Carrigeen Renewable Energy Development, County Roscommon, IRELAND

Soils & Geology Assessment
Peat Landslide Hazard Risk Assessment

Report No: 2278-24C

10th March 2026

This document has been prepared by Whiteford Geoservices Ltd on behalf of

Carraigin Power Ltd
&
Jennings O'Donovan (Consulting Engineers)

Whiteford G
Tel: 0044 (0) [illegible] Fax: 0044 (0) [illegible]
www.whitefordgeoservices.com

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A. STATEMENT OF AUTHORITY

John Whiteford BSc (Hons) Geophys MIOSH MEAGE FGS has more than 25 years of experience in the field of earth sciences, geotechnical engineering, and management. His academic qualifications are a BSc with Honours in Geophysics from Edinburgh University, with memberships of The European Association of Geoscientists and Engineers and The Institute of Safety and Health.

Commencing work with Kirk McClure Morton (Consulting Engineers) in Belfast since then has been engaged in full-time consultancy for the past 25 years and since 1996 trading as Whiteford Geoservices Ltd. The company deploys a staff of more than 10 professional and technical personnel and has completed in excess 2000 contracts for clients within the construction and mineral exploration sectors where they have built up a recognised level of specialist experience, particularly in the field of Renewable Energy. Working at home, in Europe and worldwide the company has been involved in more than 250 renewable power projects where our services have been sought in relation to foundation design, peat landslide risk assessment, geophysics, electrical earthing design and thermal resistivity analysis.

B. EXECUTIVE SUMMARY

A study of the risk associated with ground conditions was undertaken for the proposed 11nr turbine site at Carrigeen Renewable Energy Development . Given the presence of extensive blanket bog this study was extended to include an assessment of Peat Landslide Hazard, which is deemed to be the main Soils and Geology related hazard applicable to the Project

This assessment of peat characteristics yielded on average a moderate peat cover of 1.45m within the proposed construction zone, although deep pockets of peat, greater than 9.00m, were recorded at intermittent points along the Site access Roads network and Grid Connection route.

Recorded peat shear strength values averaged 26kPa, with a minimum recorded value of 6kPa (11 kPa at infrastructure) and maximum of 58kPa. Von Post classifications were generally H7 (strong decomposition) and ranged from H0 to H9 (undecomposed to almost completely decomposed) within the Wind Farm Site. Average peat thickness is consistent with a moderately high acrotelm to catotelm ratio at the site and consequently, the proportion of peat soils susceptible to “bog burst” (>2m thick) is less than 39.9% of the construction footprint. Such “bog burst” conditions are limited to three (T01, T03 and T08) of the turbine locations and 8 of the 10 stretches of new Site Access Raods. The risk of landslide in these locations is offset by both very low slope gradients of less than 2 degrees and the use of low pressure “floated road” methods of construction.

Of the main excavations proposed the thickest peat deposits to be removed are 4.50m, at T01 and T03. Maximum peat thickness to be removed at the main infrastructure will be as follows:-

T01 (4.50m)

T02 (0.70m)

T03 (4.50m)

T04 (1.60)

T05 (0.40m)

T06 (1.20m)

T07 (1.60m)

T08 (2.20m)

T09 (2.00m)

T10 (1.80m)

T11 (0.60m)

Substation (2.00m)

No peat in excess of 1.50m will be removed for the construction of the site tracks.

At the main infrastructure two locations of medium hazard have been highlighted, as follows:-

- Turbine T01
- Turbine T03

On the Site Track network six sections of medium hazard have been highlighted, as follows:-

- Site Entrance to T01
- T01 to T02
- Site Entrance to T04
- T04 to T03
- Site Entrance to Substation
- Substation to T11

The hazards at these particular locations are only elevated during the construction period when they can be successfully managed by additional mitigation safeguards written into the CEMP.

All hazards pertaining to the Project are at a maximum during the construction phase and are either Negligible or Low where the specified mitigation is undertaken.

A summary of all Soils and Geology Impacts that relate to the Project are contained in Table 7.0, below.

Table 7.0 Summary of Findings of the Peat Landslide Hazard Assessment

Hazard Ref:	Assessment Findings	Hazard Ranking
A	**Peat Landslide Hazard at Main Structures (Pre-Mitigation)** Superficial soils are composed of organic peat bog mantling tills (mineral soils) derived from limestone rock. Weak organic soils are thin to moderately deep, extending to depths of up to 4.50m at the turbine infrastructure. Excavations, where kept open for an extended period of time will require side wall support. Stability can be expected to deteriorate during wet weather when waterlogged, stockpiled soils will swell and could become unstable on or at slopes of 5 degrees to the horizontal. For this reason, stockpiling will be limited to lands sloping at <5 degrees. Major structures will use either a standard Gravity Base Foundation placed at an average depth of 3.5 to 5.0m below existing ground level, or a Deep Piled Solution (in the case of T01 and T03). Full Pre-construction SI will be undertaken to inform design in this respect. The following schedule details the pre-mitigation hazard at each of the main infrastructure elements:- T01 **HR=16** T02 **HR=7.5** T03 **HR=12** T04 **HR=7** T05 **HR=2.25** T06 **HR=2** T07 **HR=3.5** T08 **HR=4.5** T09 **HR=6** T10 **HR=3.5** T11 **HR=7** SUBSTATION and COMPOUND **HR=7**	**MEDIUM**
B	**Peat Landslide Hazard for Track / Road Construction (Pre Mitigation)** Peat stability assessment has identified organic soil (peat) thickness of >1.50m was recorded at 36.5% of the peat probe positions undertaken within the Carrigeen Renewable Energy Development landholding. 1.50m is the upper threshold for the suitability of traditional excavated access track construction. In the case of wind farm element of the Project 59.4% (est. 3,161m) of the new Site Access Road network could be better constructed using “floated” road methods. Full Pre-construction SI will be undertaken to inform design. The following schedule details the pre-mitigation hazard at each of the main infrastructure	**MEDIUM**

	elements:- SITE ENTRANCE 1 TO T01 **HR=12.5** T01 TO T02 **HR=13.75** SITE ENTRANCE 3 TO T04 **HR=12.5** T04 TO T03 **HR=11** SPUR TO T05 AND T06 **HR=6.75** T06 TO T07 **HR=8.25** T07 TO SITE ENTRANCE 4 **HR=5.5** SITE ENTRANCE 5 TO SUBSTATION **HR=13.75** SUBSTATION TO T11 **HR=13.75** SPUR AT T11 TO T08 **HR=8.75**	
C	**Geological Heritage / Sensitive Features** Carrigeen Renewable Energy Development infrastructure is located within an agricultural, peatland and commercial forested landscape removed from Sensitive Features such as Karst Landforms and Protected Areas. Consequently, there is a Low hazard of impact from Peat Landslide to geological heritage	**LOW**
D	**Peat Landslide Hazard (With Mitigation)** **Peat Landslide Hazard at Main Structures (Post-Mitigation)** Following application of the mitigation measures and recommendations specified in the Peat Landslide Hazard Assessment, these hazards reduce to **Low Hazard** of instability at **turbines T01 and T03,** with **Negligible Hazard** of instability at **T02, T04, T05, T06, T07, T08, T09, T10, T11 and Substation** following the application of mitigation measures. **Peat Landslide Hazard at Track / Road Construction (Post-Mitigation)** Following application of the mitigation measures and recommendations specified in the Peat Landslide Hazard Assessment, these hazards reduce to **Low Hazard** for **the assessed section of Track / Road Construction,** with the exception of the sections from the **Substation to T11 and from T11 to T08** which reduce to **Negligible Hazard.**	**LOW**

C. INTRODUCTION

1) Background

This Report has been prepared on behalf of Carraigin Energy Ltd and their agents, Jennings O'Donovan Cons. Engs.(JOD), in respect of a planning application for a proposed wind energy development consisting of 11no. wind turbine generators, 1 no. substation and compound, site tracks and other associated infrastructure. This Report, which relates to Chapter 10 of the Environmental Impact Assessment Report (EIAR) to be submitted as an accompaniment to the planning application, for consideration by the Commission.

Planning permission is being sought by the Applicant for the 11No. wind turbines, 1 no. Substation and associated access track and other infrastructure, including Grid Connection, to be constructed on lands between Frenchpark and Elphin, County Roscommon, Ireland.

At the request of Jennings O'Donovan Cons. Engs. (JOD), Whiteford Geoservices Ltd (WGS) undertook a soils and geology study including peat landslide risk assessment for the proposed site for Carrigeen Wind Farm , Co. Roscommon.

The purpose of this work was to:

- Undertake a study of soils, water and general ground stability conditions at the proposed Wind Farm Site.
- Identify likely impacts of the Project upon these aspects of the environment including a peat landslide risk assessment.
- Identify mitigation measures to avoid, remediate or reduce the impacts identified.
- Identify residual impacts of the Project after implementation of mitigation measures recommended.

The following report details the fieldwork undertaken to gather data required to determine the risk from peat instability to the surrounding environment. It also details the analytical process undertaken to apportion risk to the various construction elements, namely construction of the turbine bases and substation control building.

Background desk study information was obtained for the site, prior to initiating fieldwork (as per the requirements of the Scottish Guidance).

The Peat Landslide Hazard Assessment (PLHA) report is a "stand-alone" document. No data acquired by 3rd parties (at the site) has been used to augment the dataset acquired by Whiteford Geoservices Ltd, which has been used to produce this PLHA report.

No data from outside the renewable energy development planning boundary has been employed for the purpose of determining peat landslide risk. Risk from natural events originating outside of the development has not been considered.

2) Relevant Legislation

The following report is based upon the guidance contained within the Scottish Executive's "*Peat Landslide Hazard and Risk Assessments – Best Practice Guide for Proposed Electricity Generation Developments*", published as a Second edition April 2017 (referred to as "the Scottish Guidance").

This Best Practice Guide was updated, in part, in April 2017, and for the purpose of clarity the protocol adopted to determine Peat Landslide Hazard Ranking are consistent with the version of the report, as published in 2017. Unless otherwise stated, all assessments and conclusions contained within this report are made with reference to either the 2006 or 2017 publication. However, there are a number of variations from the guidance and where these occur the reason for this is provided, either within the text or as a footnote. These guidelines are commonly used in Ireland and have been accepted as authoritative, by the relevant Public Bodies.

3) Schedule of Works

Whiteford Geoservices Ltd (WGS) personnel visited the site between 25th September 2024 and 6th June 2025., following changes to the layout, to undertake an assessment of topography, geology, drainage and ground stability conditions at the proposed Wind Farm Site.

