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Surface Water Management Plan

For

Pinewood 110kV Substation,
Ballinakill,
County Laois

Project	Document	Revision	Issue	Prepared	Checked	Approved	Date
19999	**6001**	E	Planning	D Ó Buachalla	I Brosnan	J O'Leary	Sept 2020

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1 INTRODUCTION

1.1 Location and Land use of Substation

The proposed Pinewoods Wind Farm substation and grid connection ('the proposed development') is located c. 1.2km north of the county boundary between County Laois and County Kilkenny in the townland of Knockardagur, County Laois; approximately 17km south-west of Portlaoise and 25km north of Kilkenny City, and approximately centred at Irish Transverse Mercator (ITM) Grid Reference 650427, 682395.

The nearest towns are Abbeyleix, approximately 8km north-west, and Castlecomer, approximately 8km south-east. The village of Ballinakill is c.4km south-west of the subject site. There are also a number of smaller nucleated and crossroad settlements throughout the wider environs of the subject site together with numerous dispersed 'one-off' dwellings and farmsteads outside of any identified settlements. The general location of the proposed development site, in a regional context, is illustrated in Figure 1.1.

The topography in the wider environs of the subject site is dominated by the upland area known as the Castlecomer Plateau, characterised by undulating hills and steep escarpments at its fringes. Dissecting the lowlands on either side of the plateau are the rivers Barrow and Nore, which lie to the east and west respectively. The lowlands are a mixture of pasture and tillage with fields typically bordered by mature broadleaf tree lines and hedgerows. Agricultural land-uses extend into the upland areas in the form of more marginal grazing with scrubby hedgerow field boundaries.

Extensive commercial conifer plantations emerge on higher slopes and throughout the Castlecomer Plateau. There are also occasional small patches of woodland associated with demesne landscapes within lowlands as well as narrow strips of riparian vegetation at the margins of streams and rivers. A number of quarries are also present in the wider area.

The proposed development site is located in a relatively remote location as evidenced by the presence of only 5 no. dwellings within 500m of the proposed development site; the nearest of which is c. 100m east of the proposed development.

The proposed development site is located within a single agricultural landholding comprising agricultural grassland/pasture with mature hedgerows, and occasional trees, at the boundaries. The presence of this mature vegetation, which will be retained where its removal is not required to provide access to the proposed development, will also serve to screen the proposed substation and aid its absorption into the landscape.

The topography of the site is sloping with elevations ranging from approximately 225m above ordnance datum (AOD) to the west of the site and approximately 245m AOD to the east. The sloping nature of the proposed development site has brought about a requirement for a bespoke 'split-level' design.

The proposed development site is drained by the Knockardagur stream, immediately south of the footprint of the proposed substation. While, in accordance with the Environmental Protection Agency (EPA) mapping database[1], the Knockardagur is considered to be a watercourse; based on field assessments undertaken, the stream is generally dry and is assessed as only likely to contain flow following periods of intense or prolonged rainfall. In addition, due to the sloping nature of the proposed development site, all surface water runoff flows towards the Knockardagur stream either directly to the stream or via agricultural drains which then discharge to the stream.

[1] https://gis.epa.ie/EPAMaps/

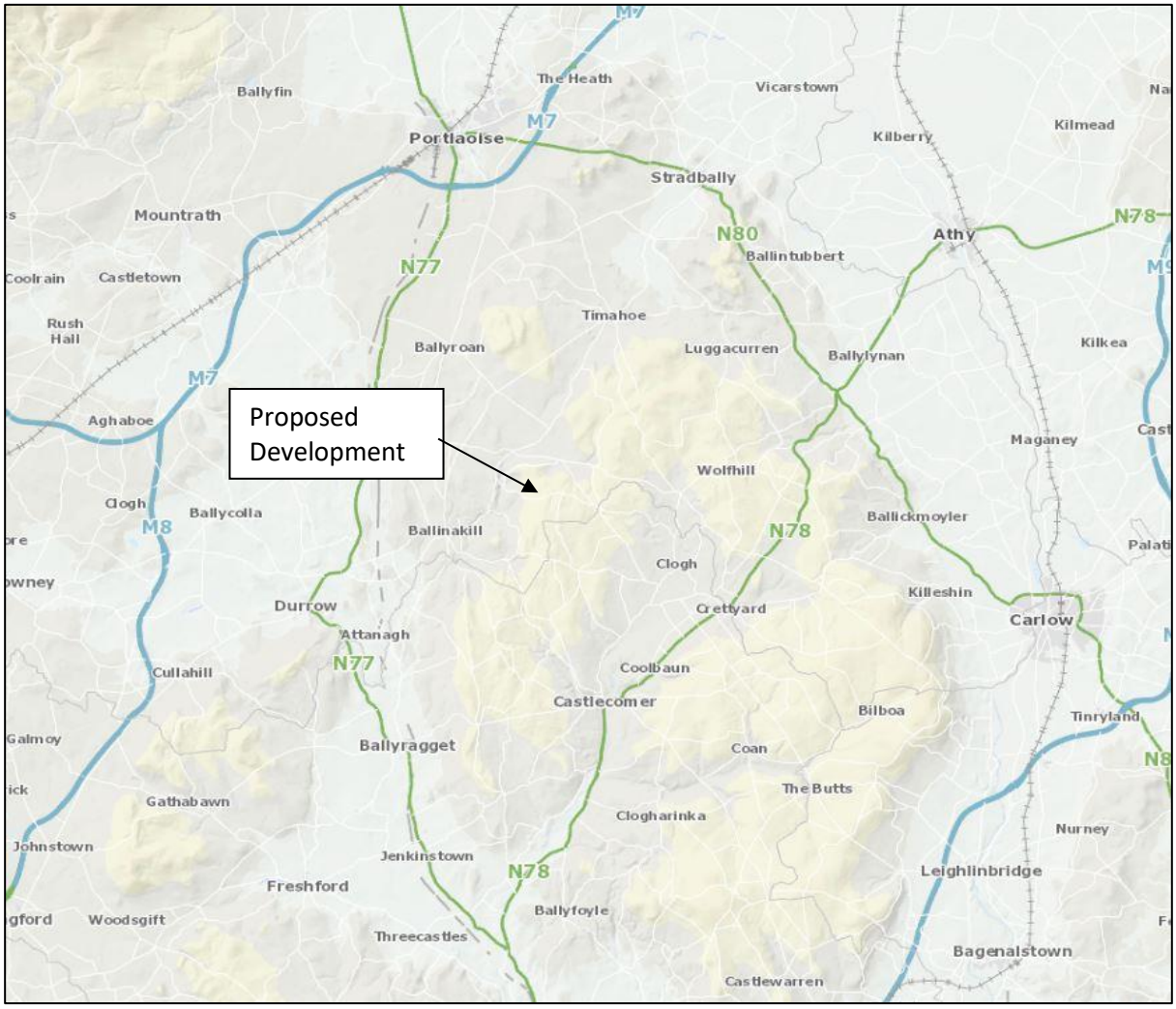

Figure 1.1 Proposed Development Location

1.2 Background

The proposed development will form part of an adjacent wind farm development, located in both counties Laois and Kilkenny, which has already been granted planning permission by An Bord Pleanála (Refs: PL11.248518 & PL10.248392, the 'Pinewoods Wind Farm). The permitted Pinewoods Wind Farm comprises 11 no. wind turbines each with a maximum tip height of up to 136.5 metres and all associated site development and ancillary works, including turbine foundations, crane hardstandings, 7.4km of site access tracks, underground electricity and communications cabling, site drainage works, 7 no. site entrances, a permanent meteorological mast with a maximum height of up to 85 metres and temporary upgrade to the R430/L7800 junction. The permitted development is located within the townlands of Knockardagur, Boleybawn, Garrintaggart, Ironmills (Kilrush) and Graiguenahown, Co. Laois; and Crutt, Co. Kilkenny.

The purpose of the proposed development is to facilitate the export of renewable electricity generated by the Pinewoods Wind Farm to the national electricity grid by way of the immediately adjacent and permitted 110kV Laois-Kilkenny Grid Reinforcement Project electricity transmission line. The planning application for the permitted Pinewoods Wind Farm had previously included for a similar 110kV substation at this general location. However, this proposed substation was omitted from the planning

permission by An Bord Pleanála by way of condition of consent.

Existing Data

A comprehensive site investigation comprising trial pits, rotary coring and dynamic probing was undertaken by Irish Drilling Limited in two phases. The first phase included trial pits and dynamic probes to determine overburden information while the second involved rotary cores to determine the underlying rock quality.

In summary, site investigations included the following:

- Trial pits (7 no.) were undertaken at strategic locations on the site to investigate overburden thickness and subsoil and bedrock lithology.
- The pits were logged and photographed by an Engineer with observations made on ground conditions, pit stability and water ingress.
- Logging of bedrock outcrops and subsoil exposures was noted;
- 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.
- Seven dynamic probes were carried out to 'refusal' using a LMSR-V(k) Geotool Dynamic probing rig.
- Five rotary cores were distributed across the site to determine the quality of the underlying rock formations.

1.3 Hydrology

The proposed development site is located in the Nore River surface water catchment within Hydrometric area 15 of the South Eastern River Basin District (SERBD). A regional hydrology map is shown as Figure 1.2.

In terms of local hydrology, the proposed development is situated within the Owenbeg (Owveg) River surface water catchment. The Owenbeg (Owveg) River flows in a generally southerly direction approximately 1.4km west of the site.

There is 1 no. watercourse within the proposed development site. The watercourse (the Knockardagur) is a small 1st order stream which flows in a westerly direction within the hedgerow located immediately south of the footprint of the proposed 110kV electricity substation.

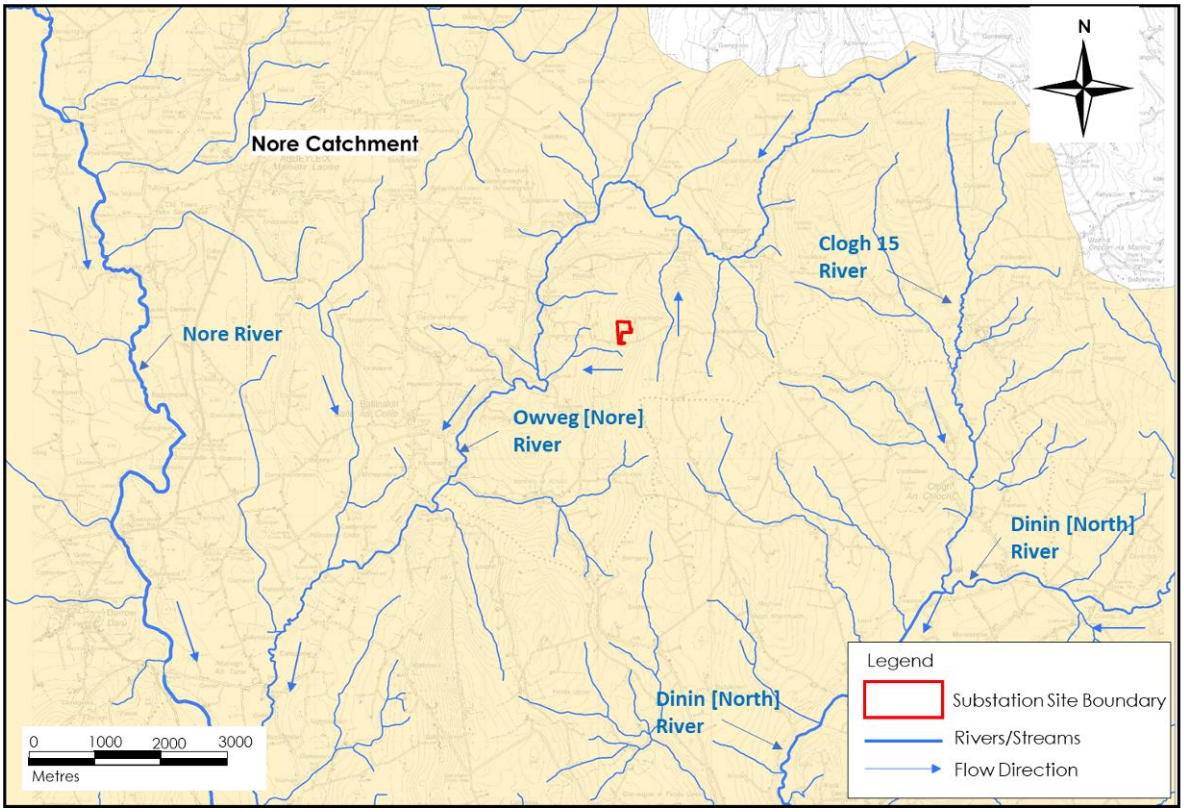

Figure 1.2 Regional Hydrology

1.4 Geology

Based on the GSI bedrock map, the bedrock units underlying the proposed development site of the substation comprises Namurian sandstone. The Namurian sandstone at this site is part of a band of bedrock with a broad gentle syncline (V-shaped fold) in which the rock strata generally dip towards the centre. There are no mapped faults in the area of the proposed development. A bedrock geology map of the area is illustrated in Figure 1.3.

