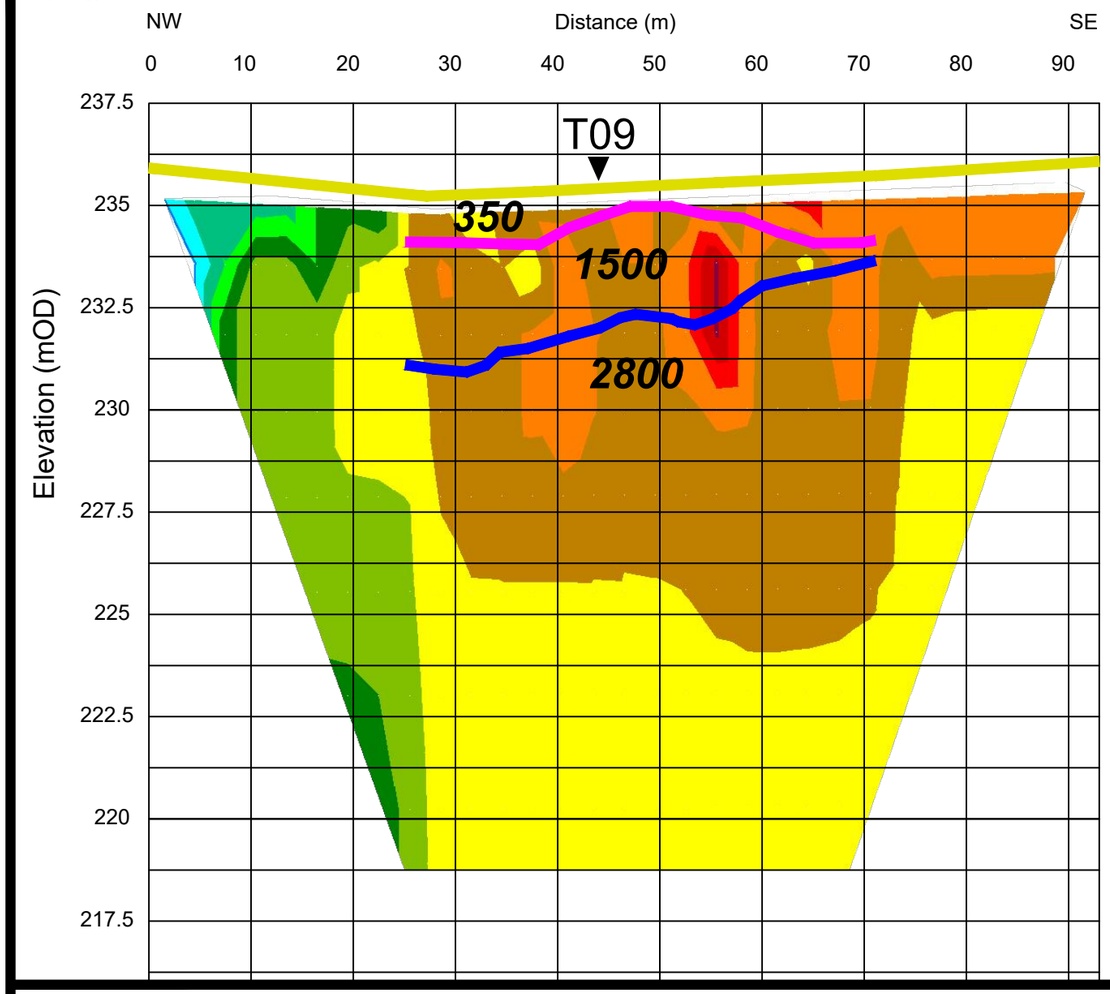
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 8: Models and Interpretation of Geophysical Survey for T8

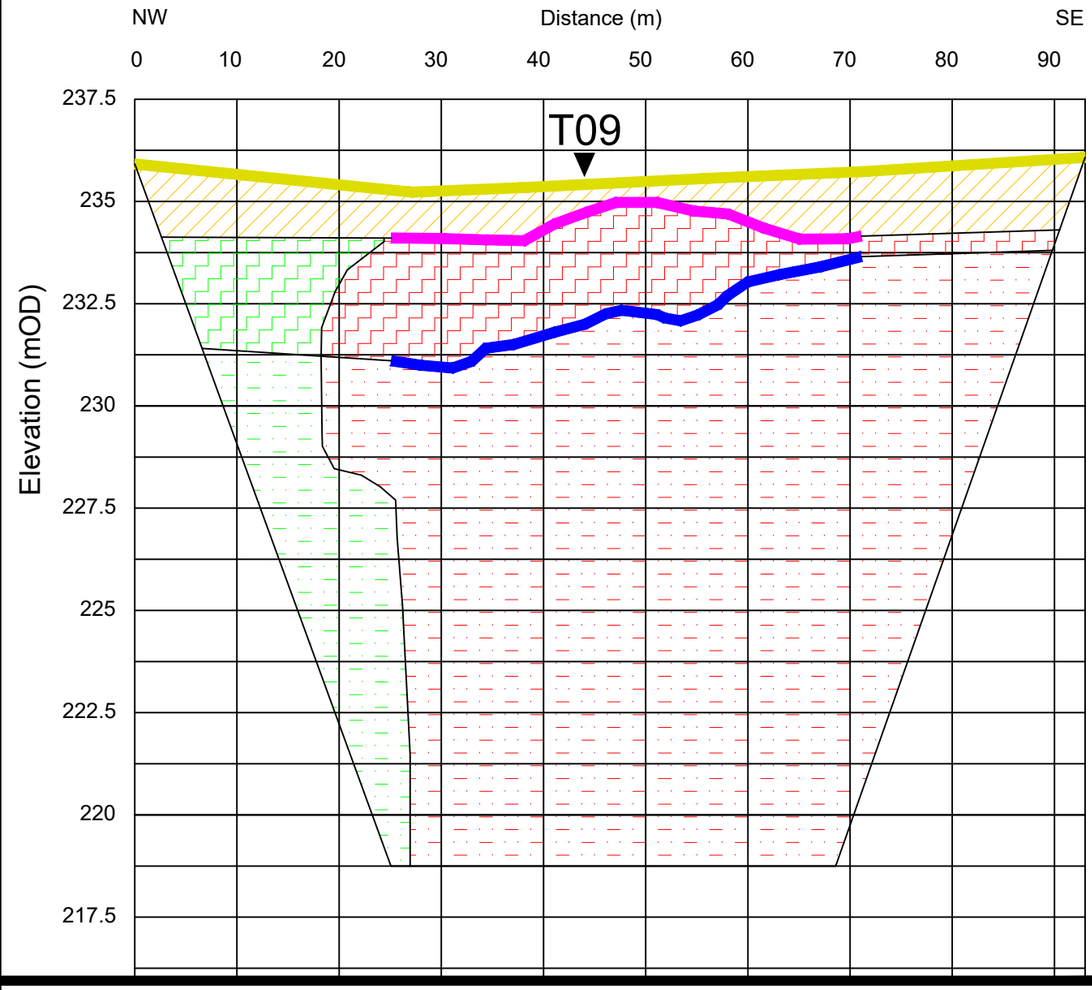
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T9

2D-Resistivity Profile R16 and Seismic Refraction Profile S16 Model



2D-Resistivity Profile R16 and Seismic Refraction Profile S16 Interpretation



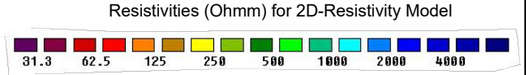
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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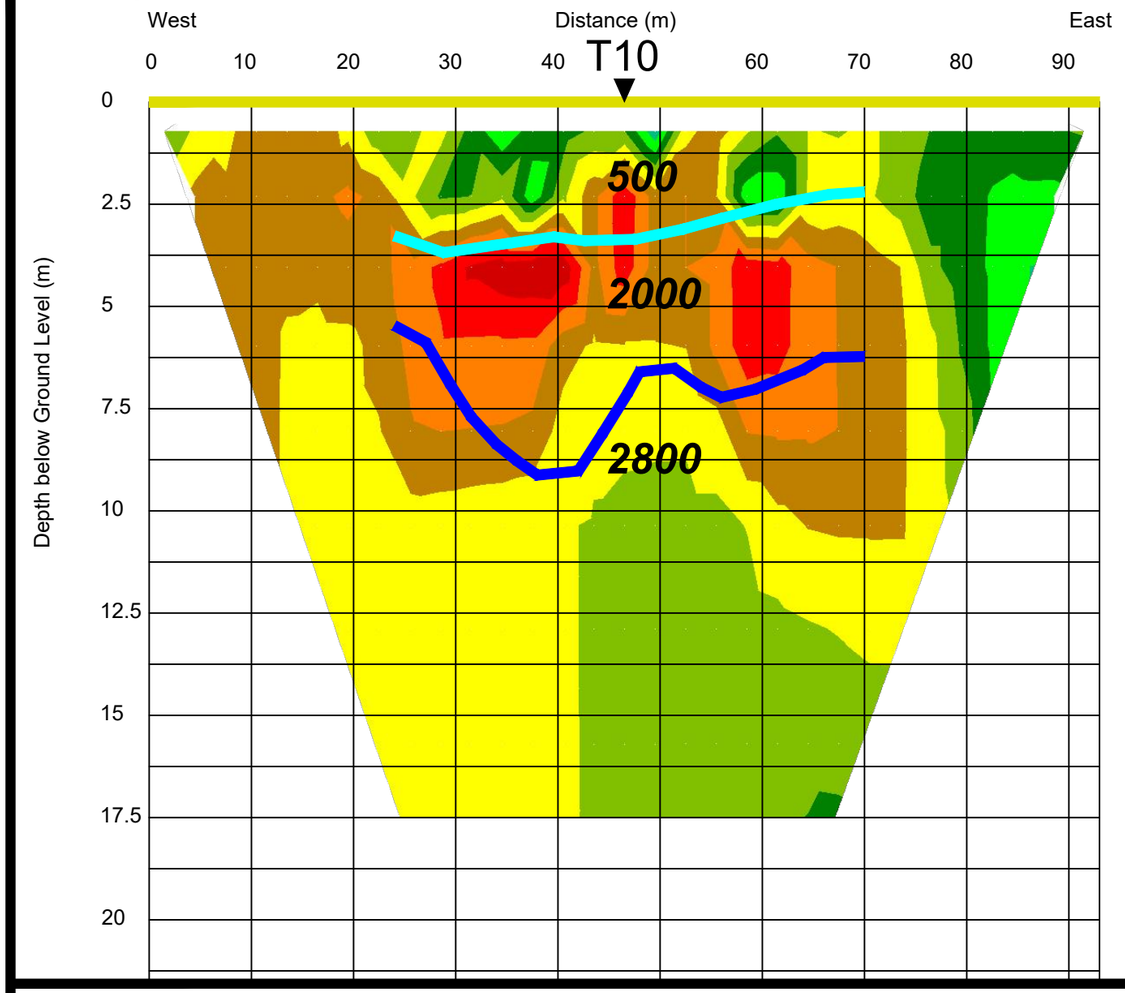
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 9: Models and Interpretation of Geophysical Survey for T9

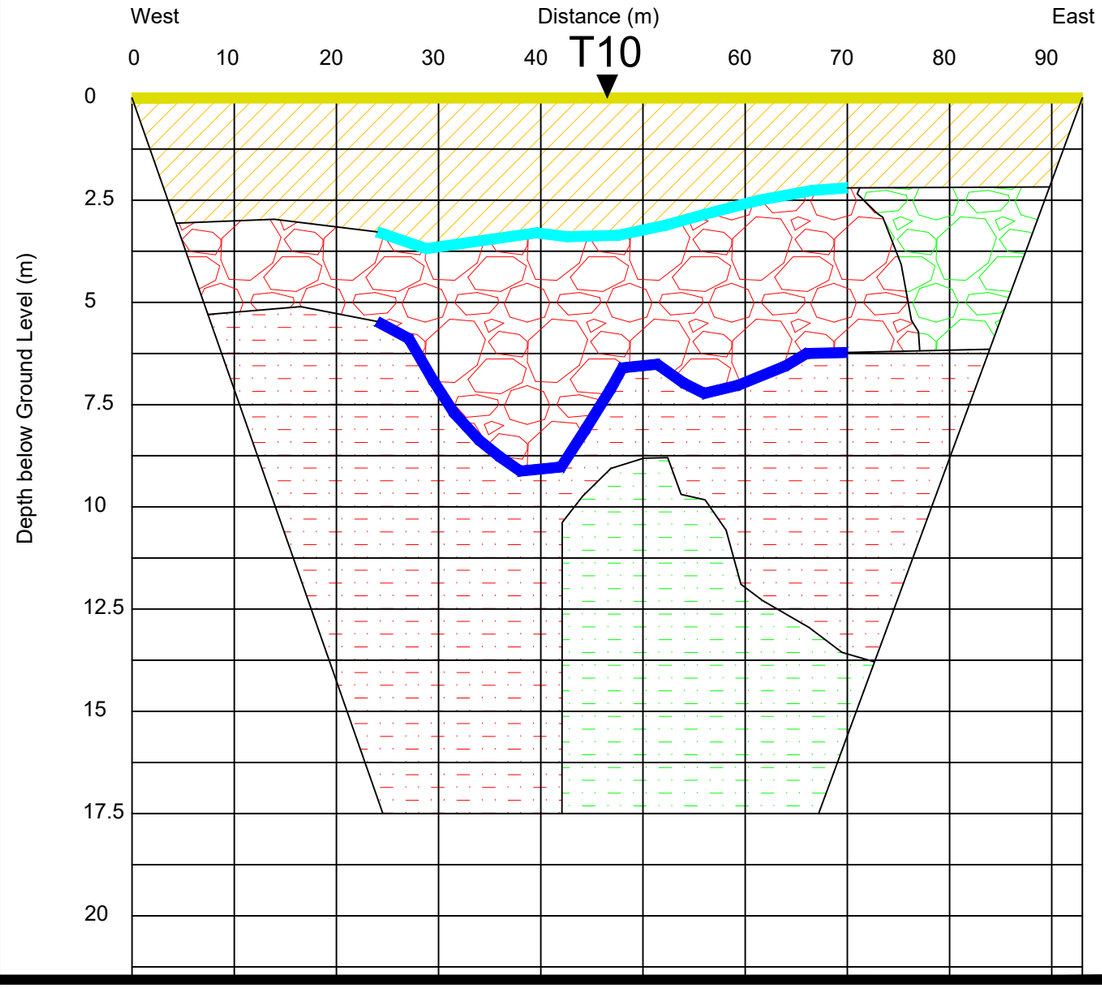
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T10

2D-Resistivity Profile R17 and Seismic Refraction Profile S17 Model



2D-Resistivity Profile R17 and Seismic Refraction Profile S17 Interpretation



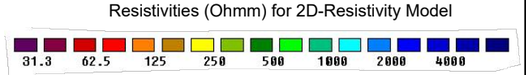
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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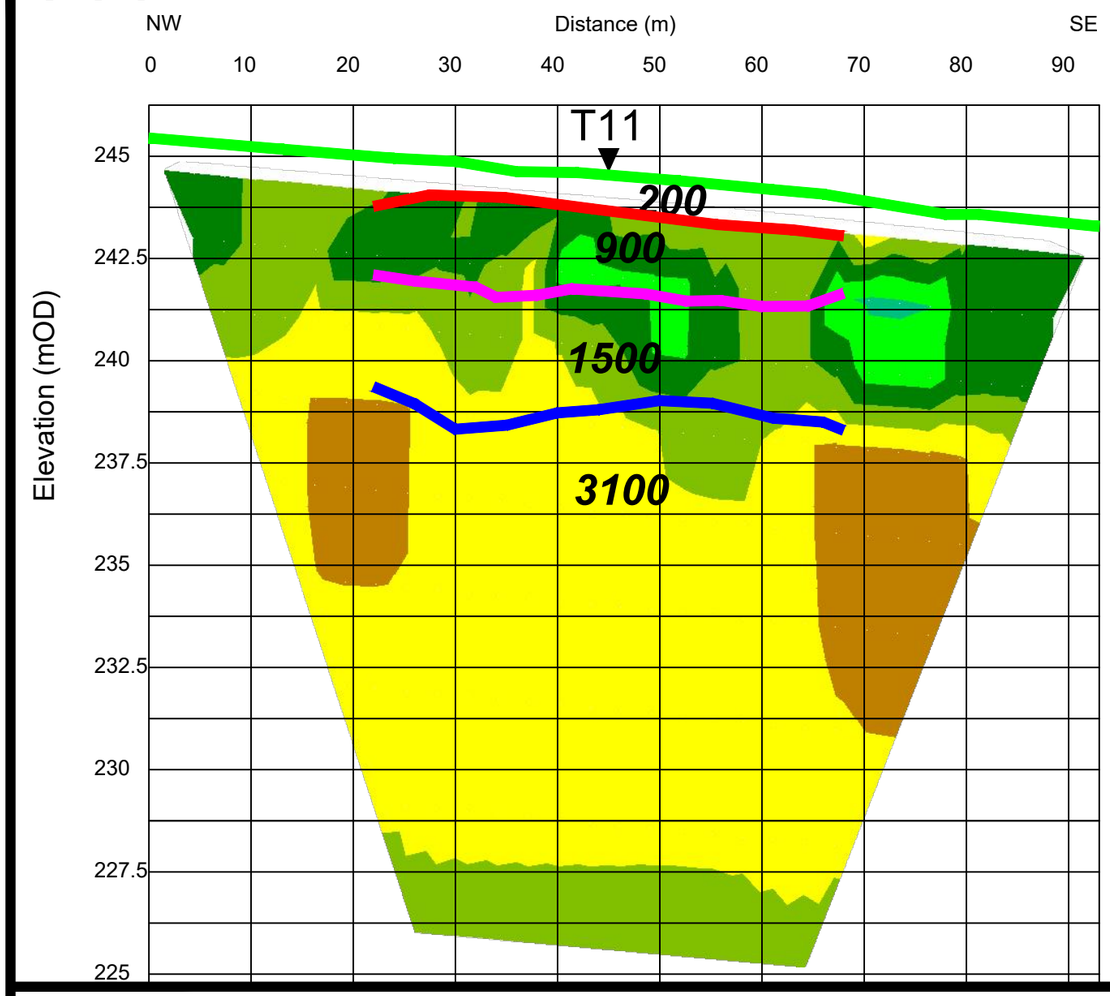
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 10: Models and Interpretation of Geophysical Survey for T10

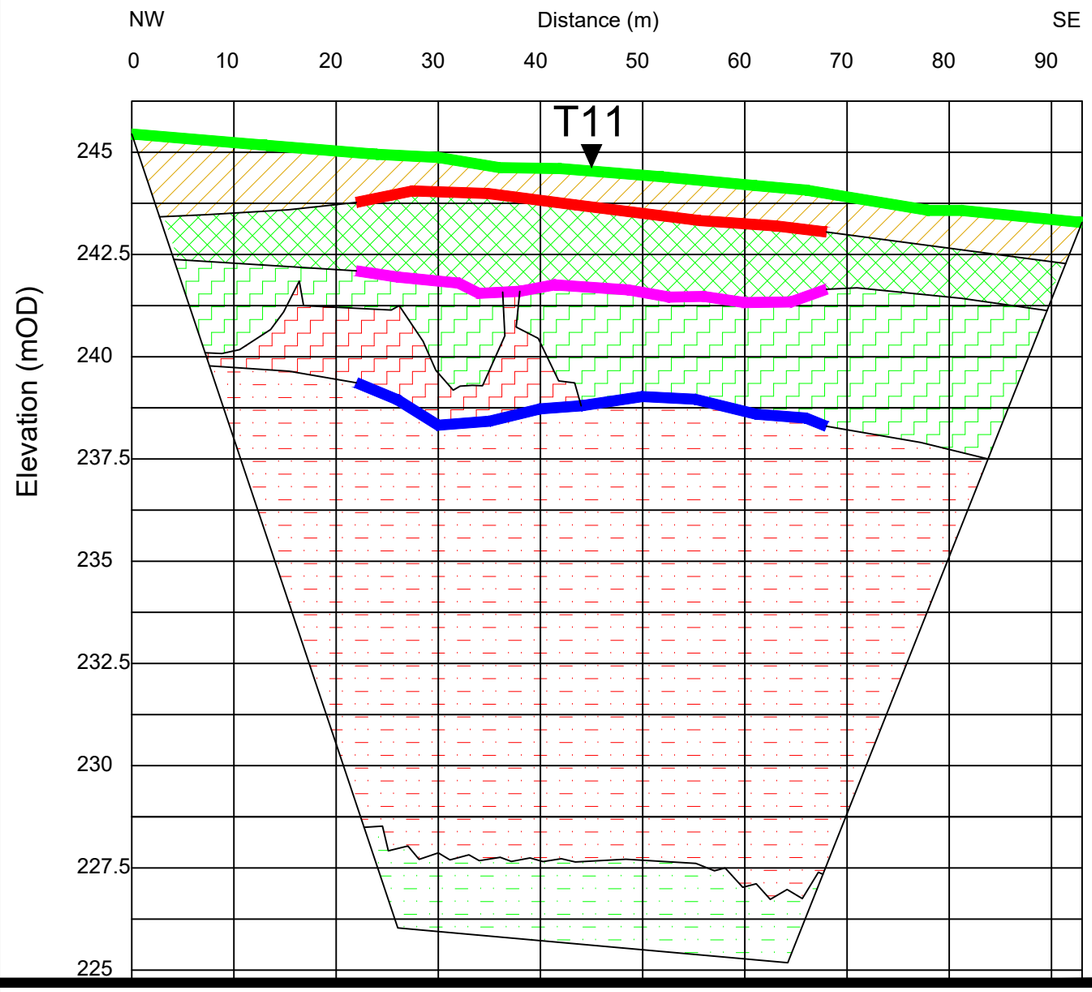
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T11

2D-Resistivity Profile R20 and Seismic Refraction Profile S20 Model



2D-Resistivity Profile R20 and Seismic Refraction Profile S20 Interpretation



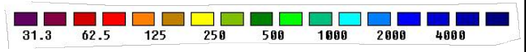
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel

6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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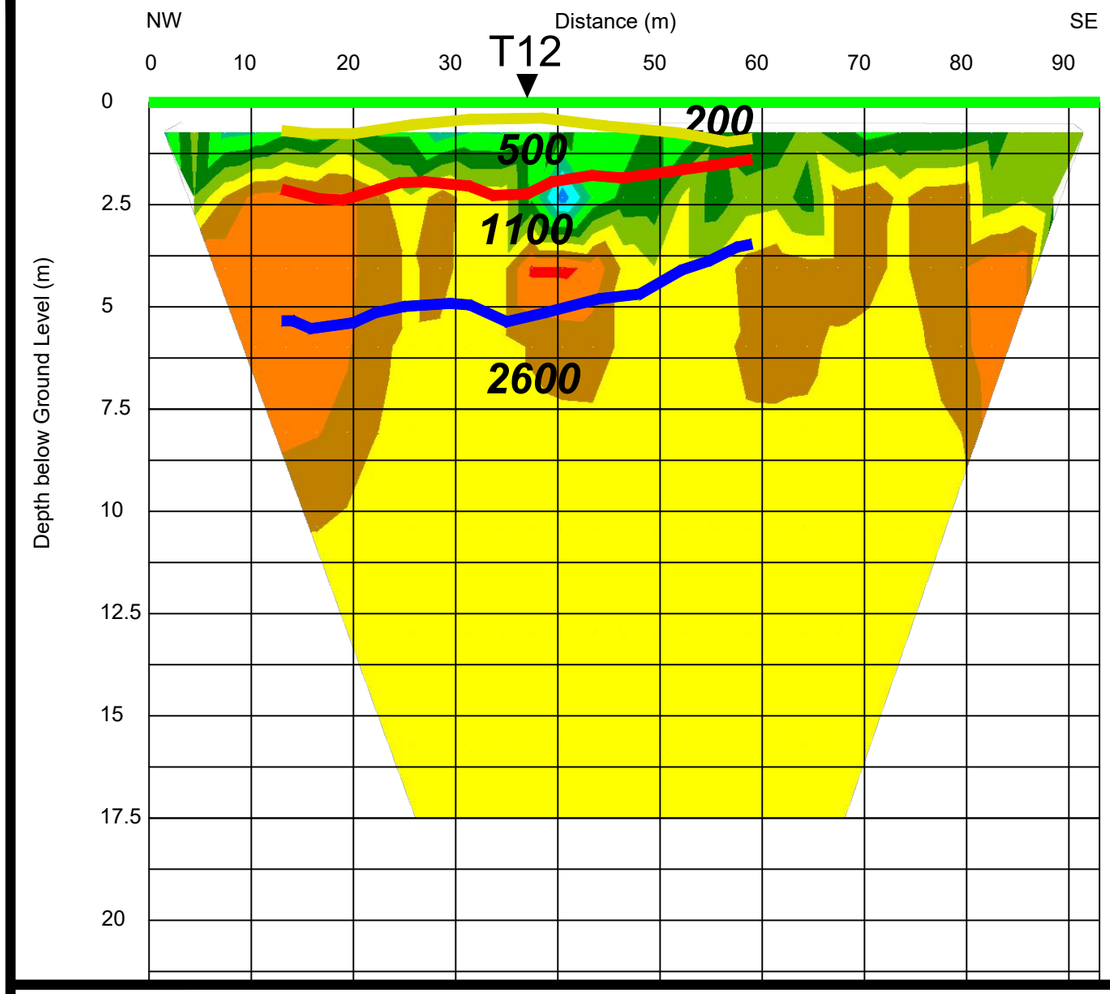
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 11: Models and Interpretation of Geophysical Survey for T11

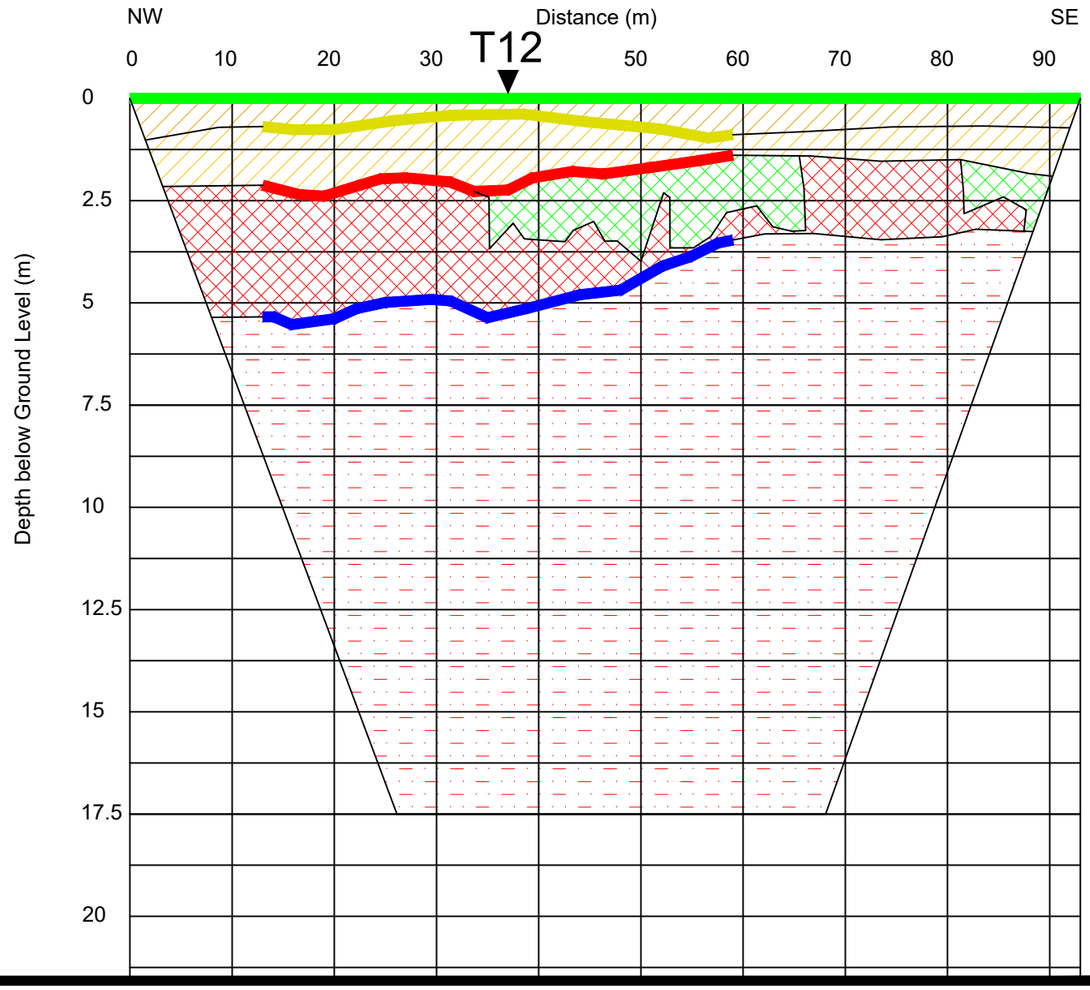
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T12

2D-Resistivity Profile R15 and Seismic Refraction Profile S15 Model



2D-Resistivity Profile R15 and Seismic Refraction Profile S15 Interpretation

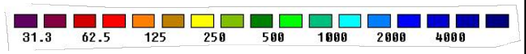


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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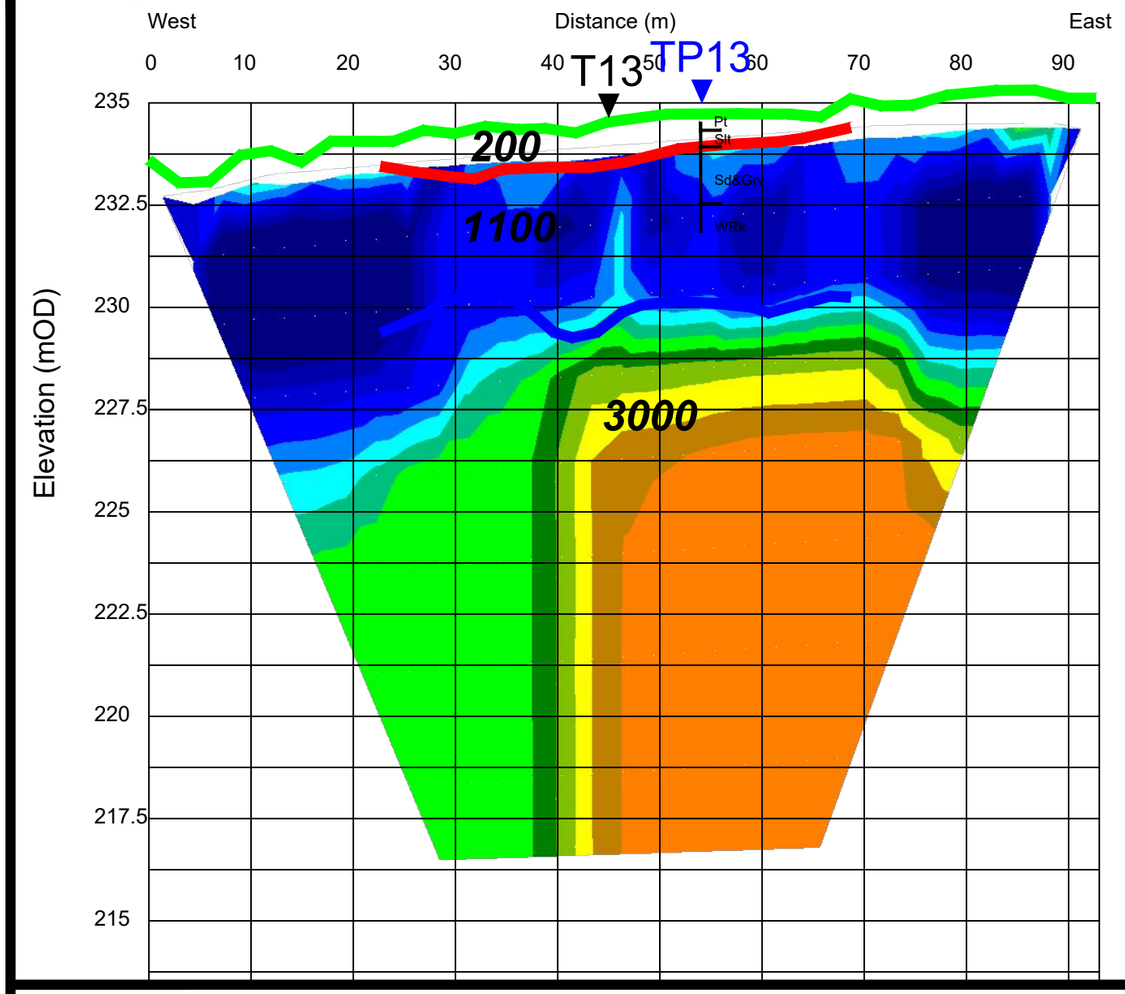
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 12: Models and Interpretation of Geophysical Survey for T12

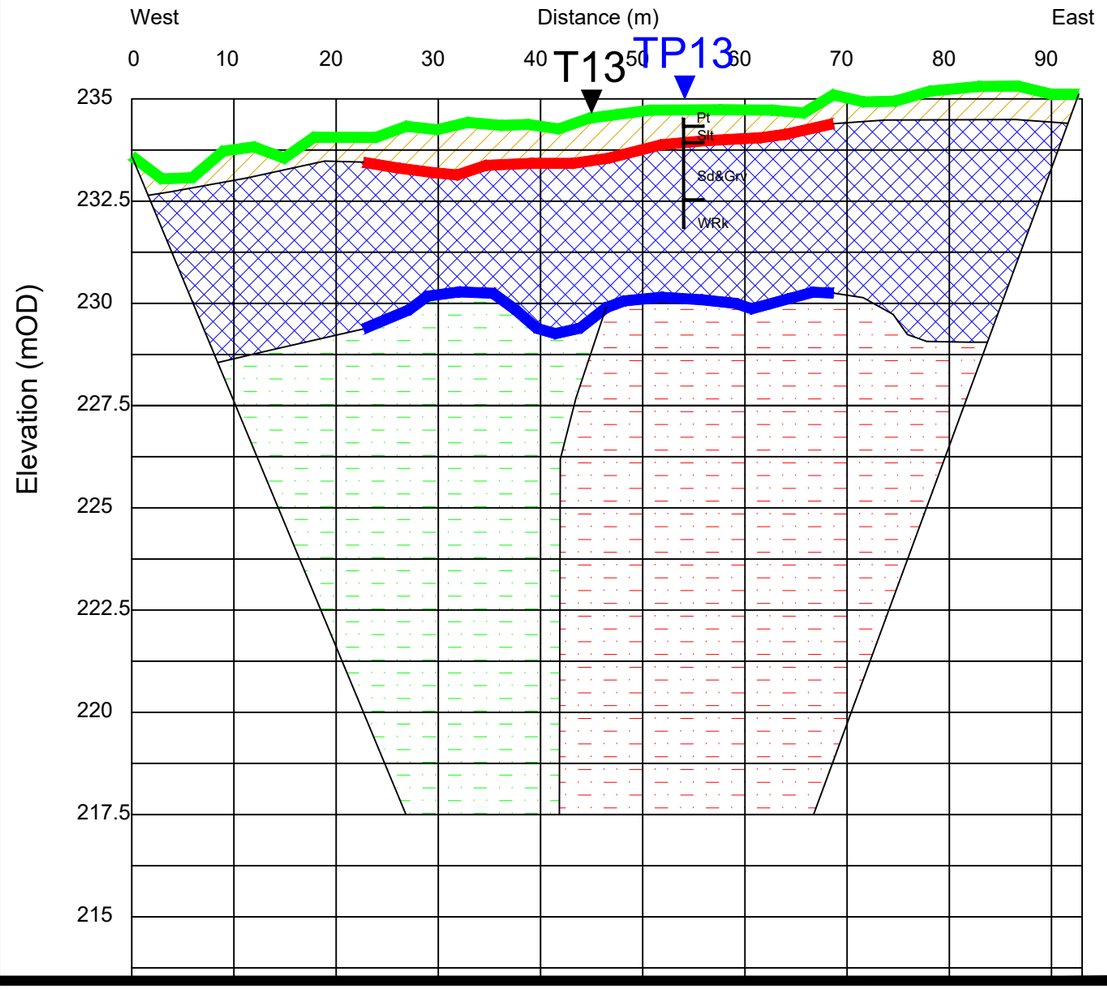
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T13

2D-Resistivity Profile R4 and Seismic Refraction Profile S4 Model



2D-Resistivity Profile R4 and Seismic Refraction Profile S4 Interpretation



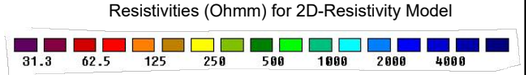
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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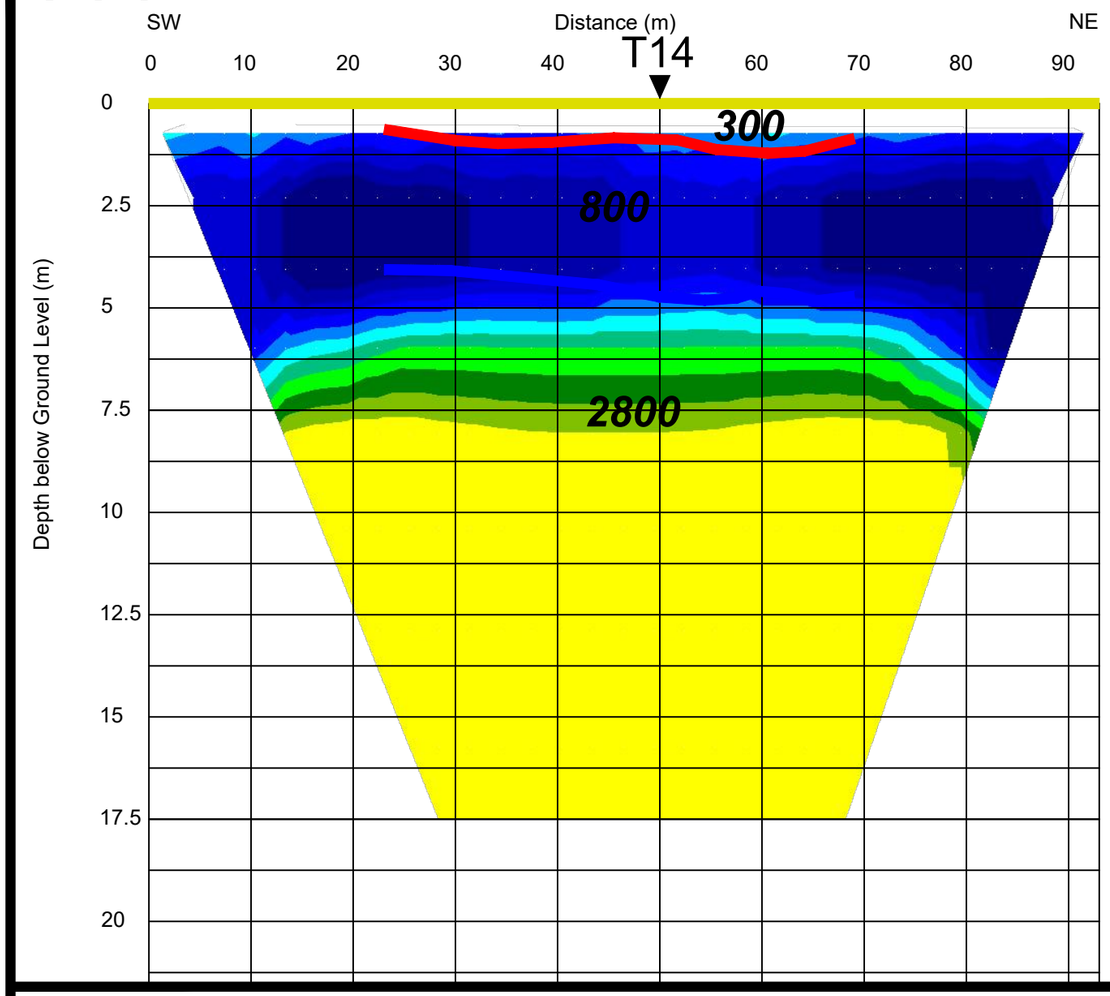
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 13: Models and Interpretation of Geophysical Survey for T13