Table 7.1 – Summary of Ground Conditions

Key Dates	Activity	Infrastructure Layout	Remarks
September and October 2024	Soils and Geology Preliminary Assessment Baseline Assessment Stage 1 Peat Studies including peat probing on a 100m x 100m grid, core coring, measurement of in-situ peat shear strength and classification of peat decomposition according to von Post.	14 No. wind turbines	Layout was subsequently amended to avoid the constraints identified. Interim PLHA produced for main structures
April, May and June 2025	Detailed Assessment Updated Baseline Assessment Stage 2 detailed peat depth mapping, slope analysis, in-situ testing, von post assessment. Geophysical ERT surveys to screen for presence of "karst" at all main structures . Trial hole investigation to physically assess peat and shallow soils with the purpose of preliminary foundation design.	12 No. wind turbines, site track network and Substation	

Key Dates	Activity	Infrastructure Layout	Remarks
November 2025	Supplementary Borrow Pit Assessment Visual assessment of existing borrow pits, further geophysical ERT surveying and further trial hole investigation	11 No. wind turbines, site track network and Substation and Compound	Areas suitable for exploitation as a Borrow Pit for the Project were identified.

D. METHODOLOGY

1) Desk Study

WGS carried out a desk study assessment of the soils, geology, hydrology and slope aspects of the proposed Wind Farm Site. This involved the following components:

- Acquire and compile all available maps of the proposed renewable energy development.
- Study any geotechnical reporting available within the public domain for the locality (*Geological Survey Ireland –Online Mapping Database. Last accessed 02/02/2026)*
- Study and assess the proposed locations of turbines with regard to available data on site topography and slope gradients (*Ordnance Survey of Ireland – Online Map Shop*).
- Study and assess the proposed locations of turbines with regard to available data on site soils, sub-soils and bedrock geology (*Geological Survey Ireland –Online Mapping Database. Last accessed 02/02/2026)*
- Study and assess the proposed locations of turbines relative to aerial photographs.
- Overlay Geological Survey of Ireland (GSI) online data to determine site bedrock geology and the presence of any major faults or other anomalies.
- Use of Geological Survey of Ireland (GSI) Quaternary mapping to determine soil classification on the site.
- Review Met Office Eireann meteorological records pertaining to the site.
- Review EPA Water data to identify water supply sources in the vicinity of the proposed renewable energy development extension. *Last accessed 02/02/2026.*
- Conduct peat landslide hazard assessment (PLHA) to identify any potential hazards at main renewable energy development infrastructure.

The equipment, software and materials used during this study consisted of:

- AutoCAD v 2024 (Graphics)
- Surfer 16 (Graphics)
- Microsoft Excel (Database)
- Microsoft Word (Report)
- Adobe PDF (Report)
- Leica DGPS System
- Peat probing “depthing” rods

- Van Walk Russian Corer
- Impact Field Shear Vane

2) Site Investigations

WGS conducted site investigations, in respect of peat, at the site of the proposed Project in three periods. The first campaign was undertaken between September and October 2024, in order to carry out a site visit, undertake a walkover survey and collect preliminary geotechnical site data. The second was undertaken between April and June 2024 when further detailed SI data was collected following the freezing of the infrastructure layout. These site investigations are detailed in Report 2278-24A, Section 7.3.3 and consisted of the following main elements:

- Bedrock and sub-soils logging and characterisation at proposed turbine locations (trial hole campaign 12 no.).
- Peat depth probing (2386 no.), undertaken manually by driving a series of "depthing" rods into the ground at turbine positions and across the site development boundary until a significant change in resistance was registered within the sub-soils. The depth of this increase in resistance was then measured and recorded.
- Shear strength of the peat was measured using a handheld shear vane (64 no. measurements).
- Von Post classification method (65 no. classifications) was employed to determine the range of peat characteristics across the proposed development site.
- The purpose of these investigation methods was to assess the impact of external factors (such as local hydrology, vegetation etc) on the tensional forces binding the peat and hence its tendency towards failure, by shear, during construction works.
- 2D Electrical Resistivity Tomography (2 no. profile at each of the 12no. prospective wind turbine generators)
- 2D Electromagnetic Conductivity Surveying (5nr surveys at the site of proposed final infrastructure for T01, T03, T05, T09 and T10)
- Recording of Irish Transverse Mercator (ITM) coordinates for all investigation locations.

The following additional equipment used during the Site Investigation phase:

- Peat probing "depthing" rods
- Van Walk Russian Corer
- Impact Field Shear Vane
- Mangusta Electrical Resistivity Imaging System
- Geofyzika CMD4 Ground Conductivity Meter
- 13T wide tracked excavator

3) Impact Assessment Methodology

From the desk and field data acquired, the following calculations and assessments were undertaken in order to evaluate peat stability, assess the underlying soils, geology, hydrology and slope aspects of the environment at the proposed Wind Farm Site. Specifically, this methodology was as follows:

- Characterisation of the site's topographical, geological, hydrological and geomorphological regime from the data acquired.
- Consideration of ground stability issues as a result of the Project, its design and methodology of construction.
- Assessment of the combined data acquired to evaluate any likely impacts on the soils, geology and hydrological aspects of the environment.
- If impacts are identified, consider measures that would mitigate or reduce the identified impact.
- Present and report these findings in a clear and logical format that complies with EIAR reporting requirements.

4) Characteristics of the Development

The Project comprises 11 No. wind turbines, substation, compound and associated infrastructure and Grid Connection to be constructed on lands between Frenchpark and Elphin, east of the L5601, County Roscommon.

The majority of the Wind Farm Site consists of blanket peat with small areas of semi-improved grassland and commercial forestry.

Analysis of the exploratory holes undertaken for the Site Investigations indicates that topsoil or peat is underlain by a natural sequence of glacial soils. Rock was no encountered during the intrusive investigations at proposed turbine positions, Stiff CLAY/SILT with some cobble and boulders was generally encountered at depths of between 3.00m and 5.00m below existing ground level. Groundwater flows, where encountered, generally between 1.00 m and 2.50m below existing ground level, typically between the PEAT and CLAY/SILT interface, with no significant volumes were recorded within what were observed to be weakly permeable soils. Slopes are generally flat to low across the study area with the site of the development (construction footprint) exhibiting very low slope gradients of between 0^0 and 3^0 to the horizontal.

Primarily, the scope of the proposed development can be characterised as follows:

- Total site area **1,218 ha** (redline boundary)
- Peat Depth Range **0.10 – >9.00m**. Average peat depth = **1.45m**. Median value = **0.70m**.
- **11 No.** 5.7MW wind turbines with an overall ground to blade tip height of 185m. The Wind Turbine will have a rotor diameter of 163m and a hub height of 103.5m.
- Construction of reinforced concrete base foundations for **11 No.** wind turbines. (Typically, circular with a foundation diameter of **26.5m**)

- Construction of turbine hardstanding areas, including main crane hardstand, assist crane hardstand, storage and blade fingers. (Total area of **11 x 3,362.3m^2** = **36,985m^2**)
- Construction of one Onsite Substation, 166m in length and 63m in width (**10,458m^2**).
- **6 no**. Temporary Contractors Compounds measuring **55m x 35m** (**1,925m^2**) in dimensions. (Total area of **1,925m^2 x 6 = 11,550m^2**).
- **1 no**. Temporary Contractors Compound (TCC 01) measuring **45m x 25m** (**1,125m^2**) in dimensions .
- Construction of approximately **5,325m** of new site access tracks having a minimum finished width of 6**m** with passing bays, of which **3,161m** will consist of floated track.
- Upgrade of approximately **6,382m** of existing site access tracks (public road).
- The construction of **5 no.** site entrances.
- **1 no**. permanent meteorological mast associated foundation and hard-standing area measuring **4.5m x 4.5m** with total area of **20.25m^2**.
- A new **110kV cable** will extend underground for approximately c**. 17.47km** from the Onsite Substation and Control Building and will connect to the existing Carrick-on-Shannon 110kV substation via underground electricity cabling.
- Installation of 33kV underground grid cable ducts from the turbines to the proposed substation. Cable trenches, which will typically be 0.60m in width and 1.20m in depth, will follow the edge of the site access tracks within the windfarm and be installed in conjunction within the tracks. The excavated material will be laid alongside the trench and employed for reinstatement following the emplacement of cables.
- The installation of a drainage system for the proposed turbine hardstandings, substation and new track sections.
- Two on-site borrow pits. The **Borrow Pits** will have total surface dimensions **50,765m2** and will require removal of approx. **5m** of overburden and extend to a total depth of **13m**. The total rock aggregate **(8m depth)** resource capacity will amount to approx. **240,000m3**.
- Amenity access for the wider community and biodiversity enhancement measures
- Tree felling to facilitate the construction and operation of the Project.
- The Study Area terrain is sloping with gradients generally between 0 – 3 degrees to the horizontal within the construction footprint.
- Ground surface elevation ranging from **64m to 82m** above sea level (Malin Head OD), within the turbine infrastructure construction footprint.

E. RECEIVING ENVIRONMENT

1) Geology

In terms of solid geology, the site is underlain by a faulted sequence of sedimentary rock formations, consisting of limestone and sandstone.