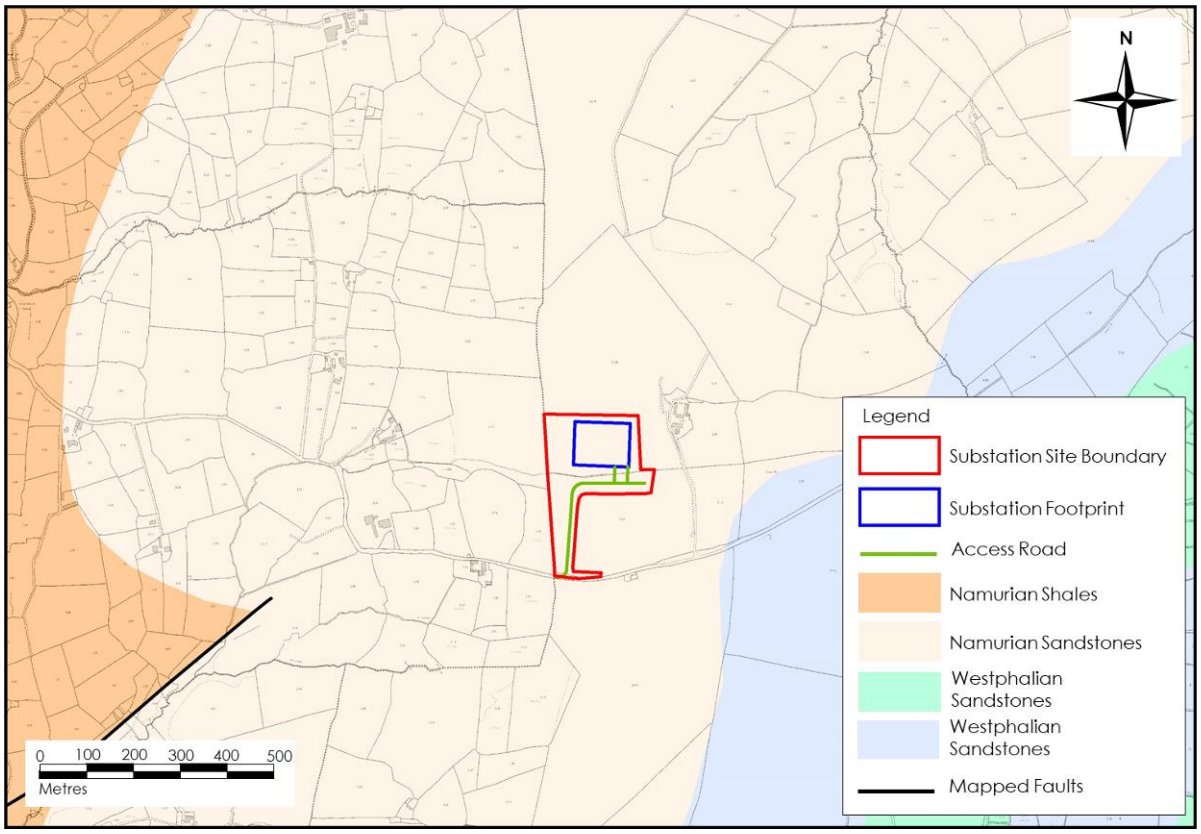

Figure 1.3 Bedrock Geology Map

Trial pits (7 no.) were undertaken at (or in the proximity of) the proposed substation and associated access track locations to investigate overburden thickness and subsoil and bedrock lithology. Shale bedrock was encountered in the trial pits TP06 and TP07. The upper profile of the shale bedrock was found to be generally weathered with some excavation of the shale being possible with the excavator bucket.

The published soils map (www.epa.ie) for the area shows that poorly draining mineral soil (AminPD) and deep well draining mineral soil (AminDW) are the dominant soil types at the site. A map of the local subsoil cover is illustrated in **Figure 1.4** (www.gsi.ie). This indicates that Namurian sandstone and shale tills are present on the far west of the proposed development site, with bedrock mapped close to or at the surface over the remainder of the site area.

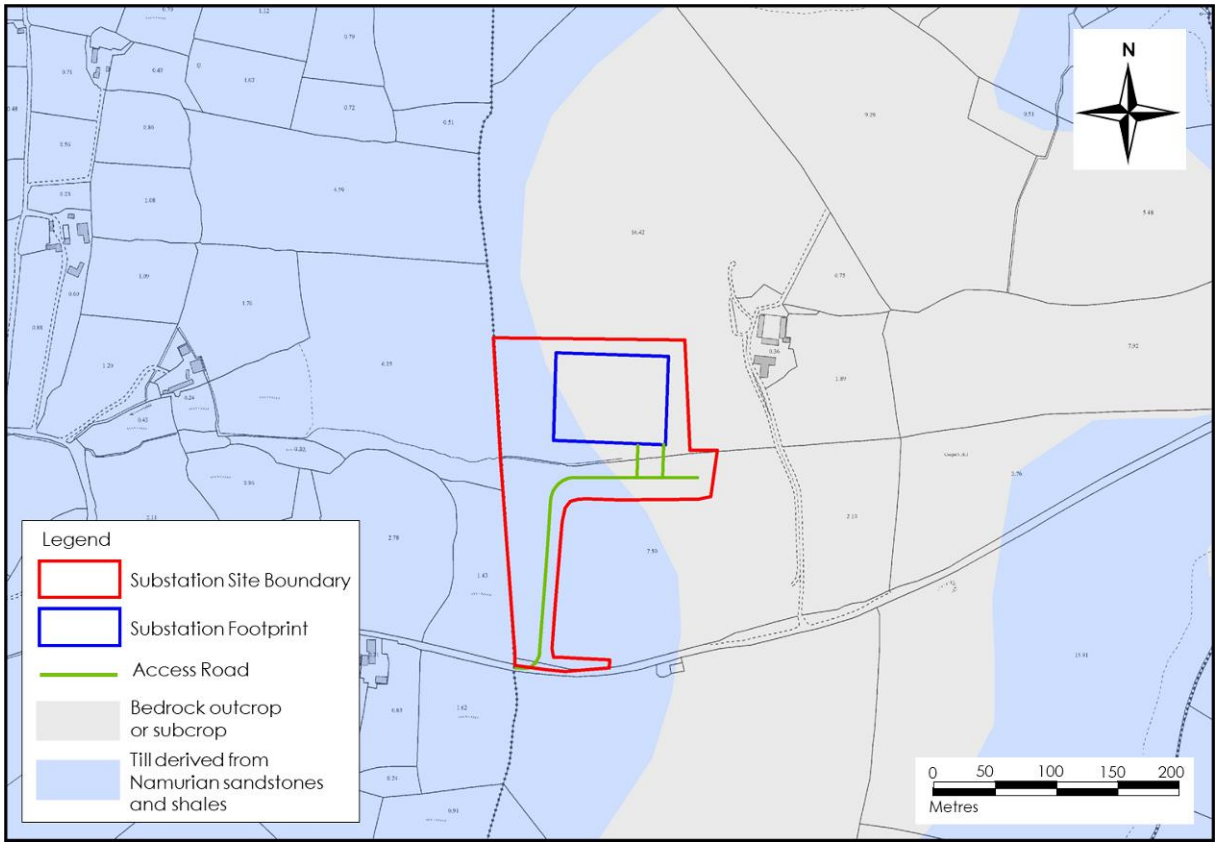

Figure 1.4 Soils Map

A summary of the trial pit results are given in Table 1.1. The full detailed records of the trial pits can be found in Appendix 1.

Table 1.1 Summary of Trial Pit Investigations

Trial Pit Name	*Location*	*Primary Subsoil Lithology*	*Depth to Bedrock (m)*
TP01	Substation site	Firm SILT	> 1.5
TP02	Substation site	Firm SILT over SAND over stiff SILT	> 3
TP03	Substation site	Firm SILT over Fine-medium GRAVEL	> 4
TP04	Substation site	Firm SILT over Fine-medium GRAVEL	3.5
TP05	Substation site	Firm SILT over Fine-medium GRAVEL	3.5
TP06	Substation site	Firm CLAY over silty GRAVEL over weathered SHALE	2.4
TP07	Substation site	Stiff SILT over weathered SHALE	3

The borehole logs, also in Appendix 1, confirm the outturn of the trial pit investigation and also provide detailed information on the underlying rock. This is a thinly interlaminated siltstone suitable for road and hardstand construction.

The factual report on the site investigation completed by Irish Drilling Limited can be found in Appendix 1.

1.5 Hydrogeology

Namurian sandstones, which are mapped to underlie the subject site are classified by the GSI (www.gsi.ie) as a Poor Aquifer, having bedrock which is generally unproductive except for local zones (Pl / Pu).

The shales and sandstones that underlie the site generally have an absence of inter- granular permeability, and most groundwater flow is expected to be in the uppermost part of the aquifer comprising a broken and weathered zone typically less than 3m thick, a zone of interconnected fissuring 10m thick, and a zone of isolated poorly connected fissuring typically less than 150m.

2 REFERENCE INFORMATION

2.1 Legislative Background

This report is carried out in accordance with the following legislation:

- S.I. 10 of 1972 Dangerous Substances Act, 1972, as amended

- S.I. No. 293 of 1988 Quality of Salmon Water Regulations
- S.I. No. 249 of 1989 Quality of Surface Water Intended for Abstraction (Drinking Water)
- S.I. No. 94 of 1997 European Communities (Natural Habitats) Regulations
- S.I. No. 41 of 1999 Protection of Groundwater Regulations
- Water Framework Directive (2000/60/EC)
- S. I. No. 600 of 2001 Planning and Development Regulations 2001, as amended
- S.I. No. 722 of 2003 European Communities (Water Policy) Regulations
- S.I. 547 of 2008 European Communities (Environmental Liability) Regulations
- S.I. No. 272 of 2009 European Communities Environmental Objectives (Surface Waters) Regulations
- S.I. No. 9 of 2010 European Communities Environmental Objectives (Groundwater) Regulations 2010
- S.I. No. 350 of 2014 European Union (Water Policy) Regulations 2014

2.2 Construction Industry Research and Information Association (CIRIA) – Guidance Manuals

- CIRIA (Construction Industry Research & Information Association) Report C502 Environmental Good Practice on Site
- CIRIA 521 - Sustainable Urban Drainage Systems; Design Manual for Scotland and Northern Ireland
- CIRIA Report C532 Control of Water Pollution from Construction Sites
- CIRIA Report C648 Control of Pollution from Linear Construction Project. Technical Guidance
- CIRIA Handbook C650 Environmental good practice on site
- CIRIA Handbook C651 Environmental good practice on site checklist
- CIRIA Report C609 - SuDS - hydraulic, structural & water quality advice
- CIRIA Report C697 - The SuDS Manual
- Guidelines on Protection of Fisheries during Construction Work in and Adjacent to Water (Inland Fisheries Ireland, January 2016).

3 DRAINAGE SYSTEM OVERVIEW

3.1 SuDS Drainage Design Criteria

The design criteria for the SuDS design are as follows:

- To minimise alterations to the ambient site hydrology and hydrogeology.
- To provide settlement and treatment controls as close to the site footprint as possible and to replicate, where possible, the existing hydrological environment of the site.
- To minimise sediment loads resulting from the development run-off during the construction phase.
- To preserve greenfield runoff rates and volumes.
- To strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed.

- To provide settlement ponds to encourage sedimentation and storm water runoff settlement.
- To reduce stormwater runoff velocities throughout the site to prevent scouring and encourage settlement of sediment locally.
- To manage the problems of erosion and allow for the effective revegetation of bare surfaces.
- To control water within the site and allow for the discharge of runoff from the site within the limits prescribed in the Freshwater Pearl Mussel and Salmonid Regulations.