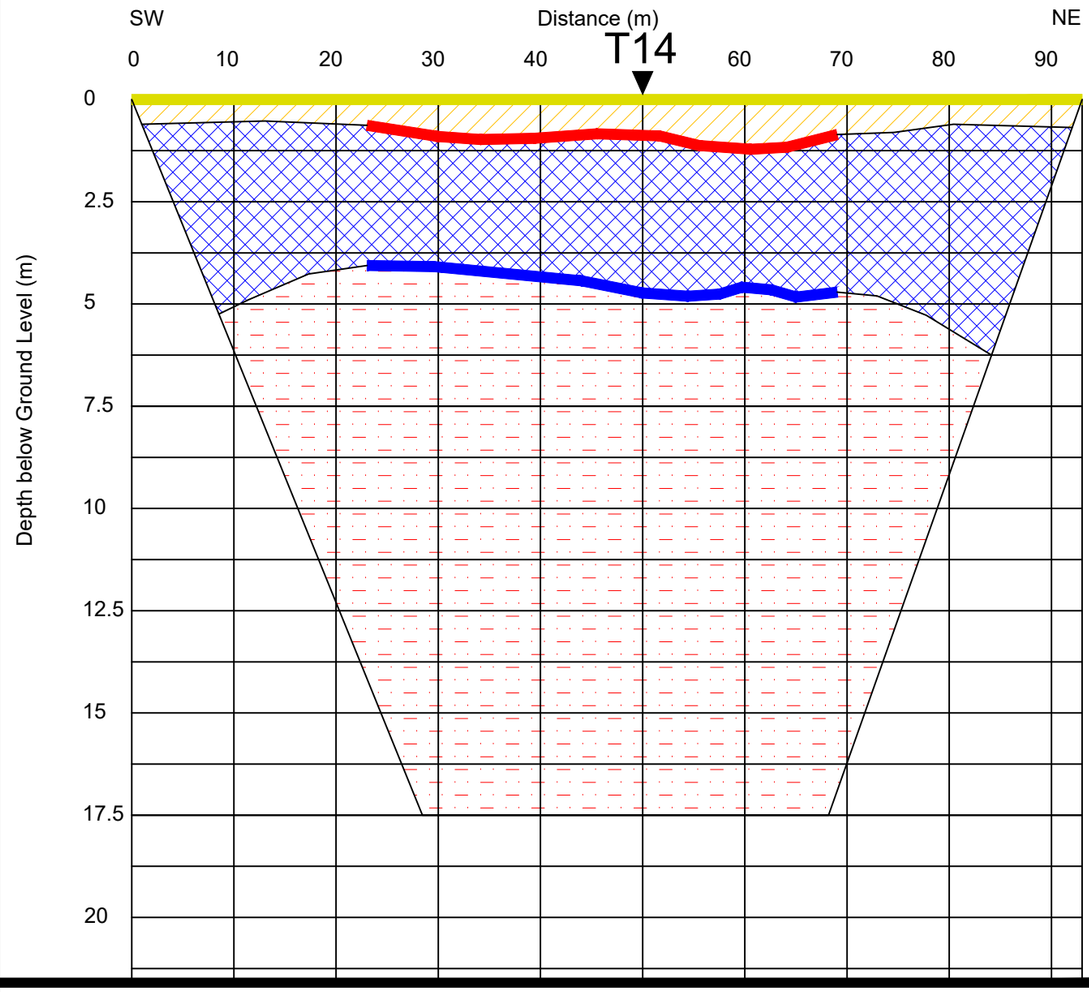
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T14

2D-Resistivity Profile R3 and Seismic Refraction Profile S3 Model



2D-Resistivity Profile R3 and Seismic Refraction Profile S3 Interpretation

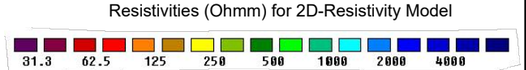


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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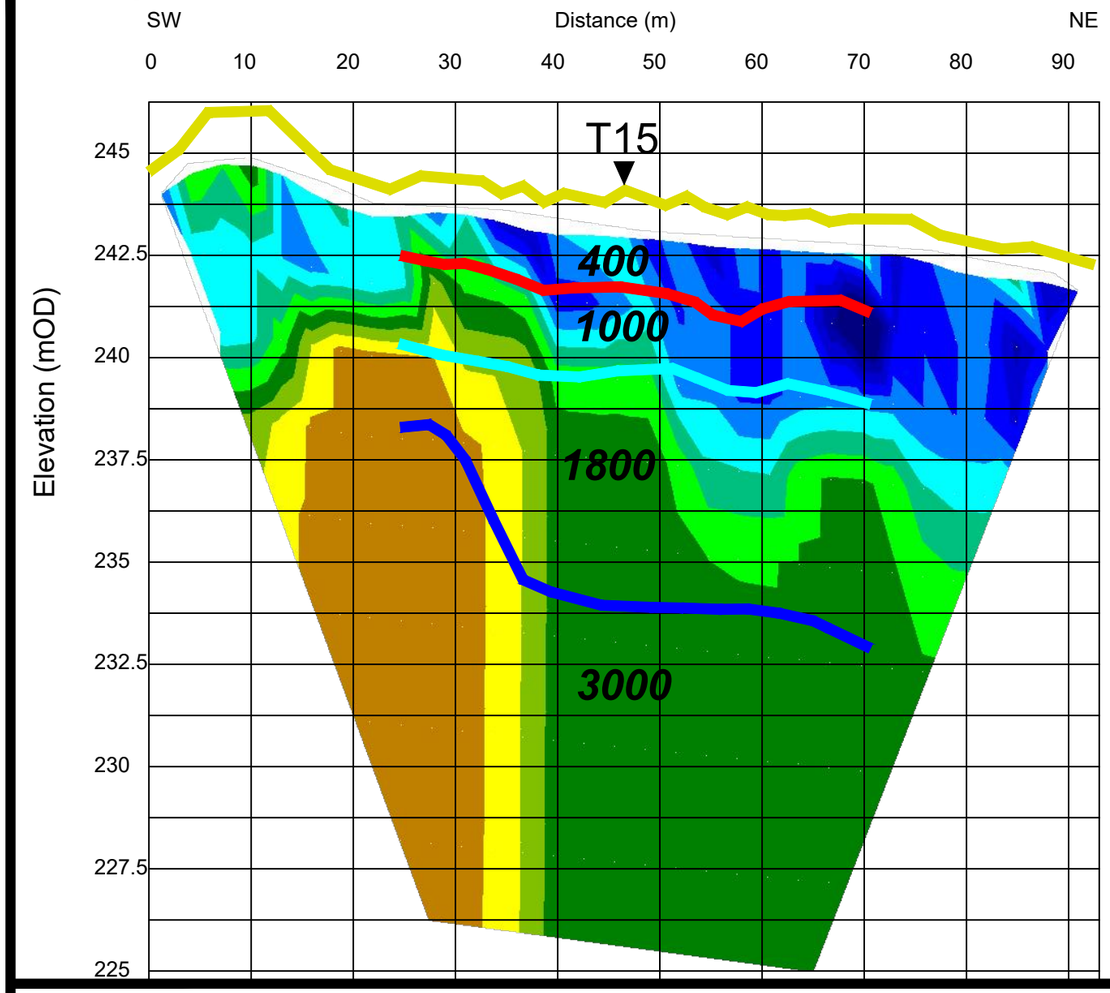
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 14: Models and Interpretation of Geophysical Survey for T14

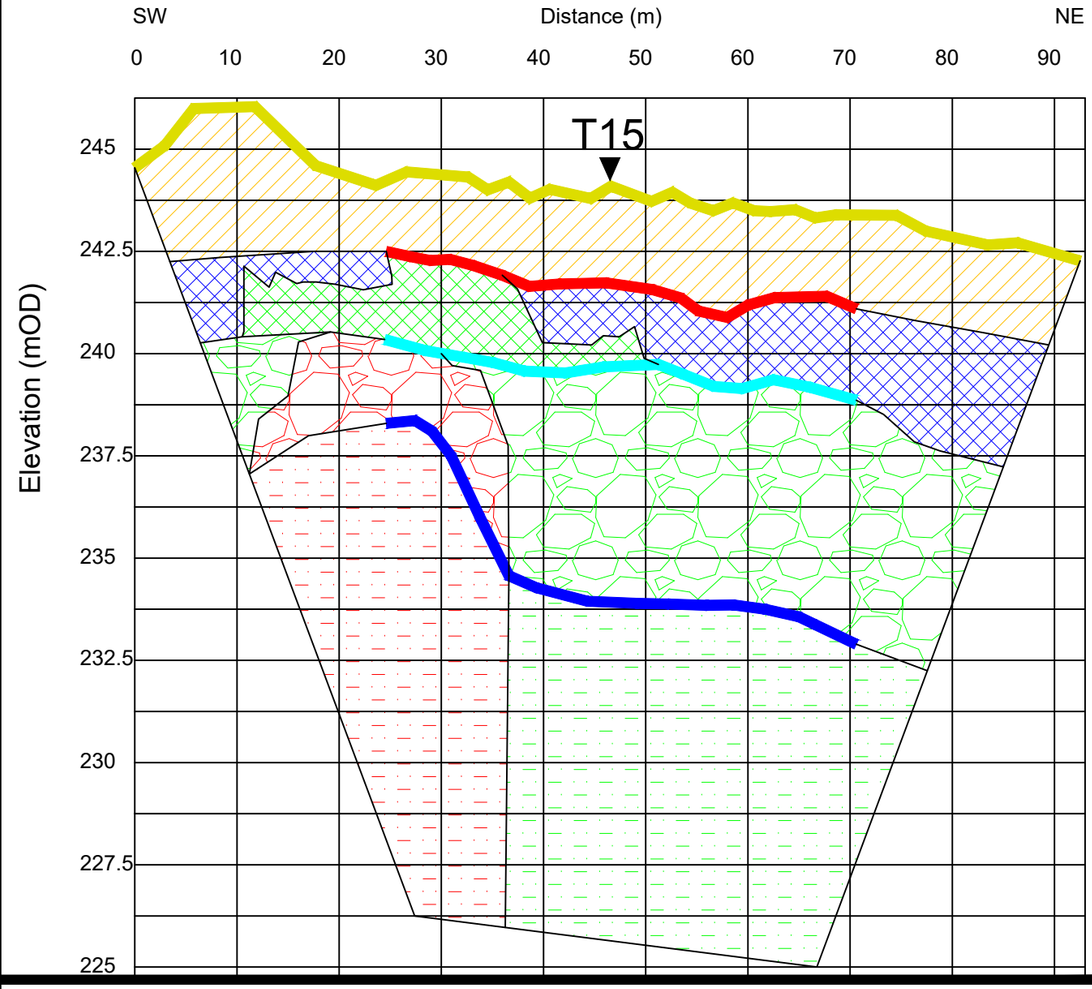
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T15

2D-Resistivity Profile R5 and Seismic Refraction Profile S5 Model



2D-Resistivity Profile R5 and Seismic Refraction Profile S5 Interpretation

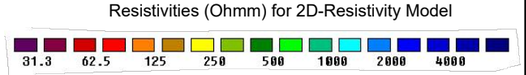


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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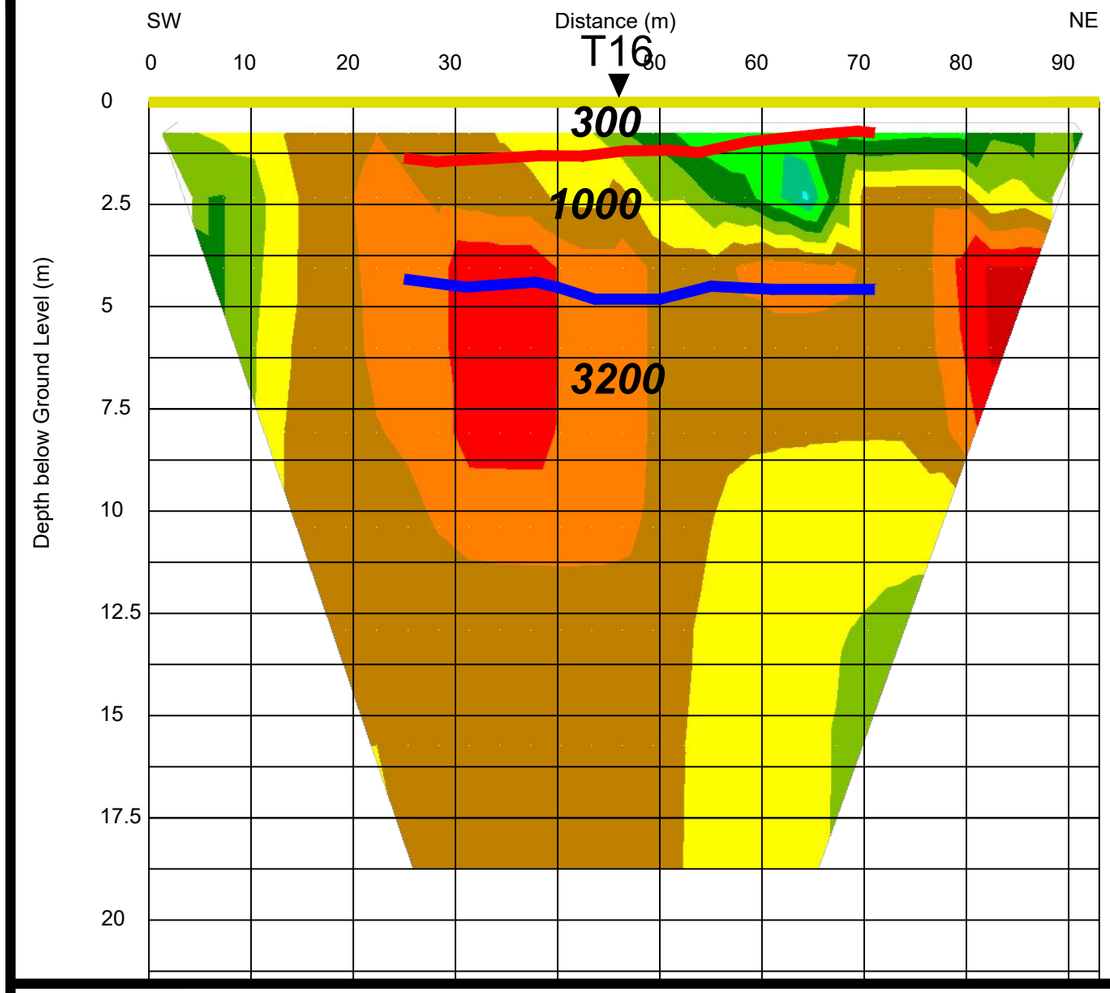
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 15: Models and Interpretation of Geophysical Survey for T15

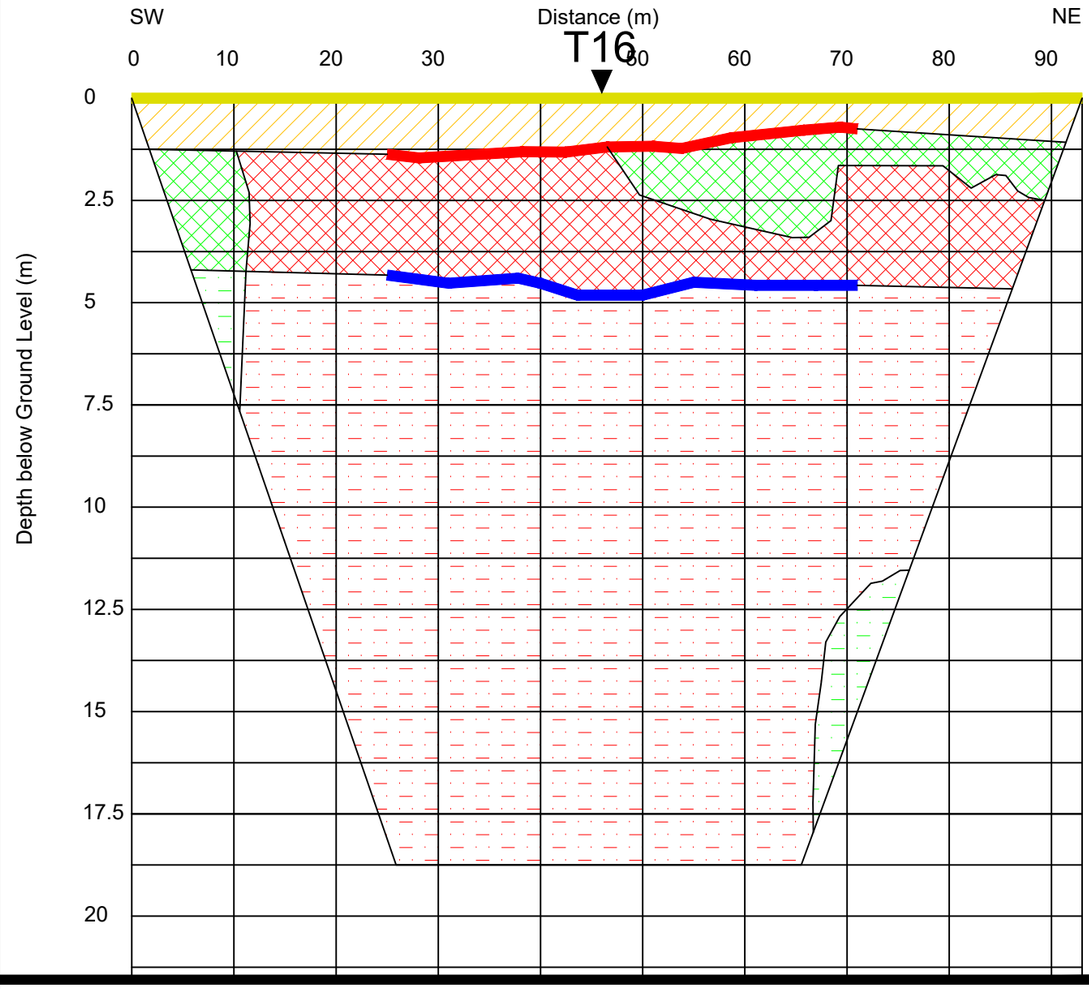
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T16

2D-Resistivity Profile R32 and Seismic Refraction Profile S23 Model



2D-Resistivity Profile R32 and Seismic Refraction Profile S23 Interpretation

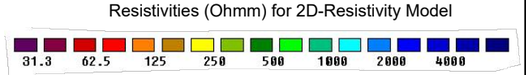


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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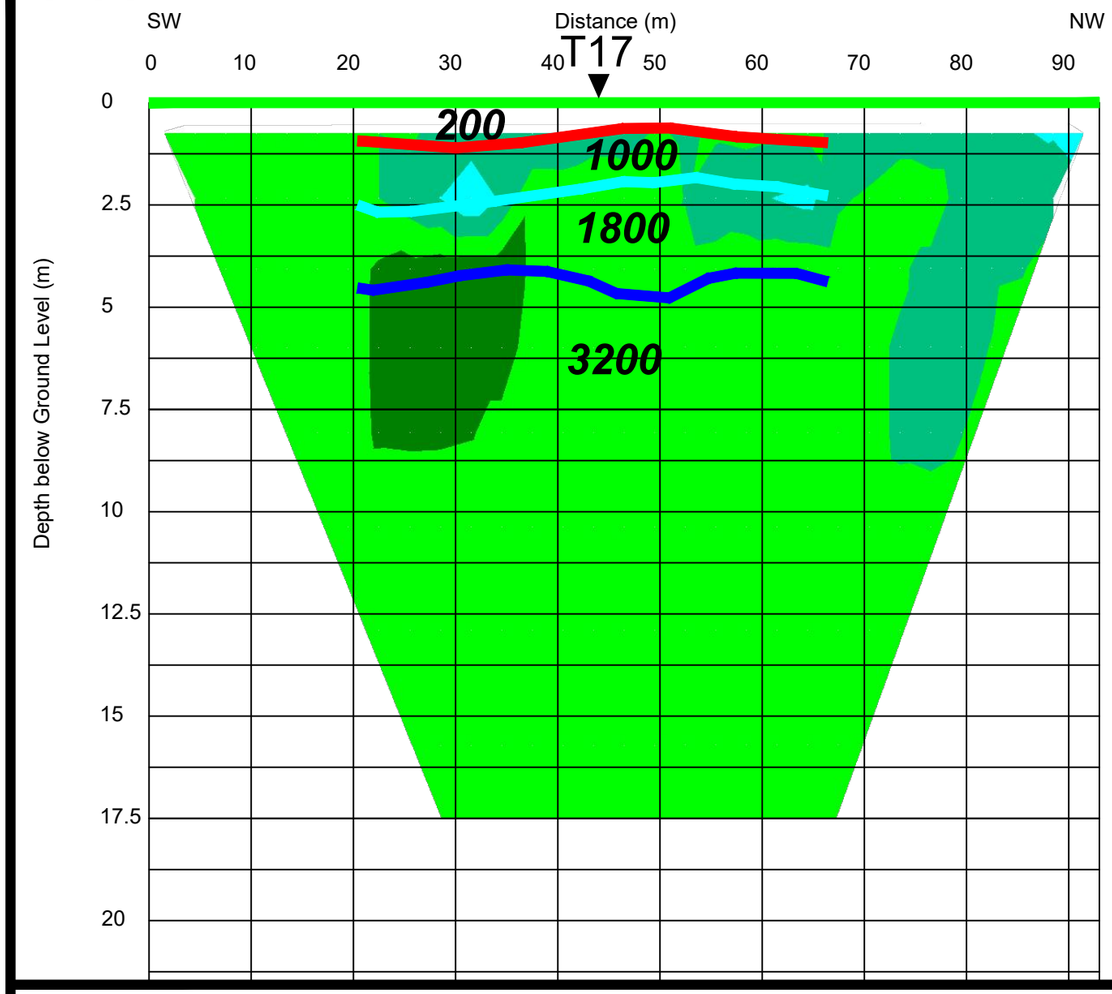
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 16: Models and Interpretation of Geophysical Survey for T16

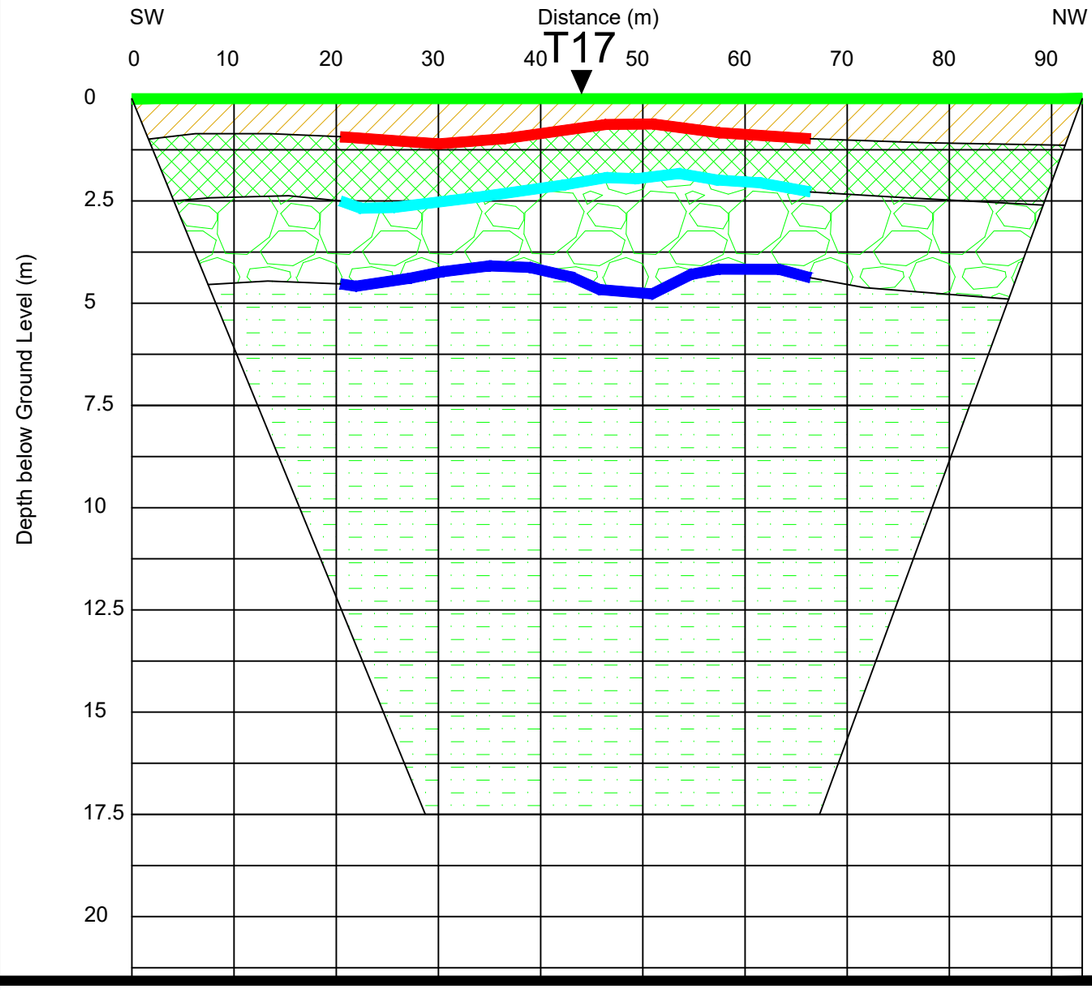
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T17

2D-Resistivity Profile R11 and Seismic Refraction Profile S11 Model



2D-Resistivity Profile R11 and Seismic Refraction Profile S11 Interpretation



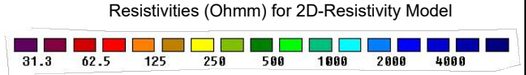
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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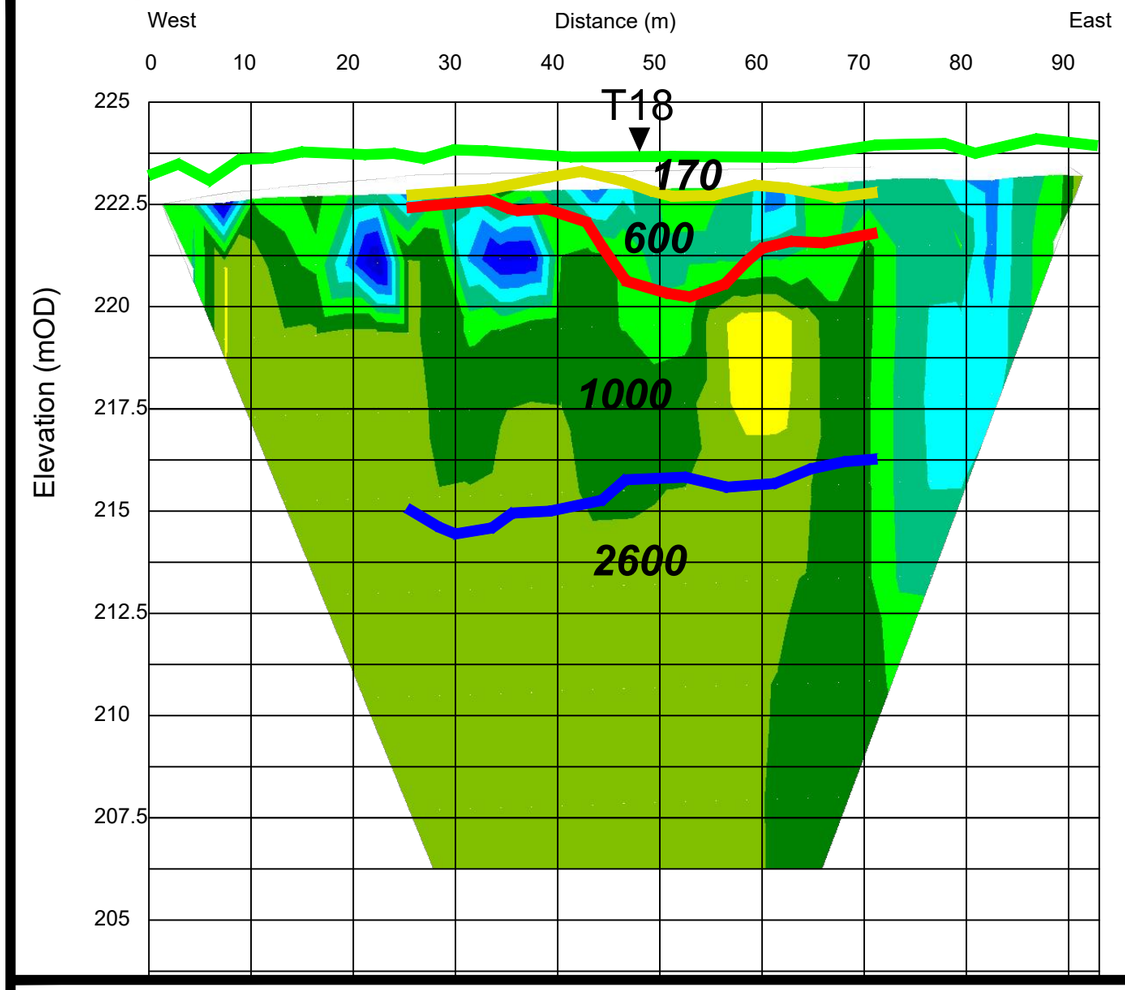
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 17: Models and Interpretation of Geophysical Survey for T17

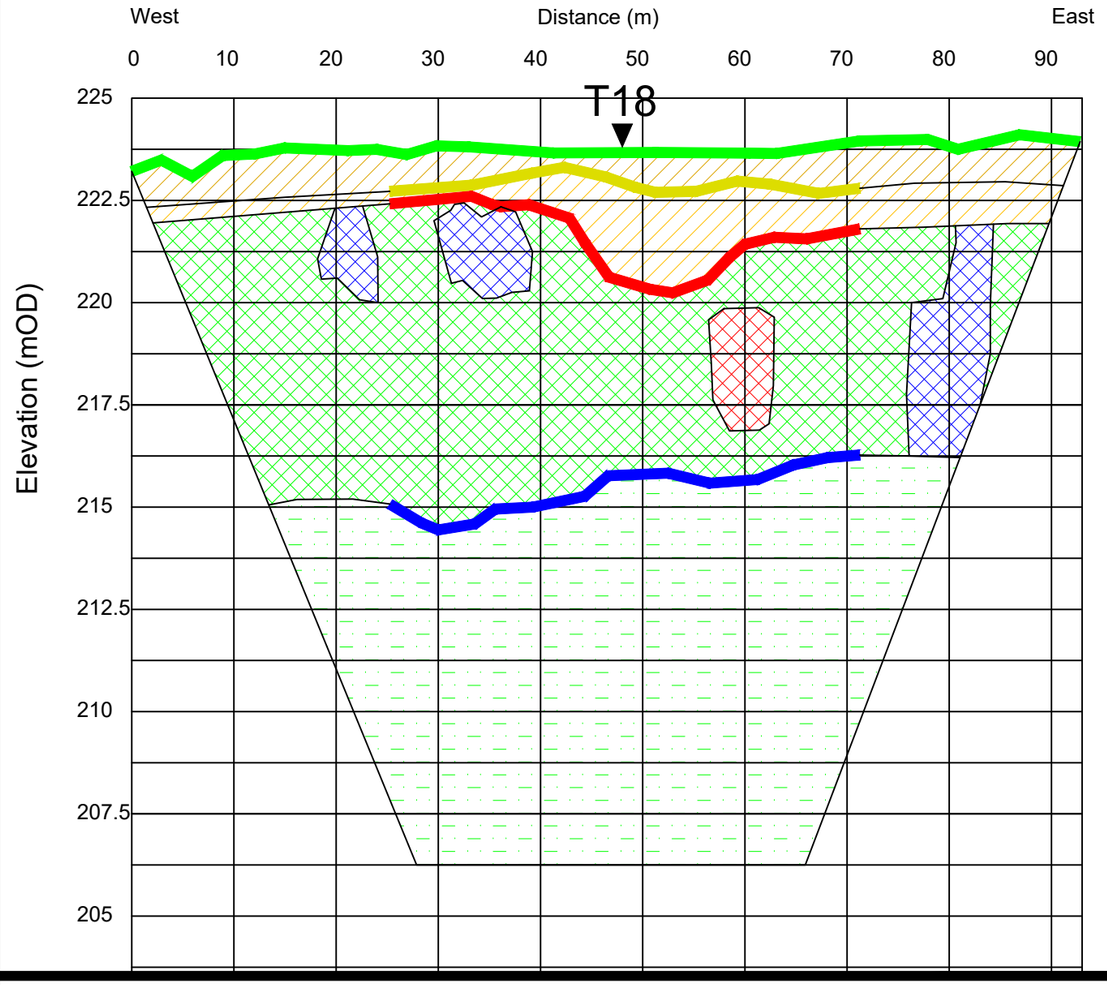
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T18

2D-Resistivity Profile R10 and Seismic Refraction Profile S10 Model



2D-Resistivity Profile R10 and Seismic Refraction Profile S10 Interpretation

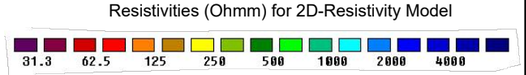


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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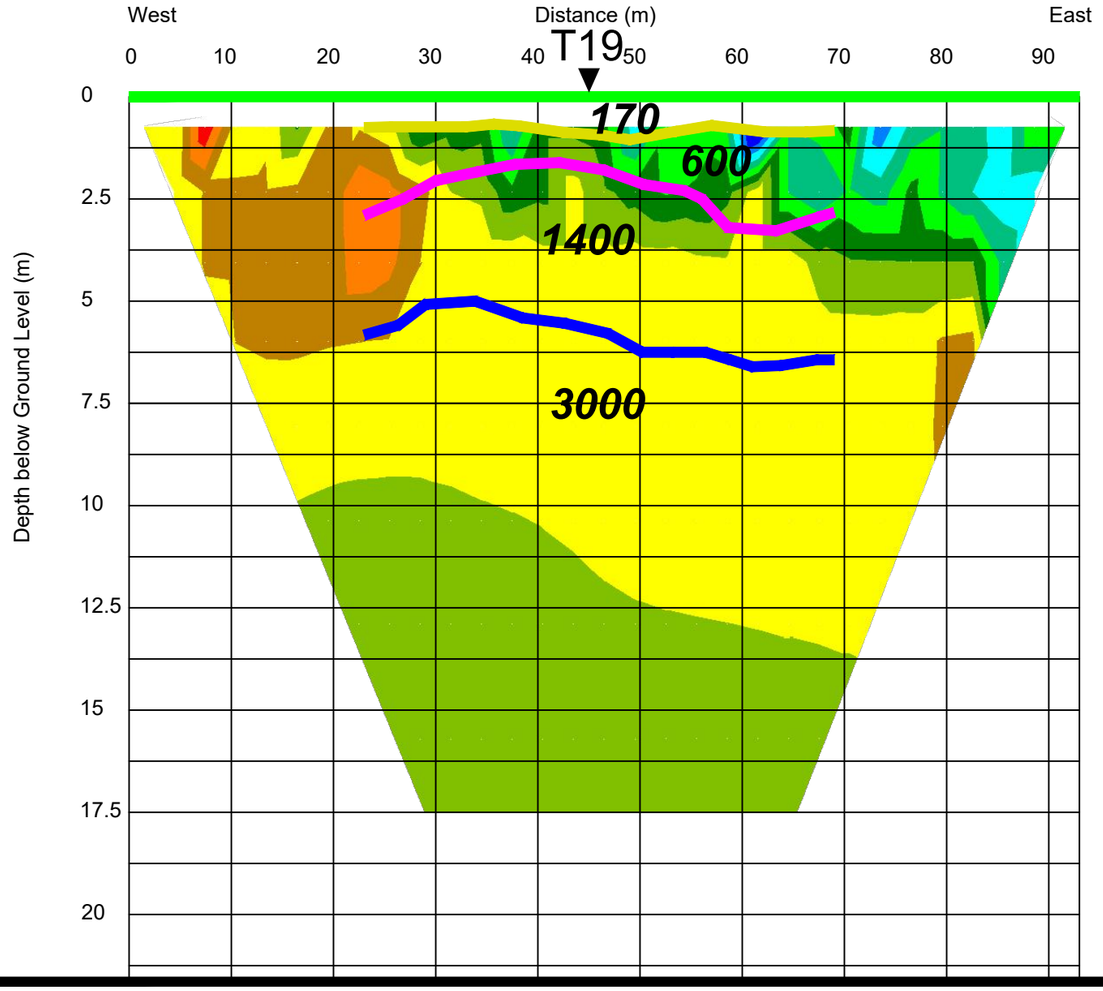
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 18: Models and Interpretation of Geophysical Survey for T18

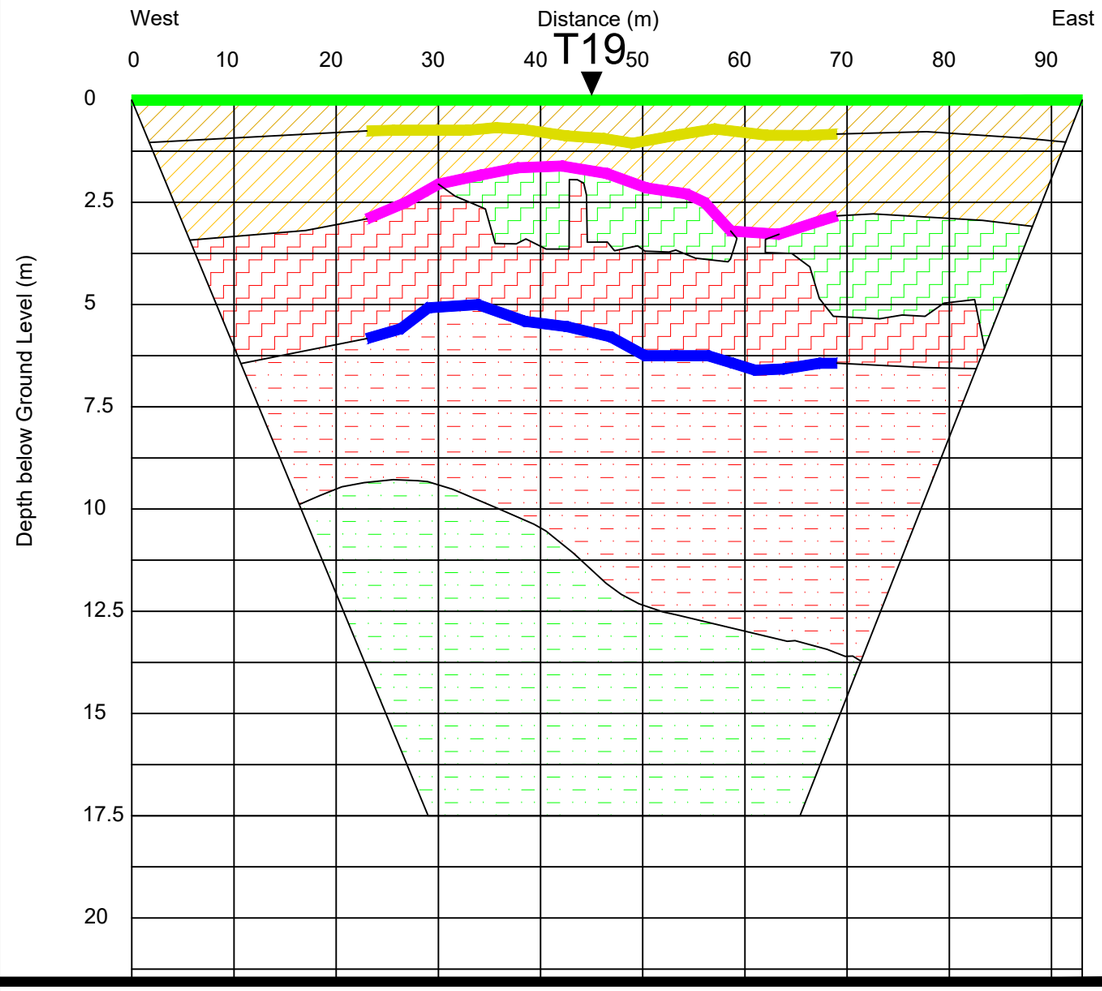
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T19

2D-Resistivity Profile R9 and Seismic Refraction Profile S9 Model



2D-Resistivity Profile R9 and Seismic Refraction Profile S9 Interpretation



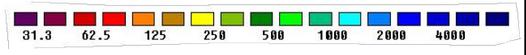
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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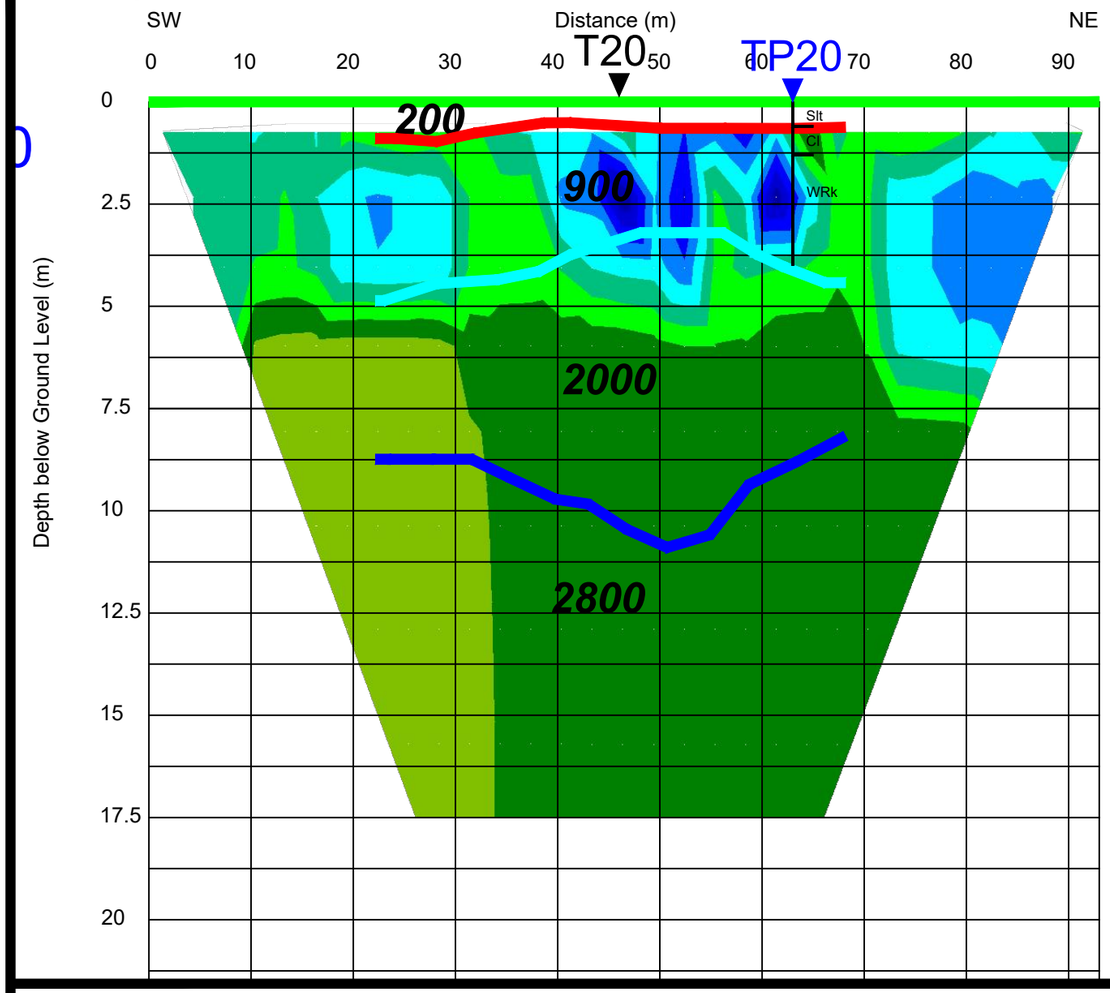
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 19: Models and Interpretation of Geophysical Survey for T19