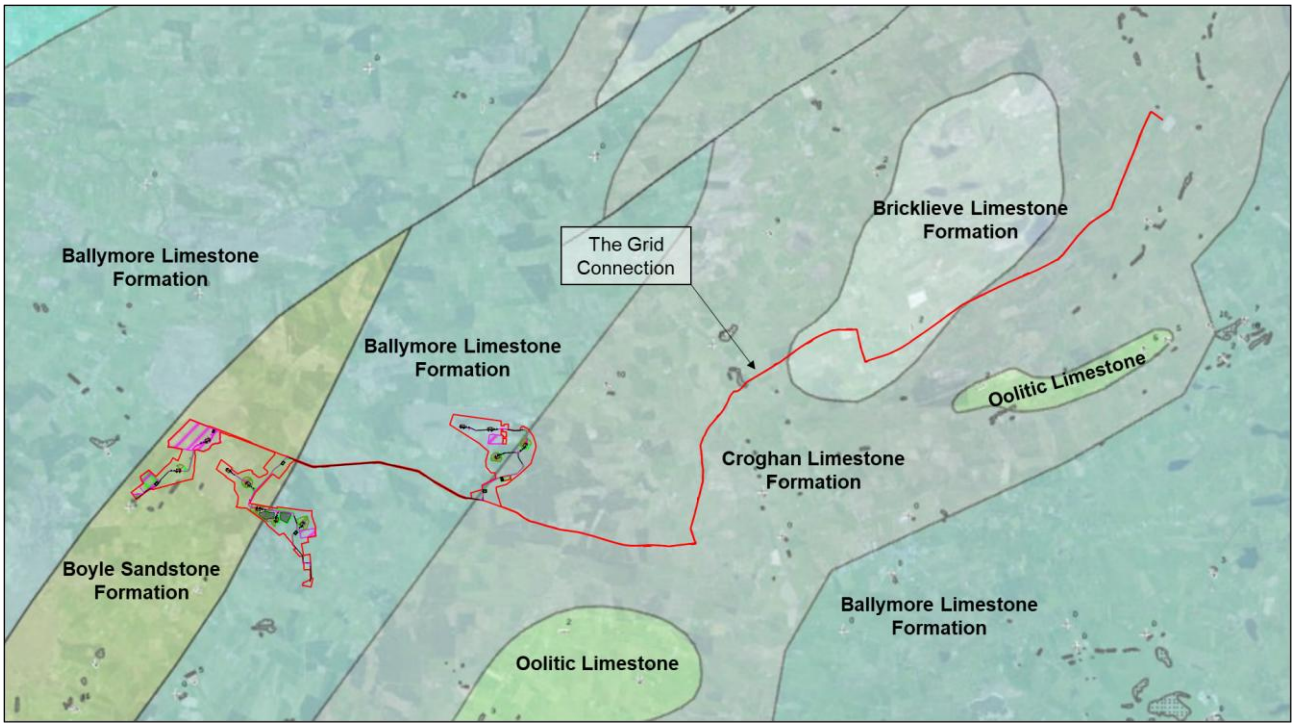

Figure 7.1A – Solid Geology ***(Reproduced from GSI Online Mapping)***

According to the GSI online database, the main central infrastructure of the Wind Farm Site is underlain by the Ballymore Limestone Formation (T06, T07, T08, T09 and T11), the Boyle Sandstone Formation (T01, T02, T03, T04 and T05) with the Substation and T10 underlain by the Croghan Limestone Formation.

The Grid Connection route is underlain by the Croghan Limestone Formation and Bricklieve Formation.

Details for each of the above-mentioned rock formations are given below.

<u>Ballymore Limestone Formation</u>

Thin- to thick-bedded limestones with shale partings. Predominantly carbonate with subordinate argillaceous units. At the base, dark, fine-grained limestones with calcareous shales are followed upwards by cleaner, pale-grey bioclastic limestones, then an upper unit of thin-bedded, argillaceous limestones with occasional chert. Carboniferous in age.

Boyle Sandstone Formation

Coarse, quartz-rich sandstone with subordinate finer units. Predominantly psammitic. At the base, medium- to coarse-grained sandstones with occasional pebble lenses are followed upwards by well-bedded, cross-laminated quarzitic sandstones, then an upper unit of finer-grained sandstones and siltstones. Devonian in age.

Croghan Limestone Formation

Thick-bedded grey limestones with shale and chert partings. Predominantly carbonate with subordinate argillaceous units. At the base, dark, muddy limestones with thin shaly beds are followed upwards by clean, pale-grey crinoidal and bioclastic limestones, then an upper unit of thin-bedded limestones with chert nodules and occasional silty partings. Carboniferous in age.

Bricklieve Formation

Interbedded limestones and calcareous shales. Predominantly carbonate with subordinate argillaceous units. At the base, dark, thin-bedded limestones with shale partings are followed upwards by thicker-bedded grey limestones with increased bioclastic content, then an upper unit of thin, argillaceous limestones and shales. Carboniferous in age.

None of these rock formations are particularly sensitive with respect to peat landslide and have negligible impact on peat landslide assessment. From a soils and geology perspective their sensitivity is considered to be low to medium, where the calcareous content of the limestone formations makes them somewhat susceptible to dissolution and formation of karst features, such as sinkholes. GSI records no observations of karst within the Wind Farm Site and limited evidence of such landforms was observed during the site walkover. Geophysical investigations undertaken at all wind turbines observed deep weathering at the original positional for turbine T6. Following review of the wind farm layout turbine T6 was repositioned to more competent ground and consequently, the risk from karst landforms to the Project is deemed low.

Although GSI does record the presence of karst features along the GCR this is considered to be of very low significance with respect to Peat or soil instability. The excavations required to install the grid circuits are of such limited depth and extent that any adverse effect from karst is considered to be negligible.

Further review of the GSI Online Database does nor yield the location of any active quarries within 10km of the site. Although, detailed analysis of recorded mineral localities and comparison to aerial imagery suggests that are actually a number of potentially active quarries / pits just beyond this radius. The closest quarries / pits identified are as follows:

1. Active Quarry 12 km north of Carrigeen Wind Farm, Roadstone Boyle at Rathdiveen, Boyle, Co. Roscommon, off the N4.

2. Active Quarry 14km east of Carrigeen Wind Farm , Hanly Quarries, at Laragan, Elphin, Co. Roscommon.

The two proposed Borrow Pits are underlain by both the Boyle Sandstone and Ballymore Limestone Formations.

No records of shafts or adits associated with mineral exploration have been recorded within the immediate vicinity

There is negligible risk associated with the proximity of these quarries or mineral localities.

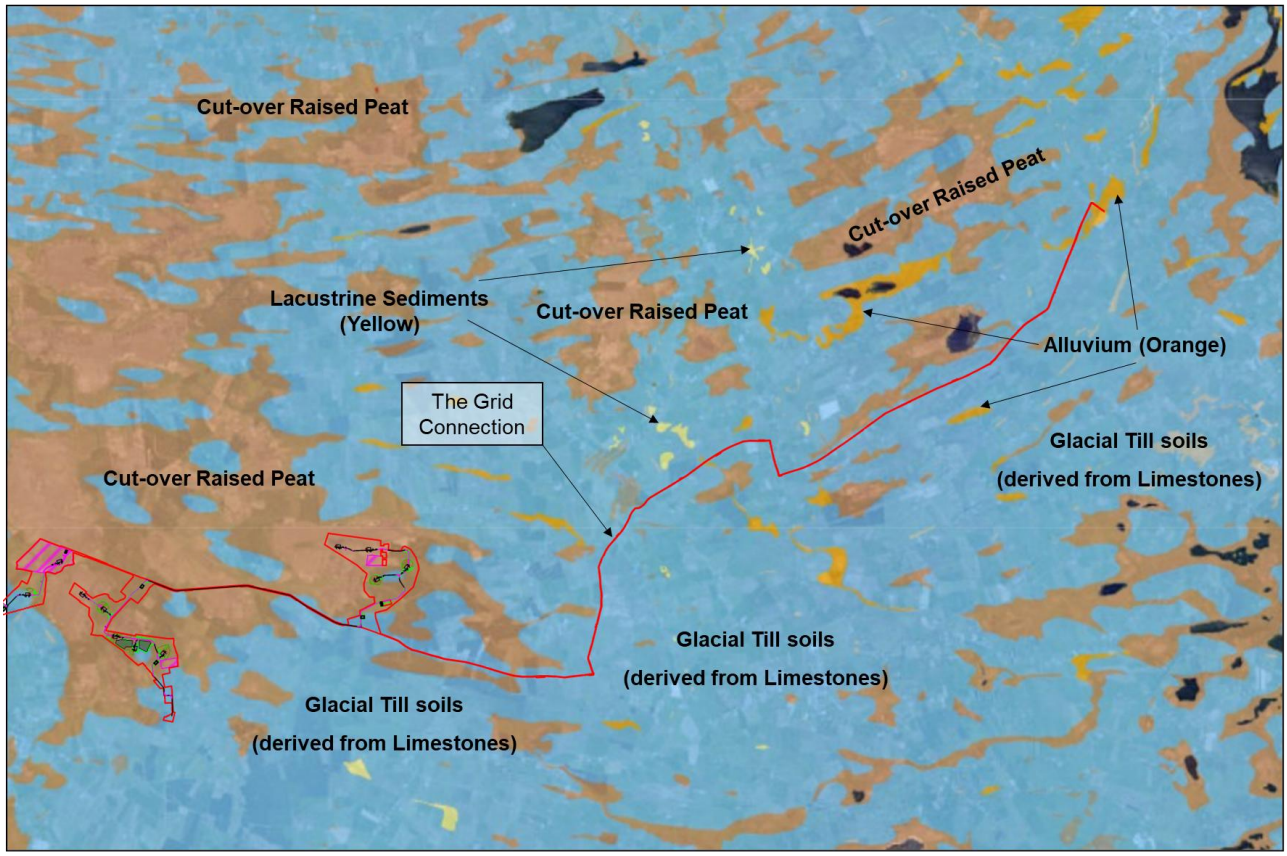

Figure 7.1B – Superficial Soils *(Reproduced from GSI Online Mapping)*

Superficial soils present within the wind farm Site consist predominantly of Cut-over Raised Peat, probably overlying sands and gravels, boulder clay (Glacial Till) or weathered rock.

Along the Grid Connection route the superficial soils are predominantly boulder clay (Glacial Till) with only short stretches of raised peat present beneath the existing road base materials.

2) Regional Hydrogeology

Aquifer Classification

A review was made with the Geological Survey of Ireland's National Bedrock Aquifer Potential map for the areas where the most significant excavations are proposed. Due to the small scale of the Grid Connection route excavations aquifer classification is considered to be of very low significance.

Essentially, surface water is anticipated to enter the sub-surface where it is permeable (topsoil or cut-over peat) and will continue vertically downwards until it comes into contact with either an impermeable stratum or the water table.

At this point the surface water will migrate in the same direction as the groundwater or according to the gradient of the impermeable stratum.