3.2 SuDS Design Philosophy

The approach to treatment and attenuation of storm water is as follows:

- Additional drainage measures will only be added as necessary. The dimensions of these features will avoid intercepting large volumes of water.
- Storm water runoff from the substation platform and road will be managed via filter drains consisting of open land drains, swales and settlement ponds/lagoon type sediment traps. A toe drain will also be installed at the base of cut slopes to appropriately manage any groundwater seepage.
- Temporary erosion protection together with silt fences will be required until the vegetation becomes established (coir matting or similar).
- The substation platform and road will be constructed from aggregate and will not be generally surfaced with bitumen materials, thus helping to reduce runoff volumes. Therefore a reduced runoff coefficient of 50% is applicable.
- An additional 20% will be included to take account for global warming.
- A large portion of the hardstanding construction will be of single sized stone therefore the pore spacing in the hardstanding and access track will also act to store and attenuate water.
- The stone used for the construction of the check dams will be washed graded stone with a size range between approximately 5mm and 40mm.
- Vegetation will be reinstated on slopes as early as possible.
- The existing field drains/streams at the entrance to both the Eirgrid and IPP compounds will be piped directly under using appropriately sized drainage pipes.
- Appropriate site management measures will be taken such that runoff from the construction site is not contaminated by fuel or lubricant spillages. An oil/petrol interceptor will be installed to intercept any runoff from the substation transformer and car parking areas.
- The drainage system will be monitored regularly during the construction phase for effectiveness, and cleaned or unblocked if necessary.

3.3 Purpose of a SuDS Drainage Design

There is increased potential for water pollution, in particular sedimentation to local watercourses due to the large volumes of spoil and emplacement of stone materials during the construction stage of the project.

The purpose of incorporating a SuDS design is:

- To provide sufficient detail such that water pollution will not occur as a result of construction activities at the site and to minimise the risk of any such occurrence.

- To regulate the rate of surface water run-off downslope to prevent scouring and to encourage settlement of sediment locally.
- To minimise the quantity of sediment laden stormwater and resulting settlement pond sizes by separating “clean” water from the “dirty” development runoff.

3.4 Water Buffer Zones

Silt fences will be installed around the watercourse to prevent sediment/silt infiltration into the watercourse and best practice methods will be employed to strictly control all surface water runoff such that no silt or other pollutants shall enter watercourses. The above measures are detailed on drawing 19999-MWP-SS-00-DR-5039-P01, 19999-MWP-SS-00-DR-5040-P01 and 19999-MWP-SS-00-DR-5041-P01.

3.5 Design Philosophy

The SuDS design will be managed and monitored, at all times and particularly after storm or heavy rainfall and during construction phase environmental auditing. The design rationale is that of an integrated approach where each element of the proposed development infrastructure is assessed for its potential contribution to sediment suspension and the appropriate mitigation measures integrated into the layout design. The design principles are as follows:

Minimise → Intercept → Treat → Disperse → Dilute

Minimise

The main principle of this SuDS design is to minimise the volume of ‘dirty’ water requiring treatment through means of informed, integrated and sustainable drainage design. It achieves this by keeping ‘clean’ water clean by interception and separation, and by collecting the ‘dirty’ water and treating it by removing the suspended sediments. The resultant outflow is dispersed across vegetation, and will become diluted through contact with the clean water runoff before entering the local drainage network. Drawing 19999-MWP-SS-00-DR-5039-P01 and 19999-MWP-SS-00-DR-5040-P01 provides details of interception drains located to the north and east of the substation footprint to ensure clean water remains clean.

Intercept

The key sediment control measure is the separation of construction runoff from the clean water runoff that arises in the undisturbed areas of the site and surrounding lands. This significantly reduces the volume and velocity of dirty water that the sediment and erosion control measures need to deal with. To achieve separation, clean water infiltration interception drains are positioned on the upslope and dirty water swales positioned downslope, with site surfaces sloped towards dirty water swales where it will be intercepted and directed towards water treatment infrastructure.

Treat, Disperse and Dilute

The clean water infiltration interceptor drains are positioned upslope of the development footprint, to prevent any mixing of the clean and ‘dirty’ water. The infiltration interceptor drains redirect the clean water away from the site infrastructure, as best suits the natural topography of the site. The clean water outflow is then discharged into either the existing drainage network or dispersed through an area of vegetation where it can percolate into the ground naturally.

On the drawings 19999-MWP-SS-00-DR-5041-P01, stone berms and silt curtains are detailed. These

collect all incident rainwater that falls on the development infrastructure. These then drain into the primary and secondary settlement ponds. Dirty water is collected on each side of the southern berm to ensure all dirty water will pass through the treatment train.

4 Detailed Design Considerations

4.1.1 Infiltration Interceptor Drains

Drainage management will ensure that natural runoff is not permitted to mix with construction runoff from sources such as excavation dewatering or runoff. Design will ensure that infiltration interceptor drains are installed upslope of the development, to intercept and divert clean surface water runoff, prior to it coming in contact with areas of excavation. Design will ensure that natural runoff infiltration interceptor drains are installed ahead of main earthworks.

This is intended to reduce the flow of natural runoff onto any exposed areas of rock and soil, thereby reducing the amount of potential silt laden runoff requiring treatment. Installed drainage will allow provision for natural runoff water, upslope of the development, to collect in infiltration interceptor drains and be directed away from the development area.

Temporary silt / pollution prevention and scour protection measures will be provided in artificial natural runoff drainage installed in order to mitigate potential for scouring and transport of sediment from newly excavated channels which will be formed as part of the construction runoff drainage provisions. All drainage is to be dispersed over vegetated ground.

Frequency of outflow points are designed to avoid collection and interception of large catchments creating significant point flows, with associated risks due to scour and hydraulic capacity.

4.1.2 Settlement Ponds

Runoff from the substation compound and access track will be attenuated to mimic natural runoff patterns. Swales will be utilised to transfer runoff to settlement ponds, where the flow velocity will reduce to allow sediment and silt to be deposited. From the settlement ponds the water will flow through a tertiary treatment system, based on a design from Altmuller and Dettmer (2006), of lagoon-type sediment ponds which will absorb the fine particles that may not settle in the primary and secondary settlement ponds. All swales and ponds will be kept as shallow as possible so that they pose no health and safety risk to plant or personnel. Maximum depth of standing water will be limited to 0.75m within the settlement ponds.

The settlement ponds are utilised to attenuate rain water runoff rates to that of existing green field rates. In addition the ponds shall aid the removal of suspended solids from site runoff water.

4.1.3 Lagoon-type Sediment Traps

In addition to the settlement ponds, a tertiary treatment system will also be designed to absorb any fine particles that may not settle in the primary and secondary settlement ponds. From the settlement ponds the water will flow through lagoon-type sediment ponds which will be designed with a retention time of 10 days. The precise design of the lagoon-type sediment traps will be refined prior to construction.

If required, a final line of defence can be provided by a water treatment train such as a “Siltbuster”, if required. If the discharge water from construction areas fails to be of a high quality, then a filtration treatment system (such as a ‘Siltbuster’ or similar equivalent treatment train (sequence of water treatment processes) will be used to filter and treat all surface discharge water collected in the dirty water drainage system.

The calculations appropriate to the settlement pond design are included in Appendix 3.

The proposed development site is located in the catchment of the specified Freshwater Pearl Mussel populations as set out in First Schedule of the European Communities Environmental Objectives (Freshwater Pearl Mussel) Regulations 2009 (S.I No. 296/2009). Sedimentation poses the biggest threat to the Freshwater Pearl Mussel which is the qualifying interest of the River Barrow and River Nore SAC (Site Code: 002162). All surface water run-off shall be strictly controlled such that no silt or other pollutants enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed.

The settlement ponds and lagoon-type sediment traps will assist as part of an overall strategy to remove any risk to Freshwater Pearl Mussel in the River Nore downstream of the proposed development. It is also proposed to use Disturbed Sediment Entrainment Mats - SEDIMATS (see http://www.hy-tex.co.uk/ht_bio_sed.html) in the Knockardagur stream. These will be installed according to the manufacturer's instructions. The use of these mats will provide a further level of protection in relation to silt release.

5 CONSTRUCTION PHASE MITIGATION

5.1 Overview

A process of mitigation by avoidance has been adopted by the design team. A number of best practice SuDS mitigation measures are also proposed to minimise impacts to water quality.

The following measures will be enforced by the appointed Contractor, on site:

- All site personnel should be made aware of their environmental responsibilities at the site.
- Prior to the commencement of construction activities, silt fencing will be placed along the western boundary of the proposed development site and up-gradient of the Knockardagur stream. It is important to note that no construction activities will commence until all necessary preliminary water quality protection measures have been implemented to the satisfaction of the Ecological Clerk of Works (ECoW) and Environmental Manager (EM).
- Requirements for contractors will include contingency plans to deal with spillages, should they occur.
- Land disturbance will be kept to minimum and disturbed areas will be stabilised as soon as possible.
- In principle, soil excavation should be undertaken during dry periods, whenever possible.
- Site visits by a Design Engineer will be agreed in advance and will be undertaken at various stages of the construction process to ensure that the proposed SuDS scheme is being constructed in line with the design.
- As-built and final inspections to review the SuDS design on site will be provided by the Design Engineer.
- In order to verify the efficacy of pollution prevention and mitigation works during construction, Water Quality Monitoring will be undertaken by a suitably qualified Environmental Manager(s), prior to, during and post completion of construction works. This will include all watercourses within the catchment of the construction area. The monitoring will comprise visual, hydrochemistry and grab sample monitoring.

5.2 Working in the Vicinity of Water

The following mitigation measures apply when working on or adjacent to the drain crossings at both the entrance to the Eirgrid compound and the IPP compound.

- Avoid construction near this drain in wet weather, whenever possible.
- Stone will be of a local geochemistry i.e. be sourced from one of the nearby quarries.
- No concrete will be used in this or any watercourse.
- Runoff from excavations will not be pumped directly to this watercourse.
- Best practice construction methods will be used to protect this watercourse, such as double silt fencing, sedimats and silt bags. Tool box talks will be given to all staff on the importance of maintaining water quality. Small working areas will be used for better control of sedimentation and all works in these areas will cease during periods of high precipitation and any bare soil will be covered.

6 OPERATIONAL PHASE

The extent of any surface water to be dispersed in the operational phase is minimal given the free draining nature of the substation platform and it is considered, therefore, that greenfield runoff rates will be maintained. Local soakways will facilitate the percolation of with the runoff from the roofs of the substation buildings to ground. The volume of the runoff will be mitigated by the fact that rainwater harvesting is being implemented for use in welfare facilities at the proposed development. The drainage from the transformer and car park area will be passed through a Class 1 full retention petrol interceptor.

The construction stage silt ponds and lagoons will be retained during the operational phase. In the early months of the operational phase, the ponds and lagoons will ensure that any residual entrained sediment will be fully attenuated. Thereafter, while continuing to protect water quality within the Knockardagur stream, they can be allowed to become overgrown and will become a localised environmental asset.

7 CONCLUSION

The drainage measures proposed provide a surface water management regime that will mitigate any adverse impact on the hydrology of the site and the wider environment during the construction phase of the project.

All drains and streams on and in the vicinity of the proposed development site have been surveyed in detail. By incorporating a SuDS design, all surface water run-off shall be strictly controlled such that no silt or other pollutants enter watercourses and that no artificially elevated levels of downstream siltation or no plumes of silt arise when substratum is disturbed. The drainage design adopts the following temporary works during the construction phase:

- Infiltration Interception Drains for upslope “clean” water
- Filtration Check Dams to reduce velocities along steeper slopes
- Settlement Ponds/sediment traps to control and store development runoff and to encourage settlement prior to discharge.
- Greenfield Runoff for the site will not be exceeded and settlement ponds/ Lagoon-type sediment traps have been designed to ensure that the capacity is adequate to achieve this.

The drainage system has been designed to mimic greenfield runoff rates so as to be capable of accommodating the extra volumes of surface water to avoid any flooding downstream of the proposed development.

In order to verify the efficacy of pollution prevention and mitigation works during construction, Water

Quality Monitoring will be undertaken by a suitably qualified Environmental Manager(s), prior to, during and post completion of construction works. This will include the runoff from the settlement ponds. The monitoring will comprise visual, hydrochemistry and grab sample monitoring.

Appendix 1

Site Investigation Report

IRISH DRILLING LIMITED

LOUGHREA, CO. GALWAY, IRELAND

CONTRACT DRILLING
SITE INVESTIGATION

Phone: (091) 841 274
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PINEWOOD WIND FARM
110kv Substation

FACTUAL REPORT

Galetech Energy Developments Ltd.,
Clondargan,
Stradone,
Co. Cavan.

	Prepared by	Approved by	Rev. Issue Date:	Revision No.
	Ronan Killeen	Declan Joyce	7th February 2019	19 LS/102-1
Signature				

FOREWORD

The probe 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 probe 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.

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3.0	Fieldwork

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Appendix 1	Trial Pit Records
Appendix 2	Dynamic Probe Records
Appendix 3	Photographs (Trial Pits)
Appendix 4	‘As-Built’ Sketch

1.0 Introduction.

Irish Drilling Ltd. (IDL) was instructed by Galetech Energy Developments Ltd, to carry out a site investigation at the site of the proposed Pinewood Wind Farm Project.