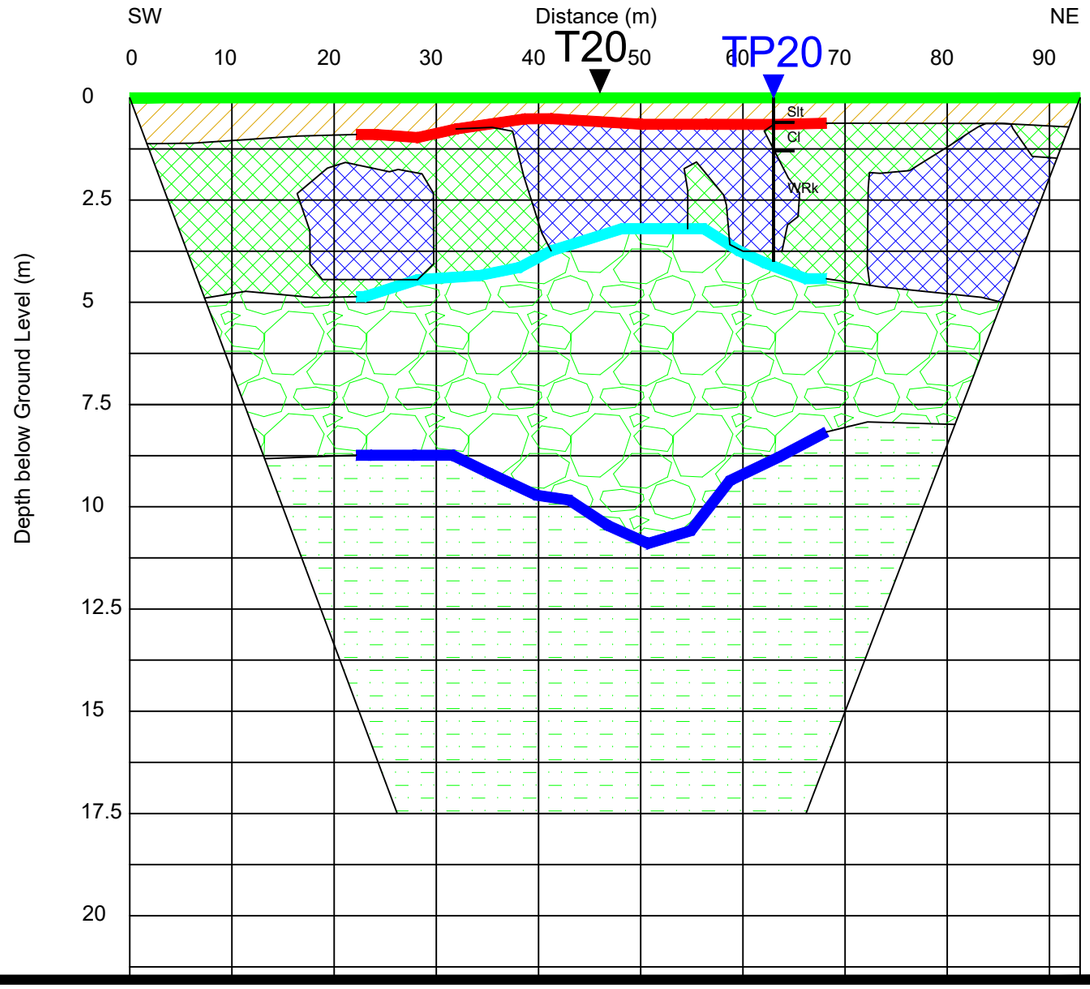
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T20

2D-Resistivity Profile R7 and Seismic Refraction Profile S7 Model



2D-Resistivity Profile R7 and Seismic Refraction Profile S7 Interpretation

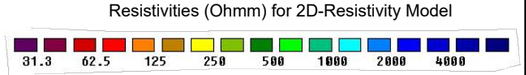


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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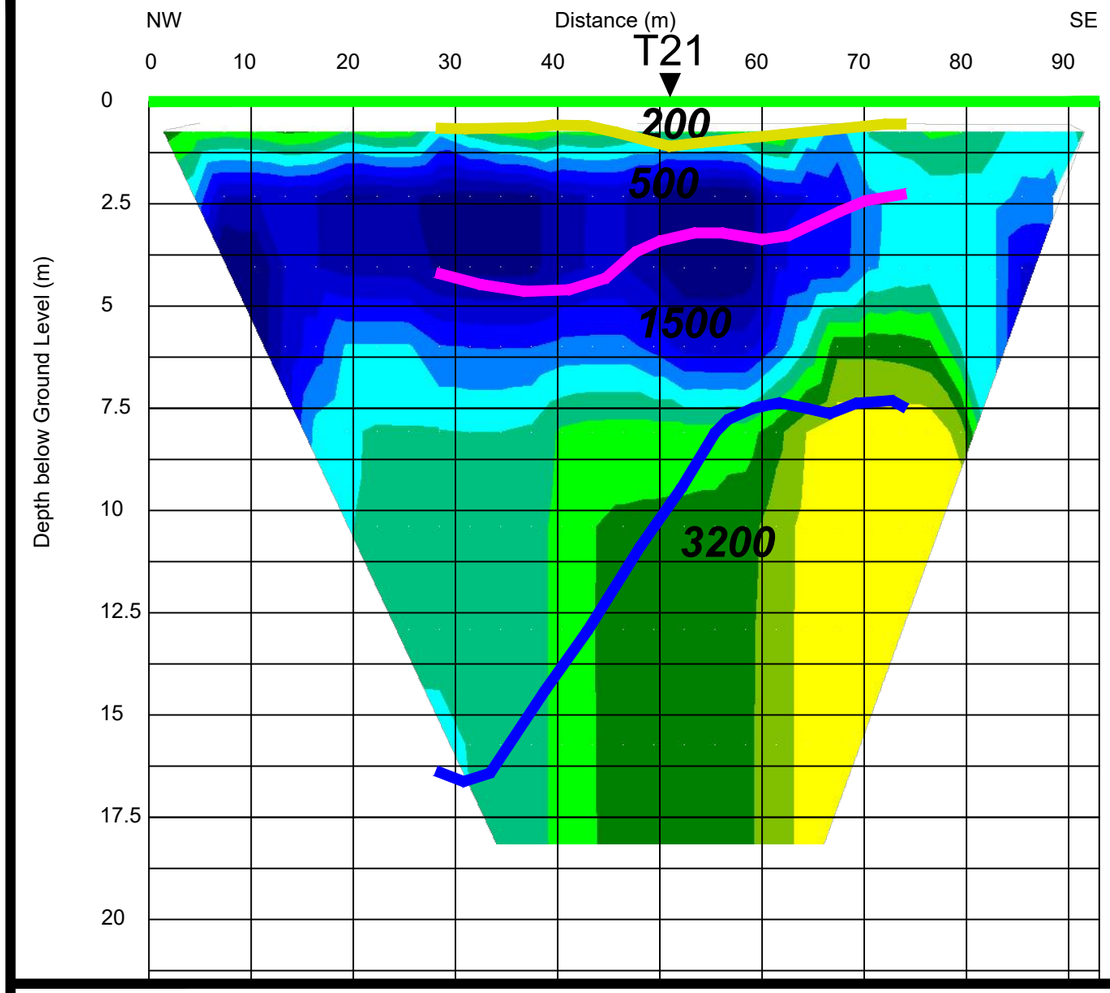
Web: www.mgx.ie

CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 20: Models and Interpretation of Geophysical Survey for T20

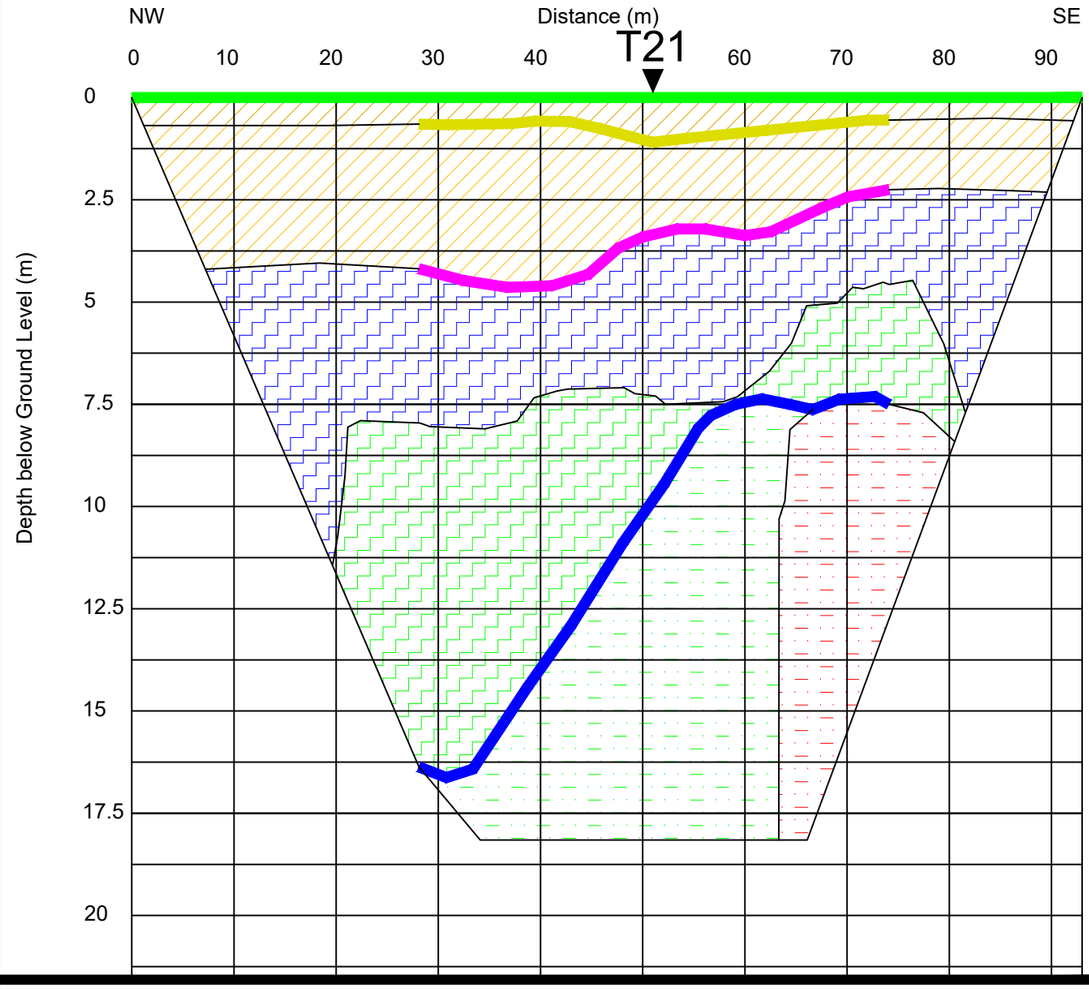
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T21

2D-Resistivity Profile R19 and Seismic Refraction Profile S19 Model



2D-Resistivity Profile R19 and Seismic Refraction Profile S19 Interpretation

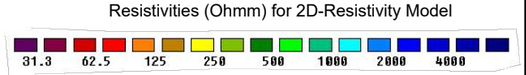


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
- 6a Fair to good Mudstone
- 6b Fair to good Interbedded Mudstone and Sandstone
- 7 Good Sandstone

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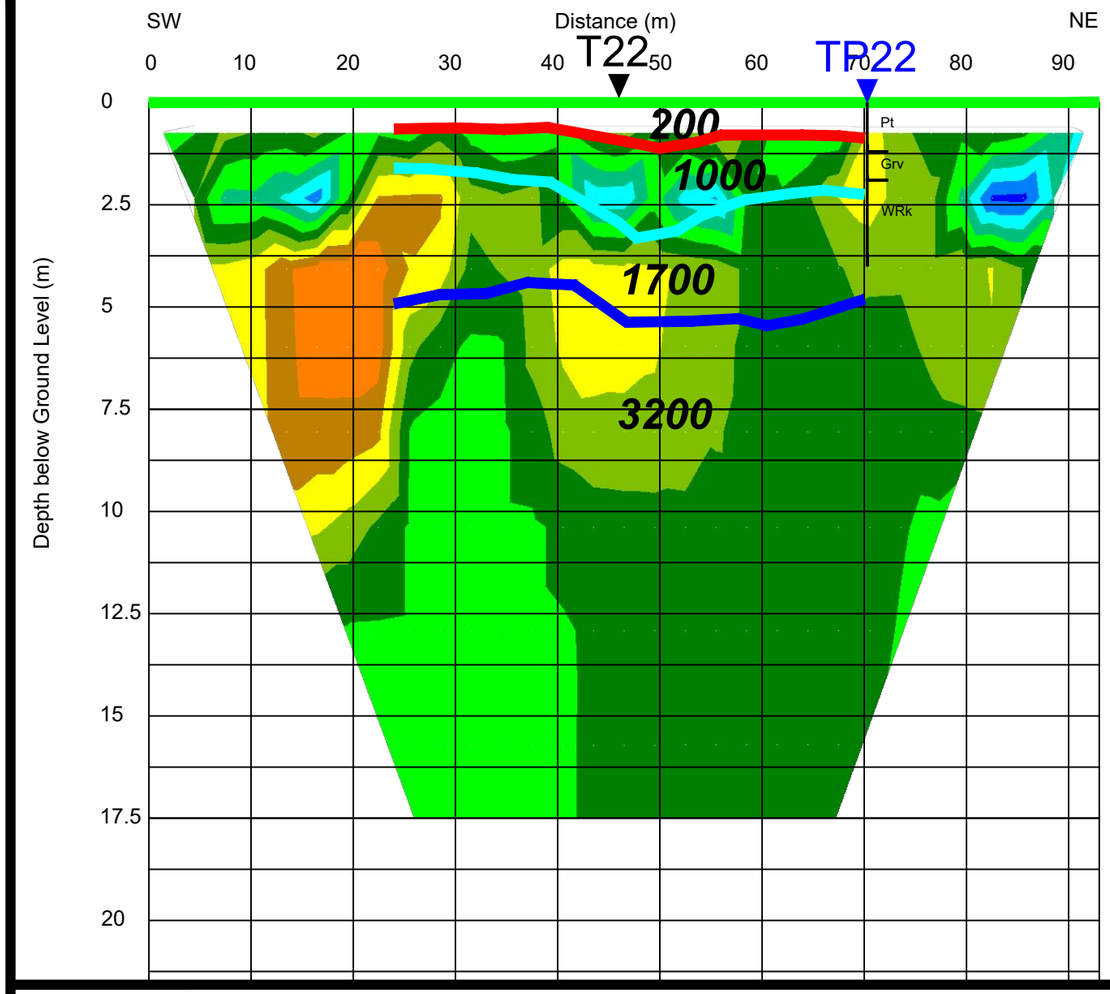
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 21: Models and Interpretation of Geophysical Survey for T21

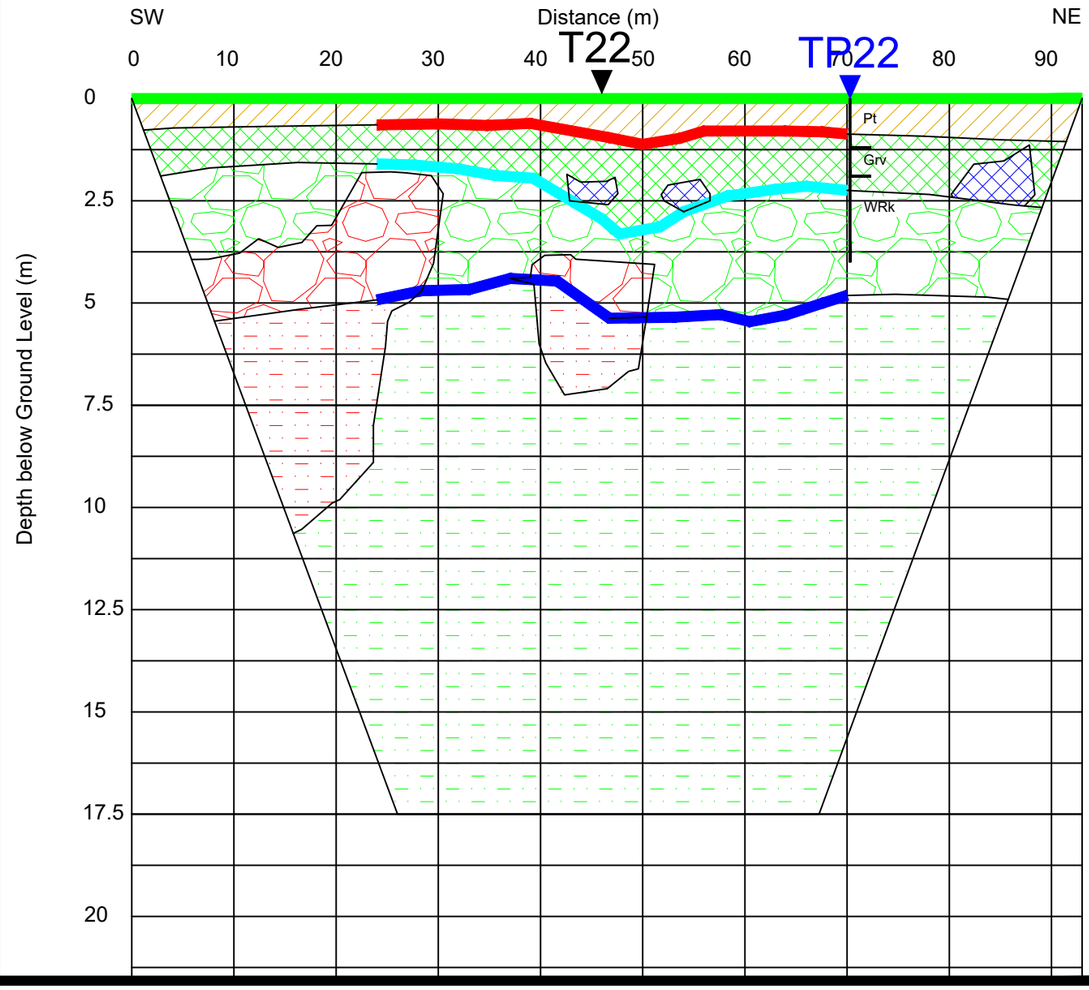
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T22

2D-Resistivity Profile R8 and Seismic Refraction Profile S8 Model



2D-Resistivity Profile R8 and Seismic Refraction Profile S8 Interpretation



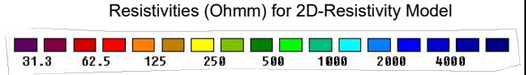
Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)

1800 Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

1 Very soft or very loose Topsoil
2 Soft or loose Topsoil

3a Firm sandy gravelly Clay and Silt
3b Medium dense clayey silty Sand and Gravel
3c Medium dense Sand and Gravel

4a Stiff sandy gravelly Clay and Silt
4b Dense clayey silty Sand and Gravel
4c Dense Sand and Gravel

5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
6a Fair to good Mudstone
6b Fair to good Interbedded Mudstone and Sandstone

7 Good Sandstone

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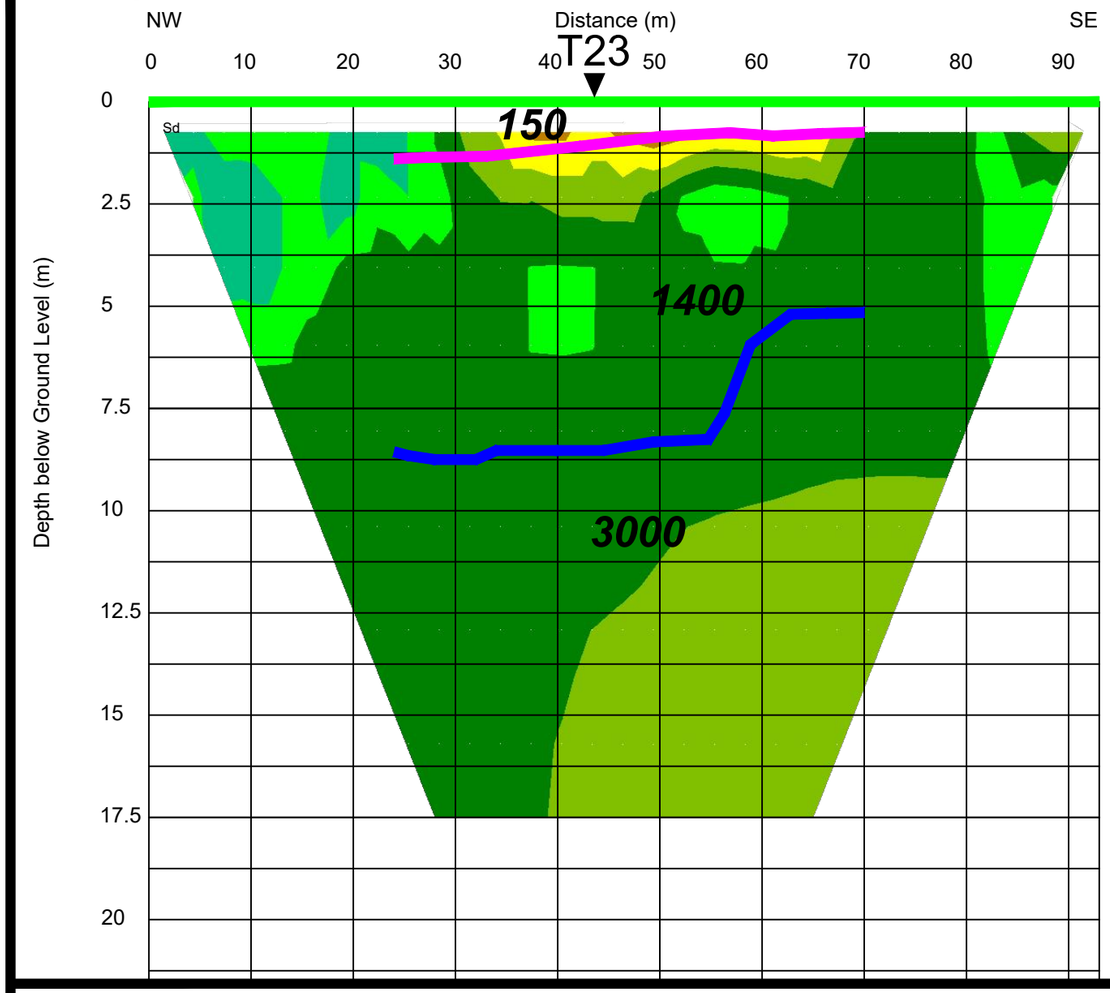
CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 22: Models and Interpretation of Geophysical Survey for T22

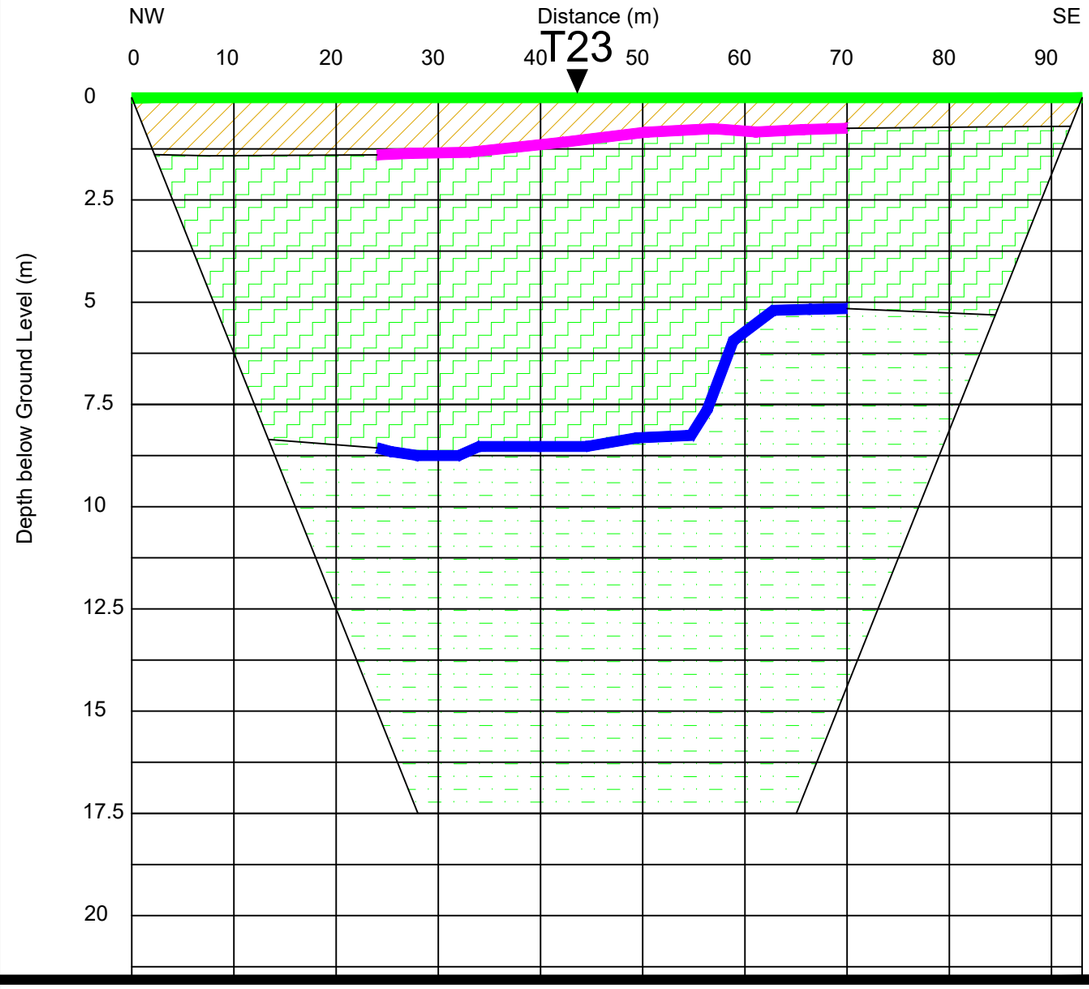
SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

T23

2D-Resistivity Profile R6 and Seismic Refraction Profile S6 Model



2D-Resistivity Profile R6 and Seismic Refraction Profile S6 Interpretation

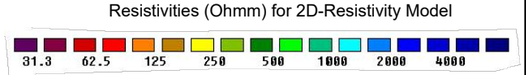


Layers from Seismic Refraction Model:

- Ground Surface/Top of Layer 1 (170 - 200 m/s)
- Ground Surface/Top of Layer 2 (300 - 600 m/s)
- Top of Layer 3 (800 - 1100 m/s)
- Top of Layer 4 (1400 - 1500 m/s)
- Top of Layer 5 (1700 - 2000 m/s)
- Top of Layer 6 (2600 - 3200 m/s)
- Top of Layer 7 (3700 - 4000 m/s)
- ***1800*** Seismic Velocity in m/s

2D-Resistivity Model Values:

Resistivities (Ohmm) for 2D-Resistivity Model



Interpretation:

- 1 Very soft or very loose Topsoil
- 2 Soft or loose Topsoil
- 3a Firm sandy gravelly Clay and Silt
- 3b Medium dense clayey silty Sand and Gravel
- 3c Medium dense Sand and Gravel
- 4a Stiff sandy gravelly Clay and Silt
- 4b Dense clayey silty Sand and Gravel
- 4c Dense Sand and Gravel
- 5a Poor weathered Mudstone or very stiff sandy gravelly Clay and Silt
- 5b Poor weathered Interbedded Mudstone and Sandstone or very dense clayey silty Sand and Gravel
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- 7 Good Sandstone

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CLIENT	Irish Drilling Ltd Fehily Timoney & Co.
PROJECT	Coom Windfarm, County Cork Geophysical Survey
TITLE	Figure 23: Models and Interpretation of Geophysical Survey for T23

SCALE:	1:600 @ A3, VE x 4
PROJECT:	6446
DRAWN:	JC
DATE:	05/07/2019
MGX FILE:	6529d_MapsFigs.dwg
STATUS:	Draft

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

Phone: (091) 841 274
Fax: (091) 847 687

email: info@irishdrilling.ie

COOM WIND FARM

APPENDIX 4

Project ID	2019C106		Client	Coillte		Remarks				
Project Name	Coom Wind Farm		Due Date	01/07/2019 10:41						
Schedule ID	2019C106_1		Scheduled Date	01/07/2019 10:41						

Sample Details							Classification						Chemical / Concrete								Compaction					Compressibility		
Location	Depth (m)	Base Depth	Sample Type	Sample Ref	Date Sampled	Storage	Moisture Content	Atterberg 4 Point	Particle Density by Gas Jar	Particle Density by Small Pyknometer	Particle Size Distribution	Hydrometer	Organic Content	Loss On Ignition	Sulphate Total	Sulphate Water Gravimetric	Carbonate Titration	ph	Chloride Content	Chloride Content Acid	Compaction Light	Compaction Heavy	Compaction Vibrating Hammer	Moisture Condition Value	Moisture Condition Relationship	CBR	Consolidation	Pressures
BP1-TP01	0.50	0.70	B	1	19/06/2019		**1**				**1**				**1**			**1**	**1**									ALS report 190730-36
BP1-TP01	1.50	1.70	B	2	19/06/2019		**1**				**1**				**1**			**1**	**1**						**1**			ALS report 190730-36
BP1-TP01	2.20	2.30	B	3	19/06/2019																							
BP1-TP02	0.50	0.70	B	1	19/06/2019		**1**				**1**																	
BP1-TP02	1.20	1.40	B	2	19/06/2019		**1**				**1**																	
BP1-TP02	2.40	2.60	B	3	19/06/2019																							
BP1-TP03	0.70	0.90	B	1	19/06/2019		**1**				**1**																	
BP1-TP03	1.70	1.90	B	2	19/06/2019		**1**				**1**																	
BP2-TP01	0.80	1.00	B	1	17/06/2019																							
BP2-TP01	1.80	2.00	B	2	17/06/2019		**1**				**1**				**1**			**1**	**1**						**1**			ALS report 190730-36
BP2-TP01	2.20	2.40	B	3	17/06/2019																							
BP2-TP02	1.10	1.30	B	1	17/06/2019		**1**				**1**																	
BP2-TP02	2.00	2.20	B	2	17/06/2019		**1**				**1**																	
BP2-TP02	2.80	3.00	B	3	17/06/2019																							
BP2-TP03	0.50	0.70	B	1	17/06/2019		**1**	**1**			**1**														**1**			
BP2-TP03	1.60	1.80	B	2	17/06/2019																							
BP2-TP03	2.50	2.70	B	3	17/06/2019		**1**				**1**																	
BP2-TP03	3.30	3.50	B	4	17/06/2019																							
BP2-TP04	1.00	1.20	B	1	17/06/2019		**1**				**1**																	
BP2-TP04	2.00	2.20	B	2	17/06/2019																							
BP2-TP04	2.80	3.00	B	3	17/06/2019																							
BP3-TP01	0.70	0.90	B	1	18/06/2019		**1**	**1**			**1**				**1**			**1**	**1**						**1**			ALS report 190730-36
BP3-TP01	0.70	0.90	D	2	18/06/2019																							
BP3-TP01	1.30	1.50	B	3	18/06/2019		**1**	**1**			**1**																	

Project ID	2019C106		Client	Coillte		Remarks				
Project Name	Coom Wind Farm		Due Date	01/07/2019 10:41						
Schedule ID	2019C106_1		Scheduled Date	01/07/2019 10:41						

Sample Details							Classification						Chemical / Concrete								Compaction					Compressibility		
Location	Depth (m)	Base Depth	Sample Type	Sample Ref	Date Sampled	Storage	Moisture Content	Atterberg 4 Point	Particle Density by Gas Jar	Particle Density by Small Pyknometer	Particle Size Distribution	Hydrometer	Organic Content	Loss On Ignition	Sulphate Total	Sulphate Water Gravimetric	Carbonate Titration	ph	Chloride Content	Chloride Content Acid	Compaction Light	Compaction Heavy	Compaction Vibrating Hammer	Moisture Condition Value	Moisture Condition Relationship	CBR	Consolidation	Pressures
BP3-TP01	1.30	1.50	D	4	18/06/2019																							
BP3-TP01	2.50	2.70	B	5	18/06/2019																							
BP3-TP01	3.30	3.50	B	6	18/06/2019																							
BP3-TP03	0.40	0.60	B	1	17/06/2019																							
BP3-TP03	0.40	0.60	D	2	17/06/2019																							
BP3-TP03	1.40	1.60	B	3	17/06/2019		**1**	**1**			**1**														**1**			
BP3-TP03	2.60	2.80	B	4	17/06/2019		**1**	**1**			**1**																	
BP3-TP03	2.60	2.80	D	5	17/06/2019										**1**			**1**	**1**									ALS report 190730-36
BP3-TP03	3.30	3.50	B	6	17/06/2019		**1**	**1**			**1**																	
TP-T13	0.30	0.50	B	1	19/06/2019																							
TP-T13	1.00	1.20	B	2	19/06/2019		**1**				**1**				**1**			**1**	**1**						**1**			ALS report 190730-36
TP-T13	2.20	2.40	B	3	19/06/2019																							
TP-T20	0.20	0.40	B	1	18/06/2019		**1**	**1**			**1**				**1**			**1**	**1**						**1**	**1**		ALS report 190730-36
TP-T20	1.30	1.50	B	2	18/06/2019																							
TP-T20	3.00	3.20	B	3	18/06/2019																							
TP-T22	0.50	0.70	B	1	18/06/2019		**1**	**1**			**1**														**1**			
TP-T22	1.50	1.70	B	2	18/06/2019		**1**				**1**															**1**		
TP-T22	2.40	2.60	B	3	18/06/2019																							
TP-T22	3.40	3.60	B	4	18/06/2019																							
TP-T23	0.40	0.60	B	1	18/06/2019																							
TP-T23	1.20	1.40	B	2	18/06/2019		**1**				**1**				**1**			**1**	**1**									ALS report 190730-36
TP-T23	2.20	2.40	B	3	18/06/2019																							
TP-T23	3.20	3.40	B	4	18/06/2019		**1**	**1**			**1**				**1**			**1**	**1**							**1**		ALS report 190730-36
TP-T23	3.20	3.40	D	5	18/06/2019																							

Project ID	2019C106	Client	Coillte	Remarks	
Project Name	Coom Wind Farm	Due Date	01/07/2019 10:41		
Schedule ID	2019C106_1	Scheduled Date	01/07/2019 10:41		

Sample Details							Classification						Chemical / Concrete								Compaction					Compressibility	
Location	Depth (m)	Base Depth	Sample Type	Sample Ref	Date Sampled	Storage	Moisture Content	Atterberg 4 Point	Particle Density by Gas Jar	Particle Density by Small Pyknometer	Particle Size Distribution	Hydrometer	Organic Content	Loss On Ignition	Sulphate Total	Sulphate Water Gravimetric	Carbonate Titration	ph	Chloride Content	Chloride Content Acid	Compaction Light	Compaction Heavy	Compaction Vibrating Hammer	Moisture Condition Value	Moisture Condition Relationship	CBR	Consolidation Pressures
	scheduled (2.7.19)						23	9	0	0	23	0	0	0	9	0	0	9	9	0	0	0	0	0	8	3	0
	Completed (10.9.19)						23	9	0	0	23	0	0	0	9	0	0	9	9	0	0	0	0	0	8	3	0

Summary of Classification Test Results

Project No.	Project Name
2019C106	Coom Wind Farm

Hole No.	Sample Ref	Top	Base	Type		Soil Description	Density bulk Mg/m3	Density dry Mg/m3	w %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
BP1-TP01	1	0.50	0.70	B		Orange very silty SAND and GRAVEL.			13.0	54					
BP1-TP01	2	1.50	1.70	B		Brown silty sandy medium and coarse GRAVEL.			19.0	26					
BP1-TP02	1	0.50	0.70	B		Brown silty very sandy coarse GRAVEL.			16.0	27					
BP1-TP02	2	1.20	1.40	B		Orange-brown silty very sandy GRAVEL.			13.0	40					
BP1-TP03	1	0.70	0.90	B		Orange-brown very silty very sandy GRAVEL.			16.0	45					
BP1-TP03	2	1.70	1.90	B		Orange-brown very sandy very silty coarse GRAVEL.			22.0	45					
BP2-TP01	2	1.80	2.00	B		Reddish-brown sandy silty medium and coarse GRAVEL.			15.0	25					
BP2-TP02	1	1.10	1.30	B		Brown very sandy very silty coarse GRAVEL.			13.0	40					
BP2-TP02	2	2.00	2.20	B		Orange-brown sandy silty coarse GRAVEL.			17.0	20					
BP2-TP03	1	0.50	0.70	B		Brown very silty very sandy medium and fine GRAVEL.			17.0	41	32	26	6		ML
BP2-TP03	3	2.50	2.70	B		Grey slightly sandy slightly silty angular coarse GRAVEL.			8.4	6					
BP2-TP04	1	1.00	1.20	B		Brown sandy very silty coarse GRAVEL.			12.0	34					
BP3-TP01	1	0.70	0.90	B		Brown slightly gravelly sandy CLAY.			26.0	86	28	20	8		CL
BP3-TP01	3	1.30	1.50	B		Purplish-brown slightly gravelly sandy SILT.			12.0	67					NP
BP3-TP03	3	1.40	1.60	B		Reddish-brown slightly gravelly sandy CLAY.			11.0	72	24	16	8		CL
BP3-TP03	4	2.60	2.80	B		Reddish-brown slightly gravelly sandy CLAY.			11.0	72	27	15	12		CL
BP3-TP03	6	3.30	3.50	B		Reddish-brown slightly gravelly sandy CLAY.			12.0	80	26	15	11		CL
TP-T13	2	1.00	1.20	B		Brown very silty very sandy medium and fine GRAVEL.			13.0	42					
TP-T20	1	0.20	0.40	B		Reddish-brown very gravelly very silty SAND.			23.0	61	39	29	10		MI
TP-T22	1	0.50	0.70	B		Yellowish-brown slightly gravelly very silty fine and medium SAND.			31.0	86	36	26	10		MI
TP-T22	2	1.50	1.70	B		Brown very silty very sandy GRAVEL.			12.0	41					
TP-T23	2	1.20	1.40	B		Brown very silty SAND and GRAVEL.			9.9	51					
TP-T23	4	3.20	3.40	B		Reddish-brown slightly gravelly sandy CLAY.			13.0	68	30	18	12		CL

All tests performed in accordance with BS1377:1990 unless specified otherwise

Key

Density test | Liquid Limit | Particle density

Linear measurement unless : | 4pt cone unless : | sp - small pyknometer

wd - water displacement | 1pt - single point test | gj - gas jar

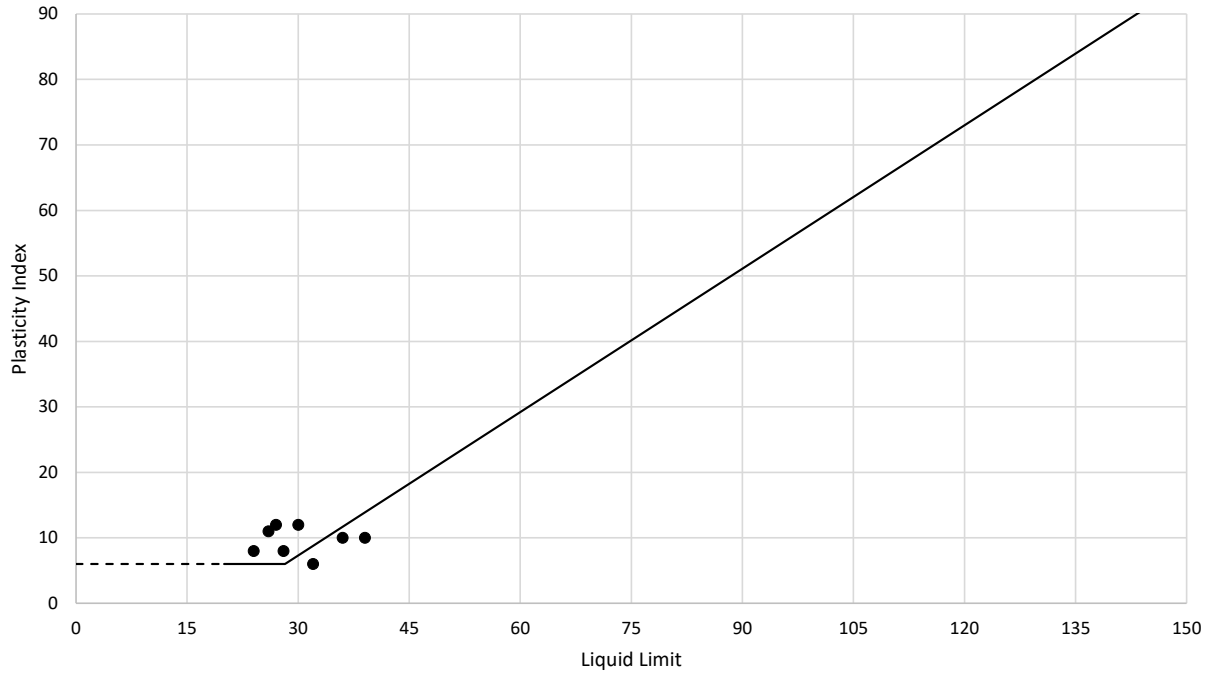
wi - immersion in water | NP - Non Plastic