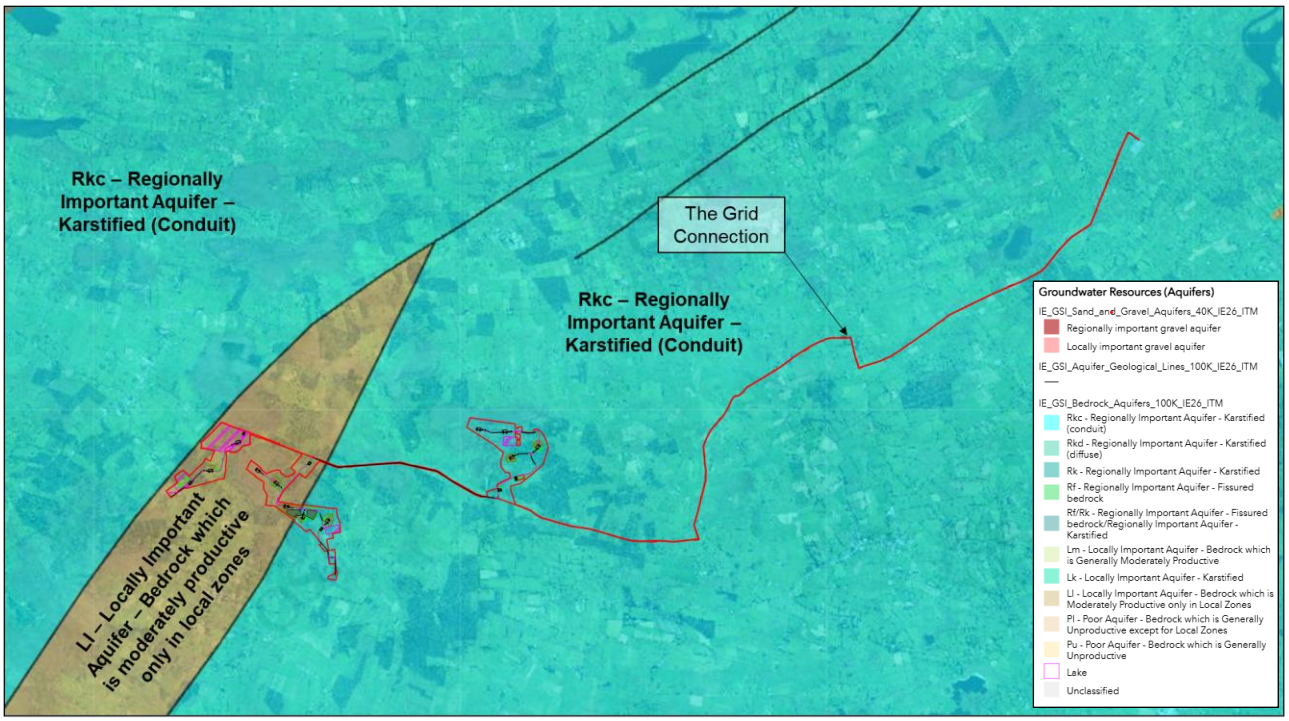

Figure 7.2 – Groundwater Resources and Surface Water Features *(Reproduced from GSI Online Mapping)*

GSI Groundwater resources mapping indicates that the proposed the Wind Farm Site is predominantly underlain by regionally important karstified bedrock aquifers, which are generally productive, with well-developed secondary permeability. Karstified bedrock aquifers are characterised by conduit flow, enlarged fractures and solutional cavities and can yield large volumes of groundwater where karst features are present. Where only fracturing is present the yields are more variable.

No potential superficial aquifers have been identified within the Wind Farm Site.

Bedrock aquifers are of very low or negligible sensitivity in the event of a peat landslide and therefore have negligible significance in the event of a peat landslide. Any risk to groundwater aquifers as a result of peat landslide is considered to be negligible.

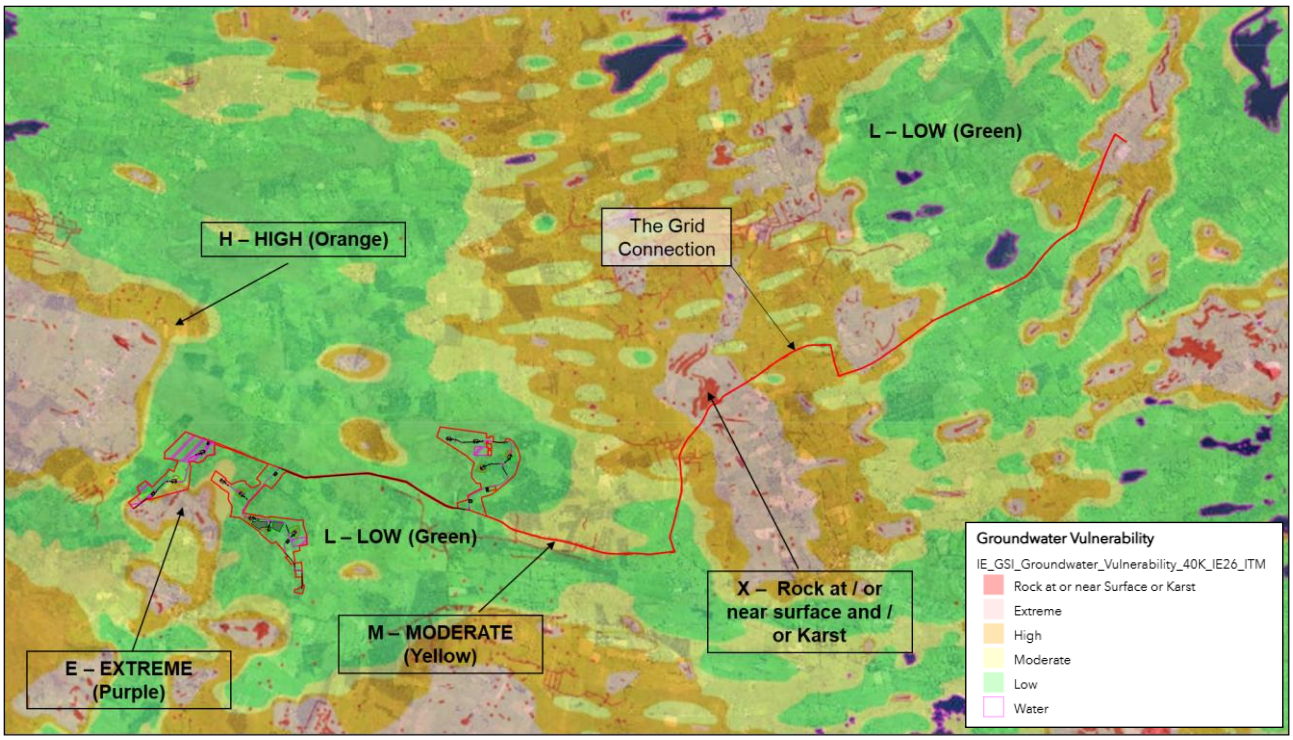

Figure 7.3 – Groundwater Vulnerability ***(Reproduced from GSI Online Mapping)***

Groundwater Vulnerability

The groundwater vulnerability within the boundaries of the proposed development site can be classified generally as Low were areas with thick, low-permeability superficial soils, such as clay or silt deposits overlay the bedrock. There are however localised areas of moderate groundwater vulnerability were areas of subsoils with intermediate thickness or permeability overlay shallower bedrock.

Assessing the productive karstified and locally important aquifers beneath the site in combination with the generally low groundwater vulnerability, the overall risk to groundwater, as a result of peat landslide, is considered low. Wind farm drainage will be designed to adequately cope with the groundwater conditions identified on site to reduce the potential for eroding surface water flows.

Wells and Discharge Consents

GSI and EPA Water mapping does not record groundwater abstraction within the site nor in the immediate vicinity.

Although not recorded in the vicinity, it is assumed that local residents discharge effluent associated with individual septic tanks. The potential for adverse impact to these facilities, or impact to the Wind Farm Site, is considered negligible.

3) Local Hydrology

Local hydrology is considered significant with respect to the calculation of peat landslide hazard. Both the proximity and scale of watercourses together with potential for run-off affect the determination of the hazard ranking, where watercourses have the ability to entrain soils, perpetuate the landslide and carry the effects far from the source.

For this reason, it is important to review site drainage, local watercourses and to a lesser extent potential subterranean flow networks associated with karst rock formations.

Site Drainage

Drainage channels are evident across the proposed development, many of which are associated with field drainage associated with the improved lands in the south. Most are generally less than 1m in width and depth, constructed around the perimeter of fields in order to effect improved drainage of the agricultural lands. It was not possible to precisely map the full extent of the man-made drainage network at this time, but this is considered to have low potential with respect to propagating a peat landslide.

Please refer to the site walkover and reconnaissance section (Section 3.0) and Appendix A, for details of site drainage features identified within the site boundary.

Local Watercourses

For the purpose of defining watercourses as sensitive receptors these are deemed to fulfil the following criteria: -

1. Consistently contain flowing water / not ephemeral.
2. Be a natural watercourse with either a designated name or very close to the site boundary. i.e. Not man made in origin.

Where a watercourse does not fulfil these criteria, but where there is still potential connectivity the potential hazard is managed (for the purpose of peat stability) by considering additional risk factors for drainage related issues, such as saturated ground, areas of flush or hydrological changes brought about by tree felling.

A number of designated watercourses are recorded, on GSI and / or EPA mapping, to extend into the renewable energy development site with some being close to the proposed infrastructure. These are:-

1. Owennaforeesha and Carrickbarher watercourses which flow towards the north east before turning north to join Breedoge which then flows northwest flowing into Lough Gara.
2. Mantua watercourse which flow towards west to join Breedoge which then flows northwest flowing into Lough Gara.

The proximity of sensitive receptors, such as watercourses, has been considered when assessing peat landslide hazard. The closer watercourses are to the construction zone, the higher will be the risk of exposure to contamination, by siltation, in the event of peat landslide. These factors have significantly affected the calculation of peat landslide hazard ranking at all turbines, substation and ancillary infrastructure and for portions of the Site Access Road network where they encroach on, or cross local watercourses.

4) Soils and Sub-soils

The following table summarises the ground conditions encountered at the Wind Fam Site during an earlier campaign of ground investigation.

Table 7.2 – Summary of Ground Conditions

Stratum Encountered	Depth range to Stratum (m)	Remarks
Peat	0.00	
Slightly sandy, slightly silty, slightly gravelly CLAY/SILT with low cobble content	0.30 – 2.80	
Stiff, slightly silty, gravely CLAY/SILT with high cobble content	1.90 –4.50	

The following tables summarise the findings of the peat probing survey and illustrates the peat thickness across the general survey area. Peat thickness assessment at individual turbine infrastructure, was used for the purchase of screening the construction site for the risk of Peat Landslide Hazard.

Current opinion is that lands mantled by >0.50m of peat are considered to be “bogland” with the peat being of sufficient thickness to influence ground stability. Peat <0.5m is not considered to influence soil stability any more than topsoil of a similar thickness would.

This threshold has been employed to determine where detailed peat stability assessment is required to determine peat stability and landslide hazard.

Peat soils in excess of 1.50m in thickness are considered too sensitive for excavation to construct new site tracks. In these cases, new track will be constructed using “floated road” methods, which will involve construction commenced on the existing ground surface and use of geotextiles and compacted stone to form an engineered surface of significantly greater width. This engineered surface will spread loads from traffic over a significantly larger areas and will reduce the stress on the underlying sensitive peat soils.

Table 7.3 – Peat Depth Distribution

Peat Depth Range (m)	Peat Depth Distribution from analysed data (%)	Peat Thickness Sufficient to influence Ground Stability?
0.00 – 0.50	1069 (44.8)	Very Unlikely
0.50 – 1.00	287 (12.0)	Likely
1.00 – 2.00	318 (13.3)	Likely
2.00 – 3.00	263 (11.0)	Very Likely
3.00 – 4.00	169 (7.1)	Very Likely
> 4.00	281 (11.8)	Very Likely

The mean peat depth encountered across the proposed Wind Farm Site was 1.45m, with a corresponding median value of 0.70m, whilst the peat thickness displayed a range from 0.10m to >4.50m within the proposed development area. 44.8% of the peat depths recorded < 0.5m of peat cover and consequently negligible risk of peat instability.