This site investigation was carried out to provide detailed factual geotechnical information of the underlying ground conditions at possible 110kv substation locations for the wind farm.

The fieldwork was carried out on January 21st 2019.

2.0 Site & Geology

The site is located in County Laois.

The fieldwork was carried out predominantly on agricultural lands.

A Site Location Plan, prepared by the client's representatives to show approximate fieldwork locations, is included with this factual report.

An 'As-Built' sketch, prepared by IDL to show 'as-built' locations is included as Appendix 4 of this factual report.

3.0 Fieldwork.

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

Geotool DPH Rig.
Daewoo 14T Excavator.

Fieldwork carried out to date has included the following:

Seven 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.

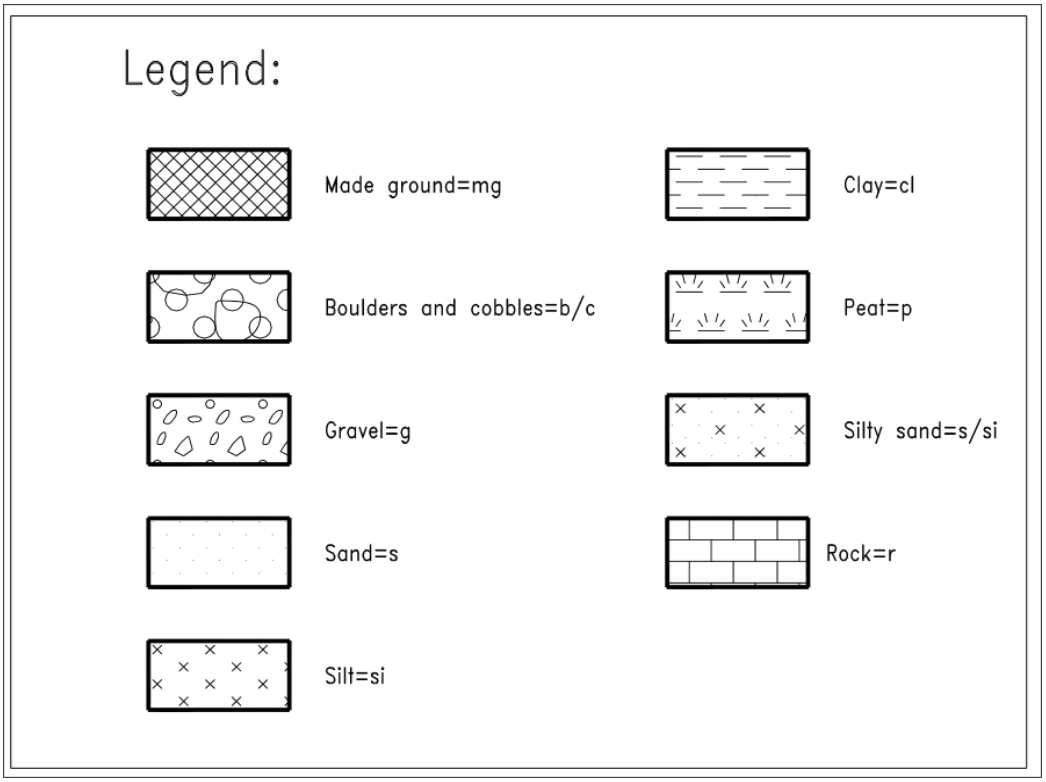
The records of same are included in Appendix 1 of this Factual Report.

Seven dynamic probes were carried out to 'refusal' using a LMSR-V(k) Geotool Dynamic Probing Rig. The dynamic probes were carried out as Dynamic Probe 'Heavy' (DPH).

The Dynamic Probing Rig involves the dropping of a 50kg hammer onto rods from a standard height (500mm) and recording the number of blows it takes to penetrate the rods (with a cone tip) a depth of 100mm into the soil.

The records of same are included in Appendix 2 of this Factual 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 Glacial Tills.

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

Possible weathered bedrock was encountered in trial pit TP 06 at a depth of 1.30m below ground level.

Reference should be made to the engineering logs for a detailed description of the ground conditions encountered.

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 National Grid (ING) with Reduced Levels recorded relative to Malin Head Datum and with an accuracy level of + or – 0.10m.

The soil and rock descriptions as noted on the 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.

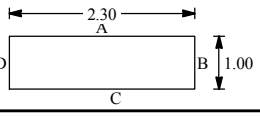
The records of all fieldwork and photographs are included in the appendices of this Factual Report.

Ronan Killeen
Chartered Engineer
Irish Drilling Limited
February 8th 2019

PROJECT: Pinewood Wind Farm	**TRIALPIT: TP01**
LOCATION: Co Laois	**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates: E 650,336.9 N 682,107.0**
ENGINEER: Galetech Energy Developments	**Rig: Daewoo tracked excavator**
Ground level: 228.51m O.D.	**Rev: DRAFT**
GROUNDWATER	**DATE: 21.1.19**

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.00 * 2.30m
LOGGED BY: MM



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							228.36	0.15	TOPSOIL: Grass over firm dark brown slightly gravelly SILT. Gravel is fine.
							227.61	0.90	Firm orange mottled grey SILT.
1			B 1 D 2	1.20-1.50 1.20-1.50			227.01	1.50	Firm orange mottled grey gravelly SILT. Gravel is angular to subangular and flat fine to medium of shale. 1.00m to 1.50m: with lenses of wet bluish grey gravelly coarse sand. Gravel is angular to subrounded fine to medium.
						END			TP terminated at 1.50m bgl on REs instruction.
2									
3									
4									
5									

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

Scale: 1:25

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TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

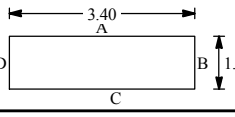
PROJECT: Pinewood Wind Farm
LOCATION: Co Laois
TRIALPIT: TP02
Sheet 1 of 1

CLIENT: Galetech Energy Developments
ENGINEER: Galetech Energy Developments
Co-ordinates: E 650,317.9 N 682,215.6
Rig: Daewoo tracked excavator
Rev: DRAFT

Ground level: 225.67m O.D.
DATE: 21.1.19

GROUNDWATER
Water strikes: Rose to after:
1st: 2.60m
2nd:
3rd:

PIT DIRECTION: 000-180
PIT DIMENSION: 1.50 * 3.40m
LOGGED BY: MM



Shoring/Support: N/A
Stability: Pit unstable. Sidewall collapse from 2.10m bgl.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0							225.47	0.20	TOPSOIL: Grass over firm dark brown slightly sandy slightly gravelly SILT.
			B 1 D 2	0.90-1.30 0.90-1.30			224.27	1.40	Firm grey mottled orange slightly sandy gravelly SILT. Gravel is rounded to subrounded fine to medium.
1			B 3 D 4	1.40-1.60 1.40-1.60			223.57	2.10	Bluish grey silty gravelly SAND. Gravel is rounded to subangular and flat fine to coarse.
2			B 5 D 6	2.10-2.50 2.10-2.50			222.67	3.00	Stiff pinkish grey slightly sandy gravelly SILT interbedded with lenses of wet clayey fine sand.
3						END			TP terminated at 3.00m bgl on REs instruction.
4									
5									

Remarks: Ingress of water at 2.60m bgl. TP backfilled with arisings.

Scale: 1:25

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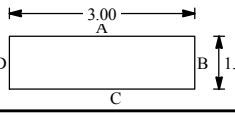
PROJECT: Pinewood Wind Farm	**TRIALPIT: TP03**
LOCATION: Co Laois	**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates: E 650,316.4 N 682,298.4** / **Rig: Daewoo tracked excavator**
ENGINEER: Galetech Energy Developments	**Rev: DRAFT**
Ground level: 224.67m O.D.	**DATE: 21.1.19**

GROUNDWATER

Water strikes: **Rose to after:**
1st: 2.40m
2nd: 4.00m
3rd:

PIT DIRECTION: 000-180
PIT DIMENSION: 1.50 * 3.00m
LOGGED BY: MM



Shoring/Support: N/A
Stability: Pit unstable. Sidewall collapse from 3.50m bgl.

Depth (m)	Date	Water	Samples	Depth (m)	In-situ Vane Tests	LEGEND	Elevation m O.D.	Depth (m)	DESCRIPTION
0									Grass and rushes over firm brown mottled orange slightly sandy gravelly SILT. Gravel is rounded to subrounded fine to medium.
1			B 1 D 2	1.30-1.50 1.30-1.50					1.30m: mottled bluish grey.
2		1	B 3 D 4	2.40-2.60 2.40-2.60			222.17	2.50	
							221.67	3.00	Wet light brown gravelly sandy SILT with cobbles.
3			B 5	3.50-4.00			220.67	4.00	Wet pinkish brown silty sandy angular to subangular fine to medium shale GRAVEL with cobbles. Sand is medium to coarse. Cobbles are flat to subrounded of shale.
4		2	W	4.00		**END**			TP terminated at 4.00m bgl on REs instruction.
5									

Remarks: Moderate ingress of water at 2.40m bgl. Rapid ingress of water at 4.00m bgl. TP backfilled with arisings.

Scale: 1:25

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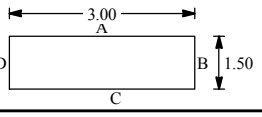
TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

PROJECT: Pinewood Wind Farm		**TRIALPIT: TP04**
LOCATION: Co Laois		**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates:**	**Rig: Daewoo tracked excavator**
ENGINEER: Galetech Energy Developments	**E 650,401.6 N 682,226.2**	**Rev: DRAFT**
Ground level: 232.71m O.D.		**DATE: 21.1.19**

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

PIT DIRECTION: 220-040
PIT DIMENSION: 1.50 * 3.00m
LOGGED BY: MM



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							232.41	0.30	TOPSOIL: Grass over firm grey SILT.
			B 1 D 2	0.70-1.00 0.70-1.00			231.31	1.40	Firm orange mottled grey slightly sandy slightly gravelly SILT.
			B 3 D 4	1.40-1.70 1.40-1.70			230.01	2.70	Stiff damp dark brown slightly sandy gravelly SILT with cobbles. Gravel is angular to subangular fine to medium. Cobbles are of shale.
			B 5 D 6	2.70-3.00 2.70-3.00			229.21	3.50	Wet pinkish brown slightly sandy silty very angular to subangular fine to medium GRAVEL.
						END			TP terminated at 3.50m bgl - obstruction.

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

Scale: 1:25

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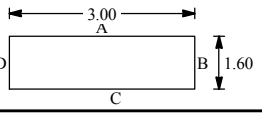
TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

PROJECT: Pinewood Wind Farm		**TRIALPIT: TP05**
LOCATION: Co Laois		**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates:**	**Rig: Daewoo tracked excavator**
ENGINEER: Galetech Energy Developments	**E 650,298.8 N 682,417.4**	**Rev: DRAFT**
Ground level: 227.03m O.D.		**DATE: 21.1.19**

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

PIT DIRECTION: 320-140
PIT DIMENSION: 1.60 * 3.00m
LOGGED BY: MM



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							226.73	0.30	TOPSOIL: Grass and rushes over firm dark grey SILT.
			B 1 D 2	0.30-0.50 0.30-0.50			225.53	1.50	Firm greyish brown mottled orange slightly sandy slightly gravelly SILT.
1									
			B 3 D 4	1.50-1.80 1.50-1.80			224.83	2.20	Stiff dark pinkish grey slightly sandy SILT with pockets of very soft silt.
2									
			B 5	2.20-2.50			224.33	2.70	Wet pinkish grey slightly sandy gravelly SILT. Gravel is subangular to angular fine to medium.
							223.53	3.50	Wet pinkish grey silty angular to subangular fine to medium GRAVEL.
3						END			TP terminated at 3.50m bgl - obstruction.
4									
5									

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

Scale: 1:25

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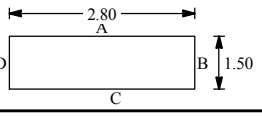
TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

PROJECT: Pinewood Wind Farm	**TRIALPIT: TP06**
LOCATION: Co Laois	**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates: E 650,376.9 N 682,425.0**
ENGINEER: Galetech Energy Developments	**Rig: Daewoo tracked excavator**
Ground level: 237.96m O.D.	**Rev: DRAFT**
	DATE: 21.1.19

GROUNDWATER

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

PIT DIRECTION: 000-180
PIT DIMENSION: 1.50 * 2.80m
LOGGED BY: MM



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							237.76	0.20	TOPSOIL: Grass and rushes over firm dark grey SILT.
							237.26	0.70	Firm brownish orange silty CLAY.
			B 1	0.70-1.30			236.66	1.30	Greyish brown silty sandy subangular to angular shale GRAVEL.
1									
							235.56	2.40	Possible weathered SHALE rock. Recovered as angular to subangular cobble and boulder sized clasts of shale with orangish brown sandy silt.
2									
						END			TP terminated at 2.40m bgl - obstruction.
3									
4									
5									

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

Scale: 1:25

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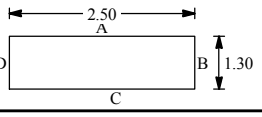
TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

PROJECT: Pinewood Wind Farm		**TRIALPIT: TP07**
LOCATION: Co Laois		**Sheet 1 of 1**
CLIENT: Galetech Energy Developments	**Co-ordinates:**	**Rig: Daewoo tracked excavator**
ENGINEER: Galetech Energy Developments	**E 650,389.9 N 682,352.5**	**Rev: DRAFT**
Ground level: 233.95m O.D.		**DATE: 21.1.19**

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

PIT DIRECTION: 090-270
PIT DIMENSION: 1.30 * 2.50m
LOGGED BY: MM



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									
							233.65	0.30	TOPSOIL: Firm light brown SILT.
									Stiff brown mottled greyish orange slightly sandy slightly gravelly SILT with cobbles. Gravel is angular to subangular and flat of shale. Cobbles are angular to subangular.
1									
									1.20m damp light brownish orange.
			B 1 D 2	1.70-1.90 1.70-1.90					
2							231.65	2.30	
									Possible weathered SHALE rock. Recovered as wet angular to subangular fine to medium gravel sized clasts of shale with brownish orange and bluish grey silty sand.
3							230.95	3.00	
							END		TP terminated at 3.00m bgl - obstruction.
4									
5									

Remarks: TP wet from 2.30m bgl. TP backfilled with arisings.