Date Printed	Approved By	Table
09/10/2019 00:00		1
QC From No: R1	DCD (10.09.19)	sheet 1

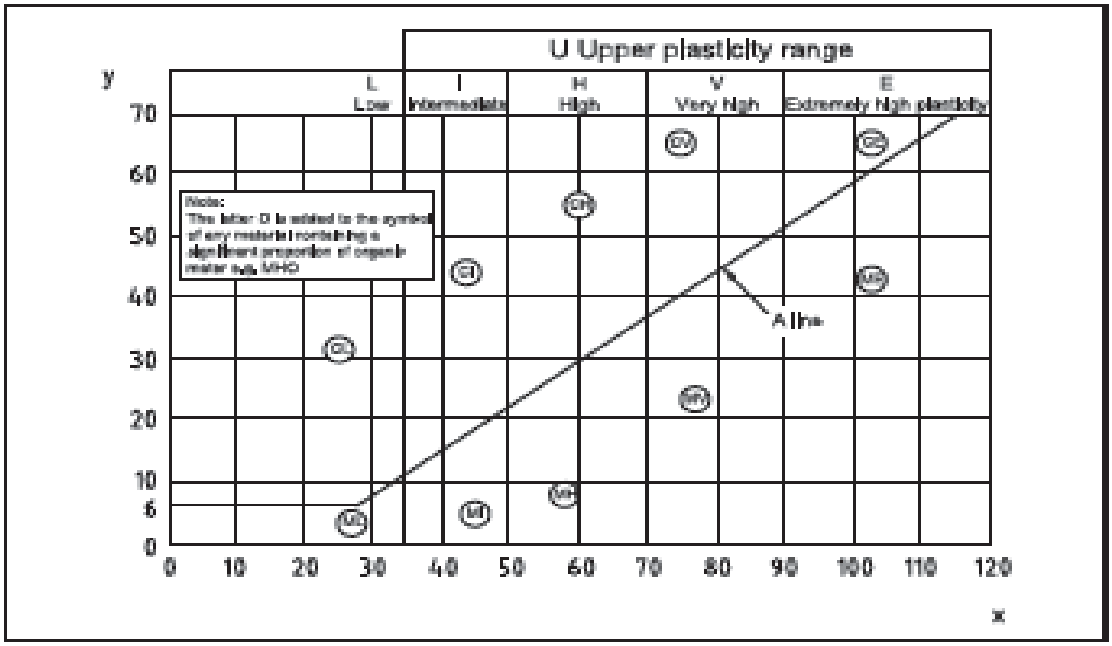
Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

	Plasticity (A-Line) Chart		Project Number
	Project Name:	Coom Wind Farm	
	Location:		2019C106

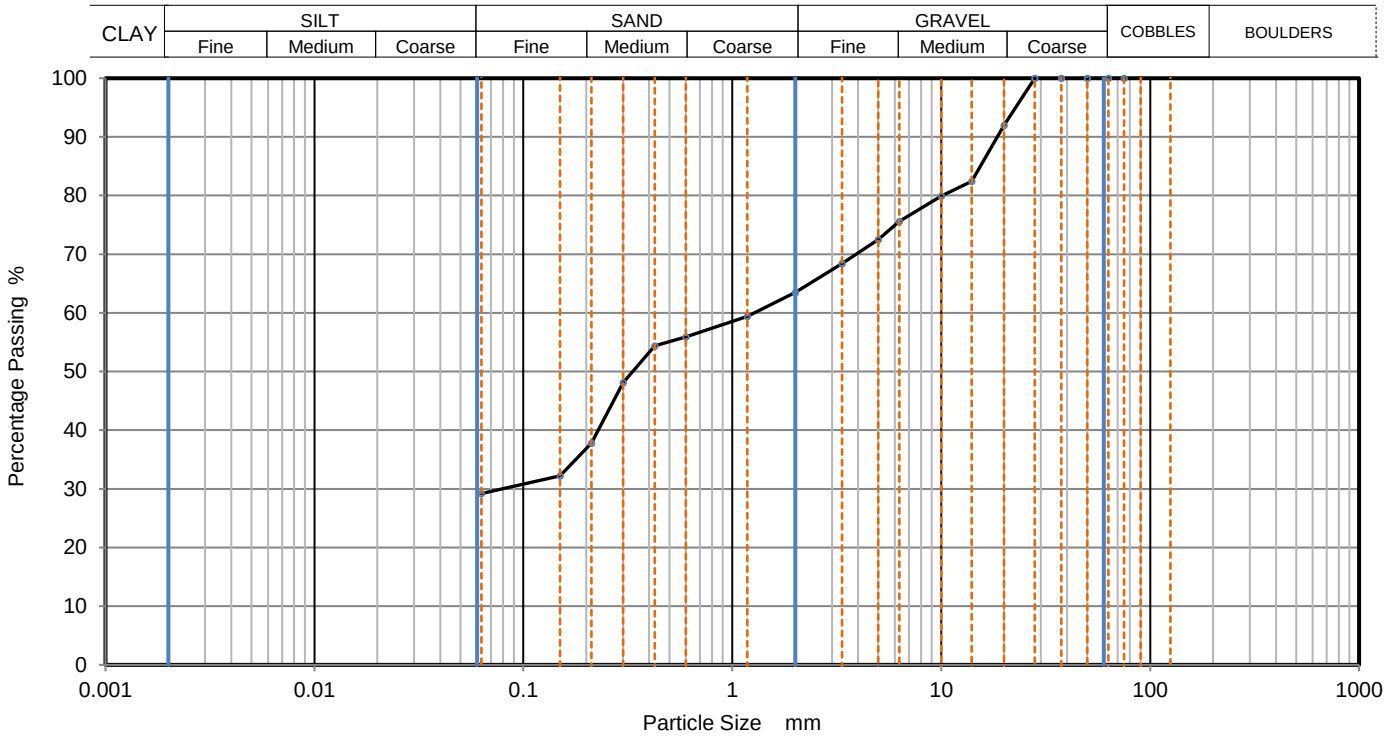


Plasticity chart



Approved By DCD 10.09.2019 QC Form: R1

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP01
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Orange very silty SAND and GRAVEL.			Depth, m	0.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627668



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	92		
14	82		
10	80		
6.3	76		
5	73		
3.35	68		
2	64		
1.18	59		
0.6	56		
0.425	54		
0.3	48		
0.212	38		
0.15	32		
0.063	29		

Dry Mass of sample, g	827

Sample Proportions	% dry mass
Very coarse	0
Gravel	37
Sand	34
Fines <0.063mm	29

Grading Analysis		
D100	mm	
D60	mm	1.28
D30	mm	0.0797
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	10/09/2019 15:46	**1** QC From No:R2

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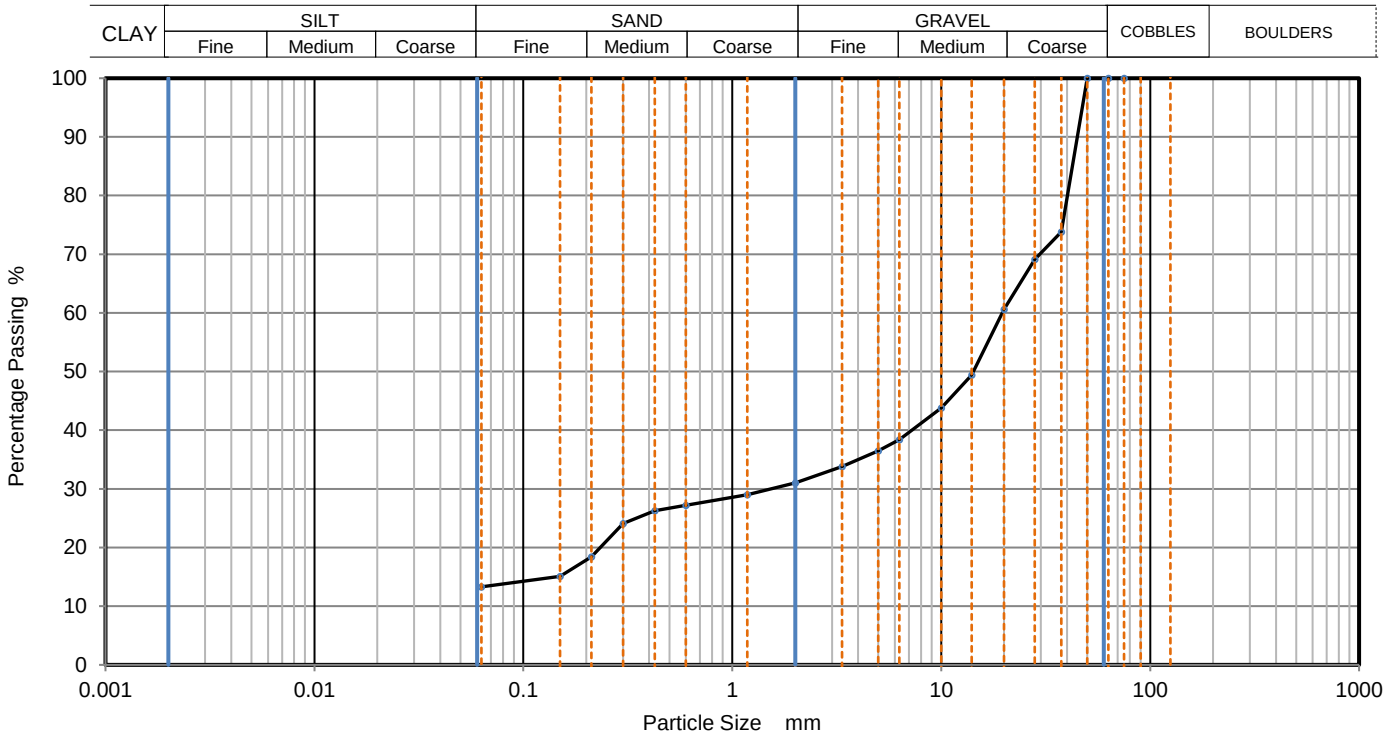
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP01
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown silty sandy medium and coarse GRAVEL.			Depth, m	1.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627669



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
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63	100		
50	100		
37.5	74		
28	69		
20	61		
14	49		
10	44		
6.3	38		
5	37		
3.35	34		
2	31		
1.18	29		
0.6	27		
0.425	26		
0.3	24		
0.212	18		
0.15	15		
0.063	13		

Dry Mass of sample, g	1337

Sample Proportions	% dry mass
Very coarse	0
Gravel	69
Sand	18
Fines <0.063mm	13

Grading Analysis		
D100	mm	
D60	mm	19.6
D30	mm	1.54
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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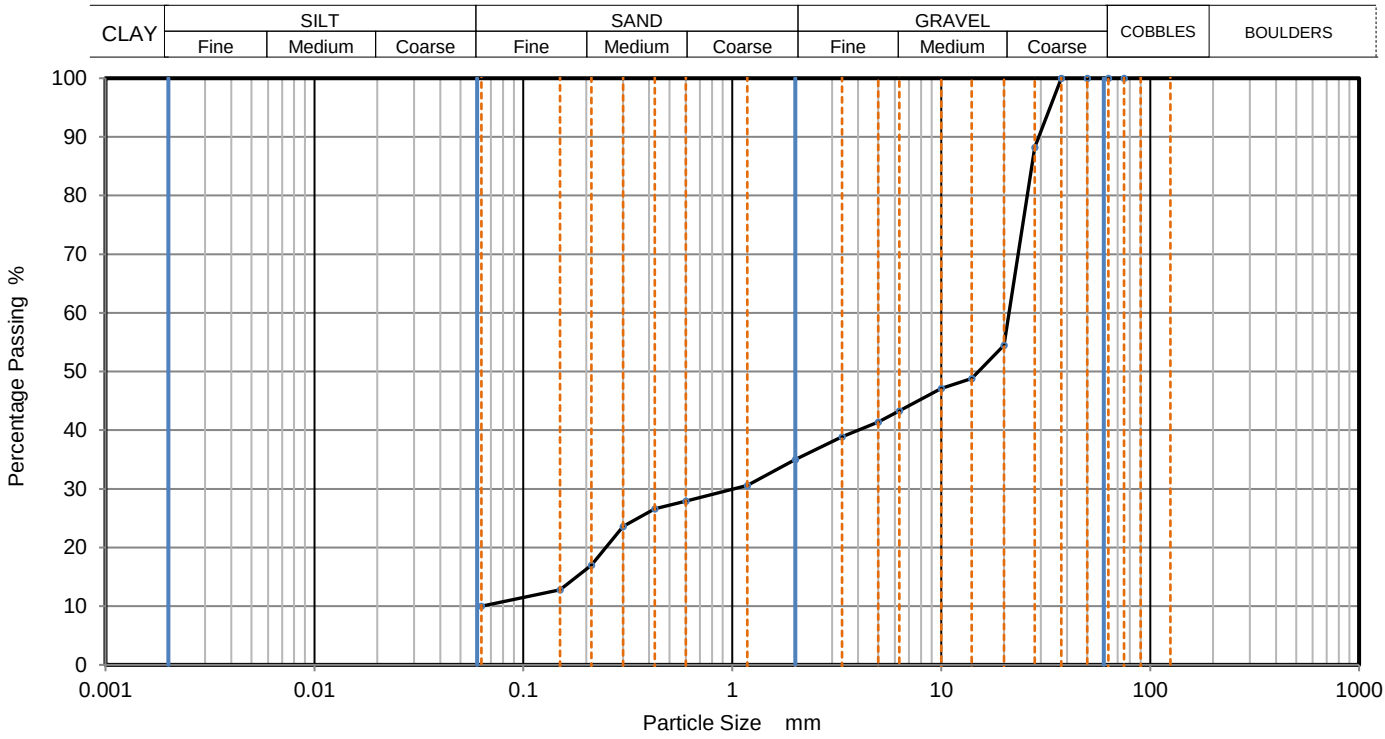
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP02
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown silty very sandy coarse GRAVEL.			Depth, m	0.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627671



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	88		
20	55		
14	49		
10	47		
6.3	43		
5	41		
3.35	39		
2	35		
1.18	31		
0.6	28		
0.425	27		
0.3	24		
0.212	17		
0.15	13		
0.063	10		

Dry Mass of sample, g	670

Sample Proportions	% dry mass
Very coarse	0
Gravel	65
Sand	25
Fines <0.063mm	10

Grading Analysis		
D100	mm	
D60	mm	21.1
D30	mm	1.01
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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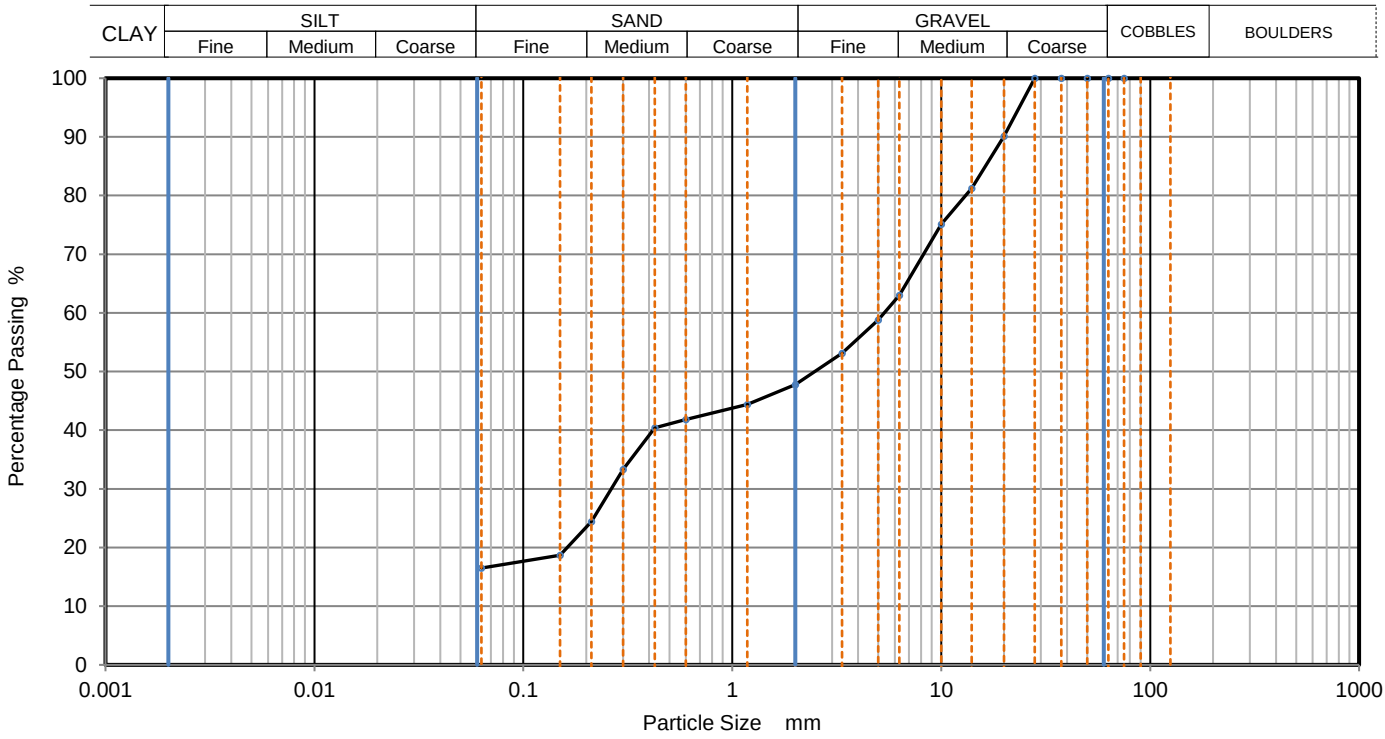
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP02
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Orange-brown silty very sandy GRAVEL.			Depth, m	1.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627672



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	90		
14	81		
10	75		
6.3	63		
5	59		
3.35	53		
2	48		
1.18	44		
0.6	42		
0.425	40		
0.3	33		
0.212	24		
0.15	19		
0.063	17		

Dry Mass of sample, g	833

Sample Proportions	% dry mass
Very coarse	0
Gravel	52
Sand	31
Fines <0.063mm	17

Grading Analysis		
D100	mm	
D60	mm	5.34
D30	mm	0.264
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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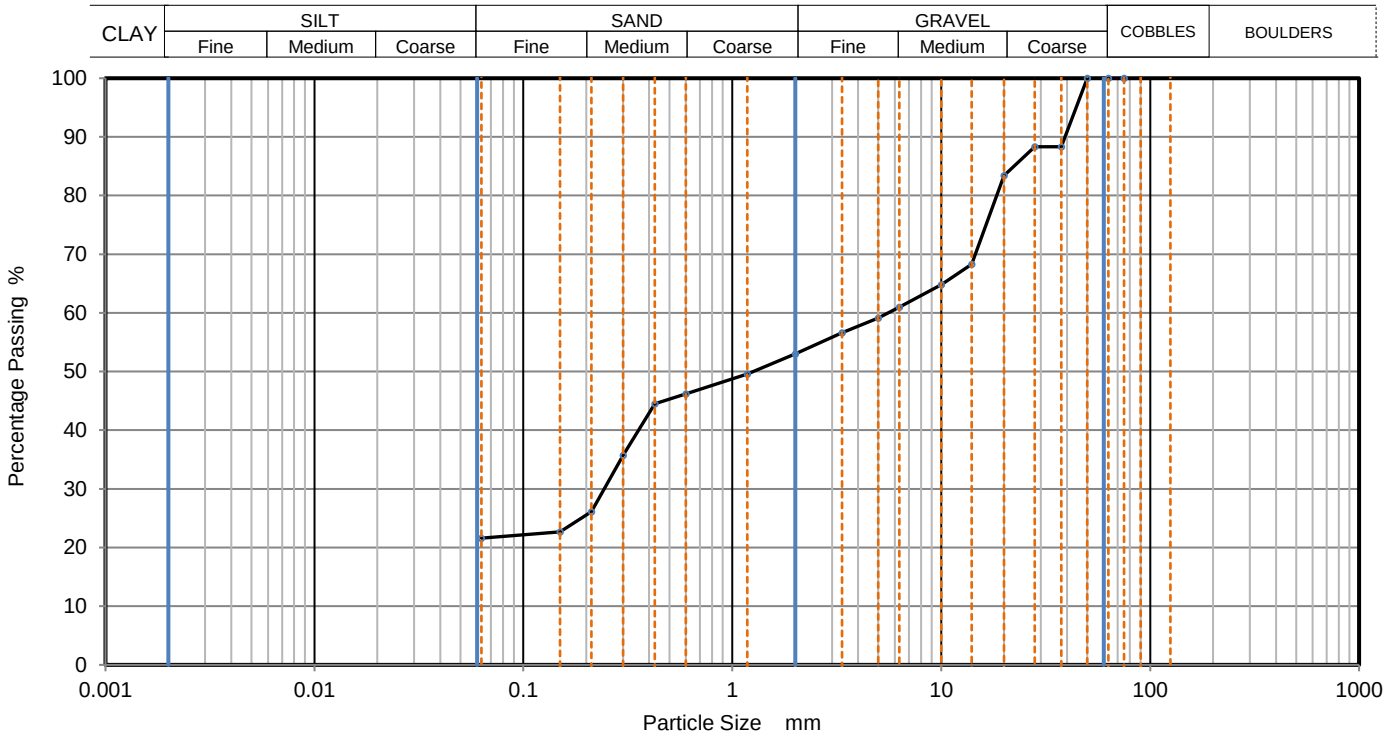
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP03
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Orange-brown very silty very sandy GRAVEL.			Depth, m	0.70
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627674



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	88		
28	88		
20	83		
14	68		
10	65		
6.3	61		
5	59		
3.35	57		
2	53		
1.18	50		
0.6	46		
0.425	45		
0.3	36		
0.212	26		
0.15	23		
0.063	22		

Dry Mass of sample, g	788

Sample Proportions	% dry mass
Very coarse	0
Gravel	47
Sand	32
Fines <0.063mm	22

Grading Analysis		
D100	mm	
D60	mm	5.6
D30	mm	0.244
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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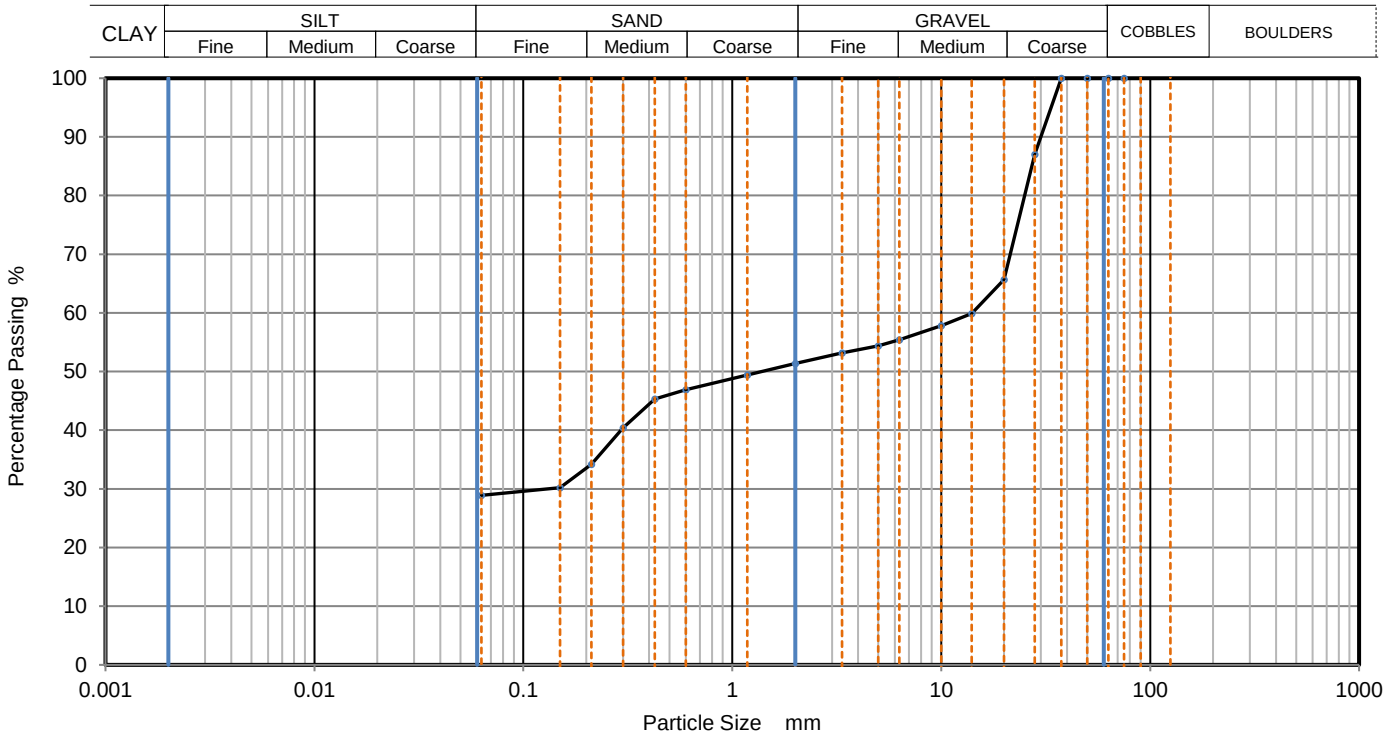
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP1-TP03
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Orange-brown very sandy very silty coarse GRAVEL.			Depth, m	1.70
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627675



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	87		
20	66		
14	60		
10	58		
6.3	55		
5	54		
3.35	53		
2	51		
1.18	49		
0.6	47		
0.425	45		
0.3	40		
0.212	34		
0.15	30		
0.063	29		

Dry Mass of sample, g	747

Sample Proportions	% dry mass
Very coarse	0
Gravel	49
Sand	23
Fines <0.063mm	29

Grading Analysis		
D100	mm	
D60	mm	14.1
D30	mm	0.132
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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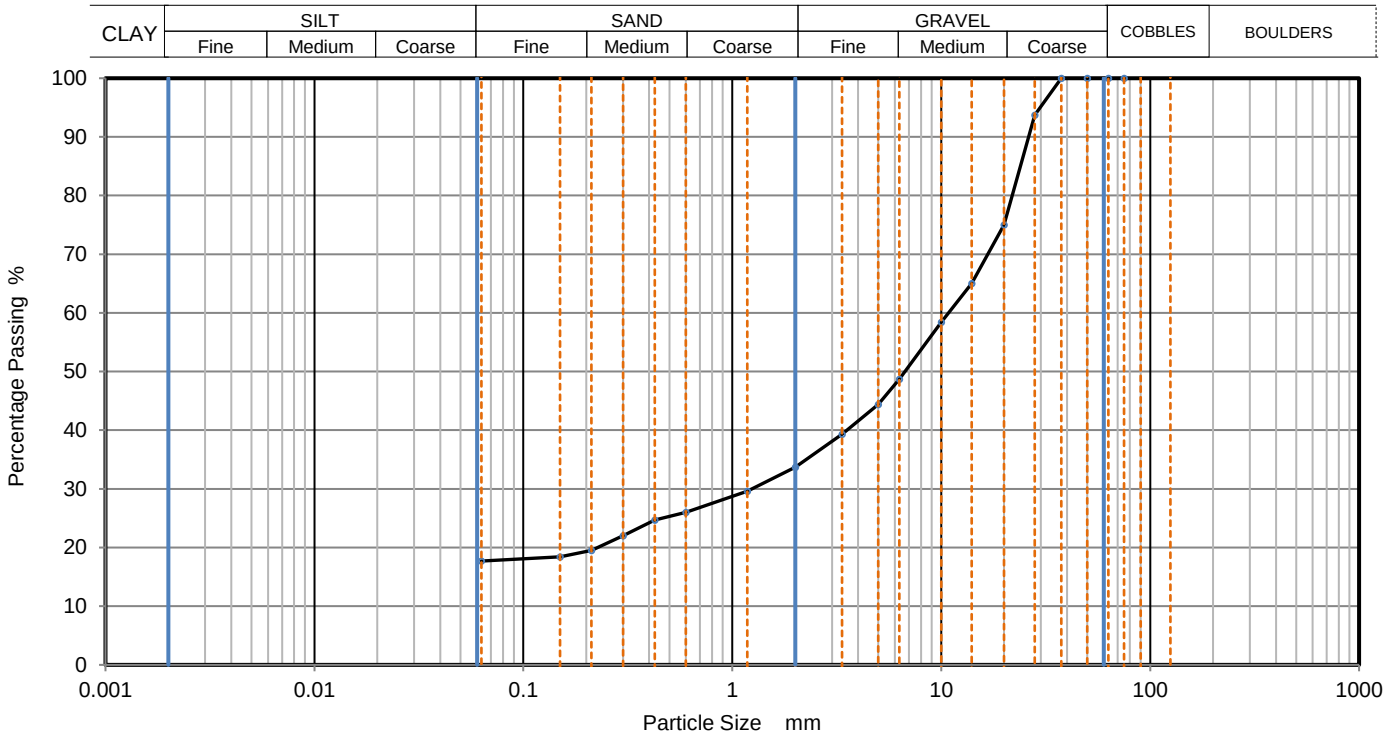
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP01
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Reddish-brown sandy silty medium and coarse GRAVEL.			Depth, m	1.80
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627677



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	94		
20	75		
14	65		
10	58		
6.3	49		
5	44		
3.35	39		
2	34		
1.18	30		
0.6	26		
0.425	25		
0.3	22		
0.212	20		
0.15	18		
0.063	18		

Dry Mass of sample, g	871

Sample Proportions	% dry mass
Very coarse	0
Gravel	66
Sand	16
Fines <0.063mm	18

Grading Analysis		
D100	mm	
D60	mm	10.8
D30	mm	1.25
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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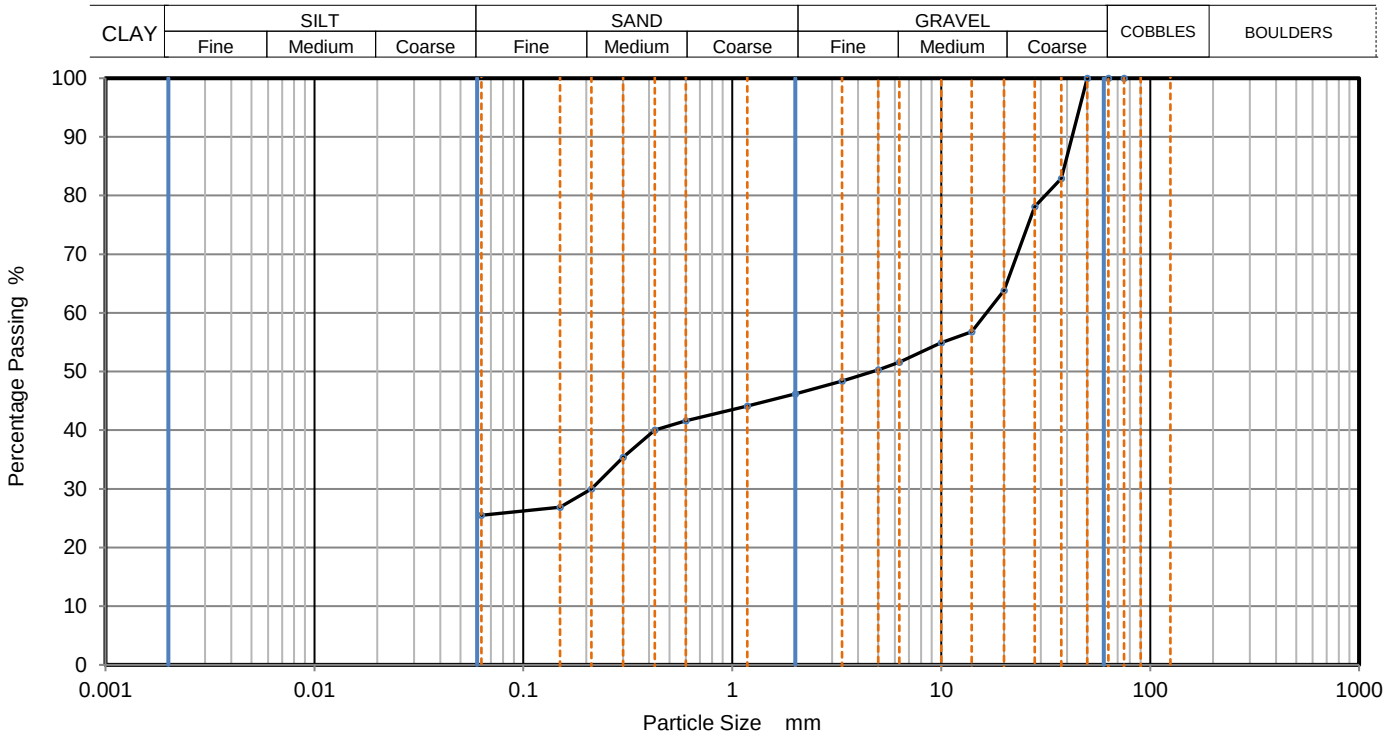
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP02
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown very sandy very silty coarse GRAVEL.			Depth, m	1.10
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627679



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	83		
28	78		
20	64		
14	57		
10	55		
6.3	52		
5	50		
3.35	48		
2	46		
1.18	44		
0.6	42		
0.425	40		
0.3	35		
0.212	30		
0.15	27		
0.063	26		

Dry Mass of sample, g	846

Sample Proportions	% dry mass
Very coarse	0
Gravel	54
Sand	21
Fines <0.063mm	26

Grading Analysis		
D100	mm	
D60	mm	16.5
D30	mm	0.213
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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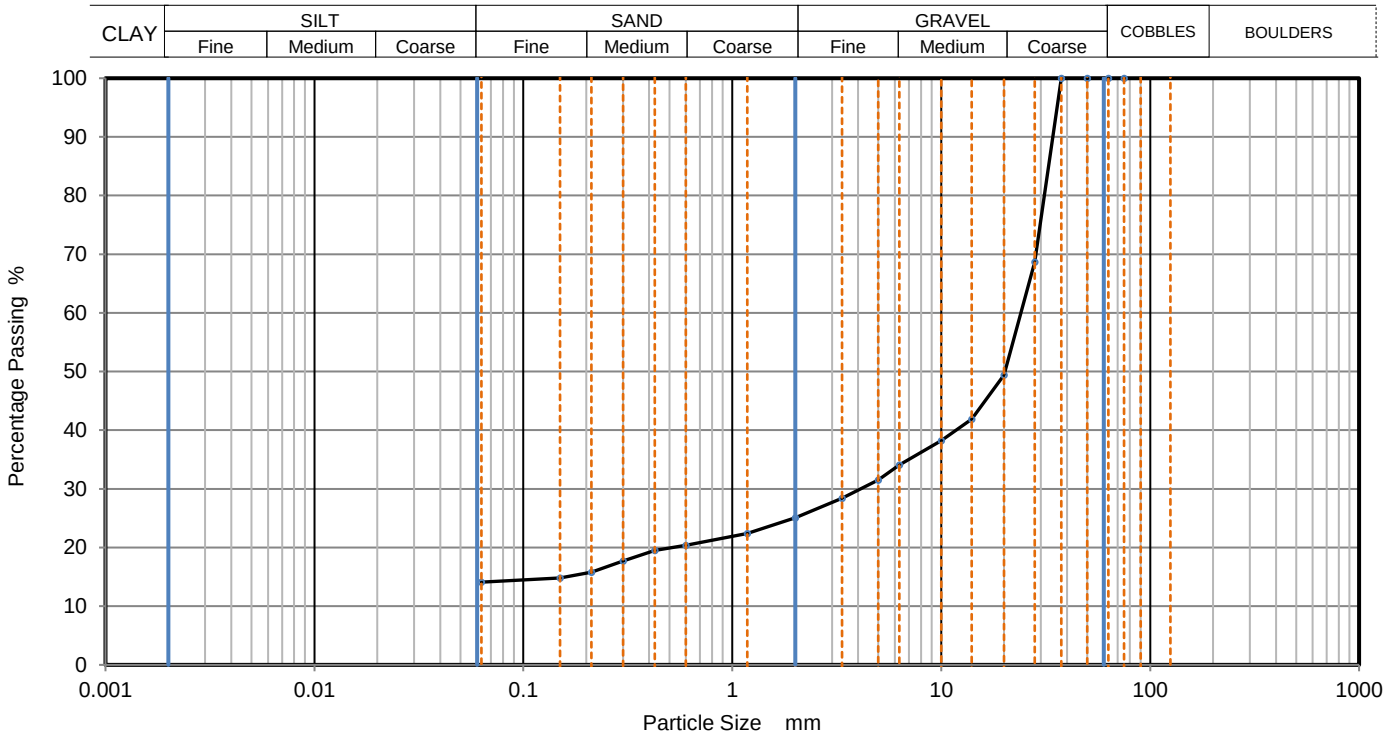
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP02
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Orange-brown sandy silty coarse GRAVEL.			Depth, m	2.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627680



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	69		
20	49		
14	42		
10	38		
6.3	34		
5	32		
3.35	28		
2	25		
1.18	22		
0.6	20		
0.425	20		
0.3	18		
0.212	16		
0.15	15		
0.063	14		

Dry Mass of sample, g	743

Sample Proportions	% dry mass
Very coarse	0
Gravel	75
Sand	11
Fines <0.063mm	14

Grading Analysis		
D100	mm	
D60	mm	24
D30	mm	4.11
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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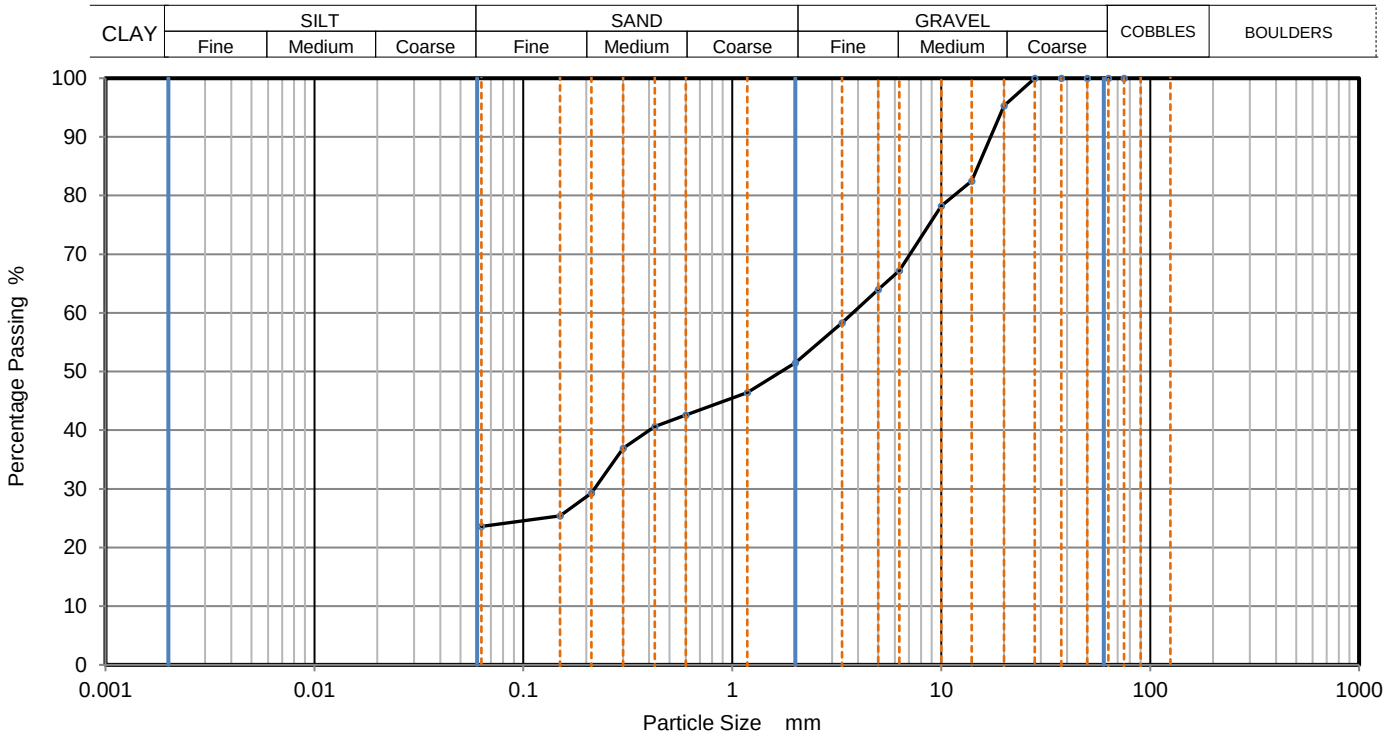
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP03
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown very silty very sandy medium and fine GRAVEL.			Depth, m	0.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627682