The table below shows the range of peat thickness encountered within the confines of the proposed construction footprint, as assessed for the turbine infrastructure and determines whether detailed peat stability assessment is required. It is within this construction footprint, that direct disturbance will occur during both construction, operational and decommissioning phases and for this reason the peat characteristics from this zone are employed to determine the potential for peat landslide.

Table 7.4 – Variation of Peat Depth at proposed Turbine / Structural Locations

ID	Coordinates (ITM)		Within Construction Footprint	Remarks
	Easting	Northing		
T01	575477	790430	4.50	Detailed peat assessment required
T02	574977	789898	0.70	Detailed peat assessment required
T03	575779	789896	4.50	Detailed peat assessment required
T04	576135	789684	1.60	Detailed peat assessment required
T05	576298	789215	0.40	Detailed peat assessment required
T06	576648	789007	1.20	Detailed peat assessment required
T07	577096	788988	1.60	Detailed peat assessment required
T08	579819	790661	2.20	Detailed peat assessment required

T09	580296	790613	2.00	Detailed peat assessment required
T10	580937	790353	1.80	Detailed peat assessment required
T11	580433	790105	0.60	Detailed peat assessment required
Substation	580612	789758	2.00	Detailed peat assessment required

Table 7.5 – Details of Estimated Peat and Mineral Soils Excavation Required

Turbine	Total Vol. of excavated peat at structure (m^3)	Total Vol. of excavated mineral soils / rock at structure (m^3)
Turbine Foundations	13,502	11,134
Turbine Hard Stands	70,945	11,096
Access Track (New, upgraded and TDR nodes)	45,476	6,273
Substation and Compound	16,864	2,530
Temporary Compounds	16,748	2,310
Internal Cabling	4,894	544
110kV Grid Connection (Removed off-site for use at licensed facility)	0	13,627
Borrow Pits (Overburden only – not rock resource)	12,450	137,550
Totals	180,879	185,064

The following sections of this report detail the Peat Landslide Hazard Assessment undertaken for the Project

Refer to drawings **2278-24 D1** for plot depicting discrete peat depth in the vicinity of wind farm infrastructure.

Drawings **2278-24 D2** illustrates the generalised peat depth for the proposed development in the form of a contoured plot, using a standard Kriging function.

Drawings **2278-24 D3** and **2278-24 D4** display the variation in ground surface as contoured plots of surface elevation and ground slope gradient respectively.

Drawings **2278-24 D5** and **2278-24 D6** present plots detailing peat shear strength and degradation characteristics respectively. At each test position a suite of tests and assessments were undertaken with the most critical values presented on each plot. i.e. minimum shear strength reading and maximum classification of peat degradation.

Drawing **2278-24 SD1** display the proposed spoil deposition arrangements for the Project.
All plots are provided as overlays on top of the proposed wind farm layout.

5) Existing Slopes

The slopes upon which peat bog resides is conserved to be one of the primary conditions with respect to peat landslide susceptibility.

In recognition of this fact, an analysis of topographic data was undertaken to identify the variation in gradient applicable to the existing ground slopes within the vicinity of the Wind farm Site.

Both Evans and Warburton (2007) and Boylan et al. (2008) found from their analysis of recorded failures in blanket bog, that these were often pertained to slopes of 4 – 8 degrees to the horizontal. The mechanism for peat landslides, in such cases of very low gradient is failure is by "bog burst", where the cause is a build-up of excessive hydrostatic pressure in the peat mass as a whole.

The failure itself will be due to internal forces and not due to a detaching of the peat soils from the underlying mineral or rock substrate. The cause will be internal rupturing resulting in local detachment the failure point. This coupled with lubrication of the basal plane by water will cause the peat mas to flow downslope as a "mud flow" type event. In the "bog-burst" case is unlikely that the peat – mineral soil/rock friction will have been exceeded. This specific risk with respect to "bog burst" is assessed by apportioning an escalating risk factor for peat thickness where the thickness of catotelm far exceeds that for the acrotelm layer.

Friction at the base of the peat is nonetheless important and thus it is important to consider the existing slope gradient as a potential trigger and a precondition for peat instability. Slopes in excess of 10 degrees allow the peat mass to store significant potential energy within even thin bogland and make them susceptible to the rapid increased loading that during storm events when peat density increases to its maximum.

For this reason and in respect to slope gradient, this report advocates a banded factor-based approach to apportioning risk. The following bands are used for this purpose, based on our experience with accidently triggered peat slides on over 100 different renewable energy development sites.

Table 7.6 – Risk Factor Assignment – Existing Slope Gradient

Existing Slope Angle (Measured at Surface of Peat, Angle to Horizontal)	Risk Factor Assigned (Using Factor Based Probabilistic Analysis)	Remarks
0 - ≤3	0	Negligible influence
3 - ≤5	1	Slight
5 - ≤ 10	2	Low

10 - ≤ 22.5	3	Medium
> 22.5	4	High

6) Observations

The following is an appraisal of ground conditions at each of locations where turbine bases and associated infrastructure are being considered, for the proposed Carrigeen Renewable Energy Development. The information provided in the following tables is an amalgamation of information garnered during the site walkover and the two subsequent phases of site investigation.

Turbine T01

Nature of Assessment	**Observations**
Position (ITM)	E= 575477 N= 790430
Max Peat Depth	**4.50m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	None observed. Saturated ground.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 200m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T02

Nature of Assessment	**Observations**
Position (ITM)	E= 574977 N= 789898
Max Peat Depth	**0.70m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 100m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T03

Nature of Assessment	Observations
Position (ITM)	E= 575779 N= 789896
Max Peat Depth	**4.50m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Saturated ground.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 500m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T04

Nature of Assessment	Observations
Position (ITM)	E= 576135 N= 789684
Max Peat Depth	**1.60m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 200m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T05

Nature of Assessment	Observations
Position (ITM)	E= 576298 N= 789215
Max Peat Depth	**0.40m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 500m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T06

Nature of Assessment	Observations
Position (ITM)	E= 576648 N= 789007
Max Peat Depth	**1.20m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Saturated ground
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	No sensitive receptors within buffer of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T07

Nature of Assessment	Observations
Position (ITM)	E= 577096 N= 788988
Max Peat Depth	**1.60m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	No sensitive receptors within buffer of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T08

Nature of Assessment	Observations
Position (ITM)	E= 579819 N= 780661
Max Peat Depth	**2.20m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Saturated ground.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 500m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T09

Nature of Assessment	Observations
Position (ITM)	E= 570296 N= 790613
Max Peat Depth	**2.00m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	Saturated ground.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 500m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T10

Nature of Assessment	Observations
Position (ITM)	E= 580937 N= 790353
Max Peat Depth	**1.80m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	No sensitive receptors within buffer of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

Turbine T11

Nature of Assessment	Observations
Position (ITM)	E= 580433 N= 790105
Max Peat Depth	**0.60m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 100m of turbine location.
Utilities: Underground or overhead	None observed.

Any other observations	High annual precipitation.

Substation

Nature of Assessment	Observations
Position (ITM)	E= 580612 N= 789758
Max Peat Depth	**2.00m**
Superficial Soils	Peat overlying sequence of probable glacial till.
Solid Geology	No rock encountered or bedrock outcropping observed.
Presence of peat landforms, evidence of past ground movement, hydrological features, other watercourses or other features of note	In forestry.
Topography	Slopes of < 3 degrees to horizontal in vicinity of turbine.
Sensitive Receptors	Minor watercourse within 200m of turbine location.
Utilities: Underground or overhead	None observed.
Any other observations	High annual precipitation.

7) Existing Services / Utilities

No significant were identified within or immediately adjacent to the Wind Farm Site boundary. Utilities are also potentially present along the minor public road adjacent to the Wind Farm Site boundary and site entrance.

The presence of these utilities will have negligible effect in respect to peat landslide hazard.

8) Audited Sites of Geological Significance

The Geological Survey of Ireland (GSI) maintains a database for known Geological Heritage Sites in Ireland. Review of this database has determined the following details in respect to site of geological significance that coincide with the Project.

Table 7.8A: RO022 Mid Roscommon Ribbed Moraines

Site Code	RO022
Site Name	Mid Roscommon Ribbed Moraines
IGH Theme 1	IGH7
IGH Theme 2	
County	Roscommon
Description	This field of ribbed moraine forms part of a small, discrete field northwest of slieve bawn
Designation	CGS. May be recommended for NHA.

Geological Description	This field of ribbed moraines form the perfect 'ribbed' topography
Report	Link
Coordinates (IG)	188269, 281685
Coordinates (ITM)	588222, 781701