Scale: 1:25

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TRIAL PIT VANE & WL RISES PINEWOOD WD TPS FILE 1 W COORDS JAN 29 2019.GPJ IRISHDRL.GDT 08/02/19

Figure 1 H:\2019LS102_Pinewood\Pictures\TP-1 (1).JPG

Figure 4 H:\2019LS102_Pinewood\Pictures\TP-2 (2).JPG

Figure 2 H:\2019LS102_Pinewood\Pictures\TP-1 (2).JPG

Figure 5 H:\2019LS102_Pinewood\Pictures\TP-3 (1).JPG

Figure 3 H:\2019LS102_Pinewood\Pictures\TP-2 (1).JPG

Figure 6 H:\2019LS102_Pinewood\Pictures\TP-3 (2).JPG

Figure 7 H:\2019LS102_Pinewood\Pictures\TP-4 (1).JPG

Figure 8 H:\2019LS102_Pinewood\Pictures\TP-4 (2).JPG

Figure 9 H:\2019LS102_Pinewood\Pictures\TP-5 (1).JPG

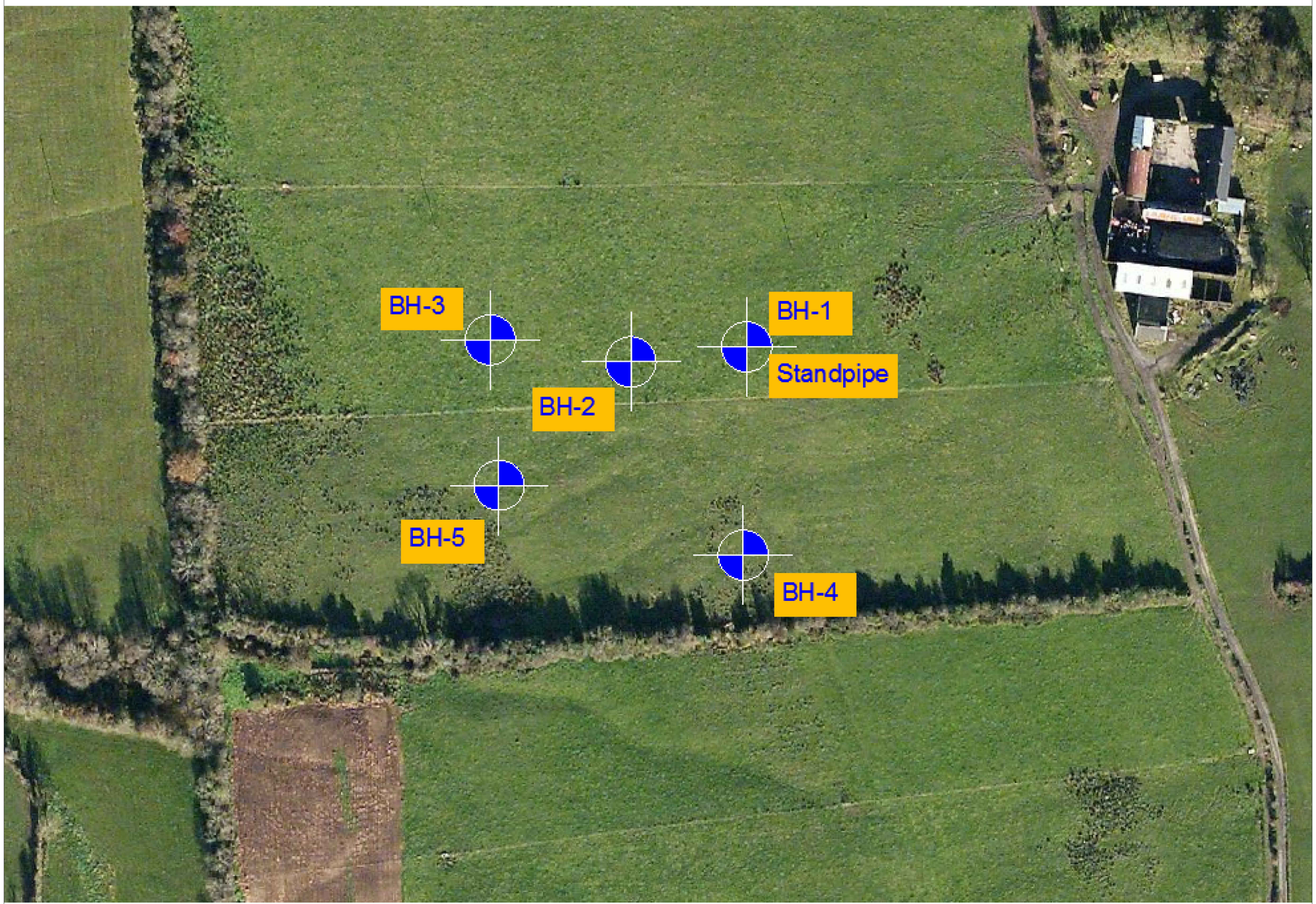
Figure 10 H:\2019LS102_Pinewood\Pictures\TP-5 (2).JPG

Figure 11 H:\2019LS102_Pinewood\Pictures\TP-6 (1).JPG

Figure 12 H:\2019LS102_Pinewood\Pictures\TP-6 (2).JPG

Figure 13 H:\2019LS102_Pinewood\Pictures\TP-7 (1).JPG

Figure 14 H:\2019LS102_Pinewood\Pictures\TP-7 (2).JPG



General Notes

No.	Revision/Issue	Date

Firm Name and Address

Project Name and Address

PINEWOOD

Project	Sheet
Date 16/07/2020	
Scale Not to Scale	

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH01**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	30-06-20 01-07-20		E 650,457.1 N 682,406.8

Engineer	Sheet	Rev.
Malachy Walsh & Partners	1 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
0.00	44 (-) -	NA 1.80 (32)			(3.20)	0.00 - 3.20 m: overburden	Firm orangish brown sandy gravelly SILT. Sand is coarse. Gravel is subangular fine to coarse of assorted brown and grey siltstone.		
1.80	25 (-) -								
3.00		3.00(53/150mm)			3.20				
3.70	100 (0) 0					3.20 - 10.40 Non-intact as weathered rock. No recovery as washout of fines during drilling. No record of cavity.	Weathered SILTSTONE rock. Recovered as angular fine to coarse gravel sized clasts of strong to medium strong thinly laminated dark grey fine grained siltstone with a little grey silt and surficial orange and orangish brown iron stain and powder.		
5.00	53 (14) 0								
6.50	100 (18) 0	NR/NI			(7.20)				
8.00	100 (24) 0								
9.50	100 (28) 0								
30.06 11.00	100 (34) 0	NI 20			10.40	10.40 - 15.00 Discontinuities, very closely spaced, locally closely spaced,			

Drilling Progress and Water Observations

Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing
30-06-20	17.30	11.00		99	63		
01-07-20	08.00	11.00		99	63		

Rotary Flush

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives.
50mm standpipe installed.
Response zone 2.50m to 15.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH01**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	30-06-20 01-07-20		E 650,457.1 N 682,406.8

Engineer	Sheet	Rev.
Malachy Walsh & Partners	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
01.07 12.50	100 (46) 0	28 NI				dipping 8 to 10°, planar, smooth, with 0.5 to 1mm thick dark grey silt smear and surficial orange and orangish brown iron stain and powder. 12.00 - 12.50 Non-intact as medium gravel sized clasts.	Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder. *(continued)*		
    14.00	100 (60) 33	4 29			(4.60)				
    01.07 15.00	100 (91) 47	13			15.00				
							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
01-07-20	12.00	15.00		99	63		

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives.
50mm standpipe installed.
Response zone 2.50m to 15.00m bgl.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

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DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH02**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	01-07-20 01-07-20		E 650,420.0 N 682,402.4

Engineer	Sheet	Rev.
Malachy Walsh & Partners	1 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
0.00	30 (-) -					0.00 - 2.50 m: overburden	Stiff orangish greyish brown slightly sandy CLAY. Sand is coarse.		
1.00		1.00 (10) NA			(2.00)				
2.00	60 (-) -				2.00				
		2.00 (29)			2.50		Stiff dark brown gravelly SILT. Gravel is subangular fine of assorted brown and grey siltstone.		
3.50	87 (6) 0					2.50 - 15.00 Discontinuities, closely spaced, locally very closely spaced, dipping 8 to 10°, planar, smooth, with 0.5 to 1mm thick orangish brown clay smear and surficial orange and orangish brown iron stain and powder.	Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder.		
5.00	100 (8) 0				(3.30)				
6.50	93 (23) 0	NR/NI			5.80	5.00 - 6.50 Non-intact as extremely closely spaced discontinuities. No recovery as washout of fines during drilling. No record of cavity.	Strong thinly interlaminated dark grey fine grained siltstone with grey fine grained SANDSTONE.		
8.00	100 (56) 0				(2.90)				
9.50	100 (76) 21				8.70		Strong locally medium strong thinly laminated dark grey slightly sandy fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder.		
11.00	100 (50) 15					9.70 - 10.70 Joint, subvertical dip, stepped, smooth, with 0.5 to 1mm thick orangish brown clay smear and surficial orange and orangish brown iron stain and powder, open. 10.80 - 11.80 Joint, subvertical dip,			

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	water	100

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH02**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	01-07-20 01-07-20		E 650,420.0 N 682,402.4

Engineer	Sheet	Rev.
Malachy Walsh & Partners	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
12.50	100 (61) 37	NI 6			(6.30)	planar, smooth, with 0.5 to 1mm thick orangish brown clay smear and surficial orange and orangish brown iron stain and powder, open.	Strong locally medium strong thinly laminated dark grey slightly sandy fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder. *(continued)* 11.80m to 15.00m: becoming slightly sandy fine and medium grained.		
13.80	100 (83) 10	16 18							
01.07 15.00	100 (96) 38	9			15.00		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
01-07-20	16.00	15.00		99	63		

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH03**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	02-07-20 02-07-20		E 650,375.6 N 682,409.9

Engineer	Sheet	Rev.
Malachy Walsh & Partners	1 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
0.00	80 (-) -	1.00 (12) NA			(2.80)	0.00 - 2.80 m: overburden	Stiff orangish greyish brown slightly sandy CLAY. Sand is medium to coarse.		
1.00									
2.00	30 (-) -	2.00 (27)							
	46 (0) 0				2.80	2.80 - 6.50 Non-intact as weathered rock.	Weathered SILTSTONE rock. Recovered as angular fine to coarse gravel sized clasts of strong to medium strong thinly laminated dark grey fine grained siltstone with a little orangish brown clay and surficial orange and orangish brown iron stain and powder.		
3.50									
	100 (19) 0	NI			(3.70)				
5.00						5.00 - 6.50 Non-intact as extremely and very closely spaced discontinuities.			
	100 (57) 0								
6.50					6.50	6.50 - 15.00 Discontinuities, closely spaced, locally very closely spaced, dipping 10 to 12°, planar, smooth, with 0.5 to 2mm thick orangish brown clay smear and surficial orange and orangish brown iron stain and powder.	Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder.		
	100 (71) 7								
8.00									
	100 (84) 44	NI							
9.50									
	100 (61) 28					10.15 - 10.80 Joint, subvertical dip, planar, smooth, with 0.5 to 2mm thick grey silt smear and surficial orange and orangish brown iron stain and			
11.00					(8.50)				