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	95		
14	83		
10	78		
6.3	67		
5	64		
3.35	58		
2	52		
1.18	46		
0.6	43		
0.425	41		
0.3	37		
0.212	29		
0.15	25		
0.063	24		

Dry Mass of sample, g	830

Sample Proportions	% dry mass
Very coarse	0
Gravel	49
Sand	28
Fines <0.063mm	24

Grading Analysis		
D100	mm	
D60	mm	3.77
D30	mm	0.219
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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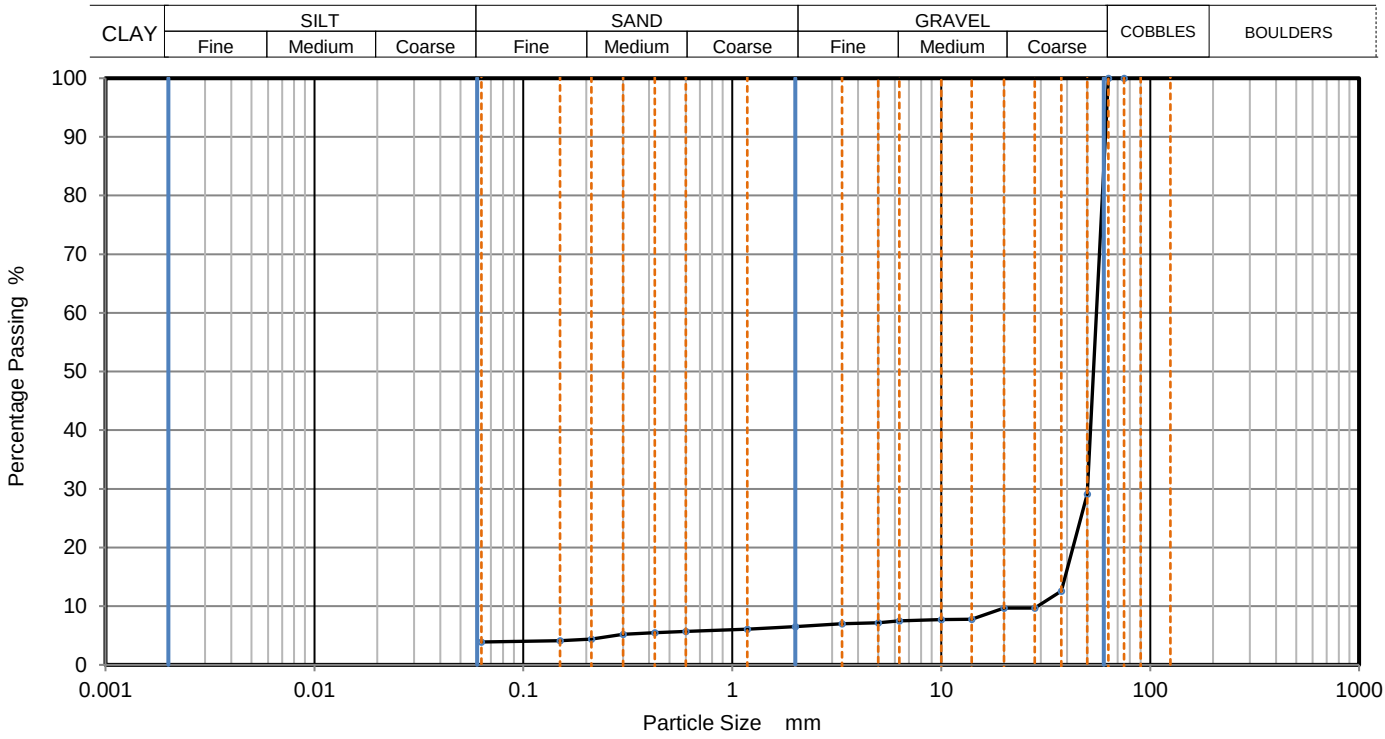
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP03
Site Name	Coom Wind Farm			Sample No.	3
Soil Description	Grey slightly sandy slightly silty angular coarse GRAVEL.			Depth, m	2.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627684



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	29		
37.5	13		
28	10		
20	10		
14	8		
10	8		
6.3	8		
5	7		
3.35	7		
2	7		
1.18	6		
0.6	6		
0.425	6		
0.3	5		
0.212	4		
0.15	4		
0.063	4		

Dry Mass of sample, g	1151

Sample Proportions	% dry mass
Very coarse	0
Gravel	94
Sand	3
Fines <0.063mm	4

Grading Analysis		
D100	mm	
D60	mm	55.3
D30	mm	50.1
D10	mm	28.7
Uniformity Coefficient		1.9
Curvature Coefficient		1.6

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
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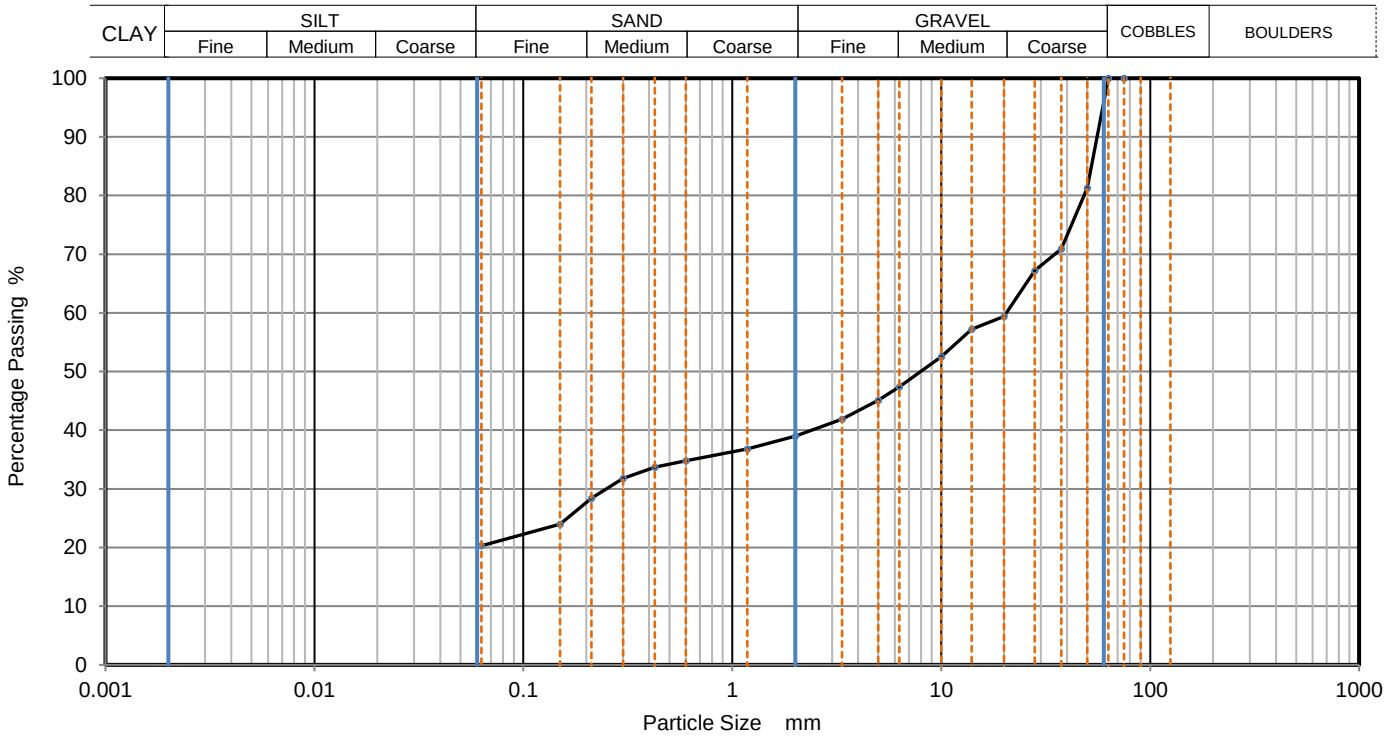
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	BP2-TP04
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown sandy very silty coarse GRAVEL.			Depth, m	1.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627686



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	81		
37.5	71		
28	67		
20	59		
14	57		
10	53		
6.3	47		
5	45		
3.35	42		
2	39		
1.18	37		
0.6	35		
0.425	34		
0.3	32		
0.212	28		
0.15	24		
0.063	20		

Dry Mass of sample, g: 853

Sample Proportions	% dry mass
Very coarse	0
Gravel	61
Sand	19
Fines <0.063mm	20

Grading Analysis		
D100	mm	
D60	mm	20.6
D30	mm	0.249
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
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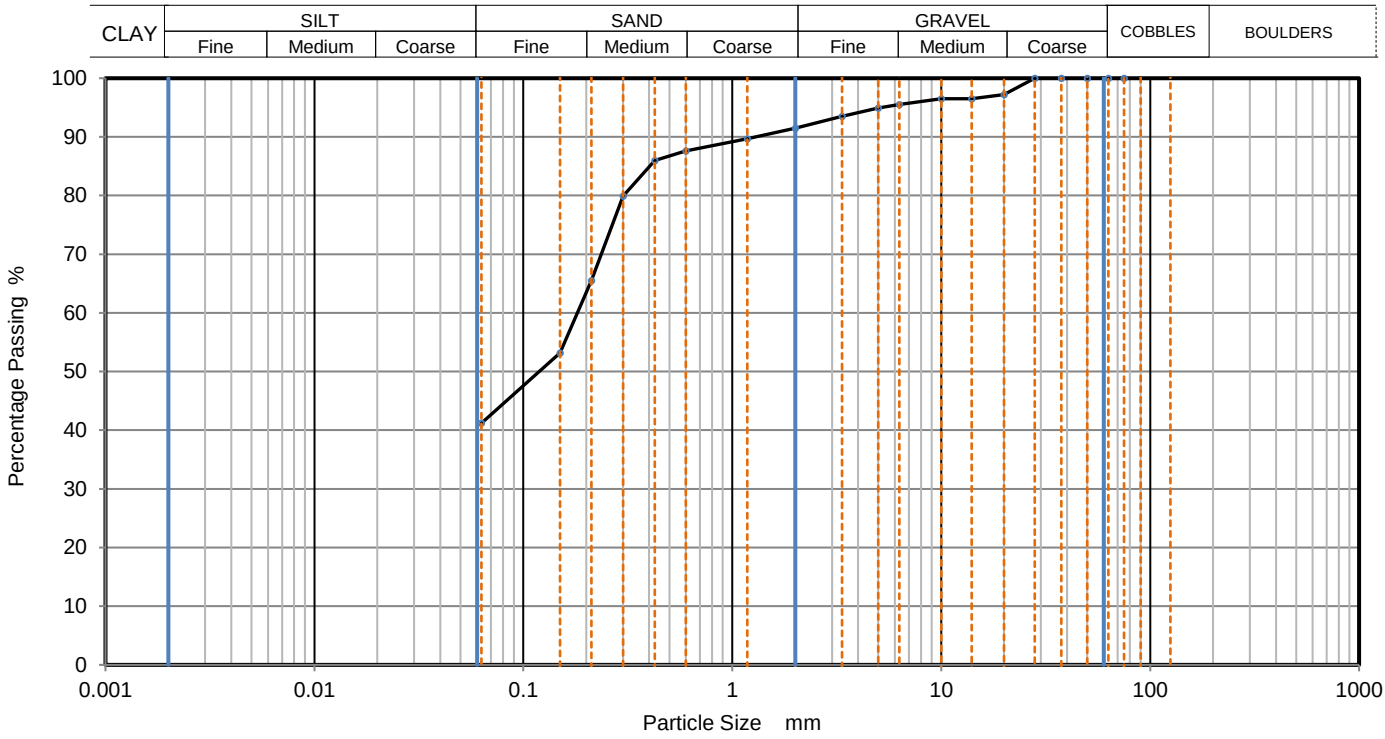
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	BP3-TP01
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown slightly gravelly sandy CLAY.			Depth, m	0.70
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627689



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	97		
10	97		
6.3	96		
5	95		
3.35	94		
2	92		
1.18	90		
0.6	88		
0.425	86		
0.3	80		
0.212	66		
0.15	53		
0.063	41		

Dry Mass of sample, g: 844

Sample Proportions	% dry mass
Very coarse	0
Gravel	9
Sand	50
Fines <0.063mm	41

Grading Analysis		
D100	mm	
D60	mm	0.182
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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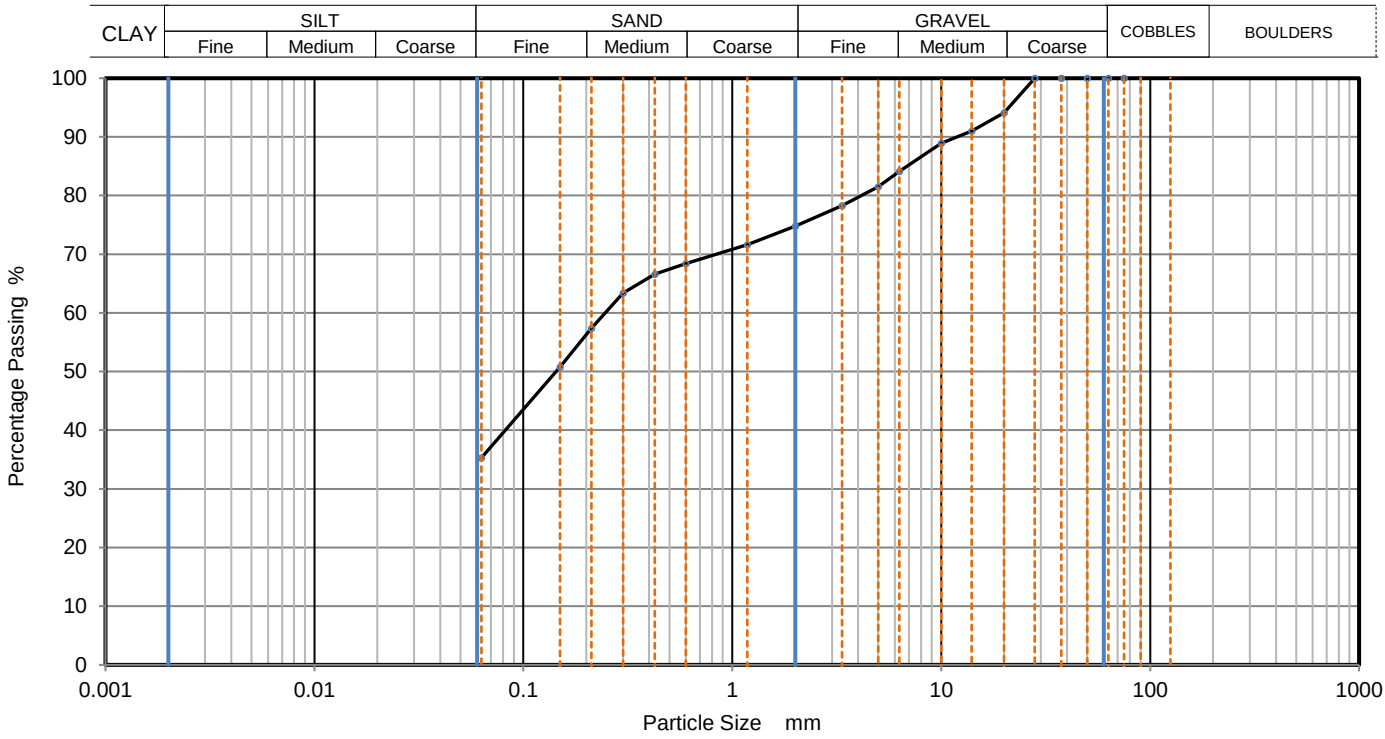
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	BP3-TP01
Site Name	Coom Wind Farm			Sample No.	3
Soil Description	Purplish-brown slightly gravelly sandy SILT.			Depth, m	1.30
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627691



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
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63	100		
50	100		
37.5	100		
28	100		
20	94		
14	91		
10	89		
6.3	84		
5	82		
3.35	78		
2	75		
1.18	72		
0.6	68		
0.425	67		
0.3	63		
0.212	57		
0.15	51		
0.063	35		

Dry Mass of sample, g	690

Sample Proportions	% dry mass
Very coarse	0
Gravel	25
Sand	40
Fines <0.063mm	35

Grading Analysis		
D100	mm	
D60	mm	0.246
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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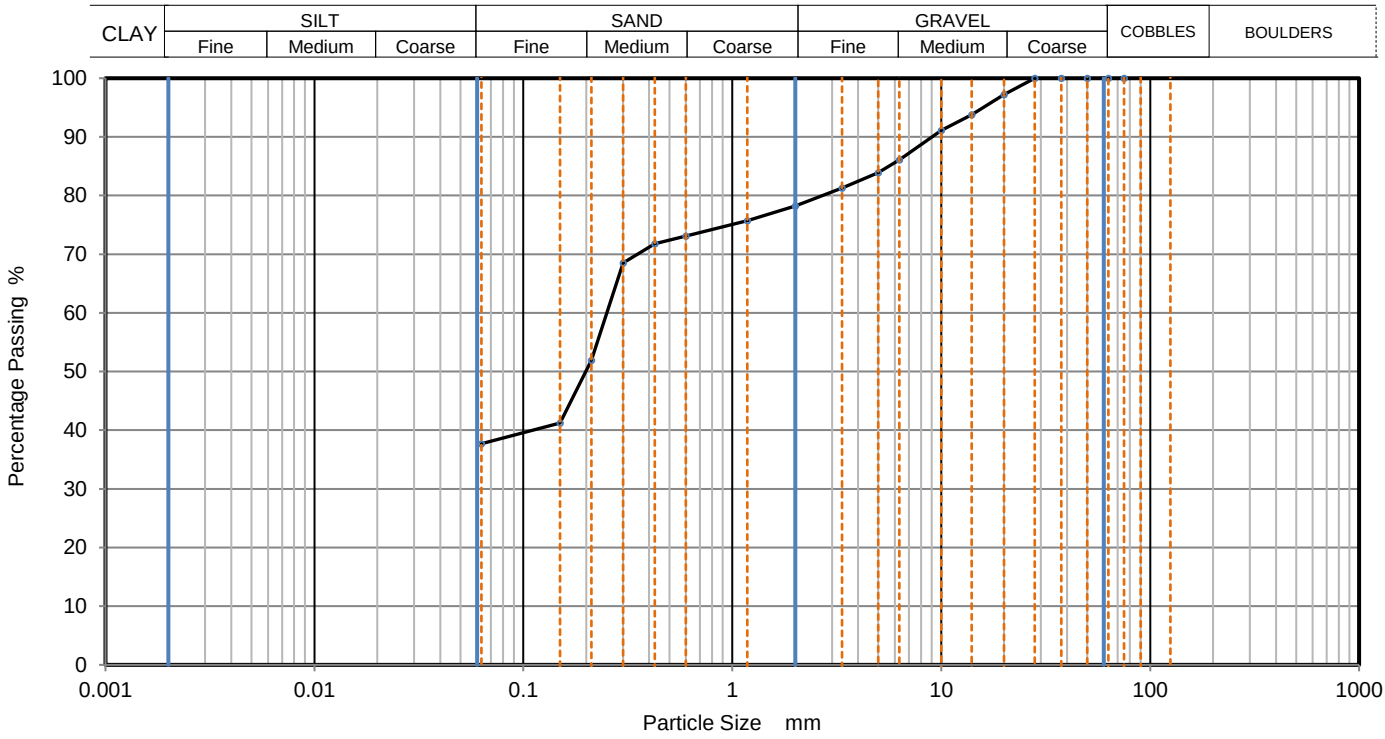
IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP3-TP03
Site Name	Coom Wind Farm			Sample No.	3
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth, m	1.40
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627697



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	94		
10	91		
6.3	86		
5	84		
3.35	81		
2	78		
1.18	76		
0.6	73		
0.425	72		
0.3	69		
0.212	52		
0.15	41		
0.063	38		

Dry Mass of sample, g	851

Sample Proportions	% dry mass
Very coarse	0
Gravel	22
Sand	41
Fines <0.063mm	38

Grading Analysis		
D100	mm	
D60	mm	0.251
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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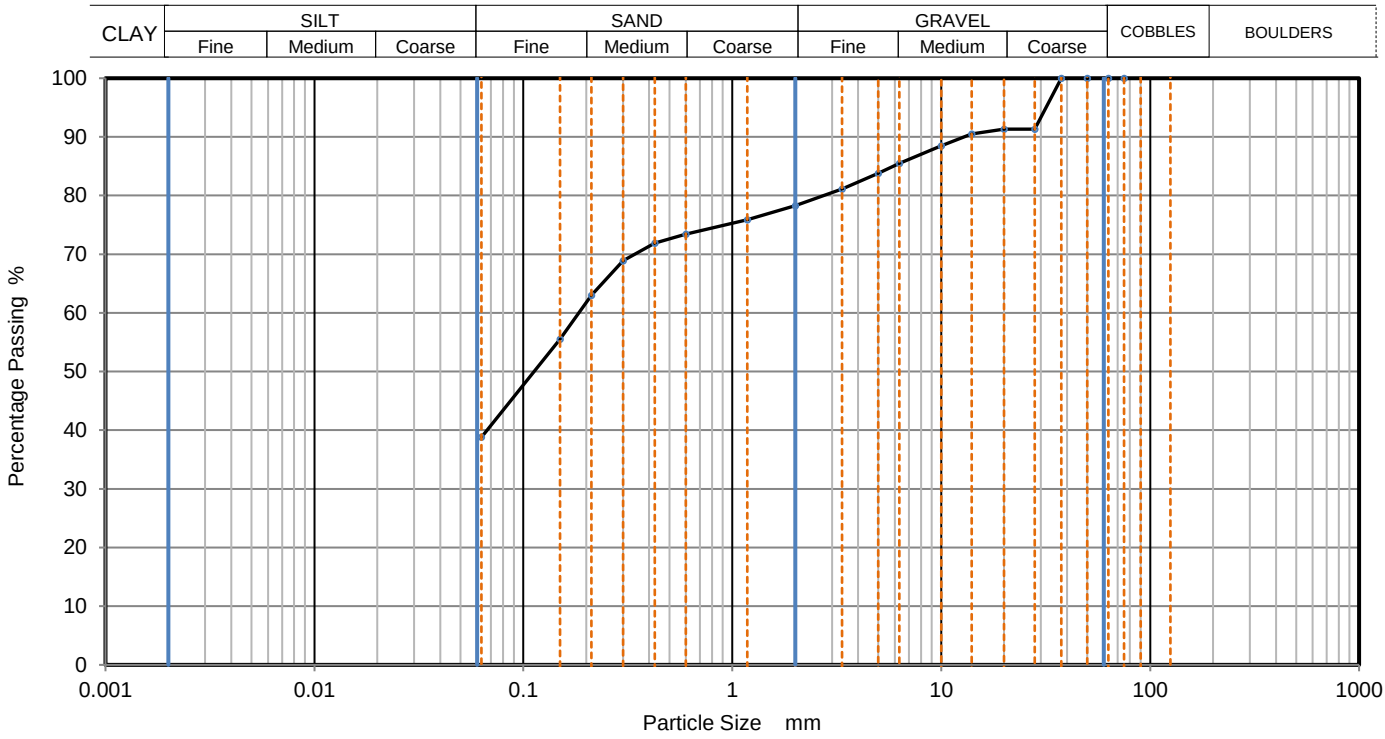
IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	BP3-TP03
Site Name	Coom Wind Farm			Sample No.	4
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth, m	2.60
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627698



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	91		
20	91		
14	91		
10	89		
6.3	86		
5	84		
3.35	81		
2	78		
1.18	76		
0.6	73		
0.425	72		
0.3	69		
0.212	63		
0.15	56		
0.063	39		

Dry Mass of sample, g	944

Sample Proportions	% dry mass
Very coarse	0
Gravel	22
Sand	40
Fines <0.063mm	39

Grading Analysis		
D100	mm	
D60	mm	0.185
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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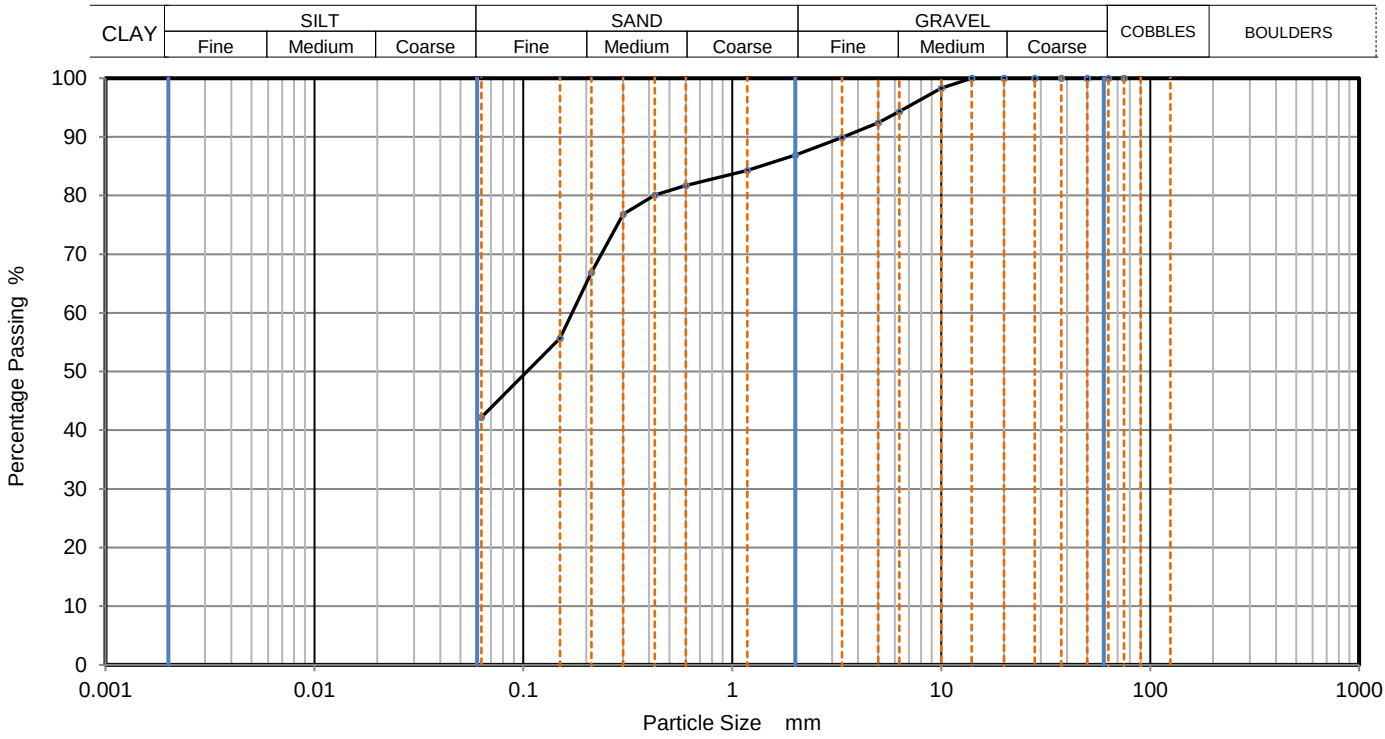
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	BP3-TP03
Site Name	Coom Wind Farm			Sample No.	6
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth, m	3.30
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627700



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	98		
6.3	94		
5	92		
3.35	90		
2	87		
1.18	84		
0.6	82		
0.425	80		
0.3	77		
0.212	67		
0.15	56		
0.063	42		

Dry Mass of sample, g: 799

Sample Proportions	% dry mass
Very coarse	0
Gravel	13
Sand	45
Fines <0.063mm	42

Grading Analysis		
D100	mm	
D60	mm	0.171
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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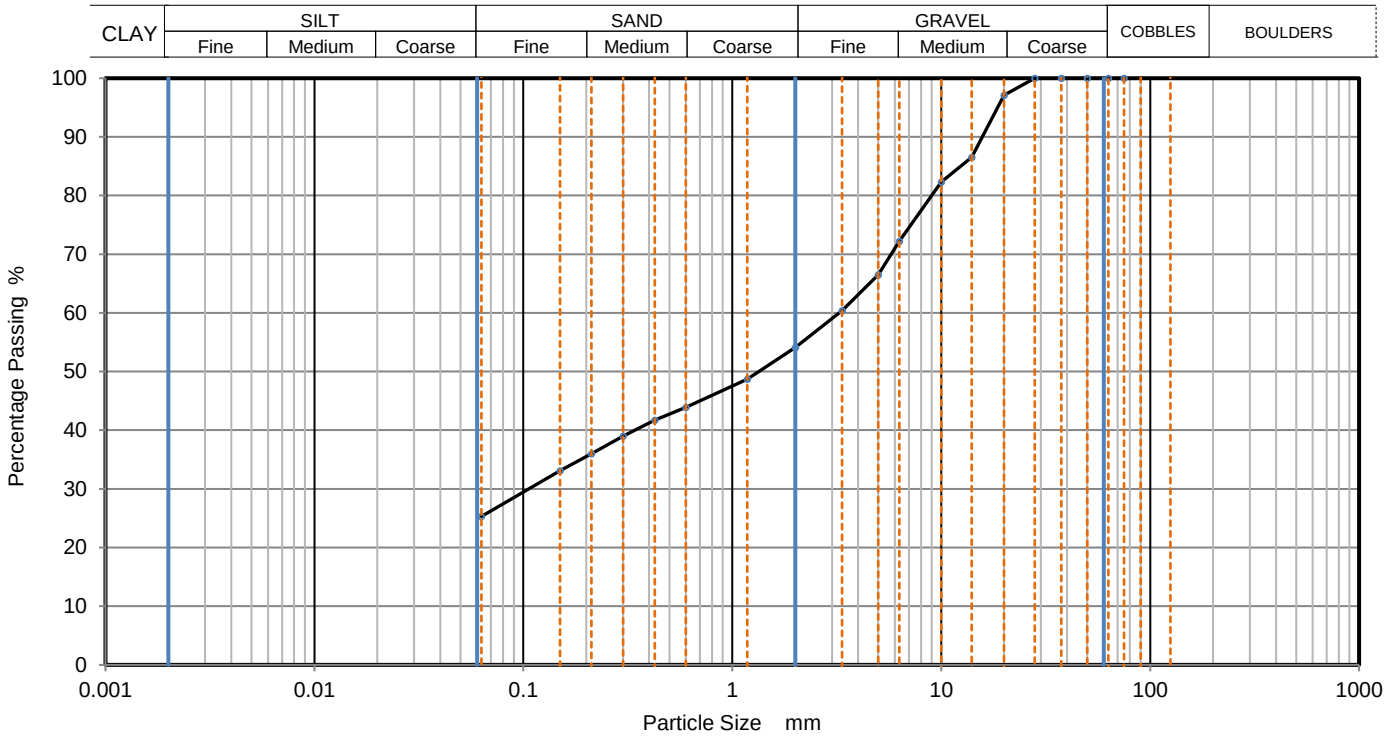
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	TP-T13
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown very silty very sandy medium and fine GRAVEL.			Depth, m	1.00
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627702



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	87		
10	82		
6.3	72		
5	67		
3.35	60		
2	54		
1.18	49		
0.6	44		
0.425	42		
0.3	39		
0.212	36		
0.15	33		
0.063	25		

Dry Mass of sample, g	787

Sample Proportions	% dry mass
Very coarse	0
Gravel	46
Sand	29
Fines <0.063mm	25

Grading Analysis		
D100	mm	
D60	mm	3.23
D30	mm	0.107
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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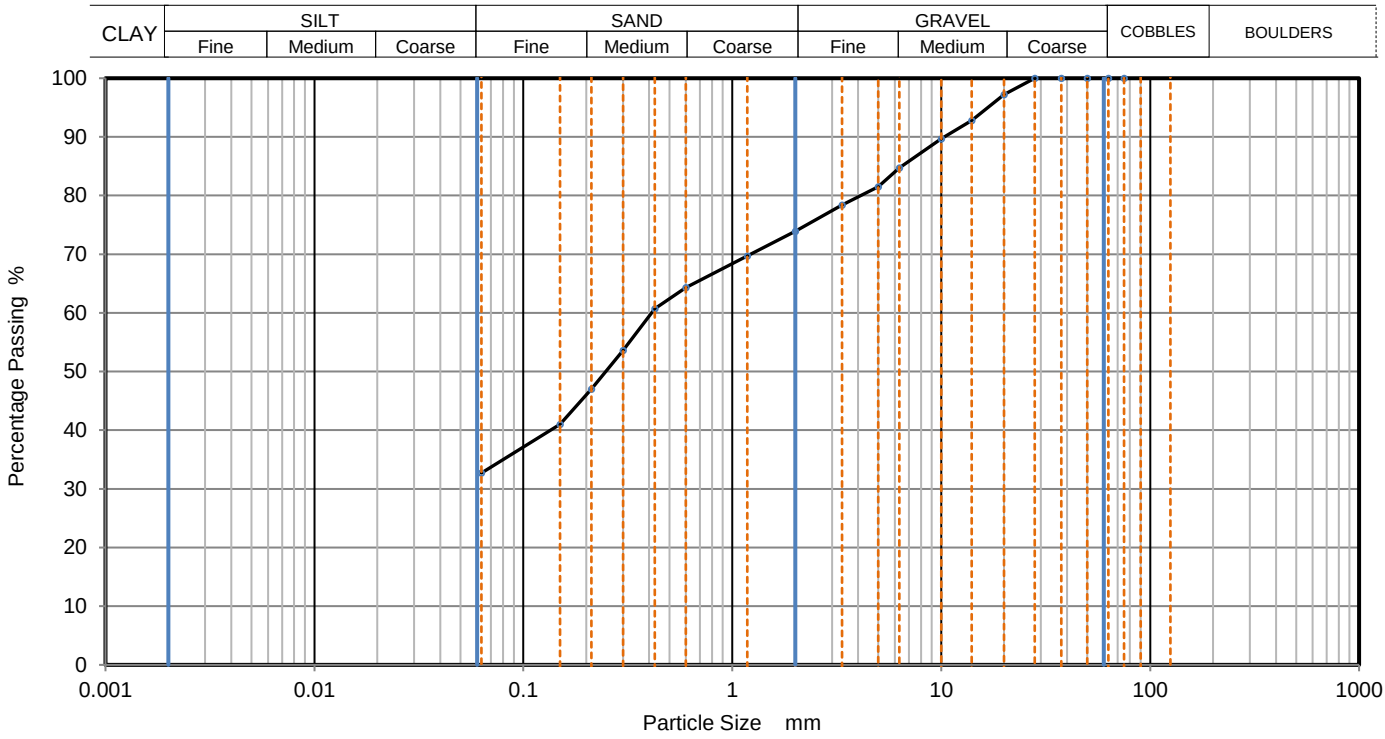
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	TP-T20
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Reddish-brown very gravelly very silty SAND.			Depth, m	0.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627704



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	93		
10	90		
6.3	85		
5	82		
3.35	78		
2	74		
1.18	70		
0.6	64		
0.425	61		
0.3	54		
0.212	47		
0.15	41		
0.063	33		

Dry Mass of sample, g	628

Sample Proportions	% dry mass
Very coarse	0
Gravel	26
Sand	41
Fines <0.063mm	33

Grading Analysis		
D100	mm	
D60	mm	0.411
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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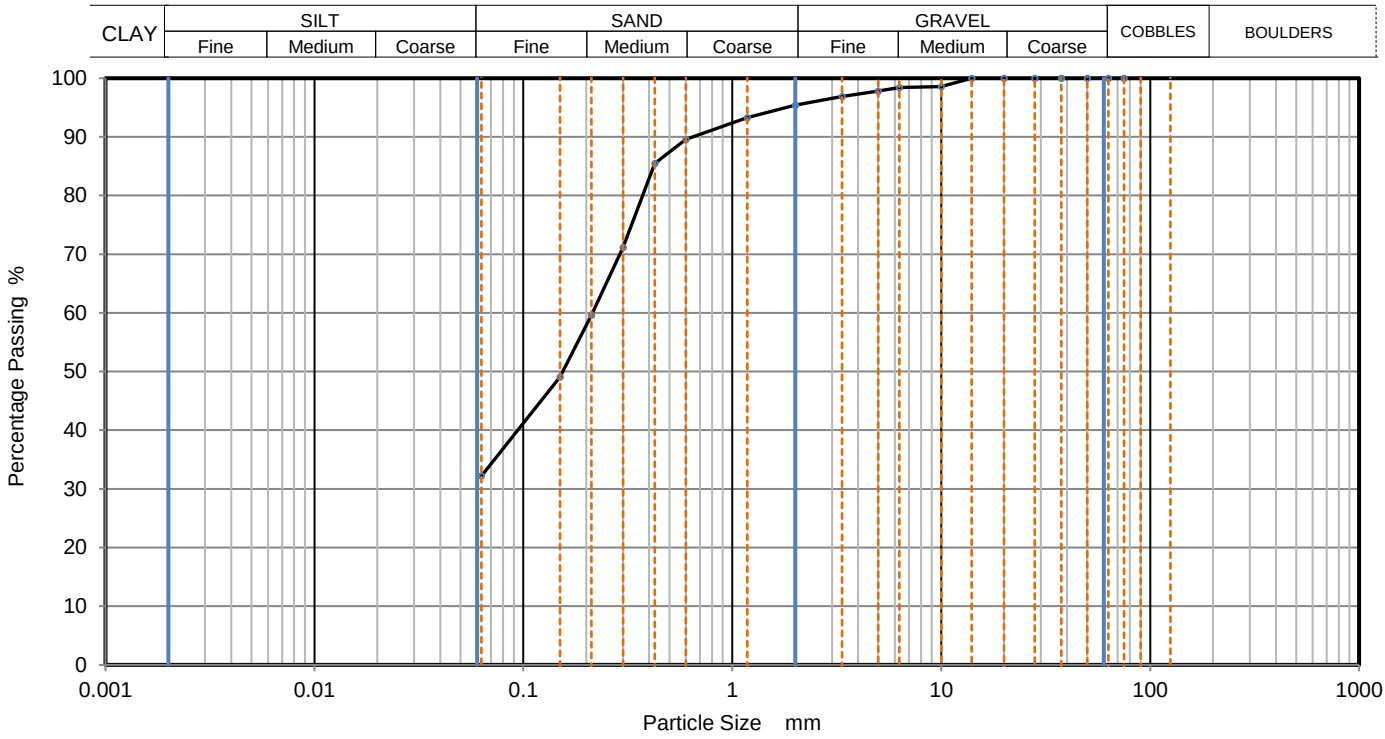
IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	TP-T22
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Yellowish-brown slightly gravelly very silty fine and medium SAND.			Depth, m	0.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627707



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	99		
6.3	98		
5	98		
3.35	97		
2	95		
1.18	93		
0.6	90		
0.425	86		
0.3	71		
0.212	60		
0.15	49		
0.063	32		

Dry Mass of sample, g	765

Sample Proportions	% dry mass
Very coarse	0
Gravel	5
Sand	63
Fines <0.063mm	32

Grading Analysis		
D100	mm	
D60	mm	0.214
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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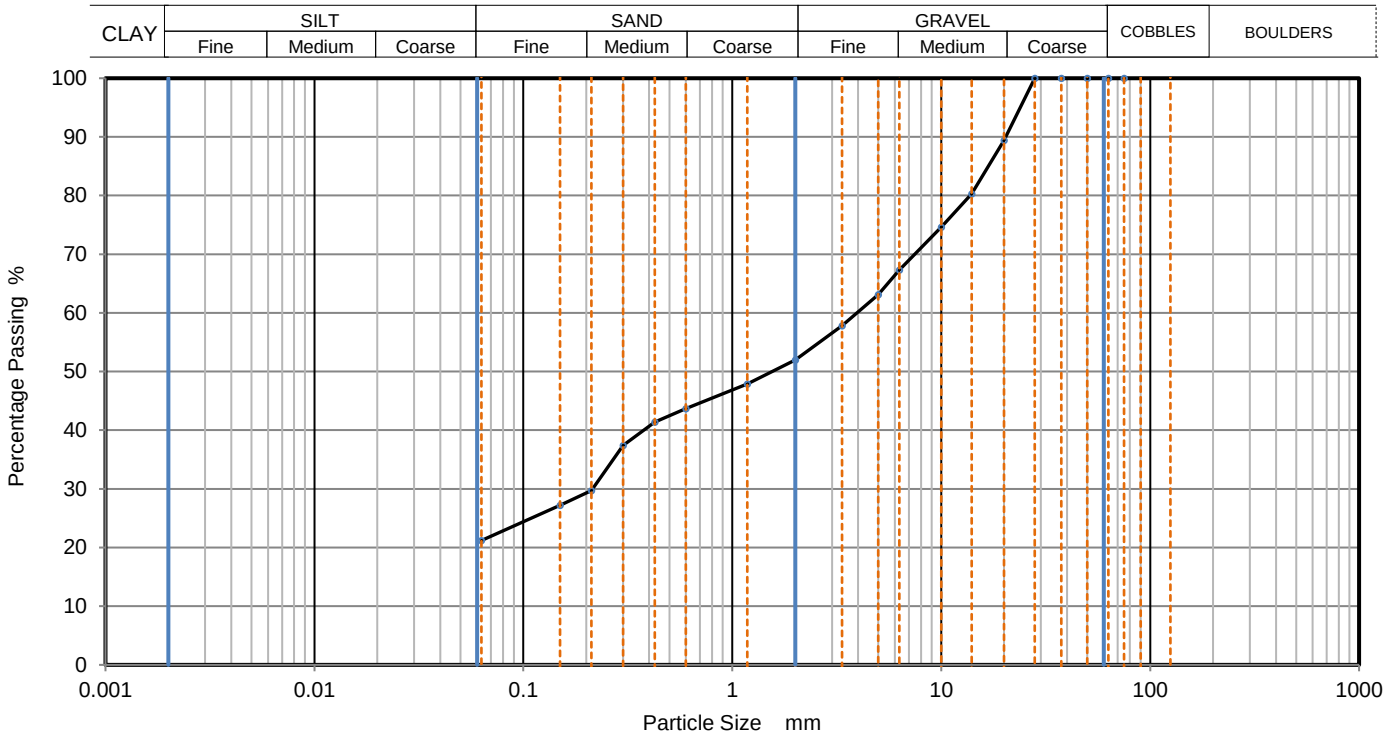
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	TP-T22
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown very silty very sandy GRAVEL.			Depth, m	1.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627708