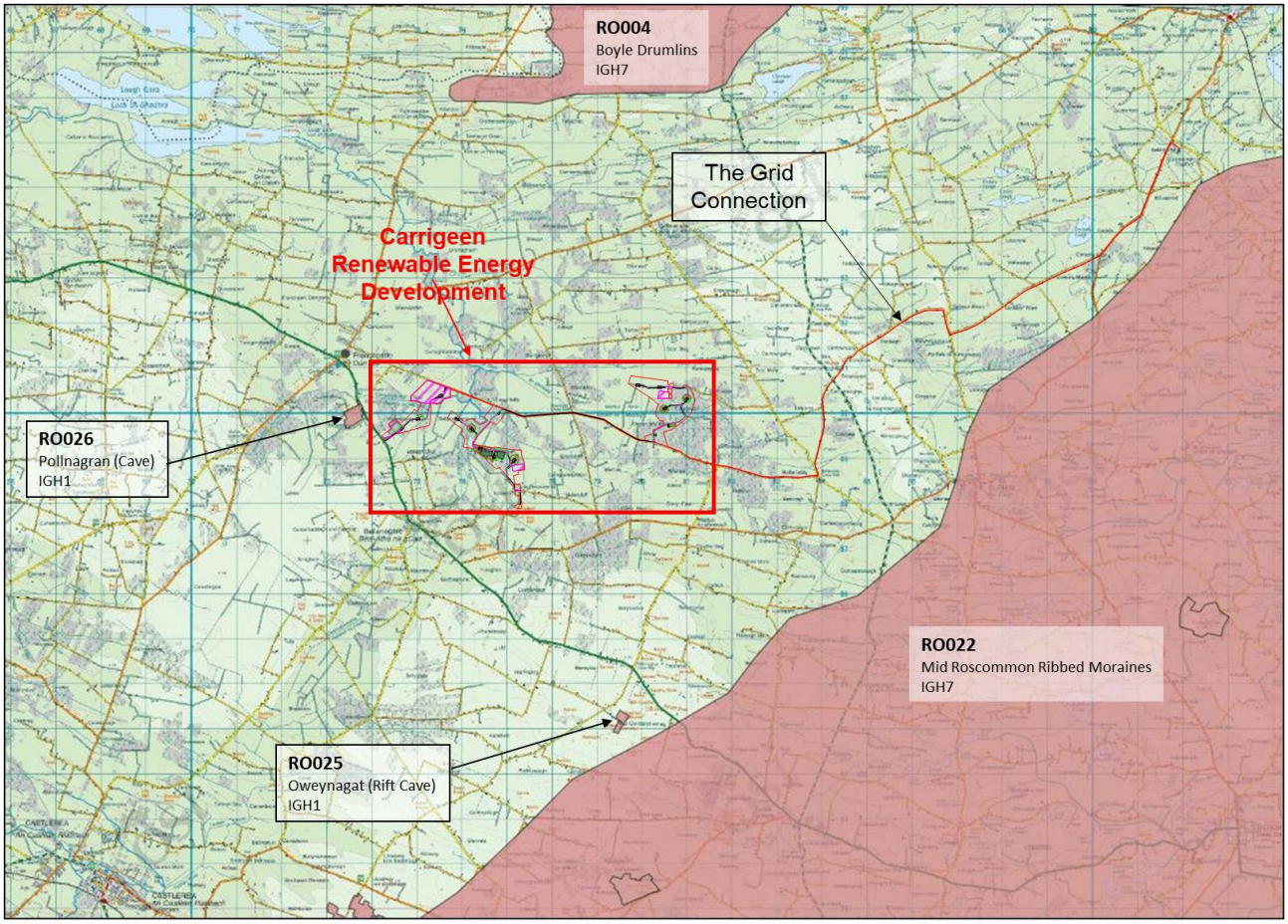

Figure 7.4 –Areas of Audited Geological Significance *(Reproduced from GSI Online Mapping)*

The author characterises the Wind Farm Site and Grid Connection route to consist of gently sloping or flat upland terrain, which is mainly mantled by raised peat bog, with improved lands and forestry evident on the fringes. Ribbed moraines and drumlins are either absent from, or not visible at these locations.

Although the Project does not coincide with Geological Heritage Sites, these are present in the vicinity but are not at direct risk of impact from the Project.

These are detailed below, but their significance with respect to peat landslide hazard is considered negligible.

Table 7.8B: RO026 Pollnagran

Site Code	**RO026**
Site Name	Pollnagran
IGH Theme 1	IGH1

County	Roscommon
Description	Pollnagran is a 750m long, active stream cave
Designation	CGS. May be recommended for NHA.
Geological Description	The cave has an entrance in a shallow blind valley where a surface stream disappears underground
Report	Link
Coordinates (IG)	173628, 289926

Table 7.8C: RO025 Oweynagat

Site Code	**RO025**
Site Name	Oweynagat
IGH Theme 1	IGH1
County	Roscommon
Description	Oweynagat is a linear rift cave entered via a souterrain
Designation	CGS
Geological Description	At Owenygat there is 37m length of a straight rift passage, with its roof close to surface
Report	Link
Coordinates (IG)	179549, 283143
Coordinates (ITM)	579504, 783159

Table 7.8D: RO004 Boyle Drumlins

Site Code	**RO004**
Site Name	Boyle Drumlins
IGH Theme 1	IGH7
County	Donegal
Description	This field of drumlins forms part of a small, discrete field southwest of Boyle
Designation	CGS
Geological Description	The features were deposited at the base of the ice sheet during the last ice Age
Report	Link
Coordinates (IG)	179368, 300720
Coordinates (ITM)	579323, 800732

9) Landslide Susceptibility and Landslide Events

Review of the GSI Online Database data indicates the following details concerning the Wind Farm Site.

1. Landslide susceptibility is recorded to Low.
2. 2 nr landslide events are recorded approximately 11km south west of the Site boundary.

10) Potential Sensitive Receptors

Analysis of desk study resources and follow up walkover surveys have identified the following sensitive receptors / exposures (See Table overleaf) with the potential to be susceptible to peat landslide generated by activity related to the proposed renewable energy development construction and / or operation.

The following figure and table detail a summary of the most sensitive of these receptors and others closest to renewable energy development infrastructure, which potentially influence or potentially impacted by soil stability.

Table 7.9 – Analysis of Sensitive Receptors Applicable to the Site

Receptor	Minimum distance to Development	Exposure Factor Assigned (Using Factor Based Probabilistic Analysis)	Remarks
Peat lands / Bog	0m	1	
Agricultural Lands	0m	1	
Designated Minor Watercourses / Water Bodies	83m	2	Numerous evident
Designated Major Watercourses / Water Bodies	> 500m	3	
Undesignated Watercourses / Drainage	0m	1	e.g. numerous drainage ditches and man-made watercourses, ephemeral run-off channels.
Site of Recorded Special Area of Conservation	Adjacent to proposed planning boundary	3	Cloonshanville Bog SAC
Site of Geological Significance	1km	3	Pollnagran
Minor Public Roads	198m	3	Minor public road north of Turbine T02

Moderately to highly trafficked Public Road	1.2km (West)	4	N5
Dwellings	400km	4	
Commercial Property	> 1km	3	
Significant Utilities (Overhead) / Underground	> 1km	3	
Population centre / Urban area	Frenchpark, Co. Roscommon	5	Pop. c.454 (2016)

11) Potential Preconditions Identified within the immediate vicinity of the Project

Analysis of desk study resources and follow up walkover survey have identified the following static or inherited factors that could potentially act as preconditions to slope instability in peatlands.

Table 7.10– Risk Analysis of Preconditions Applicable to the Site

Precondition	Minimum distance to Development (m)	Remarks
Concentrated drainage network / presence of standing water / area of flush / springs or seeps	< 100m	Presence of any of the scenarios mentioned causes elevation in the risk of peat instability. No specific banding apportioned.
Significant slopes	> 1km	Relatively flat topography
Significant peat thickness	Western side of proposed main infrastructure; Turbines T01, T03, T08, T09 and the Substation	Peat thickness capable of inducing "bog burst" was only recorded. However, at these locations slope gradients were such, (< 3 degrees) as to effectively counter this hazard. Significance based on probabilistic approach has been employed.
Very highly decomposed Peat	Turbines T04 only.	
Weak Peat and underlying mineral soils	Turbines T01, T02, T03, T04, T07, T09, T10 and T11.	Shear strength of <20kPa
Very Weak Peat and underlying mineral soils	Not recorded at Infrastructure	Shear strength of <10kPa
Potential sonic vibration or ground accelerations	Piling may be necessary to provide an appropriate turbine foundation solution. Negligible risk, of vibration causing ground accelerations capable of causing instability. No potential quarry blasting within 10km.	Vibrationally induced energy, e.g. from piling.

12) Pre-Failure Indicators within the immediate vicinity of the proposed development

Pre-failure indicators are physical landforms that are "tell-tale" signs of stress within the peatland environment.

The following pre-failure indicators have been considered for the Project:

- Historical evidence of previous movement
- Tension or compression features
- Soil creep
- Cracking / desiccation
- Other[1]

The following pre-failure indicators are present within the immediate vicinity of the Project:

Table 7.11 – Analysis of Pre-Failure Indicators Applicable to the Site

Pre-Failure Indicator	Minimum distance to Structures / Infrastructure (m)	Remarks
Historic peat cutting	0m (within site)	Peat cuttings in the form of low peat banks were recorded near T01, T03, T05, T08 and T09. The landforms at these locations where either of negligible significance or overshowed by the more significant risk caused by construction on felled forestry lands.
Evidence of historical peat / soil movement	Not at assessed infrastructure	
Evidence of tension cracking or compression features	Not at assessed infrastructure	
Evidence of soil creep	0m (within site)	Limited and of negligible significance
Cracking / desiccation	Not at assessed infrastructure	

[1] The Scottish Guidance notes other potential pre failure indicators such as artificial drainage, concentrated drainage networks, seeps, springs, soft clays and iron pans. The author considers these to be preconditions and not pre failure indicators.

F. PEAT LANDSLIDE HAZARD ASSESSMENT

1.1 INTRODUCTION

Peat landslides are caused by a combination of factors, triggering factors and preconditioning factors and thus the potential for peat landslide to occur can be considered to be a cumulative risk scenario. For the purpose of this report, most emphasis is placed on the potential for construction of the new development to trigger a peat landslide, although it is also recognised that conditions could be such that this could have occurred naturally during the lifetime of the Project.

According to the Scottish Guidance, "A number of preparatory factors also operate in peatlands which act to make peat slopes increasingly susceptible to failure without necessarily initiating a landslide. Triggering factors change the state of the slope from marginally stable to unstable and can be considered as the 'cause' of failure (DoE, 1996). There are also inherent characteristics (or preconditions) of some peat covered slopes which predispose them to failure."

Triggering factors have an immediate or rapid effect on the stability of a peat accumulation whereas preconditioning factors can influence peat stability over a much longer period. Only some of these factors can be addressed by site characterisation.

1.1.1 Preparatory Factors

The following are some of the ***Preparatory Factors*** which operate to reduce the stability of peat slopes in the short to medium term (tens to hundreds of years):

- ***Increase in mass of the peat slope through progressive vertical accumulation (deep peat formation).***
- Increase in mass of the peat slope through increases in water content.
- Increase in mass of the peat slope through growth of trees planted within the peat deposit (afforestation).
- ***Reduction in shear strength of peat or substrate from changes in physical structure caused by progressive creep and vertical fracturing (tension cracking or desiccation cracking), chemical or physical weathering or clay dispersal in the substrate.***
- Loss of surface vegetation and associated tensile strength (e.g., by dry-out, burning or pollution induced vegetation change).
- ***Increase in buoyancy of the peat slope through formation of sub-surface pools or water-filled pipe networks or wetting up of desiccated areas; and***
- Afforestation of peat areas, reducing water held in the peat body, and increasing potential for formation

Many ***Preparatory Factors*** could be considered as ***Pre-Failure Indicators***.

1.1.2 Preconditions

Preconditions to slope instability in peatlands are often present for long periods of time and are generally considered static in nature, by highly susceptible to a triggering event like a storm event, e.g.:

- Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity, especially an iron pan at the base of the peat deposit).
- ***Presence of peat on steep slopes***
- ***A convex slope or a slope with a break of slope at its head (concentration of subsurface flow).***
- Proximity to local drainage, either from flushes, pipes or streams (supply of water); and
- Significant connectivity between surface drainage and the peat mass.
- Drainage focused on a susceptible part of a slope by alterations to natural drainage patterns (e.g.by pipe blocking or drainage diversion); and
- Loading of peat by plant, fill / spoil or infrastructure.