Drilling Progress and Water Observations								Rotary Flush				GENERAL REMARKS
Date	Time	Depth	Casing Depth	Casing Dia	Core Dia mm	Water Strike	Water Standing	From (m)	To (m)	Type	Return (%)	
								0	15.00	water	100	Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH03**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	02-07-20 02-07-20		E 650,375.6 N 682,409.9

Engineer	Sheet	Rev.
Malachy Walsh & Partners	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
	100 (51) 19	NI				powder, open. 11.25 - 12.40 Joint, subvertical dip, planar, smooth, with 0.5 to 1mm thick surficial orange and orangish brown iron stain and powder, open.	Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE with surficial orange and orangish brown iron stain and powder. *(continued)*		
12.50									
	100 (89) 23					13.70 - 14.60 Joint, subvertical dip, planar, smooth, with 0.5 to 1mm thick surficial orange and orangish brown iron stain and powder, open.			
14.00									
	100 (59) 0								
02.07 15.00					15.00		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
02-07-20	16.00	15.00		99	63		

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH04**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	06-07-20 06-07-20		E 650,456.0 N 682,340.9

Engineer	Sheet	Rev.
Malachy Walsh & Partners	1 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
0.00	90 (-) -				(0.60) 0.60	0.00 - 3.50 m: overburden	Firm light brown CLAY.		
1.00		1.00 (18)					Firm orangish brown sandy gravelly SILT. Sand is coarse. Gravel is subangular fine to medium of assorted brown and grey siltstone.		
2.00	40 (-) -	NA			(2.90)				
3.50	100 (-) -	2.00 (34)			3.50				
5.00	100 (0) 0	NI			(1.70) 5.20	3.50 - 5.20 Non-intact as weathered rock.	Weathered SILTSTONE rock. Recovered as angular fine to coarse gravel sized clasts of strong to medium strong thinly laminated dark grey fine grained siltstone with surficial orange and orangish brown iron stain and powder.		
6.50	100 (51) 0	28				5.20 - 10.70 Discontinuities, very closely spaced, locally closely spaced, dipping 8 to 10°, planar, smooth, with 0.5 to 1mm thick dark grey silt smear and surficial orange and orangish brown iron stain and powder.	Strong thinly laminated dark grey fine grained SILTSTONE.		
		20							
8.00	100 (69) 14	NI 25			(5.50)				
9.50	100 (84) 57	18							
		20							
11.00	100 (55) 9	29			10.70	10.70 - 13.10 Discontinuities, closely			

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	water	100

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH04**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	06-07-20 06-07-20		E 650,456.0 N 682,340.9

Engineer	Sheet	Rev.
Malachy Walsh & Partners	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
		6				spaced, locally medium spaced, dipping 8 to 10°, planar, smooth, with 0.5 to 1mm thick orangish brown clay smear and surficial orange and orangish brown iron stain and powder.	Strong thinly interlaminated dark grey fine grained siltstone with grey fine grained SANDSTONE. *(continued)*	
	100 (97) 58	9			(2.40)	12.10 - 12.30 Joint, subvertical dip, stepped, rough, with 0.5 to 1mm thick light brown silt smear, open.		
12.50		8			13.10			
	100 (89) 43	10				13.10 - 15.00 Discontinuities, very closely spaced, locally closely spaced, dipping 8 to 10°, planar, smooth, with 0.5 to 1mm thick dark grey silt smear and surficial orange and orangish brown iron stain and powder.	Strong thinly laminated dark grey fine grained SILTSTONE.	
14.00					(1.90)	14.05 - 14.70 Joint, subvertical dip, planar, smooth, with 0.5 to 1mm thick grey silt smear and minor surficial orangish brown iron stain and powder, open.		
	100 (82) 27	11						
06.07 15.00					15.00		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
06-07-20	16.00	15.00		99	63		

Rotary Flush

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH05**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	03-07-20 03-07-20		E 650,377.8 N 682,362.3

Engineer	Sheet	Rev.
Malachy Walsh & Partners	1 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
0.00	45 (-) -	1.00 (9)			(1.70)	0.00 - 3.30 m: overburden	Stiff orangish brown CLAY.		
1.00									
1.70									
2.00	45 (-) -	NA					Stiff orangish brown sandy gravelly SILT. Sand is coarse. Gravel is subrounded to subangular fine to coarse of assorted brown siltstone.		
		2.00 (22)							
3.30	46 (-) -				(1.60)				
					3.30				
4.90	100 (50) 0	NI				3.30 - 4.50 Non-intact as extremely and very closely spaced discontinuities.	Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE.		
		12				4.50 - 15.00 Discontinuities, closely spaced, locally very closely spaced to 10.00m, then medium spaced, locally close, dipping 10 to 12°, planar, smooth, with 0.5 to 4mm thick grey silt smear.			
5.40	100 (94) 0	24				5.55 - 6.00 Joint, subvertical dip, planar, smooth, with 0.5 to 3mm thick grey silt smear and surficial orange and orangish brown iron stain and powder, open to moderately wide.			
6.50	100 (77) 11	28							
8.00	100 (67) 14	23				7.60 - 8.10 Joint, subvertical dip, planar, smooth, with 0.5 to 3mm thick grey silt smear and surficial orange and orangish brown iron stain and powder, open to moderately wide.			
9.30	100 (70) 24	18			(11.70)				
		26				9.50 - 10.00 Joint, subvertical dip, planar, smooth, with 0.5 to 3mm thick grey silt smear and surficial orange and orangish brown iron stain and powder, open to moderately wide.			
10.90	100 (81) 66	4							

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	water	100

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

irish drilling

DRILLHOLE LOG

Project	Location	DRILLHOLE No
Pinewood Wind Farm	County Laois	**BH05**

Job No	Date	Ground Level (m OD)	Co-Ordinates ()
2019LS102	03-07-20 03-07-20		E 650,377.8 N 682,362.3

Engineer	Sheet	Rev.
Malachy Walsh & Partners	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
	100 (95) 77	6						Strong locally medium strong thinly laminated dark grey fine grained SILTSTONE. *(continued)*		
12.50		6				12.35 - 12.50 Joint, subvertical dip, planar, smooth, with 0.5 to 3mm thick grey silt smear and surficial orange and orangish brown iron stain and powder, open to moderately wide.				
	100 (76) 21	10				13.30 - 14.00 Joint, subvertical dip, planar, smooth, with 0.5 to 3mm thick grey silt smear and surficial orange and orangish brown iron stain and powder, open to moderately wide.		13.00m to 13.10m: grey gravelly silt. gravel is angular fine of siltstone.		
14.00										
	100 (96) 94	5								
03.07 15.00					15.00					
								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
03-07-20	17.30	15.00		99	63		

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

GENERAL REMARKS

Co-ordinates supplied by Client representatives. BH backfilled.

All dimensions in metres Scale 1:68.75	Client: Statkraft Ireland	Method/ Plant Used: Hydreq	Bit: HQ Design	Driller: IP	Logged By: EAT

IDL AGS UK DH (SPTS) PINEWOOD WF RC FILE 1 JULY 15 2020.GPJ IDL TP TEMPLATE.GDT 15/7/20

Appendix 2

Drawings

NOTES:

1. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, BILLS OF QUANTITIES, ARCHITECTURAL, SERVICES AND ENGINEERING DRAWINGS.
2. ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM MALIN HEAD.
3. ANY DISCREPANCIES BETWEEN THESE DOCUMENTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
4. DRAWINGS ARE NOT TO BE SCALED.
5. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.

LEGEND:

- Existing Contours
- Existing Spot Levels
- Proposed Levels
- Site Boundary
- Area Of Fill
- Area of Cut
- Internal Compound Embankment
- Berm
- Clean Water Land Drainage
- Dirty Water Drainage
- Silt Fencing
- Silt Curtain
- Toe Drain

1m High Berm

Overhead ESB Cables

Clean Drain Water

Toe Drain

Toe Drain Connected To Dirty Water Runoff During Construction Period.
Drain To Be Diverted To Clean Water Drain Post Construction

Overflow Level
Spreader Discharge
To Existing Vegetation

Lagoon Area - 803m²
Depth - 1.0m
Volume - 803m³

1m High Berm

Dirty Water Drain

Pond Area - 110m²
Length - 22m
Depth - 0.75m
Width - 5m

Eirgrid Building FFL 237.500m

IPP Building FFL 240.500m

Toe Drain

Toe Drain

Toe Drain

3m Embankment @ 20°

Eirgrid Compound Level 237.250m

IPP Compound Level 240.250m

Eirgrid Compound Level 234.250m

NOTE
Pond - Development Area - 5697m²
Length - 22m
Width - 5m
Depth - 0.75m
Volume - 82.5m³
Settlement Pond Velocity - .00137m/s
Settlement Pond Duration - >4hrs

Lagoon
Contributing Area - 5697m²
10 Day Rainfall - 0.1678
C - 0.7
Volume - 803m³
Depth - 1m
Area - 803m²

Typical Settlement Ponds

Clean Drain Water

Silt Fences

450mm Ø Ridgidrain to dirty drain over extent of compound access

Stone Berm

Stone Berm

Dirty Water Drain

Stone berm with silt curtain

Silt curtain

Existing Land Drain

450mm Ø Ridgidrain to dirty drain over extent of compound access

900mmØ S&S Concrete Pipes
Cross Drain to existing
Land Drain

Clean Water Swale

Substation Site Drainage Layout Plan

Scale: 1:250

REV	DATE	DESCRIPTION	BY	APP
P02	09.09.2020	ISSUED FOR PLANNING	SM	JOL
P01	02.09.2020	ISSUED FOR PLANNING	SM	JOL

PROJECT: PINEWOOD 110kV SUBSTATION

TITLE: SUBSTATION DRAINAGE LAYOUT - CONSTRUCTION PHASE

CLIENT:

Malachy Walsh and Partners
Engineering and Environmental Consultants
Cork | Tralee | London | Limerick

Reen Point,
Blennerville,
Tralee,
Co. Kerry,
V92 X2TK

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Fax. : +353 (0) 66 7126586
E-mail : tralee@mwp.ie
Web : www.mwp.ie

DRAWN: SM	CHECKED: JOL	APPROVED: JOL
DATE: 02.09.2020	SCALE @ A0: Varies	
PROJECT NUMBER: 19999		DRAWING STATUS: S2
DRAWING NUMBER: 19999-MWP-SS-00-DR-C-5039		REV: P02

Pond Area - 110m²
Length - 22m
Depth - 0.75m
Width - 5m

Eirgrid Compound Level 234.250m

450mm Ø Ridgidrain to dirty drain over extent of compound access

Silt Fences

Stone Berm

Dirty Water Drain

Stone Berm

Stone berm with silt curtain

Silt curtain

Existing Land Drain

450mm Ø Ridgidrain to dirty drain over extent of compound access

900mmØ S&S Concrete Pipes Cross Drain to existing Land Drain

Clean Water Swale

Overflow Level Spreader Discharge To Existing Vegetation

10.0m Ø Lagoon

1m High Berm

Settlement Pond 9 x 1.2 x 0.75m

Clean Water Drain

Dirty Water Drain

Clean Water Drain

Dirty Water Swale - Check Dams To Be Provided At 10m c/c. Refer To Sections A-A

Clean Water Discharges

A

Check Dams To Be Provided At 10m c/c

Substation Site Drainage Layout Plan

Scale: 1:500

NOTE

Roadside Pond - Contributing Area - 420m²

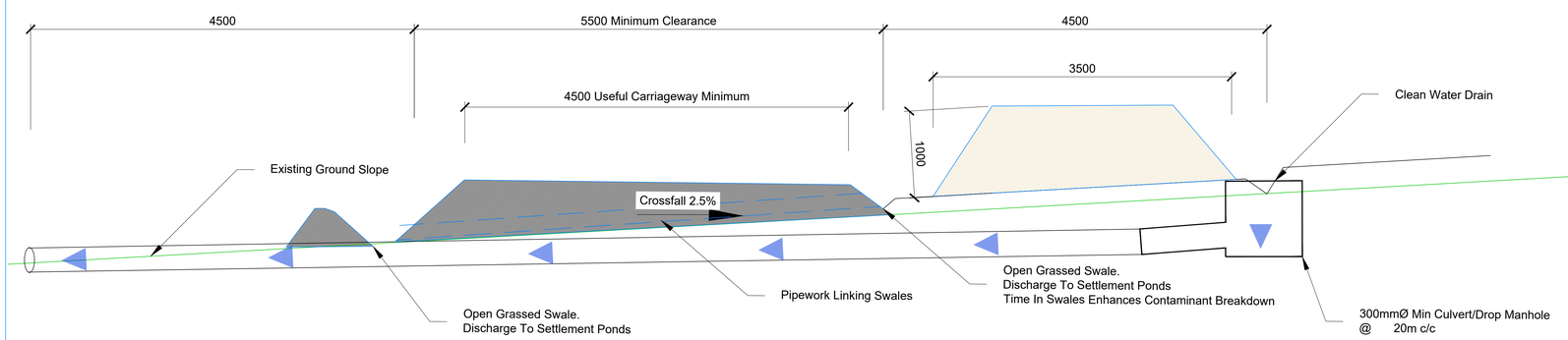
Length - 9.0m
Width - 1.2m
Depth - 0.75m
Volume - 8.1m³
Area - 10.8m²
Settlement Pond Velocity - .0023m/s

Lagoon

Contributing Area - 420m²
10 Day Rainfall - 0.1678
C - 0.7
Volume - 60m³
Depth - 0.75m
Area - 80m²

NOTE

For Silt Fencing Details Refer To Drawing No. 19999-MWP-SS-00-DR-C-5041



Section A-A

Scale: NTS

DO NOT SCALE FROM THIS DRAWING. USE FIGURED DIMENSIONS IN ALL CASES. VERIFY DIMENSIONS ON SITE AND REPORT ANY DISCREPANCIES TO THE DESIGNERS IMMEDIATELY.
THIS DRAWING TO BE READ IN CONJUNCTION WITH THE DESIGNERS SPECIFICATION.