Sieving		Sedimentation	
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63	100		
50	100		
37.5	100		
28	100		
20	89		
14	80		
10	75		
6.3	67		
5	63		
3.35	58		
2	52		
1.18	48		
0.6	44		
0.425	41		
0.3	37		
0.212	30		
0.15	27		
0.063	21		

Dry Mass of sample, g	805

Sample Proportions	% dry mass
Very coarse	0
Gravel	48
Sand	31
Fines <0.063mm	21

Grading Analysis		
D100	mm	
D60	mm	3.95
D30	mm	0.215
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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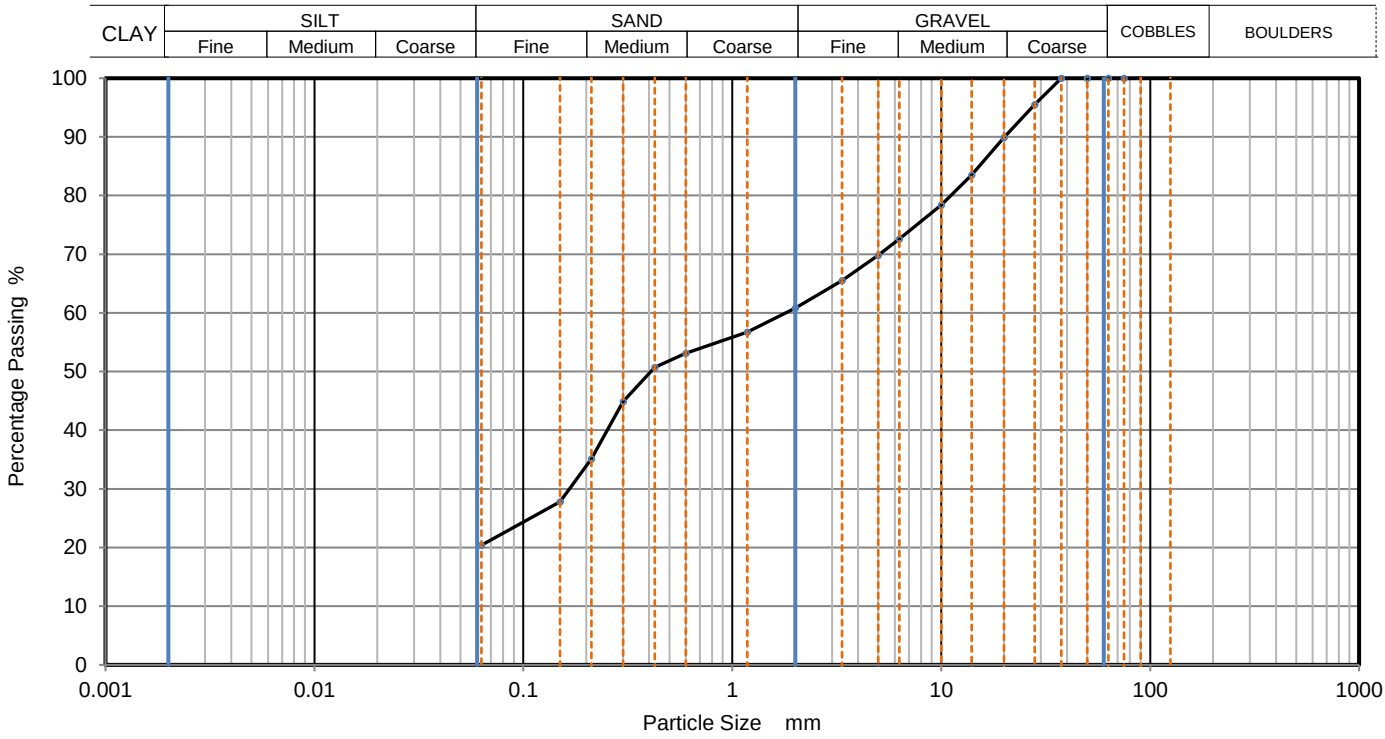
PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	TP-T23
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown very silty SAND and GRAVEL.			Depth, m	1.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627712



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	96		
20	90		
14	84		
10	78		
6.3	73		
5	70		
3.35	66		
2	61		
1.18	57		
0.6	53		
0.425	51		
0.3	45		
0.212	35		
0.15	28		
0.063	20		

Dry Mass of sample, g	907

Sample Proportions	% dry mass
Very coarse	0
Gravel	39
Sand	40
Fines <0.063mm	20

Grading Analysis		
D100	mm	
D60	mm	1.81
D30	mm	0.166
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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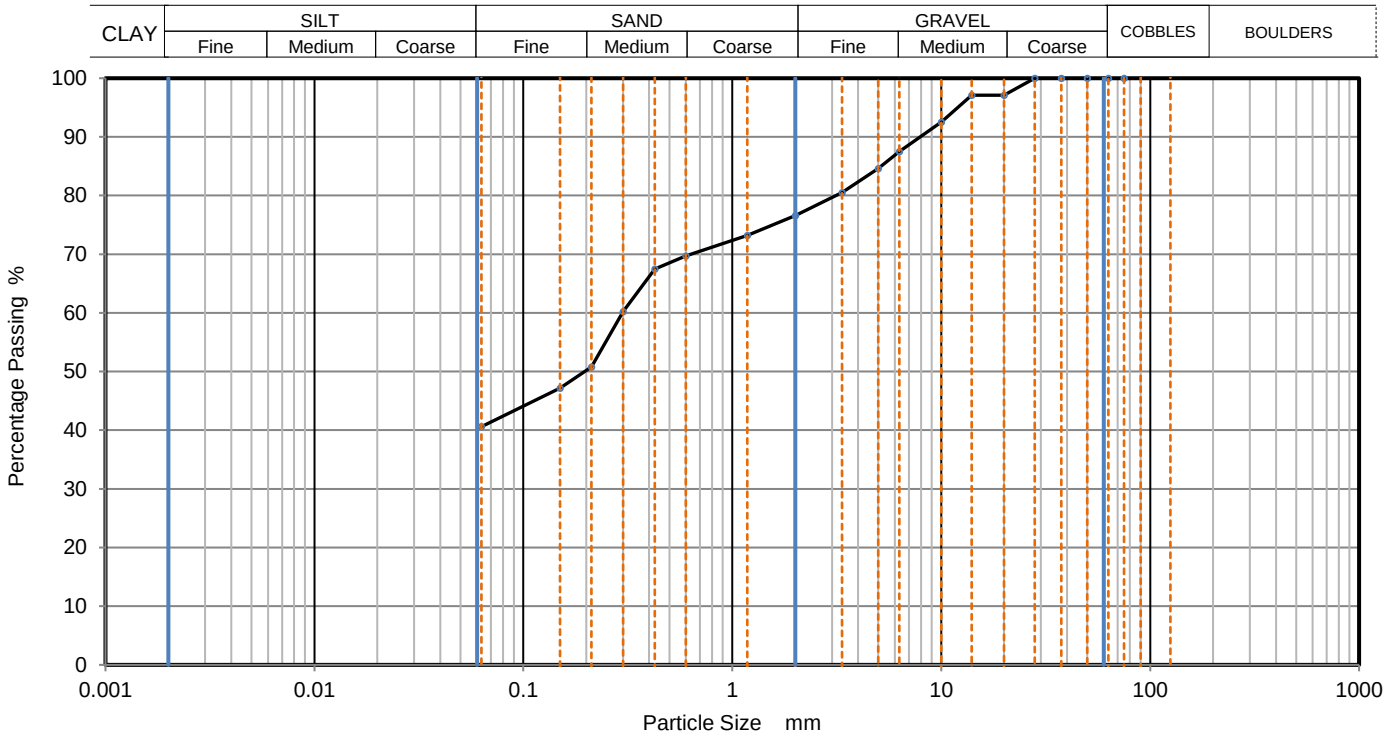
PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	TP-T23
Site Name	Coom Wind Farm			Sample No.	4
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth, m	3.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL120190627714



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
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63	100		
50	100		
37.5	100		
28	100		
20	97		
14	97		
10	93		
6.3	88		
5	85		
3.35	81		
2	77		
1.18	73		
0.6	70		
0.425	68		
0.3	60		
0.212	51		
0.15	47		
0.063	41		

Dry Mass of sample, g	1044

Sample Proportions	% dry mass
Very coarse	0
Gravel	23
Sand	36
Fines <0.063mm	41

Grading Analysis		
D100	mm	
D60	mm	0.298
D30	mm	
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

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Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

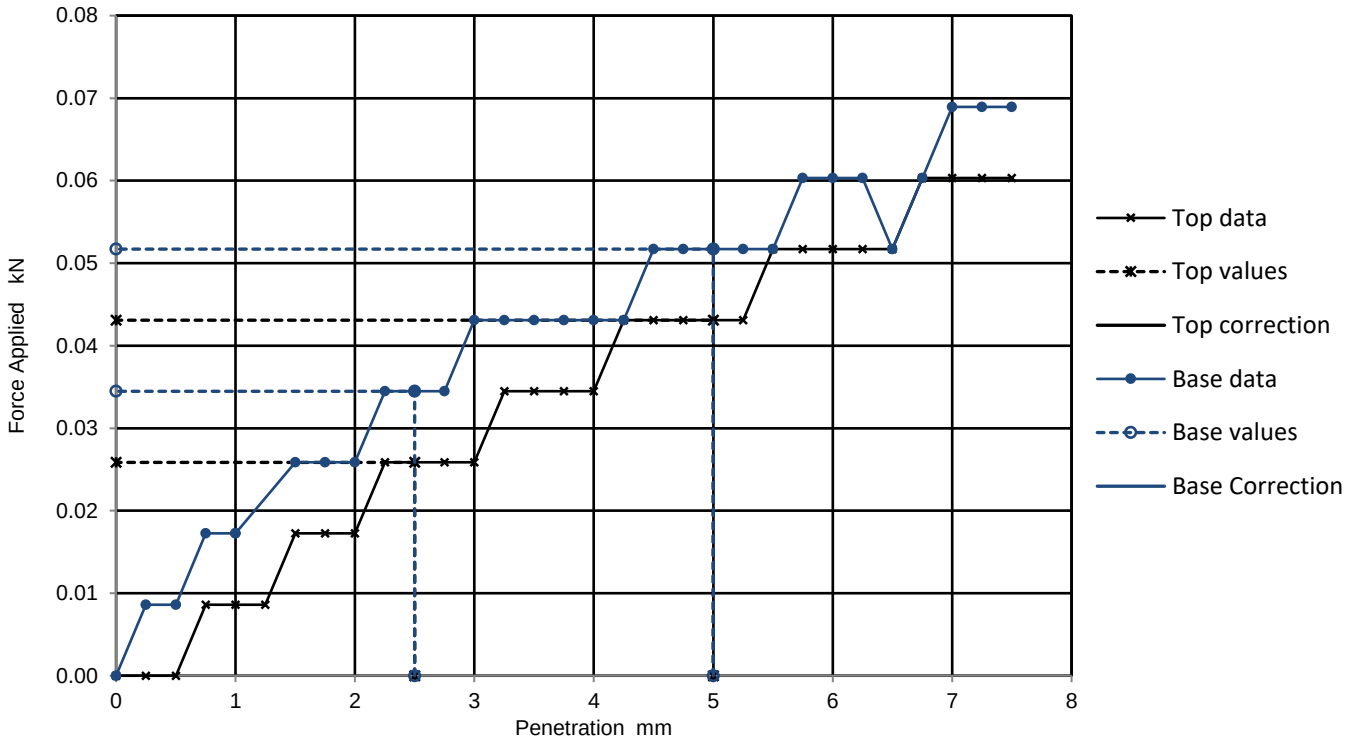
IRISH DRILLING LIMITED	**California Bearing Ratio (CBR)**			Job Ref	2019C106
				Borehole/Pit No.	TP-T20
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Reddish-brown very gravelly very silty SAND.			Depth m	0.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627704
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED	Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer	Period of soaking	days
		Time to surface	days
		Amount of swell recorded	mm
Material retained on 20mm sieve removed	%	Dry density after soaking	Mg/m3

Initial Specimen details	Bulk density	1.98	Mg/m3	Surcharge applied	2	kg
	Dry density	1.58	Mg/m3		1	kPa
	Moisture content	25.7	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP		0.2	0.2	0.2	0.2	24.4
BASE		0.3	0.3	0.3		25.5

General remarks	Test specific remarks	Approved
		DCD (10.09.19)

Fig No.	1
QC From R9	
Sheet No	1

Lab Sheet Reference :

California Bearing Ratio (CBR)

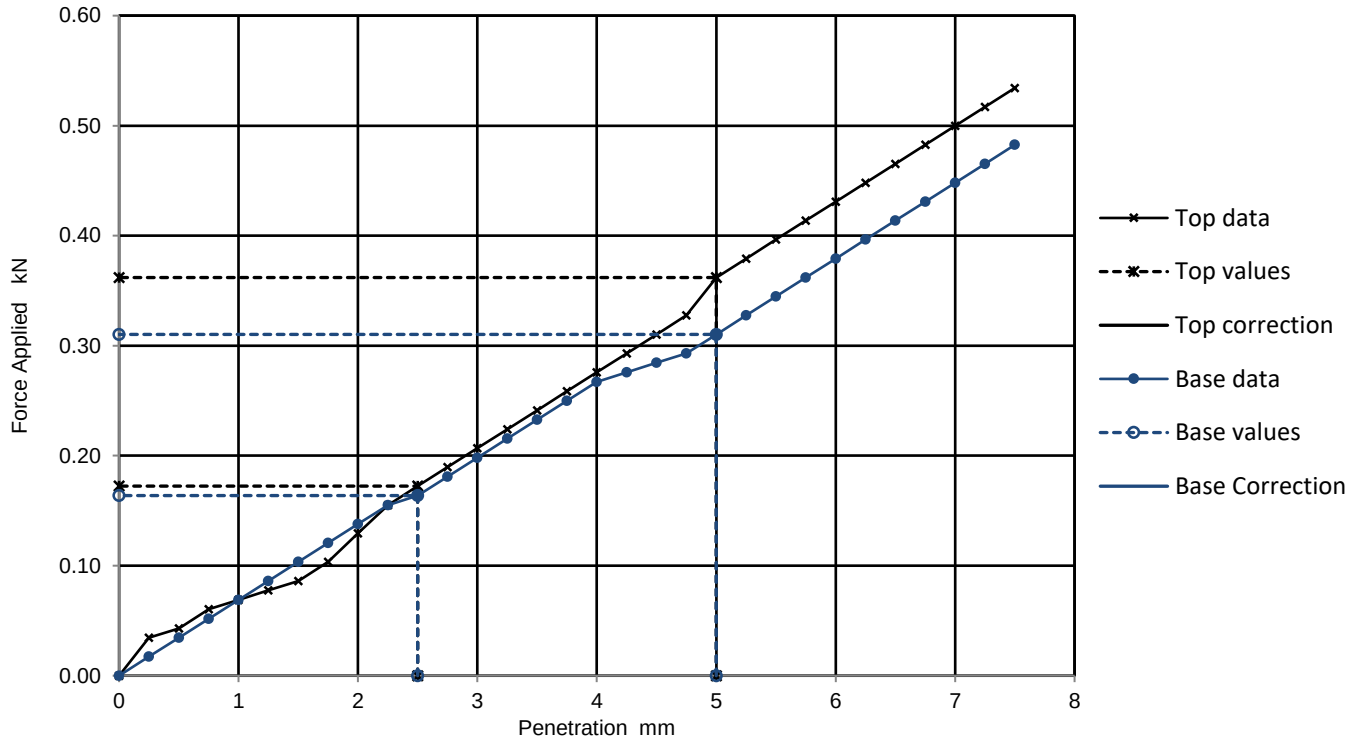
				Job Ref	2019C106
				Borehole/Pit No.	TP-T22
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown very silty very sandy GRAVEL.			Depth m	1.50
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627708
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED	Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer	Period of soaking	days
		Time to surface	days
		Amount of swell recorded	mm
Material retained on 20mm sieve removed	%	Dry density after soaking	Mg/m3

Initial Specimen details	Bulk density	1.80	Mg/m3	Surcharge applied	2	kg
	Dry density	1.61	Mg/m3		1	kPa
	Moisture content	11.8	%			

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP		1.3	1.8	1.8	1.7	11.7
BASE		1.2	1.6	1.6		13.3

General remarks	Test specific remarks	Approved
		DCD (10.09.19)

Fig No.	1
QC From R9	
Sheet No	2

Lab Sheet Reference :

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39
Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

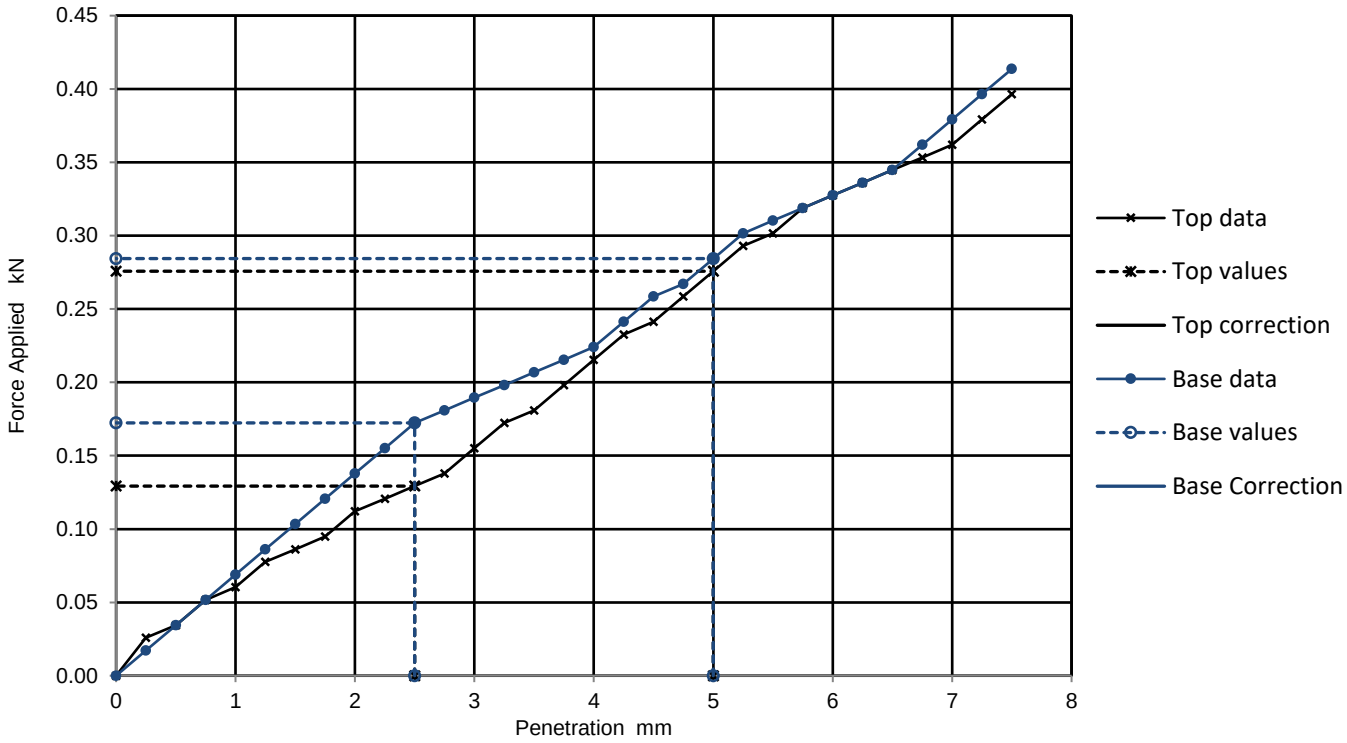
California Bearing Ratio (CBR)

				Job Ref	2019C106
				Borehole/Pit No.	TP-T23
Site Name	Coom Wind Farm			Sample No.	4
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth m	3.20
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627714
Test Method	BS1377 : Part 4 : 1990, clause 7			CBR Test Number	1

Specimen Preparation

Condition	REMOULDED			Soaking details	Not soaked
Details	Recompacted with specified standard effort using 2.5kg rammer			Period of soaking	days
				Time to surface	days
				Amount of swell recorded	mm
Material retained on 20mm sieve removed			%	Dry density after soaking	Mg/m3
Initial Specimen details	Bulk density	2.20	Mg/m3	Surcharge applied	2 kg
	Dry density	1.95	Mg/m3		1 kPa
	Moisture content	13.0	%		

Force v Penetration Plots



Results

	Curve correction applied	CBR Values, % 2.5mm	5mm	Highest	Average	Moisture Content %
TOP		1.0	1.4	1.4	1.4	13.4
BASE		1.3	1.4	1.4		12.8

General remarks	Test specific remarks	Approved
		DCD (10.09.19)

Fig No.	1
QC From R9	
Sheet No	3

Lab Sheet Reference :

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	BP1-TP01
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown silty sandy medium and coarse GRAVEL.			Depth	1.5
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627669
Test Method	BS1377:Part4:1990:clause 5.5			Date started	20/08/2019

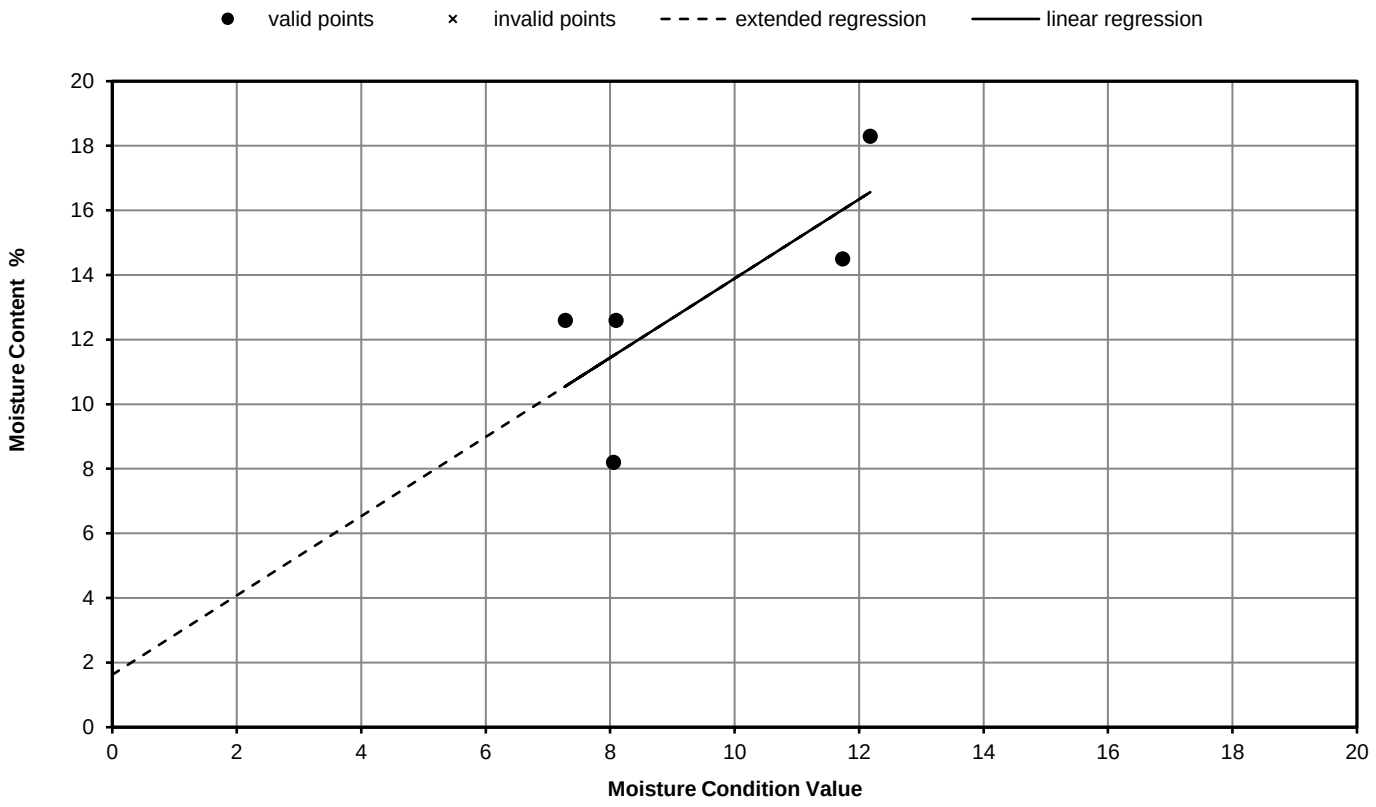
Sample preparation

Amount of material larger than 20mm sieve removed	9	%
Natural Moisture Content of sample	19	%
Initial Moisture Content of test sample below 20mm	12.6	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	12.6	8.2	12.6	14.5	18.3
Moisture Condition Value	8.1	8.1	7.3	11.7	12.2
MCV report	8.1	8.1	7.3	11.7	12.2
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	BP2-TP01
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Reddish-brown sandy silty medium and coarse GRAVEL.			Depth	1.8
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627677
Test Method	BS1377:Part4:1990:clause 5.5			Date started	20/08/2019

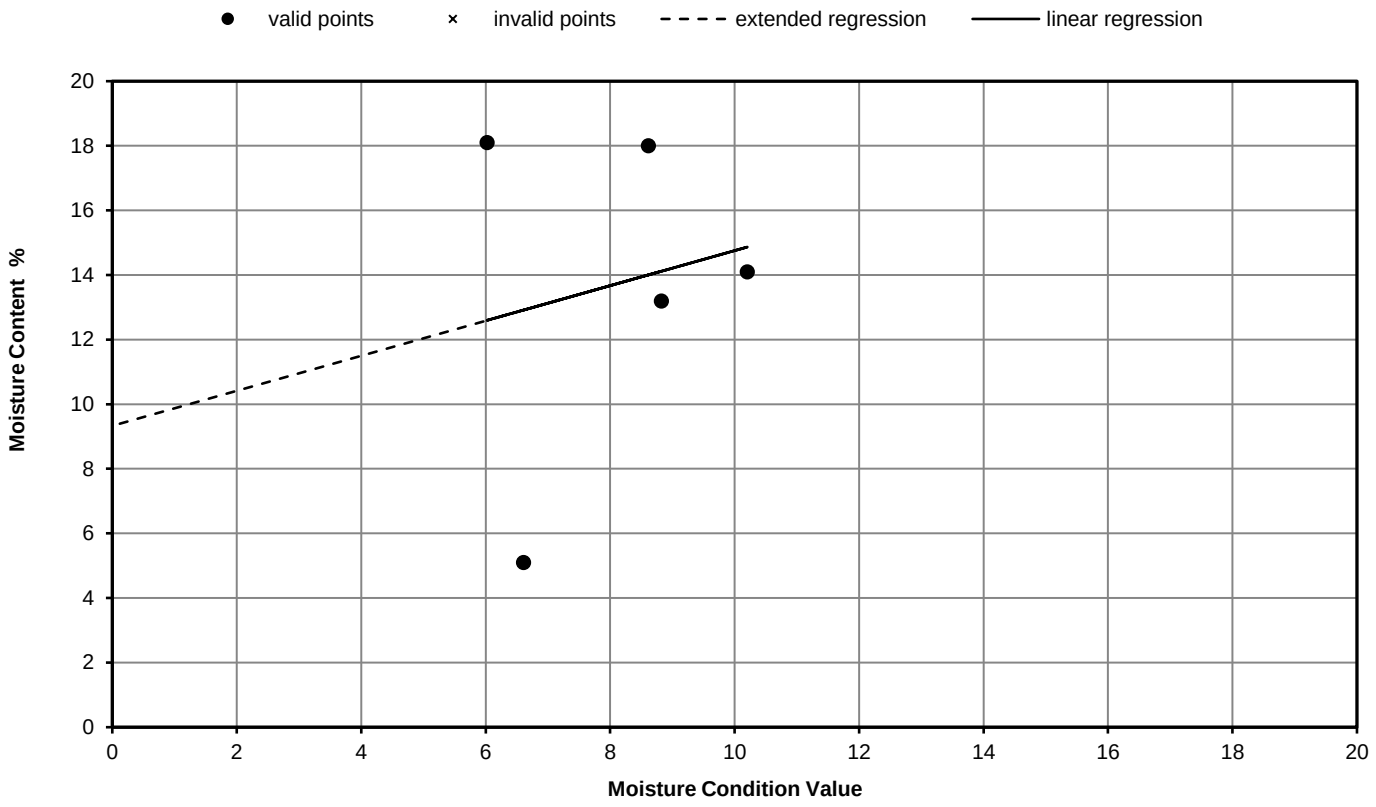
Sample preparation

Amount of material larger than 20mm sieve removed	25	%
Natural Moisture Content of sample	15	%
Initial Moisture Content of test sample below 20mm	18	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	18.0	14.1	18.1	13.2	5.1
Moisture Condition Value	8.6	10.2	6.0	8.8	6.6
MCV report	8.6	10.2	6	8.8	6.6
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	BP2-TP03
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown very silty very sandy medium and fine GRAVEL.			Depth	0.5
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627682
Test Method	BS1377:Part4:1990:clause 5.5			Date started	20/08/2019

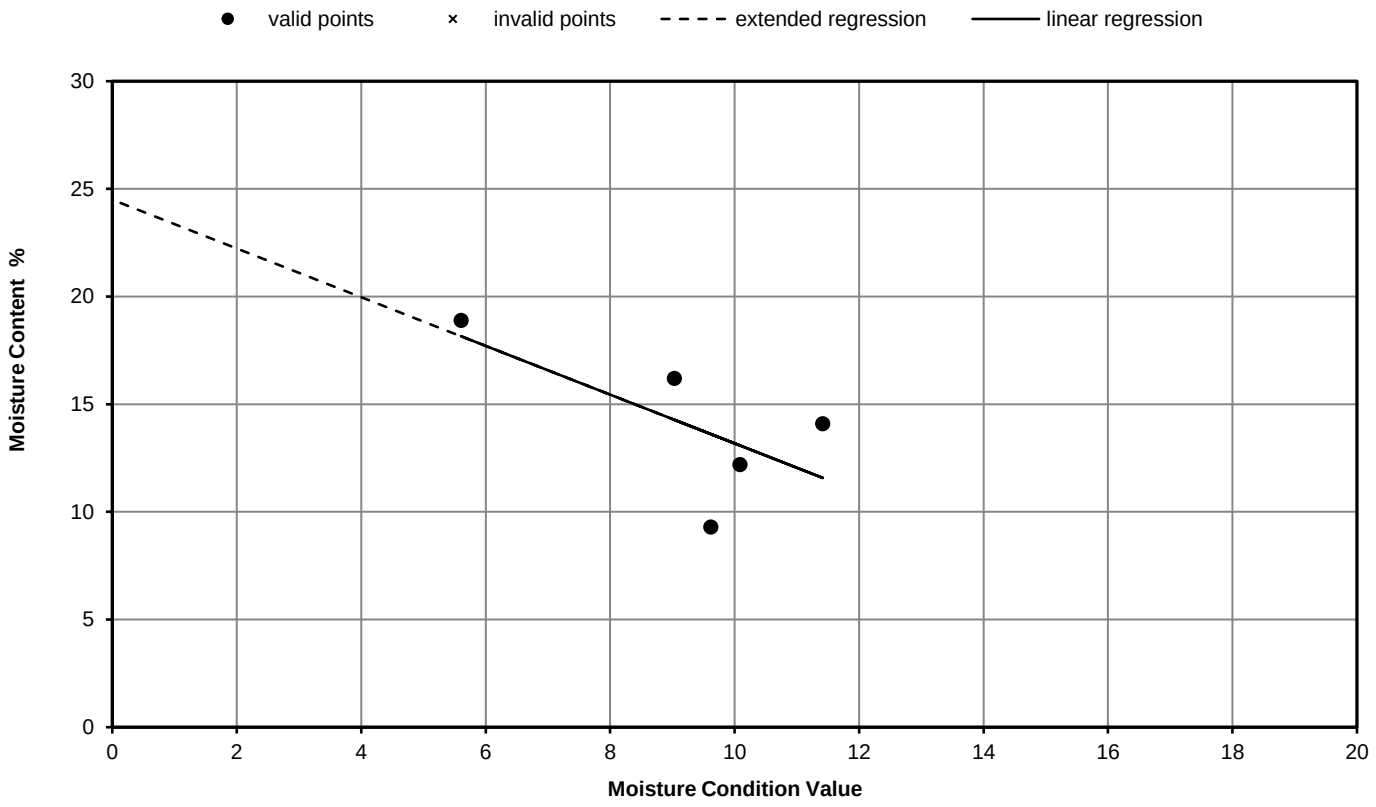
Sample preparation

Amount of material larger than 20mm sieve removed	5	%
Natural Moisture Content of sample	17	%
Initial Moisture Content of test sample below 20mm	18.9	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	18.9	14.1	16.2	12.2	9.3
Moisture Condition Value	5.6	11.4	9.0	10.1	9.6
MCV report	5.6	11.4	9	10.1	9.6
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	BP3-TP01
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Brown slightly gravelly sandy CLAY.			Depth	0.7
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627689
Test Method	BS1377:Part4:1990:clause 5.5			Date started	20/08/2019

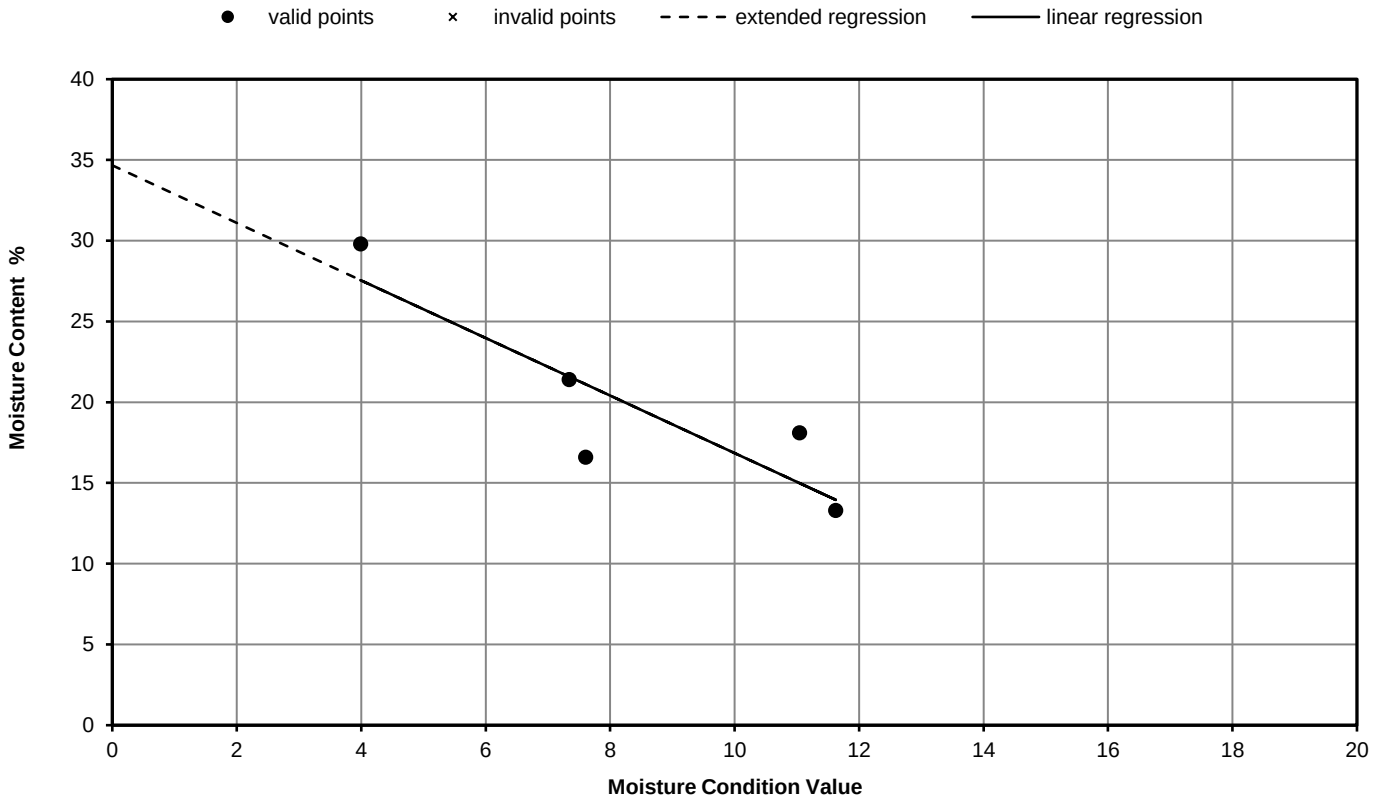
Sample preparation

Amount of material larger than 20mm sieve removed	3	%
Natural Moisture Content of sample	26	%
Initial Moisture Content of test sample below 20mm	29.8	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	29.8	21.4	16.6	13.3	18.1
Moisture Condition Value	4.0	7.3	7.6	11.6	11.0
MCV report	4	7.3	7.6	11.6	11
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	BP3-TP03
Site Name	Coom Wind Farm			Sample No.	3
Soil Description	Reddish-brown slightly gravelly sandy CLAY.			Depth	1.4
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627697
Test Method	BS1377:Part4:1990:clause 5.5			Date started	21/08/2019

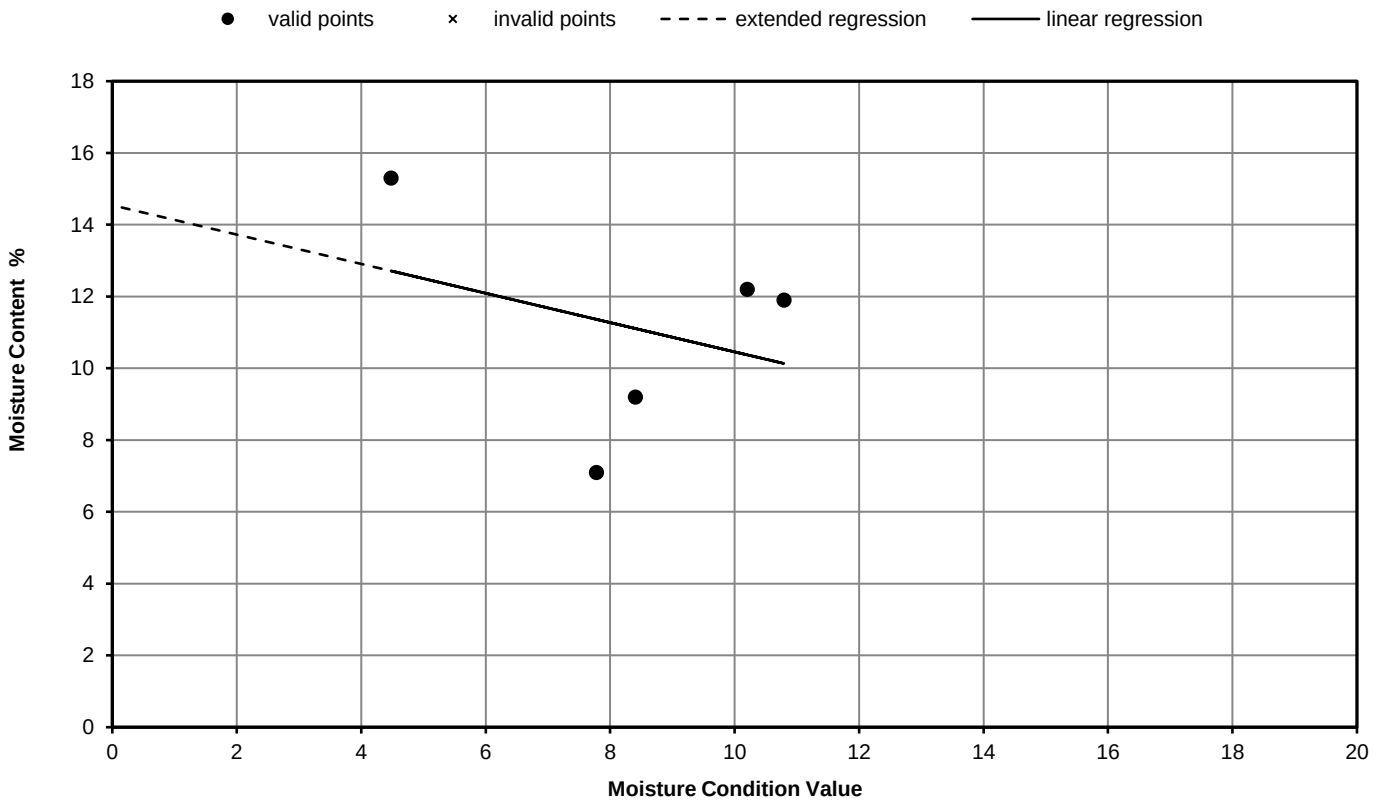
Sample preparation

Amount of material larger than 20mm sieve removed	3	%
Natural Moisture Content of sample	11	%
Initial Moisture Content of test sample below 20mm	12.2	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	12.2	15.3	9.2	11.9	7.1
Moisture Condition Value	10.2	4.5	8.4	10.8	7.8
MCV report	10.2	4.5	8.4	10.8	7.8
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	TP-T13
Site Name	Coom Wind Farm			Sample No.	2
Soil Description	Brown very silty very sandy medium and fine GRAVEL.			Depth	1
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627702
Test Method	BS1377:Part4:1990:clause 5.5			Date started	21/08/2019