1.1.3 Triggers

Peat landslides may be ***triggered*** by natural events or human activities. The following ***natural triggers*** have been reported in relation to peat instability.

- ***Intense rainfall causing development of transient high pore-water pressures along pre-existing or potential rupture surfaces (e.g., at the interface between peat and substrate).***
- Snow melt causing development of high pore-water pressures, as above.
- ***Rapid ground accelerations (earthquakes) causing a resultant force in excess of the peat shear strength.***
- Unloading of the peat mass by fluvial incision of a peat slope at its toe, reducing support to the upslope material; and
- Loading of the peat mass by landslide debris causing an increase in shear stress.

External environmental triggers such as rainfall and snowmelt cannot realistically be mitigated, though they can be managed (e.g., by limiting construction activities during periods of intense rain). Unloading of the peat mass by excavation, loading by plant and focusing of drainage can be managed by careful design, site specific stability analyses, informed working practices and monitoring.

Triggers associated with human activities include:

- ***Alteration to natural drainage patterns which focuses drainage and generates high pore-water pressures along pre-existing or potential rupture surfaces (e.g., at the discontinuity between peat and substrate).***
- ***Rapid ground accelerations (blasting or mechanical vibrations) causing an increase in shear stresses within the peat mass.***

- Unloading of the peat mass by cutting of peat at the toe of a slope reducing support to the upslope material (e.g., during track construction).
- ***Loading of the peat mass by heavy plant, structures or overburden causing an increase in shear stress; and***
- ***Kinetic energy (impact forces) associated with digging and tipping, which may be associated with building, engineering, farm machinery or industrial activity.***

1.1.4 Pre-failure Indicators

Preparatory Factors or ***Preconditions*** are often highlighted visually by **Pre-Failure Indicators**, i.e., landforms that results from their effects. Where Preparatory factors and Preconditions can often prove difficult to determine, Pre-failure Indicators are generally evident in the landscape. Typical Pre-Failure Indicators are as follows:

- Presence of historical and recent failure scars and debris.
- Presence of features indicative of tension.
- Presence of features indicative of compression.
- Evidence of 'peat creep'.
- Presence of subsurface drainage networks or water bodies.
- Presence of seeps and springs.
- Presence of artificial drains or cuts down to substrate.
- Concentration of surface drainage networks.
- Presence of soft clay with organic staining at the peat and (weathered) bedrock interface; and
- Presence of an iron pan within a mineral substrate.

In order to assess the stability of peatland sites there is a tendency to rely heavily on Pre-Failure Indicators and certain Preconditions (identified as bold italics text) in order to provide the necessary inputs to the algorithm for the purposes of risk determination.

Assessment of the risk of peat instability requires the assessment of the effect of these cumulative risk factors. In the case of ***triggers,*** we assume the "worst-case" external environmental impact attributable over a period equivalent to twice the "normal lifespan[2]" and assume that the trigger will be one of those highlighted in bold italic text above, most likely cumulative and loading / weather related. We caveat certain of the potential triggers such as "earthquake", "rapid ground accelerations", "alteration to natural drainage", "loading of peat mass"," digging or dumping" by the following respective practices: -

- Review of historic seismicity, in the context that Ireland is generally considered very low risk in this respect

[2] 50 years

- Determining whether quarry blasting occurs in the vicinity and assuming that "driven" piles will not be used as part of the construction method
- The drainage that is recommended is as a default "non-positive" primarily so that surface water will not develop significant momentum
- A competent contractor will undertake the works and understand the risks associated with construction of peatlands and will be capable of maintaining ground stability at all times
- Where ground conditions are particularly sensitive, we will advocate risk mitigation by suggesting, cessation of works during storm event and the use of low-pressure plant, at least until construction works are complete. We assume our advice will be followed.

In this way, a mixture of desktop research, visual assessment, topographic analysis, in-situ testing and laboratory testing forms the basis for the initial determination of the Hazard Ranking in respect to Peat Landslide Hazard.

Following an initial scoping assessment of the above factors / indicators, e.g., following the Desk Study and Walkover Survey report, an initial coarse assessment of the Hazard Ranking will be and deployed to assist in the production of the optimal Wind Farm layout plan.

Following this preliminary analysis further, detailed fieldwork is initiated to extend our initial coarse understanding of peat characteristics, collect soil samples and provide more comprehensive information on conditions within the construction footprint for proposed new infrastructure.

Detailed analysis using topographic, hydrological and other geological information, in-situ test data and collected peat depth data collected on a fine grid, is then employed to determine the potential for peat movement at the main structures and associated infrastructure. This analysis particularly focuses on exposure / proximity to sensitive receptors from sources of potential triggering activities.

From this analysis the following table of assessed hazards has been produced for Peat Landslide Hazard Assessment . After the appropriate mitigation (See Tables 7.25, 7.26 and 7.26A) the residual hazards are also summarised. .

Reference is made, in this section, to "*Peat Landslide Hazard and Risk Assessments Best Practice Guide for Proposed Electricity General Developments*" 2nd Edition, produced by The Scottish Executive & Halcrow Group Ltd (Apr 2017).

Table 7.12 – Summary of Peat Landslide Assessment for Carrigeen Wind Farm

Stability Issue	Turbine Base Locations
Existing Slopes	Slopes considered at the proposed turbine locations are low , displaying magnitudes of 0 – 5 degrees to the horizontal.
Landslip / Peat Landslide	Analysis of available topographic information and peat depth data gives the following assessment at each proposed turbine location. *Construction of Access Tracks* Peat depth along certain small stretches of the access track network are considered sufficient (>1.50m), for the use of "floated road" construction. "Floated road" construction may also be required to fulfil some other geotechnical or environmental purpose. This notwithstanding, the majority of the site tracks are anticipated to be either new traditionally constructed ones or upgraded existing tracks. The combination of shallow to deep peat thickness, low to moderate peat strength and low slope gradient, as well as other factors, has been considered. Consequently, the proposed site track network can initially be classified to have a designation of, **MEDIUM HAZARD** for the majority of the network, for the purposes of peat stability. The only exception to this is **LOW HAZARD** in the case of the track section from the Substation to T11 and from T11 to T08. . Proposed mitigation will reduce the risk of peat landslide further resulting in a post mitigation designation of **LOW HAZARD** and **NEGLIGIBLE HAZARD** for sections from the Substation to T11 and from T11 to T08. *Construction at Turbines and Substation* At all turbine locations the combination of moderate to high peat thickness, low to moderate peat strength and low slope gradient and other factors has been considered. Consequently, the majority of the turbine infrastructure and Substation can initially be classified to have an upper designation of **MEDIUM HAZARD** for the purposes of peat stability. **MEDIUM HAZARD** at turbines T01 and T03, **NEGLIGIBLE HAZARD** at turbines T05, T06, T07 and T10 and **LOW HAZARD** at T02, T04, T08, T09 and the Substation. Proposed mitigation will reduce the risk of peat landslide further resulting in a post mitigation designation of **NEGLIGIBLE TO LOW HAZARD**. These designations make the assumption that the general procedures outlined in the *Recommendations* section will be adopted and implemented fully during the construction period.

1.2 ANALYTICAL ANALYSIS

The following analysis uses an analytical approach to determine factors of safety to quantify the risks of peat landslides and local rotational failure or engulfment of excavations occurring.

The Scottish Guidance suggests the application of Infinite Slope Stability Analysis be employed to gauge the stability of peat on slopes and determination of the relevant Factor of Safety (FoS).

As an additional observation the Stability of Excavations within peat at the site of approved turbine excavations has also been considered. Refer to the Appendix "Analytical Analysis" for detailed analysis in respect to the above.

Results of these analyses are presented in the tables provided below: -

Table 7.13 - Analytical assessment of Infinite Slope Stability

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Dry Condition	
			Cu[3] (kPa)	Factor of Safety Sliding	Cu[4] (kPa)	Factor of Safety Sliding[5]
T01	3	4.5	11	**3.90**	5	**1.77**
T02	3	0.7	14	**31.89**	5	**11.39**
T03	3	4.5	13	**4.61**	5	**1.77**
T04	3	1.6	14	**13.95**	5	**4.98**
T05	3	0.4	20	**79.72**	5	**19.93**
T06	3	1.2	20	**26.57**	5	**6.64**
T07	3	1.6	14	**13.95**	5	**4.98**
T08	3	2.2	29	**21.02**	5	**3.62**
T09	3	2.0	19	**15.15**	5	**3.99**
T10	3	1.8	12	**10.63**	5	**4.43**
T11	3	0.6	11	**29.23**	5	**13.29**
Substation	3	2.0	20	**15.94**	5	**3.99**

[3] Minimum in-situ test values used

[4] Laboratory test values employed for similar peat soils recovered for similar projects.

[5] Dry peat immediately followed by saturation – "worst case scenario"

Table 7.14 – Analytical assessment of Stability of Excavations

LOCATION	Cu (kPa)	Maximum Face Height Considered (m)	Factor of Safety Rotational Failure
T01	11	4.5	>1.3
T02	14	0.7	>1.3
T03	13	4.5	>1.3
T04	14	1.6	>1.3
T05	20	0.4	>1.3
T06	20	1.2	>1.3
T07	14	1.6	>1.3
T08	29	2.2	>1.3
T09	19	2.0	>1.3
T10	12	1.8	>1.3
T11	11	0.6	>1.3
Substation	20	2.0	>1.3

1.3 QUANTITATIVE ANALYSIS

The following sections detail the assessment methodology[6] that has been employed to assess the stability of peat soils at Carrigeen Wind Farm .

The Scottish Guidance originally proposed an assessment of "Degree of Risk", as described by Clayton in the Institution of Civil Engineers' publication, "Managing Geotechnical Risk" (2001).

DEGREE OF RISK = LIKELIHOOD X EFFECT

This original approach was later modified, and the final formulation conceived: -

HAZARD RANKING = HAZARD X EXPOSURE

The Scottish Guidance provides no definitive approach to determination of elements required to determine HAZARD or EXPOSURE although it does provide guidance. Neither does it provide the relative weighting that should be employed to each individual term to determine its severity. The Scottish Guidance also recommends a probabilistic approach to determining risk which, in the author's opinion, cannot hope to mirror complex cumulative risks appropriate to individual sites.

For this purpose, a factor-based analysis of hazard and exposure are used in this report to obtain a calculation of hazard ranking.

For this algorithm Likelihood / Hazard is represented by a range of factors determined from a selection of Preparatory Factors, Preconditions and Pre-Failure indicators as identified previously. These Hazards are weighted depending on the relative instability they tend to cause in the peat mass system. The treatment of potential Triggers is constrained as previously mentioned and Effect / Exposure relates to a spatial examination of sensitive receptors in relation to anticipated triggering location. These exposures are weighted depending on their adverse consequence.