NOTES:

1. ALL DRAWINGS ARE TO BE READ IN CONJUNCTION WITH ALL RELEVANT SPECIFICATIONS, BILLS OF QUANTITIES, ARCHITECTURAL, SERVICES AND ENGINEERING DRAWINGS.
2. ALL LEVELS ARE IN METRES RELATED TO ORDNANCE DATUM MALIN HEAD.
3. ANY DISCREPANCIES BETWEEN THESE DOCUMENTS SHALL BE BROUGHT TO THE ATTENTION OF THE ENGINEER.
4. DRAWINGS ARE NOT TO BE SCALED.
5. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.

LEGEND:

- Existing Contours
- Existing Spot Levels
- Proposed Levels
- Site Boundary
- Area of Fill
- Area of Cut
- Internal Compound Embankment
- 1m High Mound
- Clean Water Land Drainage
- Dirty Water Drainage
- Silt Fencing
- Silt Curtain

REV	DATE	DESCRIPTION	BY	APP
P02	09.09.2020	ISSUED FOR PLANNING	SM	JOL
P01	01.09.2020	ISSUED FOR PLANNING	SM	JOL

PROJECT: PINEWOOD 110kV SUBSTATION

TITLE: ACCESS ROAD DRAINAGE LAYOUT - CONSTRUCTION PHASE

CLIENT:

Malachy Walsh and Partners
Engineering and Environmental Consultants
Cork | Tralee | London | Limerick

Reen Point, Blennerville, Tralee, Co. Kerry, V92 X2TK

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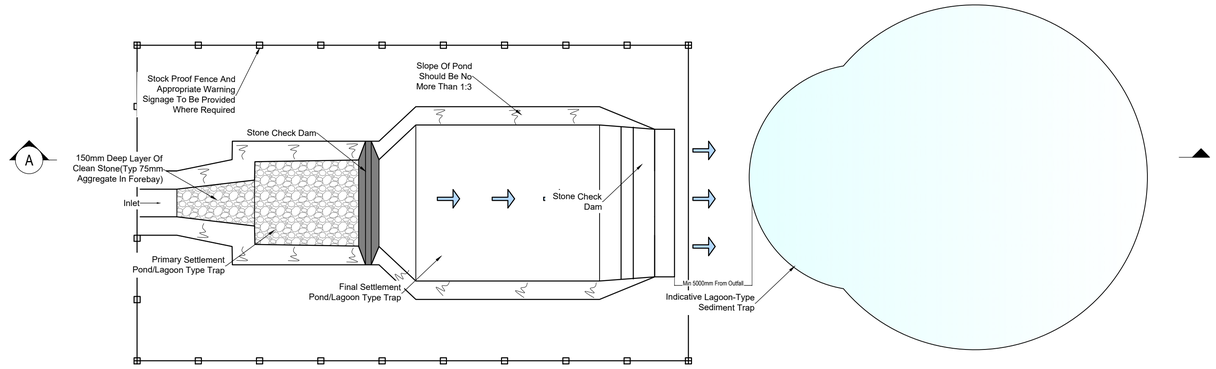
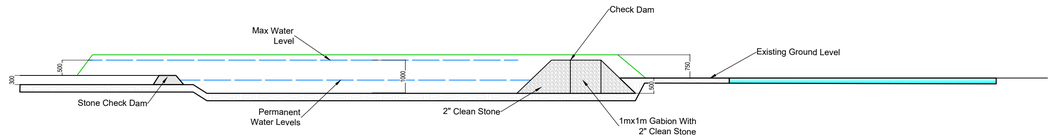
DRAWN: SM	CHECKED: JOL	APPROVED: JOL
DATE: 01.09.2020	SCALE @ A1: 1 : 250	
PROJECT NUMBER: 19999		DRAWING STATUS: S2
DRAWING NUMBER: 19999-MWP-SS-00-DR-C-5040		REV: P02



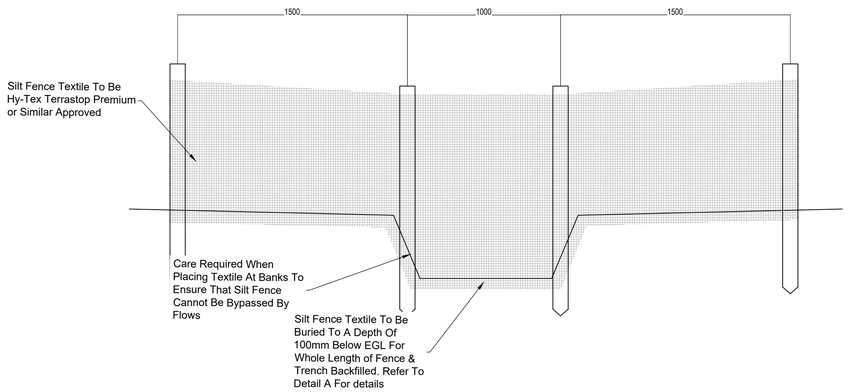
Indicative Settlement Pond/Lagoon - Type Sediment Trap Details

Scale: 1:100

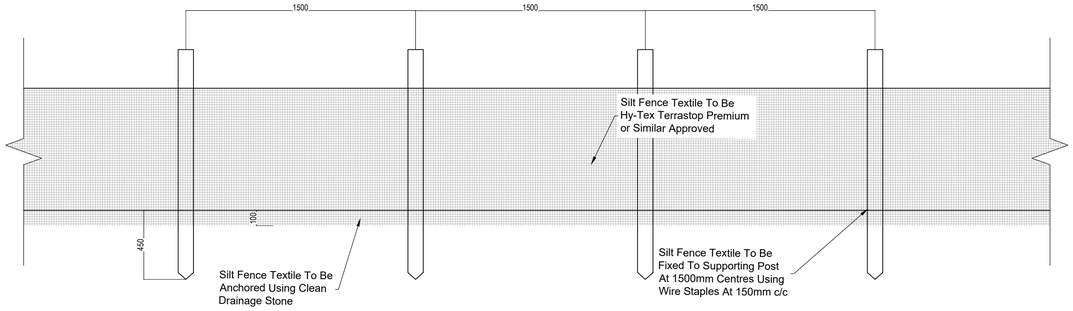


Section A-A

Scale: 1:100

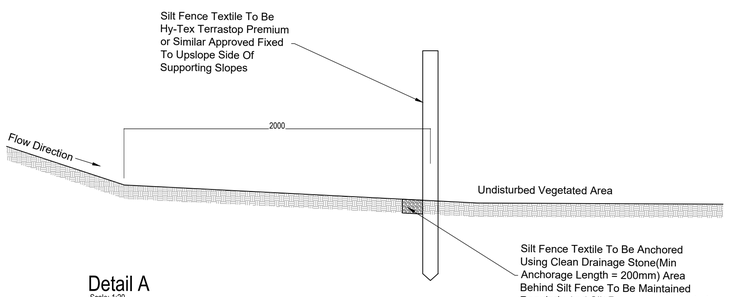


Typical Elevation Of Silt Fencing At Drainage Channel



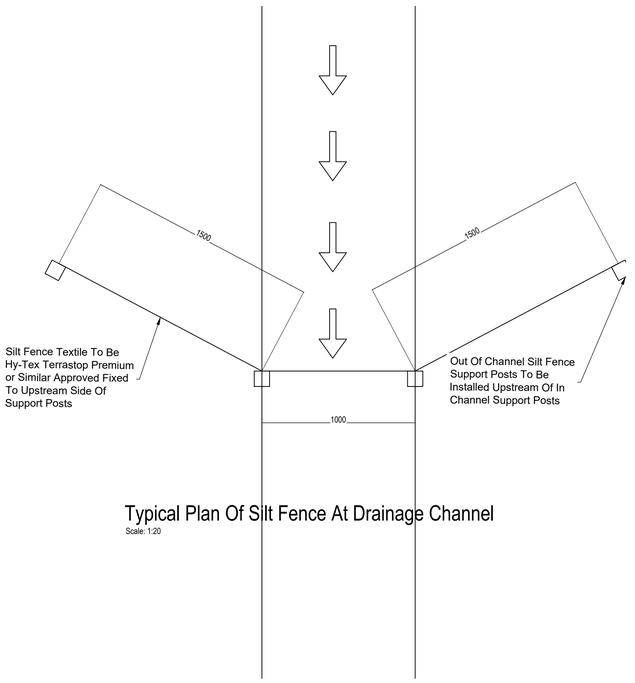
Typical Elevation Of Silt Fencing At Drainage Channel

Scale: 1:20



Detail A

Scale: 1:20



Typical Plan Of Silt Fence At Drainage Channel

Scale: 1:20

NOTES:

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4. DRAWINGS ARE NOT TO BE SCALED.
5. ALL DIMENSIONS ARE IN MILLIMETRES, UNLESS NOTED OTHERWISE.

REV	DATE	DESCRIPTION	BY	APP
P01	01.09.2020	ISSUED FOR PLANNING	SM	JOL

PROJECT:
PINEWOOD 110kV SUBSTATION

TITLE:
WATER QUALITY DETAILS SHEET 1

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DRAWN: SM	CHECKED: JOL	APPROVED: JOL	
DATE: 01.09.2020	SCALE @ A0: Varies		
PROJECT NUMBER: 19999		DRAWING STATUS: S2	
DRAWING NUMBER: 19999-MWP-SS-00-DR-C-5041			REV: P01

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Appendix 3

Settlement Pond Calculations

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Settlement pond design

Pond surface area (Compound and Road)

Generally, high intensity rainfall events have a short duration and lower intensity rainfall events tend to have a longer duration. The Met Éireann Extreme Rainfall Data for the area demonstrate that the chance of occurrence of a storm event of a given duration decreases (higher return period) as intensity increases. For a given return period the total depth of rainfall increases with storm duration but the actual rainfall rate over that period of time decreases.

For the operation of the settlement ponds it is the rate of flow rather than the total rainfall that is relevant. The return period is a measure of the likelihood that a storm of a particular intensity will occur in a given year. However, it is important to note that the chances of occurrence of a storm event with a particular return period are the same in each year but should on average occur once in that time period. For instance, a storm event with an intensity of 151.2 mm/hour and 5-minute duration would be expected to occur once in a 100-year period. 5 minute duration is 12.6mm from Met Eireann data, 12.6 * 12 increases the value to hours duration. This is more appropriately expressed as an annual exceedance probability (AEP) of 1%; that is, it has a 1% chance of being equalled or exceeded in any year. The design is for the construction phase, however a conservative design approach has been taken and includes a 20% additional allowance for a possible increase in rainfall intensity due to climate change.