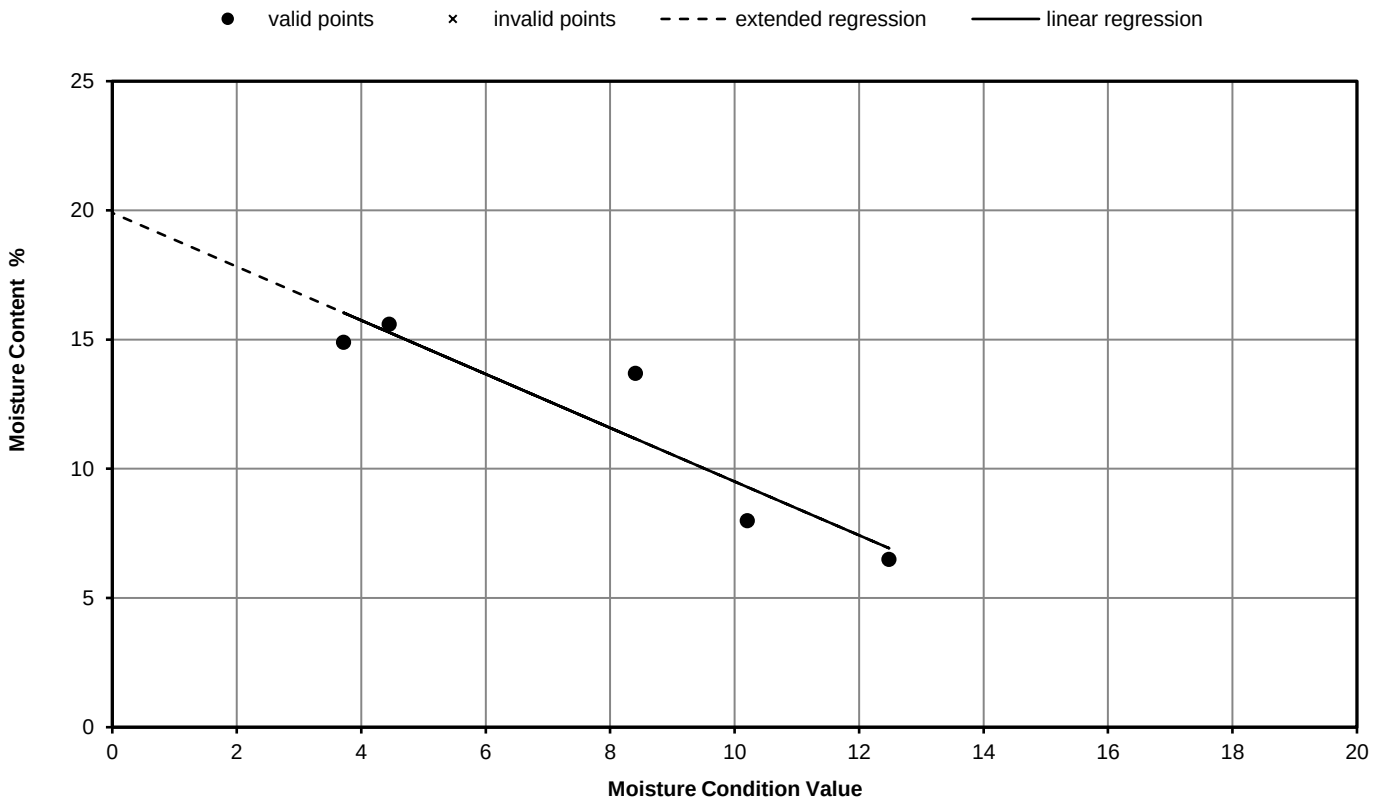
Sample preparation

Amount of material larger than 20mm sieve removed	3	%
Natural Moisture Content of sample	13	%
Initial Moisture Content of test sample below 20mm	13.7	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	13.7	14.9	15.6	8.0	6.5
Moisture Condition Value	8.4	3.7	4.5	10.2	12.5
MCV report	8.4	3.7	4.5	10.2	12.5
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	TP-T20
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Reddish-brown very gravelly very silty SAND.			Depth	0.2
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627704
Test Method	BS1377:Part4:1990:clause 5.5			Date started	25/07/2019

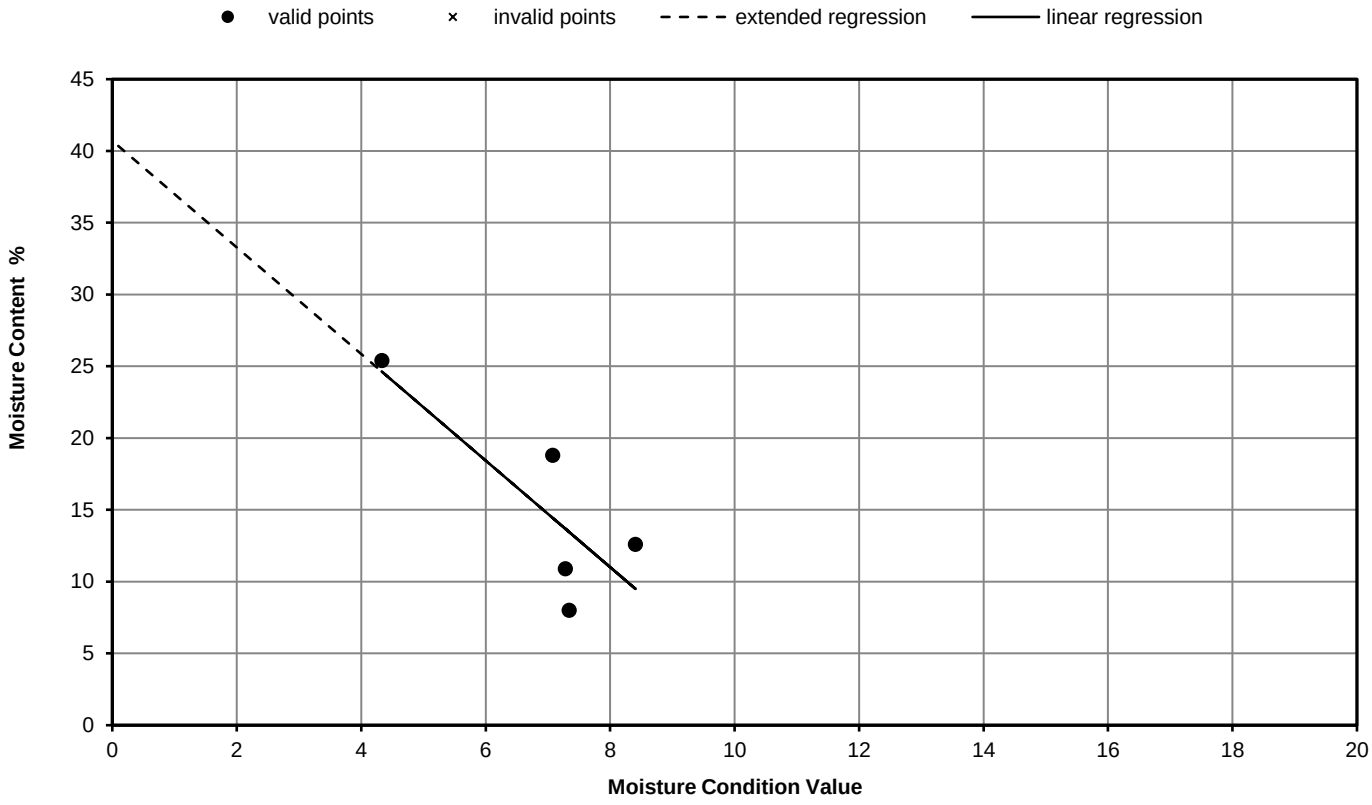
Sample preparation

Amount of material larger than 20mm sieve removed	3	%
Natural Moisture Content of sample	23	%
Initial Moisture Content of test sample below 20mm	25.4	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	25.4	12.6	10.9	8.0	18.8
Moisture Condition Value	4.3	8.4	7.3	7.3	7.1
MCV report	4.3	8.4	7.3	7.3	7.1
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

	Moisture Condition Value / Moisture Content Relationship			Job Ref	2019C106
				Borehole/Pit No.	TP-T22
Site Name	Coom Wind Farm			Sample No.	1
Soil Description	Yellowish-brown slightly gravelly very silty fine and medium SAND.			Depth	0.5
Specimen Reference		Specimen Depth	m	Sample Type	B
Specimen Description				KeyLAB ID	IDL120190627707
Test Method	BS1377:Part4:1990:clause 5.5			Date started	26/07/2019

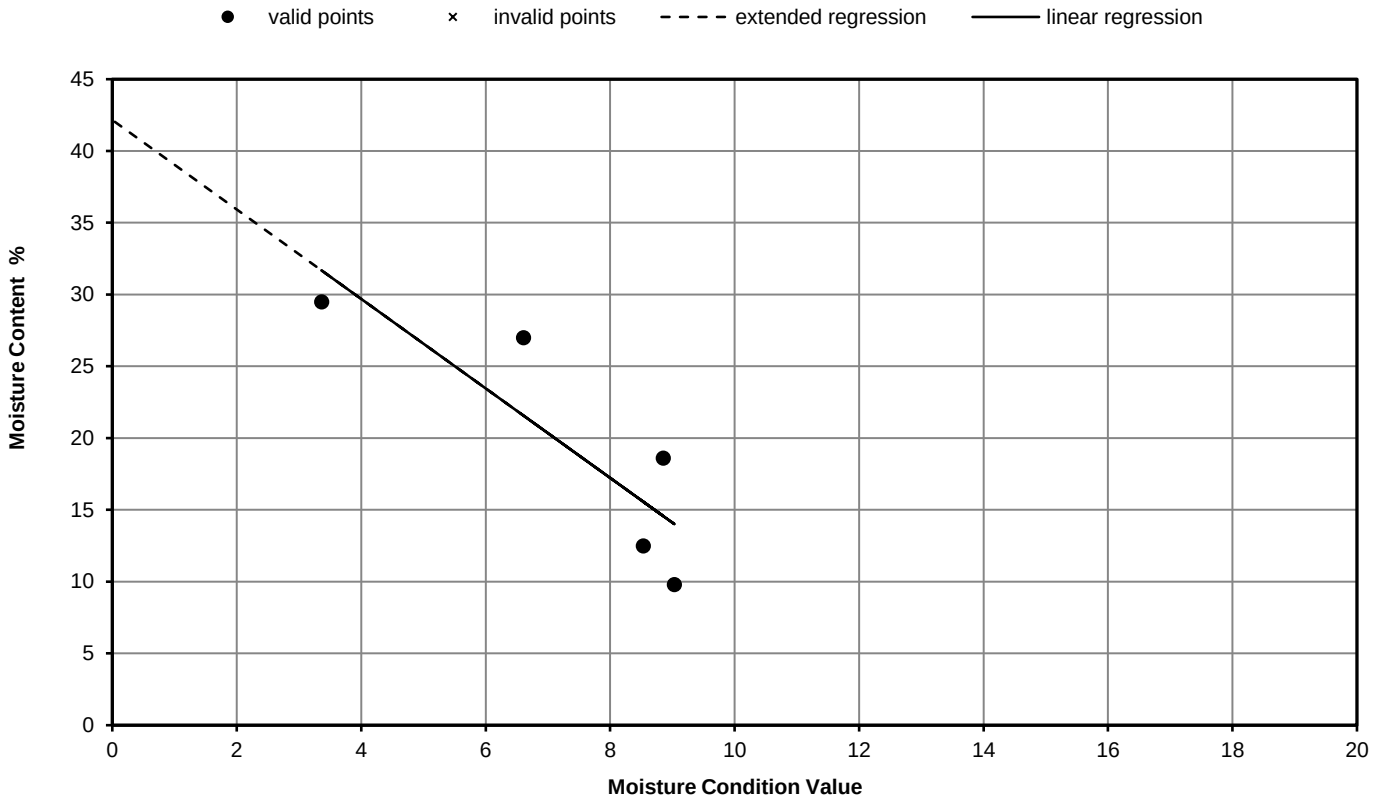
Sample preparation

Amount of material larger than 20mm sieve removed	0	%
Natural Moisture Content of sample	31	%
Initial Moisture Content of test sample below 20mm	29.5	%
Composite of fresh and reused material tested		

General remarks

Table of results

MCV Test Number	1	2	3	4	5
Moisture Content, %	29.5	18.6	12.5	9.8	27.0
Moisture Condition Value	3.4	8.9	8.5	9.0	6.6
MCV report	3.4	8.9	8.5	9	6.6
Effective / Valid data point	YES	YES	YES	YES	YES
Specimen remarks					



Tested	Checked	Approved
RG	DCD	DCD (10.09.19)

Lab Sheet Reference : QC Form R7

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Irish Drilling Limited
Old Galway Road
Loughrea
Co. Galway

Attention: Dympna Darcy

CERTIFICATE OF ANALYSIS

Date of report Generation:	05 August 2019
Customer:	Irish Drilling Limited
Sample Delivery Group (SDG):	190730-36
Your Reference:	2019C106
Location:	Coom WF
Report No:	516828

We received 9 samples on Tuesday July 30, 2019 and 9 of these samples were scheduled for analysis which was completed on Monday August 05, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.
The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

Sonia McWhan

Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
20424282	BP1-TP01	B1	0.50 - 0.70	19/06/2019
20424288	BP1-TP01	B2	1.50 - 1.70	19/06/2019
20424292	BP2-TP01	B2	1.80 - 2.00	17/06/2019
20424299	BP3-TP01	B1	0.70 - 0.90	18/06/2019
20424306	BP3-TP03	B4	2.60 - 2.80	17/06/2019
20424312	TP-T13	B2	1.00 - 1.20	19/06/2019
20424314	TP-T20	B1	0.20 - 0.40	18/06/2019
20424318	TP-T23	B2	1.20 - 1.40	18/06/2019
20424321	TP-T23	B4	3.20 - 3.40	18/06/2019

Maximum Sample/Coolbox Temperature (°C) : **18.4**

ISO5667-3 Water quality - Sampling - Part3 -

During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Results Legend

X **Test**

N **No Determination Possible**

Sample Types -

S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)			20424282	20424288	20424292	20424299	20424306	20424312	20424314	20424318	20424321
Customer Sample Reference			BP1-TP01	BP1-TP01	BP2-TP01	BP3-TP01	BP3-TP03	TP-T13	TP-T20	TP-T23	TP-T23
AGS Reference			B1	B2	B2	B1	B4	B2	B1	B2	B4
Depth (m)			0.50 - 0.70	1.50 - 1.70	1.80 - 2.00	0.70 - 0.90	2.60 - 2.80	1.00 - 1.20	0.20 - 0.40	1.20 - 1.40	3.20 - 3.40
Container			250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)
Sample Type			S	S	S	S	S	S	S	S	S
Anions by Kone (soil)	All	NDPs: 0 Tests: 9	X	X	X	X	X	X	X	X	X
pH	All	NDPs: 0 Tests: 9	X	X	X	X	X	X	X	X	X
Sample description	All	NDPs: 0 Tests: 9	X	X	X	X	X	X	X	X	X
Total Sulphate	All	NDPs: 0 Tests: 9	X	X	X	X	X	X	X	X	X

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Sample Descriptions

Grain Sizes

very fine	<0.063mm	fine	0.063mm - 0.1mm	medium	0.1mm - 2mm	coarse	2mm - 10mm	very coarse	>10mm

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Inclusions	Inclusions 2
20424282	BP1-TP01	0.50 - 0.70	Dark Brown	Loamy Sand	Stones	Vegetation
20424288	BP1-TP01	1.50 - 1.70	Dark Brown	Sandy Loam	Stones	Vegetation
20424292	BP2-TP01	1.80 - 2.00	Light Brown	Silty Clay Loam	Stones	Vegetation
20424299	BP3-TP01	0.70 - 0.90	Light Brown	Silty Clay Loam	Stones	Vegetation
20424306	BP3-TP03	2.60 - 2.80	Dark Brown	Silty Clay Loam	Stones	Vegetation
20424312	TP-T13	1.00 - 1.20	Dark Brown	Loamy Sand	Stones	Vegetation
20424314	TP-T20	0.20 - 0.40	Light Brown	Sandy Clay Loam	Stones	Vegetation
20424318	TP-T23	1.20 - 1.40	Dark Brown	Loamy Sand	Stones	Vegetation
20424321	TP-T23	3.20 - 3.40	Dark Brown	Sandy Loam	Stones	Vegetation

These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally ocurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.

Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Validated

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Results Legend

#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	BP1-TP01	BP1-TP01	BP2-TP01	BP3-TP01	BP3-TP03	TP-T13
			Depth (m)	0.50 - 0.70	1.50 - 1.70	1.80 - 2.00	0.70 - 0.90	2.60 - 2.80	1.00 - 1.20
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
			Date Sampled	19/06/2019	19/06/2019	17/06/2019	18/06/2019	17/06/2019	19/06/2019
			Sample Time	.	.	.	.	.	.
			Date Received	30/07/2019	30/07/2019	30/07/2019	30/07/2019	30/07/2019	30/07/2019
			SDG Ref	190730-36	190730-36	190730-36	190730-36	190730-36	190730-36
			Lab Sample No.(s)	20424282	20424288	20424292	20424299	20424306	20424312
			AGS Reference	B1	B2	B2	B1	B4	B2
Moisture Content Ratio (% of as received sample)	%	PM024		10	9	9.4	17	9.5	9.2
pH	1 pH Units	TM133		5.68 @ M	6.62 @ M	5.46 @ M	7.81 @ M	5.46 @ M	5.73 @ M
Sulphate, Total	<48 mg/kg	TM221		<48 M	<48 M	<48 M	<48 M	<48 M	<48 M
Chloride (soluble)	<5 mg/kg	TM243		9.36 @ M	14.1 @ M	10.6 @ M	13.7 @ M	8.23 @ M	7.5 @ M

Validated

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	TP-T20	TP-T23	TP-T23			
			Depth (m)	0.20 - 0.40	1.20 - 1.40	3.20 - 3.40			
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)			
			Date Sampled	18/06/2019	18/06/2019	18/06/2019			
			Sample Time	.	.	.			
			Date Received	30/07/2019	30/07/2019	30/07/2019			
			SDG Ref	190730-36	190730-36	190730-36			
			Lab Sample No.(s)	20424314	20424318	20424321			
			AGS Reference	B1	B2	B4			
Moisture Content Ratio (% of as received sample)	%	PM024		16	5.5	12			
pH	1 pH Units	TM133		7.22 @ M	6.35 @ M	5.44 @ M			
Sulphate, Total	<48 mg/kg	TM221		<48 M	<48 M	<48 M			
Chloride (soluble)	<5 mg/kg	TM243		13.8 @ M	7.19 @ M	7.57 @ M			

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description
PM024	Modified BS 1377	Soil preparation including homogenisation, moisture screens of soils for Asbestos Containing Material
TM133	BS 1377: Part 3 1990;BS 6068-2.5	Determination of pH in Soil and Water using the GLpH pH Meter
TM221	Inductively Coupled Plasma - Atomic Emission Spectroscopy. An Atlas of Spectral Information: Winge, Fassel, Peterson and Floyd	Determination of Acid extractable Sulphate in Soils by IRIS Emission Spectrometer
TM243		Mixed Anions In Soils By Kone

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

Validated

CERTIFICATE OF ANALYSIS

SDG:	190730-36	**Client Reference:**	2019C106	**Report Number:**	516828
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	20424282	20424288	20424292	20424299	20424306	20424312	20424314	20424318	20424321
Customer Sample Ref.	BP1-TP01	BP1-TP01	BP2-TP01	BP3-TP01	BP3-TP03	TP-T13	TP-T20	TP-T23	TP-T23
AGS Ref.	B1	B2	B2	B1	B4	B2	B1	B2	B4
Depth	0.50 - 0.70	1.50 - 1.70	1.80 - 2.00	0.70 - 0.90	2.60 - 2.80	1.00 - 1.20	0.20 - 0.40	1.20 - 1.40	3.20 - 3.40
Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
Anions by Kone (soil)	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019
pH	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	02-Aug-2019	04-Aug-2019
Sample description	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019	30-Jul-2019
Total Sulphate	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019	05-Aug-2019

Appendix General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

18. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**

19. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.
Standing Committee of Analysts, *The Quantification of Asbestos in Soil (2107).*

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

Phone: (091) 841 274
Fax: (091) 847 687

email: info@irishdrilling.ie

COOM WIND FARM

APPENDIX 5

Project ID	2019C106	Client	Coillte	Remarks	Turnaround
Project Name	Coom Wind Farm	Due Date	14/10/2019 11:14		
Schedule ID	2019C106_2	Scheduled Date	14/10/2019 11:14		

Sample Details							Classification						Chemical / Concrete								Compaction					Compressibility			Strength (Total)						Shear Stregth (Effective Stress)			Rock		Other								
Location	Depth (m)	Base Depth	Sample Type	Sample Ref	Date Sampled	Storage	Moisture Content	Atterberg 4 Point	Particle Density by Gas Jar	Particle Density by Small Pyknometer	Particle Size Distribution	Hydrometer	Organic Content	Loss On Ignition	Sulphate Total	Sulphate Water Gravimetric	Carbonate Titration	ph	Chloride Content	Chloride Content Acid	Compaction Light	Compaction Heavy	Compaction Vibrating Hammer	Moisture Condition Value	Moisture Condition Relationship	CBR	Consolidation	Pressures	Swelling Pressure Test	Laboratory Vane test	Small Direct Shearbox	Ring shear Test	Triaxial Quick Undrained	(Specify Cell Pressure)	Triaxial UU Multi Stage	Triaxial UU Multi Specimen	Consolidated Drained Triaxial Test	Consolidated Undrained Triaxial Test	Consolidated Undrained Triaxial Multi	Rock Uniaxial compression	Point Load							
RC01	0.00	2.00	C		07/10/19																																										
RC01	2.00	3.20	C		07/10/19																																										
RC01	3.20	4.60	C		07/10/19																																										
RC01	4.60	6.10	C		07/10/19																																										
RC01	6.10	7.50	C		07/10/19											1	1																								1	1							ALS Ref: 191021-15
RC02	0.00	2.00	C		08/10/19																																										
RC02	2.00	3.50	C		08/10/19																																										
RC02	3.50	5.00	C		08/10/19		1				1																																			
RC02	5.00	6.50	C		08/10/19																																										
RC02	6.50	8.00	C		08/10/19		1				1																																			
RC02	8.00	9.50	C		08/10/19																																										
RC02	9.50	11.00	C		08/10/19																																										
RC02	11.00	12.50	C		08/10/19											1	1																								0*	1							ALS Ref: 191021-15
RC02	12.50	13.60	C		08/10/19																																				0*	1							
RC02	13.60	14.20	C		08/10/19																																										
RC03	0.00	2.00	C		04/10/19																																										
RC03	2.00	3.50	C		04/10/19		1	1			1																																			
RC03	3.50	5.00	C		04/10/19																																										
RC03	5.00	6.50	C		04/10/19		1	1			1					1	1																														ALS Ref: 191021-15
RC03	6.50	8.00	C		04/10/19																																										
RC03	8.00	8.60	C		04/10/19																																										
RC03	8.60	9.50	C		04/10/19		1				1																																			
RC03	9.50	11.00	C		04/10/19																																										
RC03	11.00	12.50	C		04/10/19																																										
RC03	12.50	14.00	C		04/10/19		1				1																																			
RC03	14.00	15.00	C		04/10/19																																										
Tests Completed							6	2	0	0	6	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	0	0	

0* Core not suitable

Summary of Classification Test Results

Project No.	Project Name
2019C106	Coom Wind Farm

Hole No.	Sample Ref	Top	Base	Type		Soil Description	Density bulk Mg/m3	Density dry Mg/m3	*w* %	Passing 425µm %	LL %	PL %	PI %	Particle density Mg/m3	Remarks
RC02		3.50	5.00	C	3.5-3.8	Multicoloured coarse GRAVEL.			0.8	0					
RC02		6.50	8.00	C	6.5-8.0	Multicoloured slightly silty slightly sandy coarse and medium GRAVEL.			0.6	3					
RC03		2.00	3.50	C	2.3-2.5	Red-brown slightly gravelly slightly sandy SILT.			16.0	89	39	18	21		CI
RC03		5.00	6.50	C	6.1-6.4	Red-brown very sandy very silty medium GRAVEL.			4.7	42	29	17	12		CL
RC03		8.60	9.50	C	8.6-9.5	Grey sandy medium anc coarse GRAVEL.			0.4	3					
RC03		12.50	14.00	C	12.5-14.0	Red-brown very sandy very silty medium and coarse GRAVEL.			5.0	43					

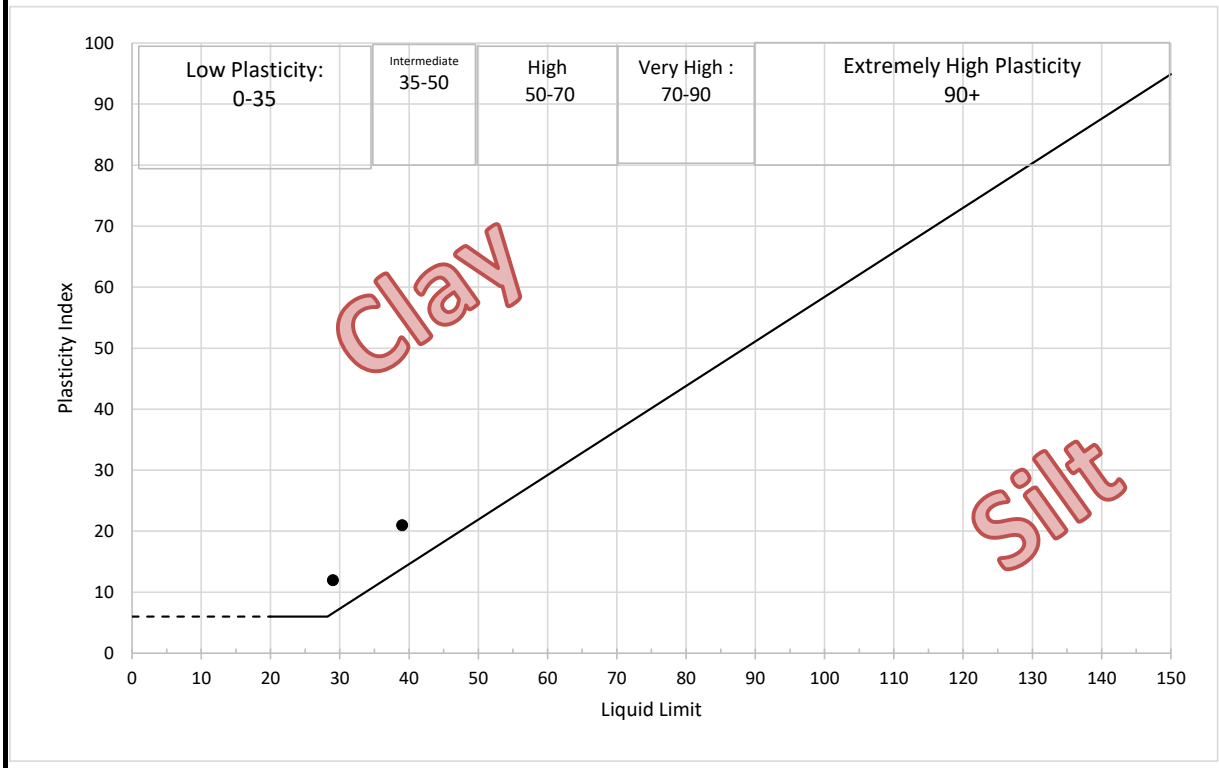
All tests performed in accordance with BS1377:1990 unless specified otherwise

Key			Date Printed	Approved By	Table
Density test	Liquid Limit	Particle density			1
Linear measurement unless :	4pt cone unless :	sp - small pyknometer	31/10/2019		
wd - water displacement	1pt - single point test	gj - gas jar			sheet
wi - immersion in water	NP - Non Plastic		QC From No: R1		1

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

	Plasticity (A-Line) Chart	Project Number
Project Name:	**Coom Wind Farm**	
Location:		2019C106



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

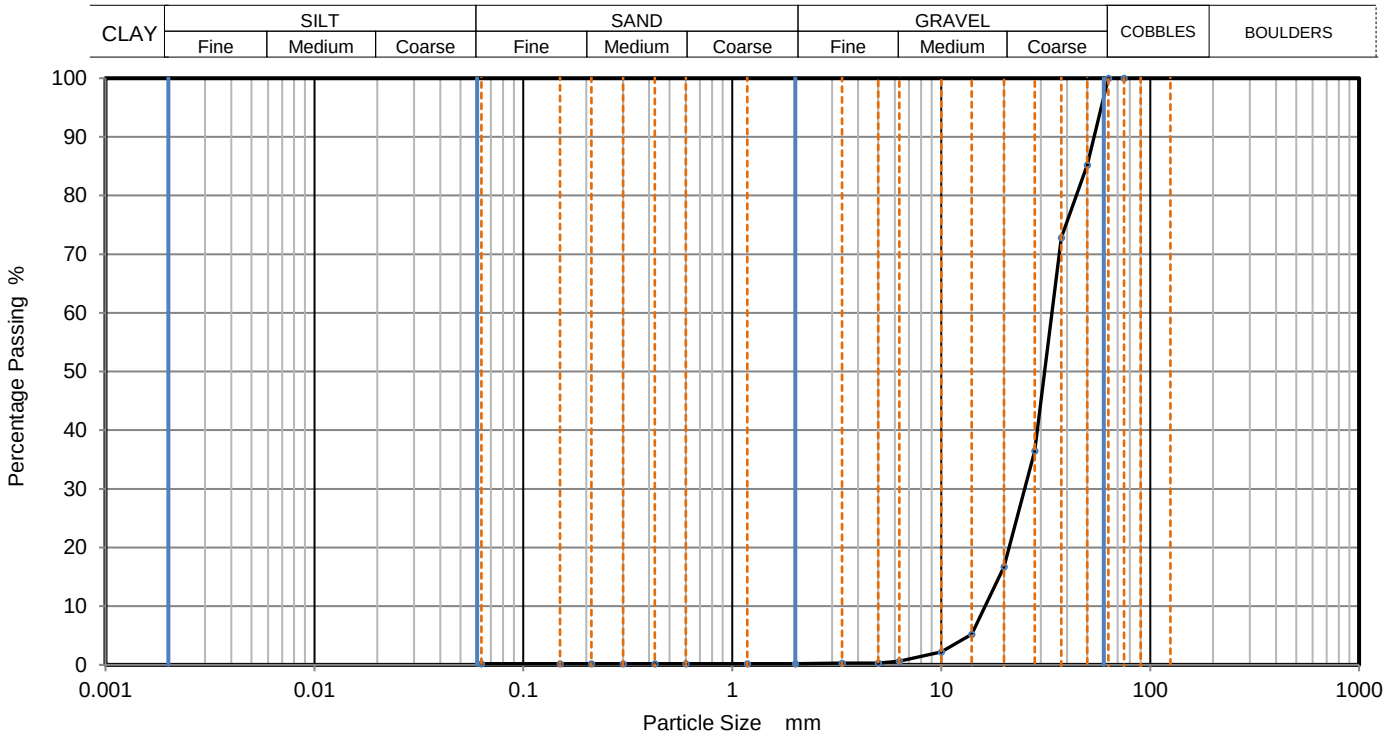
Plasticity abeviations: L = Low, I = Intermediate = H = High, V = Very High, E = Extremely High.

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

Chart taken from BS5930: 2010

QC Form: R1

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	RC02
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Multicoloured coarse GRAVEL.			Depth, m	3.50
Specimen Reference		Specimen Depth	3.5-3.8 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL1201910149



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	85		
37.5	73		
28	37		
20	17		
14	5		
10	2		
6.3	1		
5	0		
3.35	0		
2	0		
1.18	0		
0.6	0		
0.425	0		
0.3	0		
0.212	0		
0.15	0		
0.063	0		

Dry Mass of sample, g	1043

Sample Proportions	% dry mass
Very coarse	0
Gravel	100
Sand	0
Fines <0.063mm	0

Grading Analysis		
D100	mm	
D60	mm	33.8
D30	mm	25.1
D10	mm	16.3
Uniformity Coefficient		2.1
Curvature Coefficient		1.1

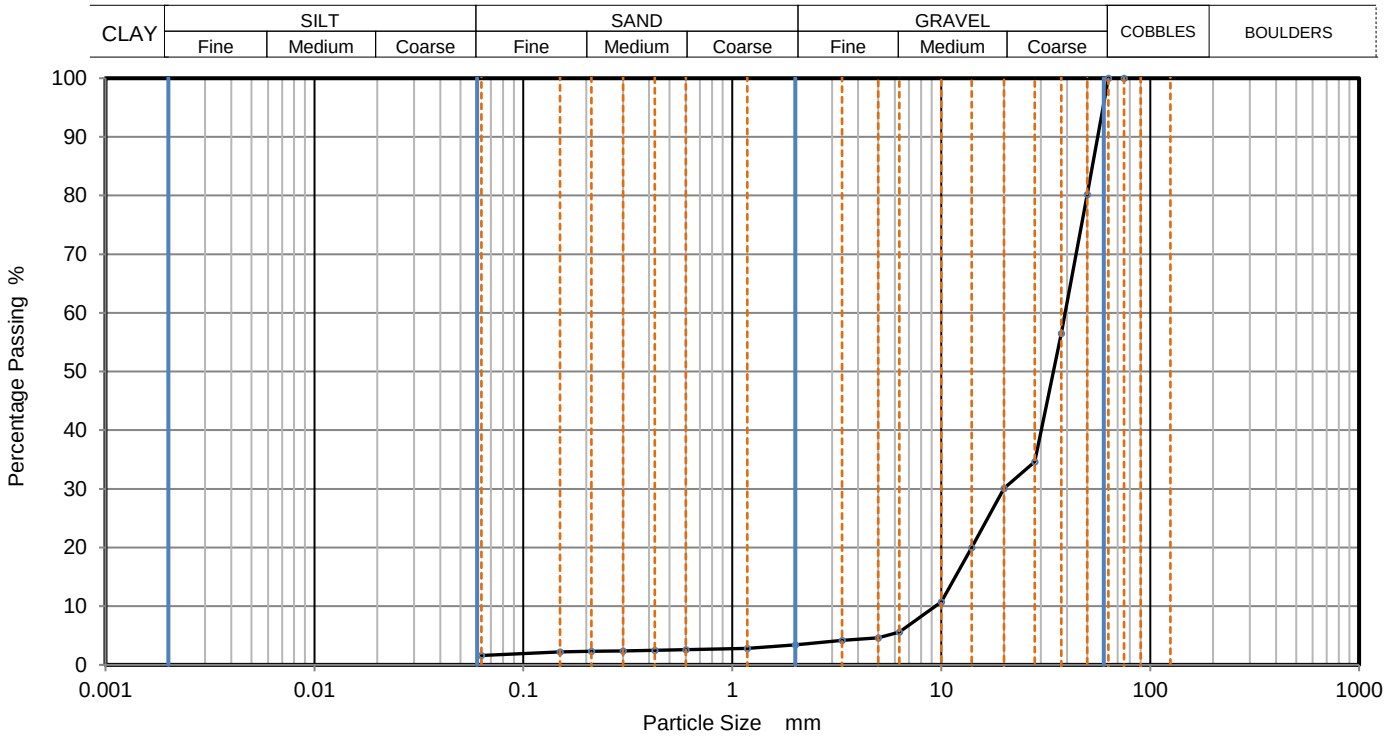
Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

PARTICLE SIZE DISTRIBUTION

				Job Ref	**2019C106**
				Borehole/Pit No.	RC02
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Multicoloured slightly silty slightly sandy coarse and medium GRAVEL.			Depth, m	6.50
Specimen Reference		Specimen Depth	6.5-8.0 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL12019101413



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	80		
37.5	57		
28	35		
20	30		
14	20		
10	11		
6.3	6		
5	5		
3.35	4		
2	3		
1.18	3		
0.6	3		
0.425	3		
0.3	2		
0.212	2		
0.15	2		
0.063	2		

Dry Mass of sample, g	1184

Sample Proportions	% dry mass
Very coarse	0
Gravel	97
Sand	2
Fines <0.063mm	2

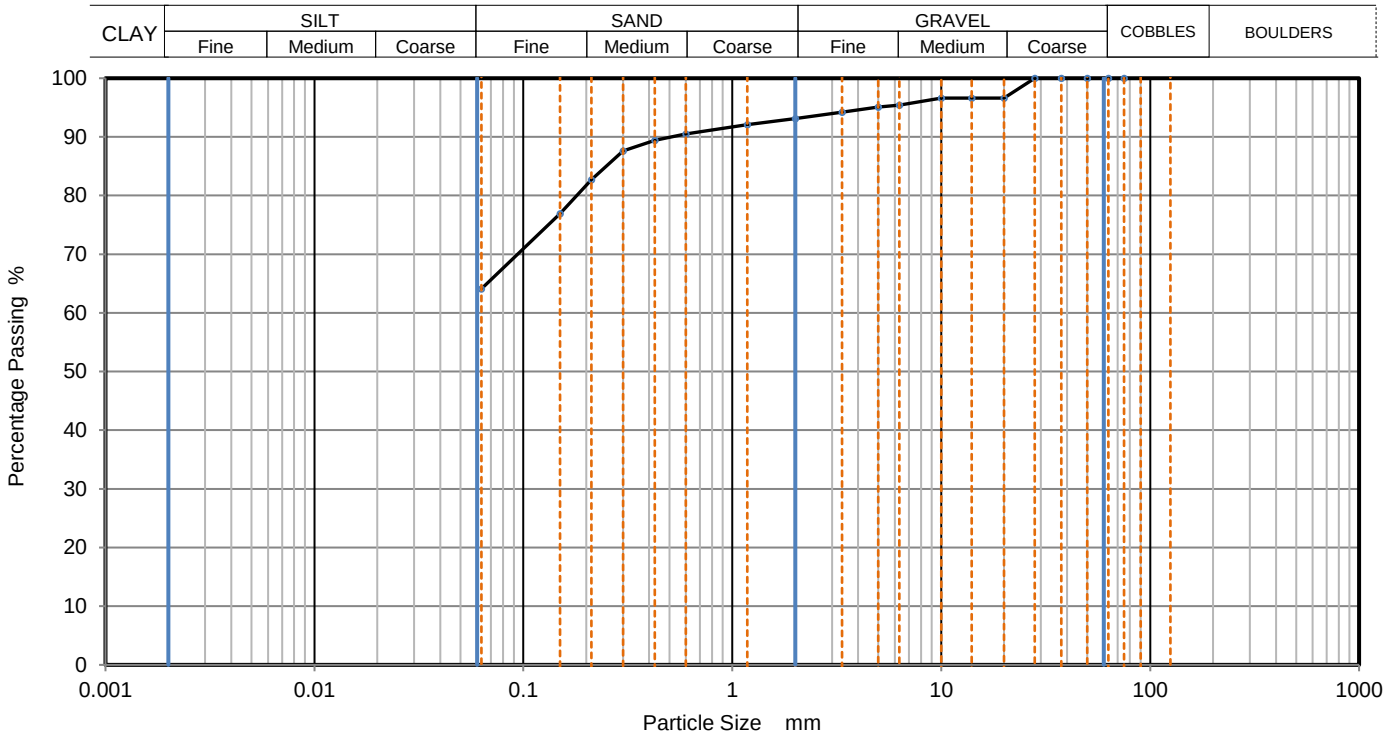
Grading Analysis		
D100	mm	
D60	mm	39.1
D30	mm	19.9
D10	mm	9.41
Uniformity Coefficient		4.2
Curvature Coefficient		1.1

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	RC03
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Red-brown slightly gravelly slightly sandy SILT.			Depth, m	2.00
Specimen Reference		Specimen Depth	2.3-2.5 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL12019101423



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	100		
20	97		
14	97		
10	97		
6.3	95		
5	95		
3.35	94		
2	93		
1.18	92		
0.6	91		
0.425	89		
0.3	88		
0.212	83		
0.15	77		
0.063	64		

Dry Mass of sample, g	769

Sample Proportions	% dry mass
Very coarse	0
Gravel	7
Sand	29
Fines <0.063mm	64

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

Remarks

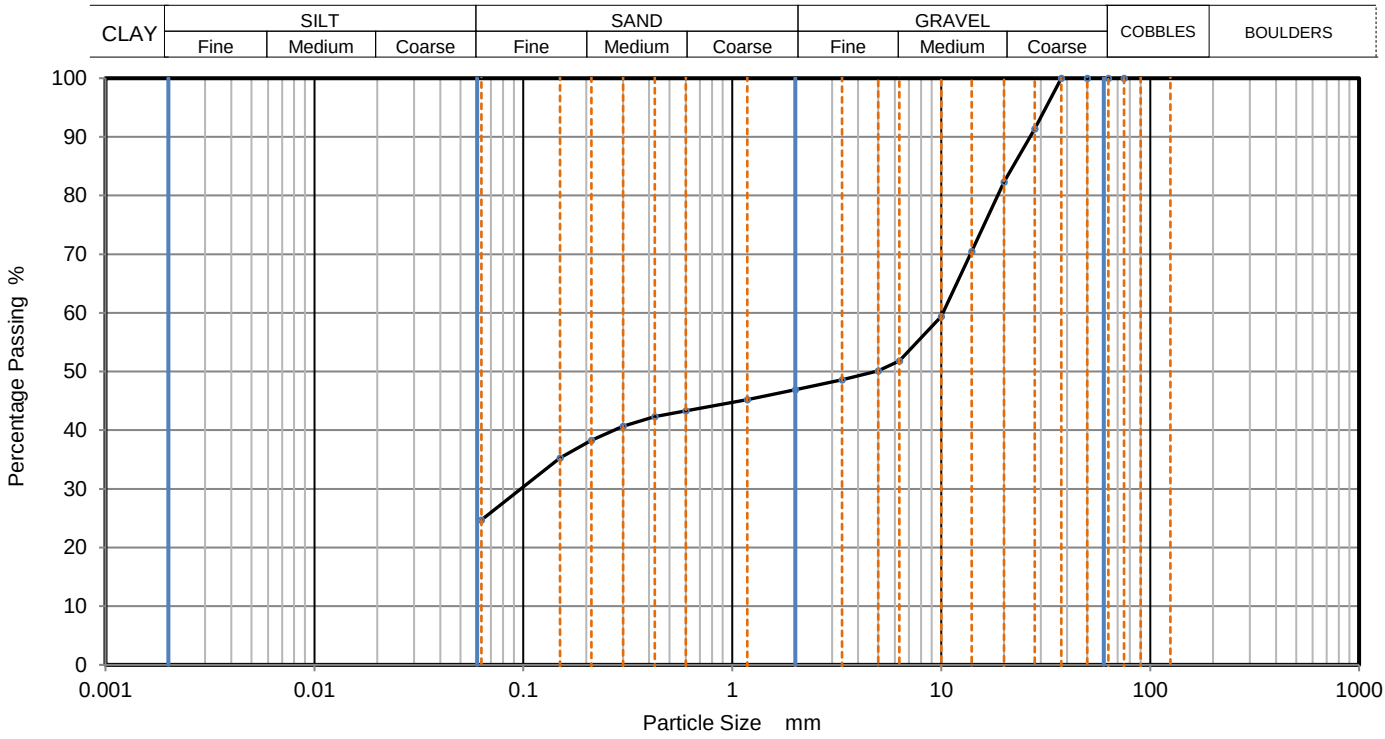
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	RC03
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Red-brown very sandy very silty medium GRAVEL.			Depth, m	5.00
Specimen Reference		Specimen Depth	6.1-6.4 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL12019101427



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	100		
28	91		
20	82		
14	71		
10	59		
6.3	52		
5	50		
3.35	49		
2	47		
1.18	45		
0.6	43		
0.425	42		
0.3	41		
0.212	38		
0.15	35		
0.063	25		

Dry Mass of sample, g	587

Sample Proportions	% dry mass
Very coarse	0
Gravel	53
Sand	22
Fines <0.063mm	25

Grading Analysis		
D100	mm	
D60	mm	10.2
D30	mm	0.0975
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

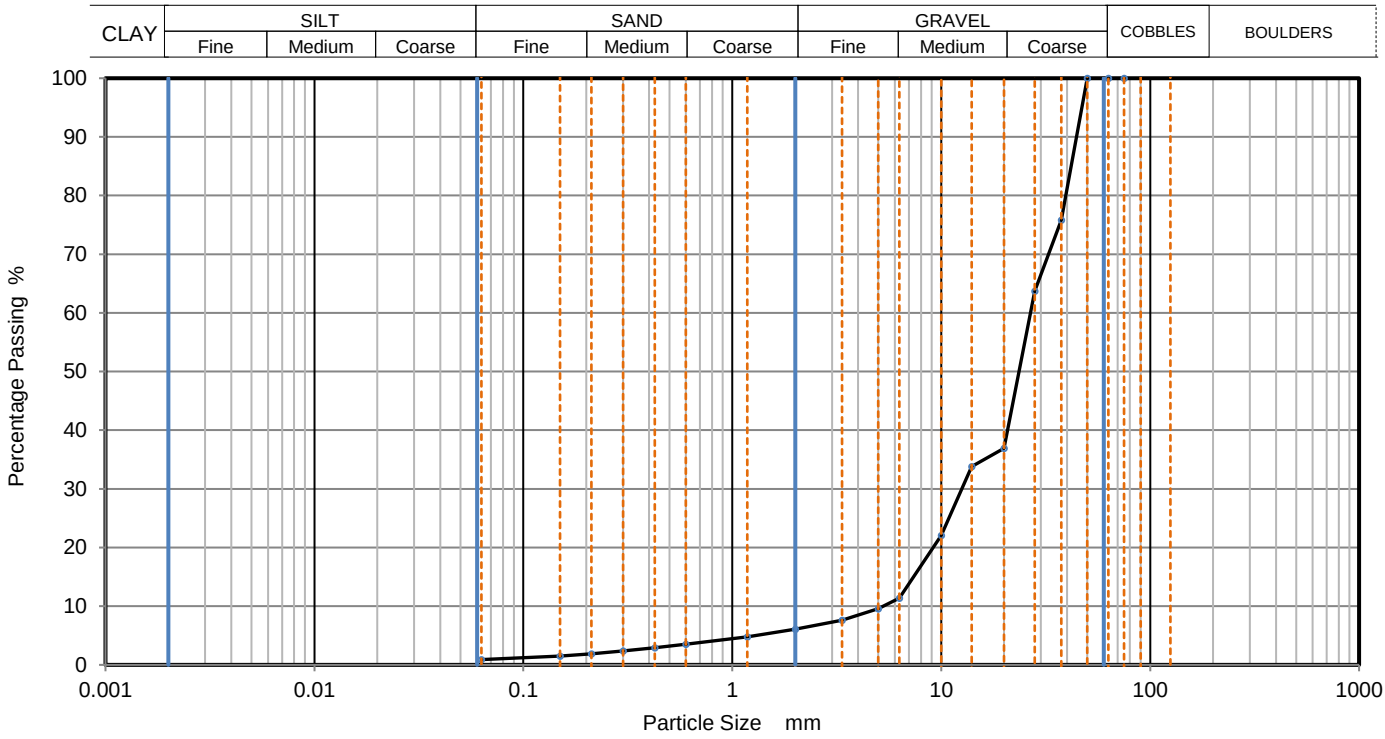
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	RC03
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Grey sandy medium anc coarse GRAVEL.			Depth, m	8.60
Specimen Reference		Specimen Depth	8.6-9.5 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL12019101433



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	76		
28	64		
20	37		
14	34		
10	22		
6.3	11		
5	10		
3.35	8		
2	6		
1.18	5		
0.6	4		
0.425	3		
0.3	2		
0.212	2		
0.15	2		
0.063	1		

Dry Mass of sample, g	1837

Sample Proportions	% dry mass
Very coarse	0
Gravel	94
Sand	5
Fines <0.063mm	1

Grading Analysis		
D100	mm	
D60	mm	26.7
D30	mm	12.6
D10	mm	5.29
Uniformity Coefficient		5.1
Curvature Coefficient		1.1

Remarks

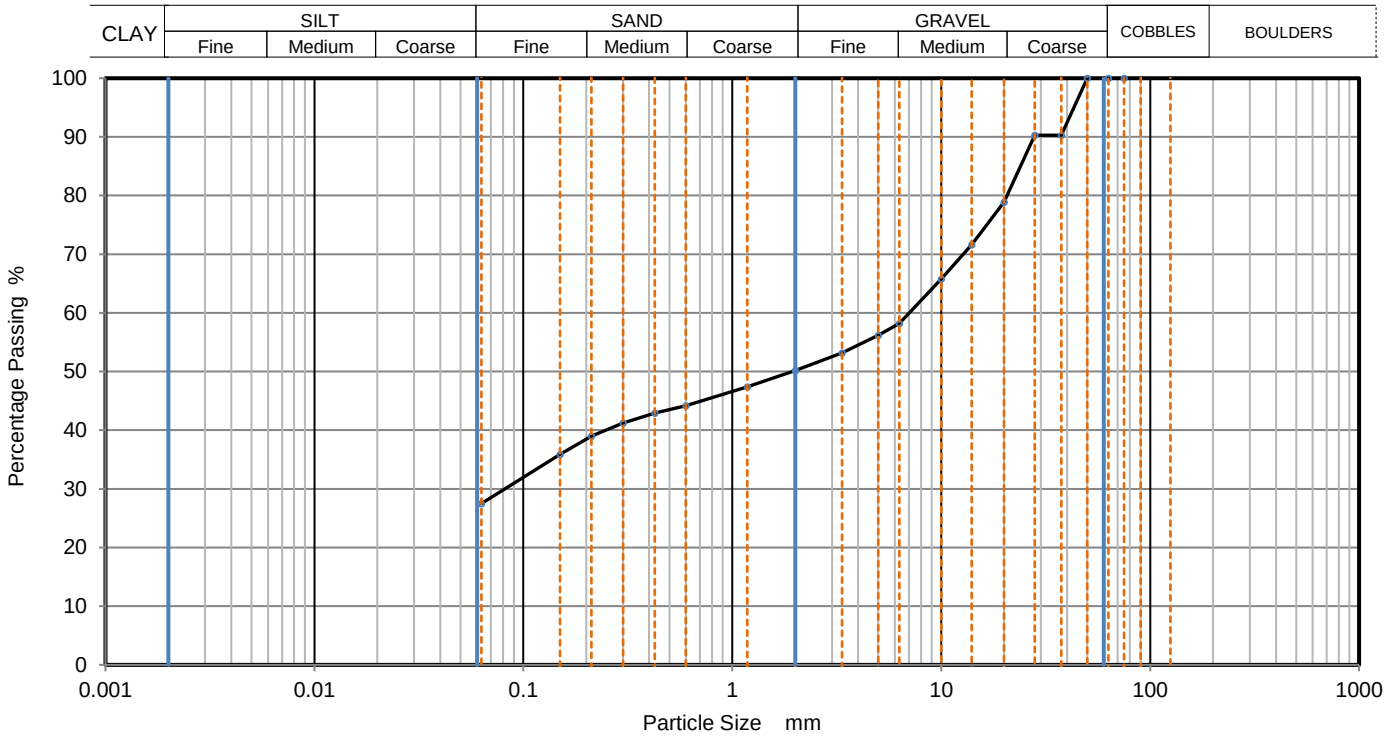
Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED	**PARTICLE SIZE DISTRIBUTION**			Job Ref	**2019C106**
				Borehole/Pit No.	RC03
Site Name	Coom Wind Farm			Sample No.	
Soil Description	Red-brown very sandy very silty medium and coarse GRAVEL.			Depth, m	12.50
Specimen Reference		Specimen Depth	12.5-14.0 m	Sample Type	C
Test Method	BS1377:Part 2:1990, clause 9.2			KeyLAB ID	IDL12019101438



Sieving		Sedimentation	
Particle Size mm	% Passing	Particle Size mm	% Passing
75	100		
63	100		
50	100		
37.5	90		
28	90		
20	79		
14	72		
10	66		
6.3	58		
5	56		
3.35	53		
2	50		
1.18	47		
0.6	44		
0.425	43		
0.3	41		
0.212	39		
0.15	36		
0.063	28		

Dry Mass of sample, g	1689

Sample Proportions	% dry mass
Very coarse	0
Gravel	50
Sand	23
Fines <0.063mm	28

Grading Analysis		
D100	mm	
D60	mm	7.03
D30	mm	0.0816
D10	mm	
Uniformity Coefficient		
Curvature Coefficient		

Remarks

Preparation and testing in accordance with BS1377 unless noted below

Operator	Checked	Approved	Sheet printed	
		Dympna Darcy B.Sc.	31/10/2019 10:42	**1** QC From No:R2

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) 528700
Fax: (01244) 528701
email: hawardencustomerservices@alsglobal.com
Website: www.alsenvironmental.co.uk

Irish Drilling Limited
Old Galway Road
Loughrea
Co. Galway

Attention: Dympna Darcy

CERTIFICATE OF ANALYSIS

Date of report Generation:	28 October 2019
Customer:	Irish Drilling Limited
Sample Delivery Group (SDG):	191021-15
Your Reference:	2019C106
Location:	Coom WF
Report No:	527195

We received 3 samples on Monday October 21, 2019 and 3 of these samples were scheduled for analysis which was completed on Monday October 28, 2019. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.
The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

Sonia McWhan

Operations Manager

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Received Sample Overview

Lab Sample No(s)	Customer Sample Ref.	AGS Ref.	Depth (m)	Sampled Date
20983715	RC1	CORE1	6.10 - 6.40	07/10/2019
20983717	RC2	CORE1	11.90 - 12.40	08/10/2019
20983719	RC3	CORE1	6.50 - 6.60	04/10/2019

Maximum Sample/Coolbox Temperature (°C) : **12.4**

ISO5667-3 Water quality - Sampling - Part3 -

During Transportation samples shall be stored in a cooling device capable of maintaining a temperature of (5±3)°C.

ALS have data which show that a cool box with 4 frozen icepacks is capable of maintaining pre-chilled samples at a temperature of (5±3)°C for a period of up to 24hrs.

Only received samples which have had analysis scheduled will be shown on the following pages.

Validated

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Results Legend

X **Test**

N **No Determination Possible**

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

Lab Sample No(s)			20983715	20983717	20983719
Customer Sample Reference			RC1	RC2	RC3
AGS Reference			CORE1	CORE1	CORE1
Depth (m)			6.10 - 6.40	11.90 - 12.40	6.50 - 6.60
Container			250g Amber Jar (ALE210)	250g Amber Jar (ALE210)	250g Amber Jar (ALE210)
Sample Type			S	S	S
Anions by Kone (soil)	All	NDPs: 0 Tests: 3	X	X	X
pH	All	NDPs: 0 Tests: 3	X	X	X
Sample description	All	NDPs: 0 Tests: 3	X	X	X

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Sample Descriptions

Grain Sizes

very fine	<0.063mm	fine	0.063mm - 0.1mm	medium	0.1mm - 2mm	coarse	2mm - 10mm	very coarse	>10mm

Lab Sample No(s)	Customer Sample Ref.	Depth (m)	Colour	Description	Inclusions	Inclusions 2
20983715	RC1	6.10 - 6.40	Dark Brown	Stone/Soil	Stones	Vegetation
20983717	RC2	11.90 - 12.40	Dark Brown	Stone/Soil	Stones	None
20983719	RC3	6.50 - 6.60	Dark Brown	Loamy Sand	Stones	None

These descriptions are only intended to act as a cross check if sample identities are questioned, and to provide a log of sample matrices with respect to MCERTS validation. They are not intended as full geological descriptions.

We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally ocurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample.

Other coarse granular materials such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

Validated

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Results Legend	
#	ISO17025 accredited.
M	mCERTS accredited.
aq	Aqueous / settled sample.
diss.filt	Dissolved / filtered sample.
tot.unfilt	Total / unfiltered sample.
*	Subcontracted - refer to subcontractor report for accreditation status.
**	% recovery of the surrogate standard to check the efficiency of the method. The results of individual compounds within samples aren't corrected for the recovery
(F)	Trigger breach confirmed
1-3+§@	Sample deviation (see appendix)

Component	LOD/Units	Method	Customer Sample Ref.	RC1	RC2	RC3			
			Depth (m)	6.10 - 6.40	11.90 - 12.40	6.50 - 6.60			
			Sample Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)			
			Date Sampled	07/10/2019	08/10/2019	04/10/2019			
			Sample Time	.	.	.			
			Date Received	21/10/2019	21/10/2019	21/10/2019			
			SDG Ref	191021-15	191021-15	191021-15			
			Lab Sample No.(s)	20983715	20983717	20983719			
			AGS Reference	CORE1	CORE1	CORE1			
Moisture Content Ratio (% of as received sample)	%	PM024		5.1	5.2	12			
pH	1 pH Units	TM133		7.4 #	7.58 #	8.58 M			
Water Soluble Sulphate as SO4 2:1 Extract	<0.004 g/l	TM243		0.0168 #	<0.004 #	0.0077 M			

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Table of Results - Appendix

Method No	Reference	Description
PM024	Modified BS 1377	Soil preparation including homogenisation, moisture screens of soils for Asbestos Containing Material
TM133	BS 1377: Part 3 1990;BS 6068-2.5	Determination of pH in Soil and Water using the GLpH pH Meter
TM243		Mixed Anions In Soils By Kone

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Life Sciences Ltd Hawarden (Method codes TM) or ALS Life Sciences Ltd Aberdeen (Method codes S).

Validated

CERTIFICATE OF ANALYSIS

SDG:	191021-15	**Client Reference:**	2019C106	**Report Number:**	527195
Location:	Coom WF	**Order Number:**	7431	**Superseded Report:**	

Test Completion Dates

Lab Sample No(s)	20983715	20983717	20983719
Customer Sample Ref.	RC1	RC2	RC3
AGS Ref.	CORE1	CORE1	CORE1
Depth	6.10 - 6.40	11.90 - 12.40	6.50 - 6.60
Type	Soil/Solid (S)	Soil/Solid (S)	Soil/Solid (S)
Anions by Kone (soil)	28-Oct-2019	28-Oct-2019	28-Oct-2019
pH	28-Oct-2019	28-Oct-2019	28-Oct-2019
Sample description	22-Oct-2019	22-Oct-2019	22-Oct-2019

Appendix General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 30 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of one month after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. Mercury results quoted on soils will not include volatile mercury as the analysis is performed on a dried and crushed sample.

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as "mixed hydrocarbons". Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

18. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

1	**Container with Headspace provided for volatiles analysis**
2	**Incorrect container received**
3	**Deviation from method**
§	**Sampled on date not provided**
♦	**Sample holding time exceeded in laboratory**
@	**Sample holding time exceeded due to late arrival of instructions or samples**

19. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2005), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as "Not detected". If no asbestos fibre types are found all will be reported as "Not detected" and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of

Identification of Asbestos in Bulk Materials & Soils

The results for identification of asbestos in bulk materials are obtained from supplied bulk materials which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2005).

Asbestos Type	Common Name
Chrysotile	White Asbestos
Amosite	Brown Asbestos
Crocidolite	Blue Asbestos
Fibrous Actinolite	-
Fibrous Anthophyllite	-
Fibrous Tremolite	-

Visual Estimation Of Fibre Content

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

Respirable Fibres

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.
Standing Committee of Analysts, *The Quantification of Asbestos in Soil (2107).*

Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.

The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.

IDL

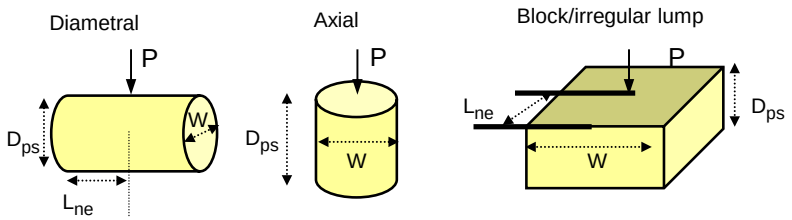
Point Load Strength Index Tests
Summary of Results

Project No.: 2019C106

Project Name: Coom Wind Farm

Borehole No.	Sample			Specimen		Rock Type and Test condition	Test Type see ISRM		Failure Valid (Y/N)	Dimensions				Force P	Equivalent diameter, De	Point Load Strength Index		Remarks (including water content if measured)
	Top Depth	Base Depth	Type	Ref	Depth		Type (D, A, I, B)	Direction (L, P or U)		Lne	W	Dps	Dps'			Is	Is(50)	
	m	m		m	m					mm	mm	mm	mm	kN	mm	MPa	MPa	
RC01	6.10	7.5	C	6.75	7.04		D	U	YES		63.0		63.0	1.4	63.0	0.4	0.4	Weak
RC02	11.00	12.5	C	11.8	11.94		D	U	YES		63.0		63.0	2.2	63.0	0.6	0.6	Weak
RC02	12.50	13.6	C	12.7	12.86		D	U	YES		63.0		63.0	2.8	63.0	0.7	0.8	Weak

Test Type
D - Diametral, A - Axial, I - Irregular Lump, B - Block
Direction
L - parallel to planes of weakness
P - perpendicular to planes of weakness
U - unknown or random
Dimensions
Dps - Distance between platens (platen separation)
Dps' - at failure (see ISRM note 6)
Lne - Length from platens to nearest free end
W - Width of shortest dimension perpendicular to load, P



Test performed in accordance with ISRM Suggested Methods : 2007, unless noted otherwise
Detailed legend for test and dimensions, based on ISRM, is shown above.
Size factor, F = (De/50)0.45 for all tests.

Date Printed: 31/10/2019

Approved By:

Table: 1

sheet: 1

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IDL

UNIAXIAL COMPRESSION TEST ON ROCK - SUMMARY OF RESULTS

Project No.: 2019C106

Project Name: Coom Wind Farm

Hole No.	Sample				Specimen Depth (m)	Specimen Dimensions2			Bulk Density2	Water Content 1	Uniaxial Compression3				Remarks
	Ref	Top	Base	Type		Dia. mm	Length mm	H/D	Mg/m3	%	Condition	Stress Rate MPa/s	Mode of failure	UCS MPa	
RC01		6.10	7.50	C	6.4-6.75	63.0	166.6	2.6	2.61		as received	0.1412	S	4.9	Very Weak

Notes

1 ISRM p87 test 1, water content at 105 ± 3 oC, specimen as tested for UCS

2 ISRM p86 clause (vii), Caliper method used for determination of bulk volume and derivation of bulk density

3 ISRM p153 part 1, determination of Uniaxial Compressive Strength (UCS) of Rock Materials

above notes apply unless annotated otherwise in the remarks

Mode of failure :

S - Single shear MS - multiple shear

AC - Axial cleavage F - Fragmented

Test Specification	Date Printed	Approved By	Table
International Society for Rock Mechanics, The complete ISRM suggested methods for Rock Characterization Testing and Monitoring, 2007	31/10/2019		1 sheet 1

Tested in: Irish Drilling Ltd.(IDL), Old Galway Road, Loughrea, Co. Galway, Ireland. H62VX39

Approved Signatures: Dympna Darcy (DCD) Lab Manager, Declan Joyce (DJ) Chartered Geotechnical Engineer, Ronan Killeen (RK) Quality Manager.

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

Phone: (091) 841 274
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email: info@irishdrilling.ie

COOM WIND FARM

APPENDIX 6


Coom WF
Bottlehill,
Co. Cork
2019C106
RC 1
Box
1.2
START
2m
3.2
4.6
6m
7.5


Coom WF
Bottlehill,
Co. Cork
2019C106
RC 2
Box
1.2
START
2m
3.5
5
6.5m
8m
9.5m
11m
12.5
14.2 EOH


Coom WF
Bottlehill,
Co. Cork
2019C106
RC 3
Box
1.2
2m
3·5
5m
6·5
8M
8·6
9·5
11M
12·5
14
15
EOH

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

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SITE INVESTIGATION

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email: info@irishdrilling.ie

COOM WIND FARM

APPENDIX 7

Figure 1 H:\2019C106_CoomWF\Bp1-tp1...jpg

Figure 3 H:\2019C106_CoomWF\Bp1-tp1.jpg

Figure 2 H:\2019C106_CoomWF\Bp1-tp1..jpg

Figure 4 H:\2019C106_CoomWF\Bp1-tp2....jpg

Figure 5 H:\2019C106_CoomWF\Bp1-tp2..jpg

Figure 7 H:\2019C106_CoomWF\Bp1-tp3...jpg

Figure 6 H:\2019C106_CoomWF\Bp1-tp2.jpg

Figure 8 H:\2019C106_CoomWF\Bp1-tp3..jpg

Figure 9 H:\2019C106_CoomWF\Bp1-tp3.jpg

Figure 11 H:\2019C106_CoomWF\Bp2-tp1..jpg

Figure 10 H:\2019C106_CoomWF\Bp2-tp1...jpg

Figure 12 H:\2019C106_CoomWF\Bp2-tp1.jpg

Figure 13 H:\2019C106_CoomWF\Bp2-tp2...jpg

Figure 15 H:\2019C106_CoomWF\Bp2-tp2.jpg

Figure 14 H:\2019C106_CoomWF\Bp2-tp2..jpg

Figure 16 H:\2019C106_CoomWF\Bp2-tp3...jpg

Figure 17 H:\2019C106_CoomWF\Bp2-tp3..jpg

Figure 19 H:\2019C106_CoomWF\Bp2-tp4..jpg

Figure 18 H:\2019C106_CoomWF\Bp2-tp3.jpg

Figure 20 H:\2019C106_CoomWF\Bp2-tp4.jpg

Figure 21 H:\2019C106_CoomWF\Bp3-tp1...jpg

Figure 22 H:\2019C106_CoomWF\Bp3-tp1..jpg

Figure 23 H:\2019C106_CoomWF\Bp3-tp1.jpg

Figure 24 H:\2019C106_CoomWF\Bp3-tp3...jpg

Figure 25 H:\2019C106_CoomWF\Bp3-tp3..jpg

Figure 27 H:\2019C106_CoomWF\T13...jpg

Figure 26 H:\2019C106_CoomWF\Bp3-tp3.jpg

Figure 28 H:\2019C106_CoomWF\T13..jpg

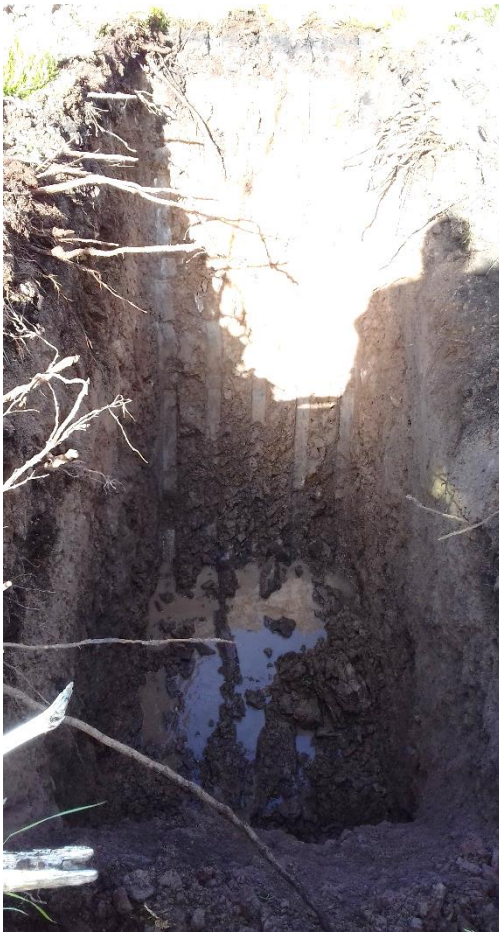

Figure 29 H:\2019C106_CoomWF\T13.jpg

Figure 31 H:\2019C106_CoomWF\T20..jpg

Figure 30 H:\2019C106_CoomWF\T20...jpg

Figure 32 H:\2019C106_CoomWF\T20.jpg

Figure 33 H:\2019C106_CoomWF\T22...jpg

Figure 34 H:\2019C106_CoomWF\T22..jpg

Figure 35 H:\2019C106_CoomWF\T22.jpg

Figure 36 H:\2019C106_CoomWF\T23...jpg

Figure 37 H:\2019C106_CoomWF\T23..jpg

Figure 39 H:\2019C106_CoomWF\Tp2-bp4...jpg

Figure 38 H:\2019C106_CoomWF\T23.jpg

IRISH DRILLING LIMITED

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COOM WIND FARM

APPENDIX 8

SEPARATE FOLDER

IRISH DRILLING LIMITED

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SITE INVESTIGATION

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COOM WIND FARM

APPENDIX 9

General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project: Borrow Pit 1
Sheet:
Date: 15.11.2019
Scale: Not to Scale

General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

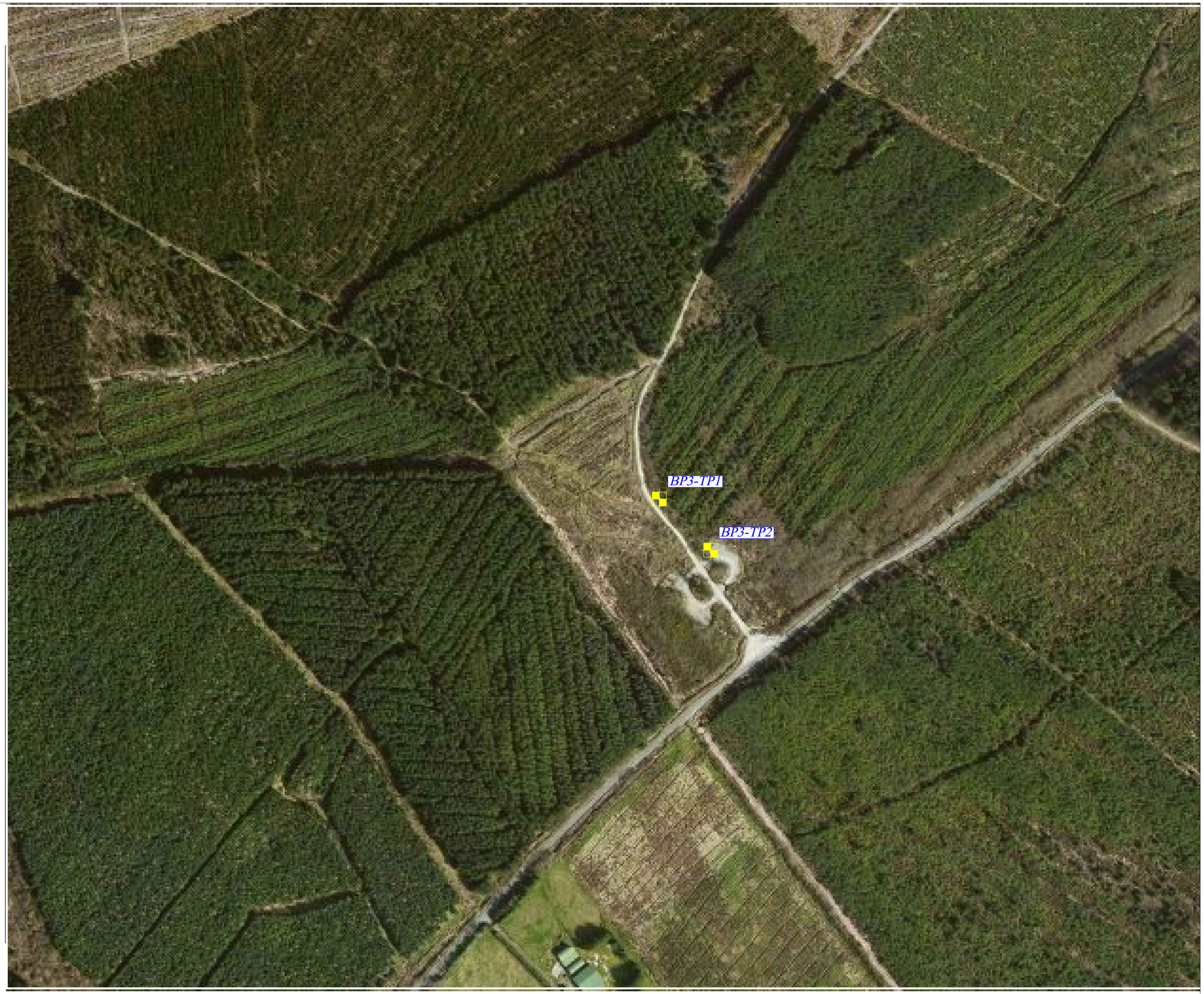
Coom Windfarm
IDL As Built

Project
Borrow Pit 2

Sheet

Date
15.11.2019

Scale
Not to Scale



General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project
Borrow pit 3

Sheet

Date
15.11.2019

Scale
Not to Scale

General Notes

IRISH DRILLING LIMITED

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project	Sheet
TP–T13	
Date: 15.11.2019	
Scale: Not to Scale	

General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project: TP–T20/T22	Sheet:
Date: 15.11.2019	
Scale: Not to Scale	

General Notes

IRISH DRILLING LIMITED

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project	Sheet
TP-T23	
Date: 15.11.2019	
Scale: Not to Scale	

General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

Coom Windfarm
IDL As Built

Project	Sheet
RC-1/RC2	
Date: 15.11.2019	
Scale: Not to Scale	

FEHILY TIMONEY
30 YEARS

CONSULTANTS IN ENGINEERING,
ENVIRONMENTAL SCIENCE & PLANNING

APPENDIX D

Geotechnical Risk Register

No.	Work Element	Hazard	Cause	Risk (i.e. Potential Impact)	Risk Rating			Potential Control Measures		Risk Rating			Residual Risk?
					P	I	R	Design	Construction	P	I	R	
1	Hardstandings & Platforms	Global Slope Instability	Slopes with inherent instability issues used as sub-grade for working platform / introducing load causing instability to existing slopes	Failure of the working platform. Slope instability causing toppling of plant	3	5	15	Carry out slope stability analysis of areas where working platforms are specified on sloping ground, especially for slopes of greater than 10%	On site supervision and monitoring of working platforms	1	5	5	No
2	Hardstandings & Platforms	Edge of Working Platform	All working platforms have edges of some kind	Plant working close to the edge could fall or topple. Support at the edge of slopes is significantly reduced from support in the centre of the platform	3	5	15	Specify exclusion zones at the edge of working platforms (50% of machine width is usual)	Provide clear markings to show the extent of the working area and any exclusion zones	1	4	4	No
3	Hardstandings & Platforms	Access Slopes	Access slopes are narrower and more difficult to navigate than flat areas	Insufficient size and strength of access slopes could cause toppling of plant	4	5	20	Include additional thickness of platform material or reinforcement at access slopes (50% increase on design thickness)	Provide clear markings, signage and barriers at access slopes to allow safe access by plant	1	3	3	No
4	Hardstandings & Platforms	Differential Settlement	Variable underlying strata cause differential settlement under loading	The vertical alignment of the surface may become out of specification if differential settlement is excessive	3	4	12	Calculate thicknesses based on underlying subgrade strength. Specify on-site testing of both subgrade and finished road to ensure compliance. Specify use of the observational method to allow for additional thickness of material in softer areas	Comply with monitoring action plan. Ensure designer is notified at an early stage if rutting occurs differentially	1	3	3	No
5	Hardstandings & Platforms	Durability of fill material	Variable sources of materials (borrow pits for example) may allow less durable materials	Low durability materials can cause excess weathering of the fill material causing degradation of performance prior to the design life	2	4	8	Specify a testing regime to allow for control on materials used in roads	Comply with testing regime	1	3	3	No
6	Hardstandings & Platforms	Deep drains adjacent to Hardstandings & Platforms	Topography and the required fall for drainage can lead to excessively deep drainage channels	Excessively deep drainage channels are a health and safety risk	2	4	8	Use 3D CAD to model drainage. Provide culverted drainage where excessively deep drainage is likely (or redirect drainage)	Comply with design. Notify designer if deep drainage is required	1	3	3	No
7	Hardstandings & Platforms	Unexpected ground conditions	Ground investigation is limited and as such there is significant risk of localized variability within the large hardstand area.	If soft or voided ground is encountered at the affection level, then localized excavation and replacement will be required	4	5	20	Complete Additional Ground Investigation at detailed design stage. Design is to be based on conservative design values to allow for some variation on site (in terms of the strength of the materials encountered)	Closely monitor the ground conditions. Have formation inspections from geotechnical engineer. Comply with testing regime	2	4	8	No
8	Hardstandings & Platforms	Unstable excavation and embanking slopes	Glacial Till is a variable strata and can contain loose layers of sands and gravels which can become unstable when subjected to water flow or if slopes are constructed at too steep an angle. Also, unfavourable dip angles in rock cuttings can cause instability.	Risk of collapse of side slopes causing injury or death to workers	3	5	15	Design of side slopes for stable angle based on the anticipated geology	Adhere to design slope angles. Verify assumed ground conditions on site. Monitor slopes during construction for signs of instability	1	4	4	No
9	Hardstandings & Platforms	Groundwater ingress to temporary excavation	Shallow groundwater seepages in a range of 0.6 to 3.5 m bgl	Risk of inundation, softening of formation and danger to construction workers	4	4	16	Notify contractor of groundwater ingress issue through risk register	Design and utilise sufficient groundwater control method (such as sump pumping or groundwater extraction wells)	1	3	3	No

No.	Work Element	Hazard	Cause	Risk (i.e. Potential Impact)	Risk Rating			Potential Control Measures		Risk Rating			Residual Risk?
					P	I	R	Design	Construction	P	I	R	
10	Hardstandings & Platforms	Deterioration of formation by surface or ground water	Once excavated the formation is at risk of deterioration either due to loosening of granular materials or softening of cohesive materials from water ingress	Any degradation in strength or stiffness may necessitate additional excavation to find a competent foundation	5	4	20	Identify competent strata which is not susceptible to degradation where possible	Carry outappropriate checks and testing in a timely fashion. Protect the formation during rainfall and include appropriate drainage to prevent surface water ingress. Use appropriate groundwater control. Check weather before working and do not excavate during periods of rain	2	4	8	Yes – extreme weather events may override mitigation measures and cause deterioration
11	Access Roads	Differential Settlement on access roads	Variable underlying strata cause differential settlement under loading	The vertical alignment of the road may become out of specification if differential settlement is extreme	3	4	12	Calculate thicknesses based on underlying subgrade strength. Specify on-site testing of both subgrade and finished road to ensure compliance. Specify use of the observational method to allow for additional thickness of material in softer areas	Comply with monitoring action plan. Ensure designer is notified at an early stage if rutting occurs differentially	1	3	3	No
12	Access Roads	Durability of aggregate used in access roads	Variable sources of materials (borrow pits for example) may allow less durable materials into the road make-up	Low durability materials can cause excess weathering of the road make-up causing degradation of performance prior to the design life	2	4	8	Specify a testing regime to allow for control on materials used in roads.	Comply with testing regime	1	3	3	No
13	Access Roads	Formation of high, steep banks	Topography combined with underlying geology leads to high steep access road sides	High steep banks are a health and safety risk to workers on site	2	4	8	Use 3D CAD to model access roads and identify areas where steep, high slopes are formed	Comply with design. Notify designer if high, steep slopes are likely to be formed. Provide edge protection if required	1	3	3	No
14	Access Roads	Deep drains adjacent to roads	Topography and the required fall for drainage can lead to excessively deep drainage channels	Excessively deep drainage channels are a health and safety risk	2	4	8	Use 3D CAD to model drainage. Provide culverted drainage where excessively deep drainage is likely (or redirect drainage)	Comply with design. Notify designer if deep drainage is required	1	3	3	No
15	Turbine Foundations	Unexpected ground conditions	There is significant risk of localised variability within the large footprint of the turbine foundations. Detailed ground investigation should be undertaken before design stage	If soft or voided ground is encountered at the founding level, level then localised excavation and replacement will be required. Mixed soil must be avoided at the bottom of excavation	4	5	20	Detailed ground investigation should be undertaken before design stage	Monitor the ground conditions. Have formation inspections from geotechnical engineer. Comply with testing regime	1	4	4	No
16	Turbine Foundations	Unstable side slopes	Glacial Till is a variable strata and can contain loose layers of sands and gravels which can become unstable when subjected to water flow or if slopes are constructed at too steep an angle. Also, unfavourable dip angles in rock cuttings can cause instability.	Risk of collapse of side slopes causing injury or death to workers	3	5	15	Design of side slopes for stable angle based on the anticipated geology	Adhere to design slope angles. Verify assumed ground conditions on site. Monitor slopes during construction for signs of instability	1	4	4	No
17	Turbine Foundations	Groundwater ingress to temporary excavation	Groundwater was noted at 0.6 – 3.5m bgl during ground investigation	Risk of inundation, softening of formation and danger to construction workers	4	4	16	Detailed ground investigation should be undertaken before design stage. Notify contractor of groundwater ingress issue through risk register	Contractor to design and utilise sufficient groundwater control method (such as sump pumping or groundwater extraction wells) as well as perimetric dewatering ditches at the bottom of excavation and outside	1	3	3	No
18	Turbine Foundations	Variable Ground Profile	Variable underlying strata cause differential settlement under loading	The impact of this is potential differential settlement across the base. During cyclic loading the clay material could degrade at a different rate to the granular - bedrock and cause differential settlement	5	4	20	Carry out sensitivity design to identify potential differential settlement. Specify dig and replace of clay to provide sufficient load spread onto underlying clay to prevent differential settlement	Adhere to Inspection & Testing Plan, carry out PLT at formation level. Dig and replace clay materials with suitable granular fill	1	4	4	No – if all softer materials are replaced then the risk is negligible

No.	Work Element	Hazard	Cause	Risk (i.e. Potential Impact)	Risk Rating			Potential Control Measures		Risk Rating			Residual Risk?
					P	I	R	Design	Construction	P	I	R	
19	Turbine Foundations	Deterioration of formation by surface or ground water	Once excavated the formation is at risk of deterioration either due to loosening of granular materials or softening of cohesive materials from water ingress	Any degradation in strength or stiffness may necessitate additional excavation to find a competent foundation	5	4	20	Identify competent strata which is not susceptible to degradation where possible	Carry out appropriate checks and testing in a timely fashion. Protect the formation during rainfall and include appropriate drainage to prevent surface water ingress. Use appropriate groundwater control. Check weather before working and no not excavate during periods of rain	2	4	8	Yes – extreme weather events may override mitigation measures and cause deterioration

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