The runoff control measures for the Compound and Road have been designed in the context of storm events of varying duration and intensity. The settlement ponds have been designed to cater for a maximum continuous flow rate associated with a medium-intensity rainfall event. Higher intensity runoff will be attenuated by the open drain collection system which provides temporary storage and limits the rate at which it enters the settlement ponds. This is achieved by the use of check dams within the open drains as described elsewhere in this document. Longer duration storms of 24 hours or more generally have very low intensity and are not critical in terms of the runoff rates that they generate. The design is for the construction phase

The modular settlement ponds are designed to operate effectively for the runoff rate associated with a continuous high rainfall rate of 18.8 mm/hour. This is equivalent to a 60-minute duration storm event with a 10-year return period (M10-60) or a 30 minute duration storm event with a 2-year return (M2-30). These rates are taken from the Met Éireann Point Rainfall Frequency table for the site location.

The compound area calculations are detailed here and are provided within an Excel print out. The Road calculations are provided in an excel printout. Met Eireann data is enclosed.

The design runoff rate is calculated using the formula:

$Q = c\,i\,A$

where c is the runoff coefficient,
i is the rainfall intensity in m/sec, and
A is the catchment surface area in m^2.

A runoff coefficient of 0.70 is assumed for the hardcore surface. For a rainfall intensity of 18.8mm/hour +20% for climate change = 22.56mm/hr and an area of 5,697m^2 the runoff rate is:

$Q = 0.70 \times (0.02256/3600) \times 5{,}697\ m^3/sec$

$= 0.024\ m^3/sec$ (25 litres/sec)

The main design parameter for the settlement pond is the water surface area. The required surface area is the design flow rate in m^3/sec divided by the particle settlement velocity (V_s) in m/sec (Area = $Q/V_s\ m^2$).

The particle settlement velocity is determined using the formula derived by Stokes in 1851 as follows:

$V_s = 2\,r^2\,(D_p - D_f) / (9\,n)$

where V_s is the particle settlement velocity (m/sec),
r is the radius of the particle (metres),
D_p is the density of the particles (kg/m^3),
D_f is the density of the fluid (kg/m^3), and
n is the viscosity of the fluid (0.000133 kg sec/m^2 @ 10°C).

For a particle density of 2,400kg/m^3, water density of 1,000kg/m^3 and particle diameter of 20 microns (radius 10^{-5} metres) the settlement velocity, V_s, is:

$V_s = 2 \times (10^{-5})^2 \times (2{,}400 - 1{,}000) / (9 \times 0.000133)$

$= 2 \times 10^{-10} \times 1{,}400 / 0.001197$

$= 0.000234$ m/sec.

The required settlement pond surface area is

$A_p = Q/V_s$

$= 0.025/0.000234$

$= 107m^2$

The Road pond area required is 10.135m^2, 10.8m is being provided; refer to calculations for the detailed sizing.

Theoretically the pond depth is not relevant but in practice a minimum depth is required to ensure laminar flow and to allow temporary storage of settled silt. The modular settlement pond has been designed with a surface area of 24m^2 (12m x 2m) and a depth of 1m. This is divided into three chambers of equal length and in practice it has been found that most of the settlement occurs in the first chamber with very low turbidity levels being achieved in the final effluent. The design is conservative and therefore has sufficient redundancy to cater for occasional higher runoff rates or sediment loads.

For practical reasons it may be necessary to increase the area directed to a settlement pond in which case the pond surface area will be increased pro rata.

Lagoon-type Sediment Traps

In addition to the settlement ponds, a tertiary treatment system will also be designed to absorb any fine particles that may not settle in the primary and secondary settlement ponds. From the settlement ponds the water will flow through lagoon-type sediment ponds which will be designed with a retention time of 10 days. For design of maturation ponds the retention time is generally 5 – 10 days.

From Met Eireann rainfall return periods, the following rainfalls would arise based on a 1 in 100 year return period:

10 Days– 167.8mm (Factor up by 1.2 for climate change)

Run-off is computed from the formula Q = CIA where

I = Rainfall intensity

A = Area

C = Factor based on degree of impermeability

For unsealed site roads and hardstands, ‘C’ is generally assumed to be in the range of

0.6 to 0.85. For this report, 0.7 is assumed.

Q= 1.2 x 0.1678 x 5697 x 0.7 = 803m^3

Plan Area 803^2 at 1.0m deep

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Road side Lagoon Sizing

Q= 1.2 x 0.1678 x 420 x 0.7 = 60m^3

Plan Area 80m^2 at 0.75m deep

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Compound Water Quality and Attuenation

Settlement pond design			
Rainfall	**Units**	**Values**	**Comments**
Rainfall M10-60	mm	18.8	From Met Eireann data
Rainfall intensity - i	mm/hr	22.56	Increased to Achieve 20% Climate Change
Catchment			
Catchment area considered	ha	0.5697	
Routing coefficient - C_r	-	1	Varies with the shapes of the time-area diagram and the rainfall profile.
Volumetric run-off coefficient - C_v	-	0.7	0.6 on catchments with rapidly draining soils 0.9 on catchments with heavy soils
Flow from catchment - Q	m^3/s	0.02501	Modified Rational Method
Settlement pond			
Length of pond	m	22	
Width of pond	m	5	
Depth of water	m	0.75	
CSA of pond	m^2	3.75	
Velocity of flow thru pond	m/s	0.00667	
Particles			
Particle size considered	micron	20	Medium silt particle
Particle radius - r	m	0.00001	
Particle density - D_p	kg/m^3	2400	
Fluid density - D_f	kg/m^3	1000	
Fluid viscosity - n	$kg\ s/m^2$	0.000133	
Settling velocity - V_s	m/s	0.00023	Stokes formula to be less than 0.0016
Time to travel thru pond	s	3,298.6	
Depth particle will settle	m	0.77	Baffle in first pond will force the entering water down 0.5m, thus the particles will only have to settle 1.0m to reach the bottom of pond
Minimum Pond Area Q/Vs	m^2	106.92131	
Area Provided	m^2	110	
Settling Duration Hours >4hrs	hrs	26.125	

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Road Water Quality Treatment and Attuenatioon			
Settlement pond design			
Rainfall	**Units**	**Values**	**Comments**
Rainfall M10-60	mm	18.8	From Met Eireann data
Rainfall intensity - i	mm/hr	22.56	Increased to Achieve 20% Climate Change
Catchment			
Catchment area considered	ha	0.042	
Routing coefficient - C_r	-	1	Varies with the shapes of the time-area diagram and the rainfall profile.
Volumetric run-off coefficient - C_v	-	0.9	0.6 on catchments with rapidly draining soils 0.9 on catchments with heavy soils
Flow from catchment - Q	m^3/s	0.00237	Modified Rational Method
Settlement pond			
Length of pond	m	9	
Width of pond	m	1.2	
Depth of water	m	0.75	
CSA of pond	m^2	0.9	
Velocity of flow thru pond	m/s	0.00263	
Particles			
Particle size considered	micron	20	Medium silt particle
Particle radius - r	m	0.00001	
Particle density - D_p	kg/m^3	2400	
Fluid density - D_f	kg/m^3	1000	
Fluid viscosity - n	kg s/m^2	0.000133	
Settling velocity - V_s	m/s	0.00023	Stokes formulato be less than 0.0016
Time to travel thru pond	s	3,416.7	
Depth particle will settle	m	0.80	Baffle in first pond will force the entering water down 0.5m, thus the particles will only have to settle 1.0m to reach the bottom of pond
Minimum Pond Area Q/Vs	m^2	10.1347213	
Area Provided	m^2	10.8	
Settling Duration Hours >4hrs	hrs	10.6875	

Met Eireann
Return Period Rainfall Depths for sliding Durations
Irish Grid: Easting: 250403, Northing: 182275,

	Interval		Years												
DURATION	6months,	1year,	2,	3,	4,	5,	10,	20,	30,	50,	75,	100,	150,	200,	250,	500,
5 mins	2.7,	3.7,	4.2,	5.0,	5.5,	5.9,	7.1,	8.5,	9.4,	10.7,	11.8,	12.6,	13.9,	14.9,	15.7,	N/A ,
10 mins	3.8,	5.2,	5.9,	7.0,	7.7,	8.2,	9.9,	11.9,	13.1,	14.9,	16.4,	17.5,	19.3,	20.7,	21.8,	N/A ,
15 mins	4.5,	6.1,	6.9,	8.2,	9.0,	9.6,	11.7,	14.0,	15.4,	17.5,	19.3,	20.6,	22.7,	24.4,	25.7,	N/A ,
30 mins	6.0,	8.0,	9.0,	10.5,	11.6,	12.3,	14.8,	17.5,	19.3,	21.7,	23.8,	25.5,	27.9,	29.8,	31.4,	N/A ,
1 hours	7.9,	10.4,	11.7,	13.6,	14.8,	15.7,	18.8,	22.0,	24.1,	27.0,	29.5,	31.4,	34.3,	36.5,	38.3,	N/A ,
2 hours	10.4,	13.6,	15.2,	17.5,	19.0,	20.1,	23.8,	27.7,	30.2,	33.6,	36.5,	38.8,	42.2,	44.7,	46.8,	N/A ,
3 hours	12.3,	15.8,	17.6,	20.2,	21.9,	23.2,	27.3,	31.6,	34.4,	38.2,	41.4,	43.9,	47.6,	50.4,	52.7,	N/A ,
4 hours	13.8,	17.7,	19.7,	22.5,	24.3,	25.7,	30.1,	34.8,	37.7,	41.8,	45.2,	47.9,	51.8,	54.8,	57.2,	N/A ,
6 hours	16.2,	20.7,	22.9,	26.1,	28.1,	29.7,	34.5,	39.7,	43.0,	47.4,	51.2,	54.1,	58.4,	61.7,	64.3,	N/A ,
9 hours	19.1,	24.1,	26.6,	30.2,	32.5,	34.2,	39.6,	45.4,	49.0,	53.9,	58.1,	61.2,	65.9,	69.4,	72.3,	N/A ,
12 hours	21.5,	26.9,	29.7,	33.5,	36.0,	37.9,	43.7,	49.9,	53.8,	59.0,	63.4,	66.8,	71.8,	75.5,	78.6,	N/A ,
18 hours	25.3,	31.5,	34.5,	38.9,	41.6,	43.7,	50.2,	57.0,	61.3,	67.0,	71.9,	75.5,	81.0,	85.1,	88.4,	N/A ,
24 hours	28.4,	35.2,	38.5,	43.2,	46.2,	48.4,	55.4,	62.7,	67.2,	73.3,	78.5,	82.4,	88.2,	92.5,	96.0,	107.7,
2 days	36.4,	44.2,	47.9,	53.2,	56.5,	59.0,	66.7,	74.7,	79.6,	86.1,	91.6,	95.7,	101.8,	106.3,	110.0,	122.1,
3 days	43.1,	51.8,	55.9,	61.7,	65.3,	68.0,	76.3,	84.8,	90.1,	97.0,	102.9,	107.2,	113.6,	118.3,	122.2,	134.8,
4 days	49.2,	58.6,	63.1,	69.3,	73.2,	76.1,	84.9,	94.0,	99.5,	106.8,	113.0,	117.5,	124.2,	129.2,	133.1,	146.3,
6 days	60.3,	71.0,	76.0,	83.0,	87.4,	90.6,	100.4,	110.3,	116.4,	124.4,	131.0,	135.9,	143.2,	148.5,	152.8,	166.8,
8 days	70.5,	82.2,	87.8,	95.4,	100.2,	103.7,	114.3,	125.1,	131.6,	140.1,	147.3,	152.5,	160.2,	165.8,	170.4,	185.2,
10 days	80.0,	92.8,	98.8,	107.0,	112.2,	115.9,	127.3,	138.7,	145.7,	154.7,	162.3,	167.8,	175.9,	181.9,	186.6,	202.2,
12 days	89.2,	102.9,	109.3,	118.1,	123.5,	127.5,	139.6,	151.7,	159.0,	168.5,	176.4,	182.2,	190.7,	196.9,	201.9,	218.1,
16 days	106.6,	122.0,	129.2,	138.9,	144.9,	149.4,	162.6,	175.9,	183.9,	194.3,	202.9,	209.2,	218.3,	225.1,	230.4,	247.9,
20 days	123.2,	140.1,	148.0,	158.6,	165.2,	170.0,	184.4,	198.7,	207.2,	218.4,	227.6,	234.3,	244.1,	251.3,	257.0,	275.5,
25 days	143.2,	161.9,	170.5,	182.1,	189.3,	194.6,	210.2,	225.6,	234.9,	246.9,	256.8,	264.0,	274.5,	282.1,	288.2,	307.9,

NOTES:
N/A Data not available
These values are derived from a Depth Duration Frequency (DDF) Model
For details refer to:
'Fitzgerald D. L. (2007), Estimates of Point Rainfall Frequencies, Technical Note No. 61, Met Eireann, Dublin',
Available for download at www.met.ie/climate/dataproducts/Estimation-of-Point-Rainfall-Frequencies_TN61.pdf