Numerical calculation of peat stability is also employed but only as a check to the factor-based algorithm.
The parameters employed in this particular assessment of risk are given in the following sections.

HAZARD: *Likelihood of the peat landslide event occurring*
(This relates to the potential for a peat landslide to be triggered. Factors considered include the topographic slope, peat thickness, strength of peat, type of peat present, method of construction proposed, etc.)
The tables below give the factors used to establish overall Peat Landslide HAZARD.

[6] Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments, Prepared for Energy Consents Unit Scottish Government, Second Edition, April 2017

Table 7.15 – Qualitative assessment of Peat Landslide Hazard – Peat Depth

Scale of Risk	Hazard
0	Peat depth less than 0.5m
+0.5	Peat depth between 0.5 – 1.0m
+1	Peat depth between 1.0 – 2.0m
+2	Peat depth between 2.0 – 3.0m
+3	Peat depth >1.50m (Floated Track Construction Only)
+4	Peat depth greater than 3.0m ("*Firm*)
+6	Peat depth greater than 4.0m ("*Firm*)
+10	Peat depth greater than 3.0m ("*Quaking*")

Table 7.16 – Qualitative assessment of Peat Landslide Hazard – Slope

Scale of Risk	Hazard
0	Slopes < 3 degrees to the horizontal
+1	Slopes between 3 and 5 to the horizontal
+2	Slopes between 5 and 10 to the horizontal
+3	Slopes between 10 and 22.5 degrees to the horizontal
+4	Slopes > 22.5 degrees to the horizontal

Multiplication factor of 1.25 added for convex slopes

Table 7.17 – Qualitative assessment of Peat Landslide Hazard – Drainage

Scale of Risk	Hazard
0	No Drainage Issues within construction zone
+1	Drainage Issues: Areas of forestry either already felled or due to be felled to facilitate construction
+0.5	Drainage Issues: Water table at or near the surface; standing water / ephemeral lakes within construction zone
+0.5	Drainage Issues: Concentrated drainage network evident in vicinity

Table 7.18 – Qualitative assessment of Peat Landslide Hazard – Relic Peat Landforms

Scale of Risk	Hazard
0	No Relic Peat Landforms present in vicinity of the construction zone
+1	Relic Peat Landforms present in vicinity of construction zone (1). Eroded peat hags, tension cracks, peat banks (0 – 1.5m height) present within construction zone
+2	Relic Peat Landforms present in vicinity of construction zone (2). Peat substrate cut for peat harvesting, pipe pipes, "bog holes", peat detachment evident

Table 7.19 – Qualitative assessment of Peat Landslide Hazard – Piling

Scale of Risk	Hazard
0	No Sonic/Seismic Activity locally (Piling or Blasting within 500m)
+1	Sonic/Seismic Activity locally (Piling or Blasting within 500m)

Table 7.20 – Qualitative assessment of Peat Landslide Hazard – Humification

Scale of Risk	Hazard
-0.5	H0 –H2 Von Post Classification of Peat Degradation [7] Where very low rates of degradation are present this tends to correspond to a highly organic silty clay soil and as such these soils exhibit a much-reduced risk of instability.
0	H3 –H8 Von Post Classification of Peat Degradation
+1	H9 –H10 Von Post Classification of Peat Degradation

Table 7.21 – Qualitative assessment of Peat Landslide Hazard – Shear Strength

Scale of Risk	Hazard
-0.5	>60 kPa Vane Test Classification of Shear Strength at 1.5m depth. Refer to Table 11. Applies where very low rates of decomposition are present and the soils are more akin to highly organic silty clays.
0	20-60 kPa Vane Test Classification of Shear Strength at 1.5m depth
+1	10-20 kPa Vane Test Classification of Shear Strength at 1.5m depth
+2	5-10 kPa Vane Test Classification of Shear Strength at 1.5m depth
+3	*<5 kPa Vane Test Classification of Shear Strength at 1.5m depth*

Table 7.22 – Qualitative assessment of Peat Slide Hazard– Annual Precipitation

Scale of Risk	Hazard
0	Annual Precipitation: Low (<1100mm)
+0.25	Annual Precipitation: Moderate (>1100mm to 1250mm)
+0.5	Annual Precipitation: High (>1250mm to 1350mm)
+0.75	Annual Precipitation: Very High (1350mm to 1500mm)
+1.0	Annual Precipitation: Extremely High (>1500mm)

Table 7.23 – Qualitative assessment of Peat Slide Hazard– Peat Landslide History (GSI - 5km Radius)

Scale of Risk	Hazard
0	Peat Landslide History: None recorded
+0.25	Peat Landslide History: < 5 events recorded

[7] Negative factors are only employed where the positive sum of all other HAZARD factors >4

+0.5	Peat Landslide History: <10 events recorded
+1.0	Peat Landslide History: Major incident / significant event recorded

EXPOSURE: *Adverse Consequence / Impact that such an event might have at this particular location*

The Scottish Guidance assesses exposure in terms of impact, e.g. Very Low Impact to Extremely High Impact, but does not state directly what type of receptors are of concern. The two receptor types identified by the Scottish Guidance are potential for "Financial Impact" and / or "Environmental Impact". For this report a combination of Public Safety and Environmental Impact have been used to derive receptors.

The chosen rationale, for the selection of EXPOSURE receptors, in this report is as follows:

1. The main purpose of this report is to determine the risk to 3rd parties. That is infrastructure, structures and environmentally sensitive receptors, such as watercourses and protected zones, whilst avoiding determination of Hazard Ranking for the wind farm installation itself.

The individual EXPOSURES employed, and their relative weightings are summarised in Table 7.24, below., which gives a general view of some examples of the factors used to establish EXPOSURE.

Table 7.24 – Qualitative Assessment of Peat Landslide Exposure

Scale of Exposure	Examples of Determining Factors	Impact upon total project
1	Flat agricultural land or blanket bog within 100m of structure or tracks. Default condition. If zone of environmental / archaeological or other sensitivity indicated within 300m screen with reference to category C.	Very low Impact (<1%)
1.5 2.0* 3.0 2.5**	Structure or site track <500m from major water course, area of flush or another sensitive landform. Structure or site track <200m from minor water course, area of flush or another sensitive landform. Structure or site track <200m from major water course Structure or site track <100m from area of minor water course or < 200m from site of special scientific interest, special conservation area, or other designated European Site, where there is potential of indirect / downslope impact. *If there is a very sensitive receptor, such as a weak bridge (or other receptor that could be detrimentally impacted by entrained debris flow) within 2km down-steam, a factor of 0.5 is added to the scale of exposure. **If there is a sensitive receptor within 1km down steam a factor of 0.25 is added to the scale of exposure.	Low Impact (1% - 4%)
3	Structure or site tracks <200m from receptor of commercial, municipal or identified environmental sensitivity – e.g. uninhabited buildings, structure or minor roads <200m from receptor of strategic importance, e.g. public roads (if lightly trafficked reduce exposure to 2), major public utilities.	High Impact (4% - 10%)
4	Structure or site tracks <300m from moderately to highly trafficked public road or minor rail lines, area of designated special scientific interest where there is potential for direct / downslope impact, sensitive buildings, water abstraction etc.	Very High Impact (10% - 100%)

Scale of Exposure	Examples of Determining Factors	Impact upon total project
5	Structure or site tracks <400m proximity to temporarily or permanently inhabited buildings, areas of public congregation, primary rail lines and infrastructure or other sensitive facility.	Extremely High Impact (> 100%)

The precise classification of each EXPOSURE is determined in consultation with other members of the team.

By assessing the potential for peat landslide against the scales given above, it is possible to determine the hazard ranking by multiplying the hazard and exposure of each event. This results in a Hazard Ranking value as follows.

HAZARD RANKING = HAZARD x EXPOSURE

The following table outlines the suggested action for the different levels of hazard ranking as determined by the factor-based risk assessment process. The rationale employed to determine the relative severity of Hazard Rankings is based upon the Scottish Guidance.

Table 7.25 – Hazard Ranking and Suggested Actions (Refer to "Peat Landslide Hazard and Risk Assessment – Best Practice Guide for Proposed Electricity Generation Developments", Dec 2017, Section 5, Table 5.3, Page 5-6)

Hazard Ranking	Hazard Ranking Level	Action Suggested
≥17	**High**	Avoid project development at these locations
11 – 16	**Medium**	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to Low or Negligible
5 – 10	**Low**	Project may proceed through the use of mitigation techniques applied during construction.
0 – 4	**Negligible**	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

The following tables summarise the Hazard Ranking of each Turbine, Structure and segment of new Access Track to be constructed at the Carrigeen Wind Farm site.

Table 7.26 – Hazard Ranking for each Structure at Carrigeen Wind Farm

ID	ITM Co-ordinates		Peat Stability Hazard Ranking
	Easting	Northing	
T01	575477	790430	**16**
T02	574977	789898	**7.5**

T03	575779	789896	**12**
T04	576135	789684	**7**
T05	576298	789215	**2.25**
T06	576648	789007	**2**
T07	577096	788988	**3.5**
T08	579819	790661	**4.5**
T09	580296	790613	**6**
T10	580937	790353	**3.5**
T11	580433	790105	**7**
SUBSTATION	580612	789758	**7**

Table 7.26A – Hazard Ranking for each stretch of new site access track

ID	Peat Stability Hazard Ranking
Site Entrance 1 to T01	**12.5**
T01 to T02	**13.75**
Site Entrance 3 to T04	**12.5**
T04 to T03	**11**
Spur to T05 to T06	**6.75**
T06 to T07	**8.25**
T07 to Site Entrance 4	**5.5**
Site Entrance 5 to Substation	**13.75**
Substation to T11	**13.75**
Spur at T11 to T08	**8.75**

Appraisal of the Hazard Rankings for each proposed turbine location provides the following findings. The following discourse offers an appraisal of ground conditions at each of the structural locations.

1. At turbine location **T01** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 4.50m	+6
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+0.5
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0

G	Representative Peat Strength in range 11kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		8

Preliminary Peat Landslide Risk is 8

Potential Exposure Risk is 2. (Minor w/c within 200m)
This equates to a **Hazard Ranking of 16** and places turbine construction at this location in the **MEDIUM RISK Category.**

2. At turbine location **T02** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 0.70m	+0.5
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0
G	Representative Peat Strength in range 14kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3

Preliminary Peat Landslide Risk is 3

Potential Exposure Risk is 2.5 (Minor w/c within 100m)
This equates to a **Hazard Ranking of 7.5** and places turbine construction at this location in the **LOW-RISK Category.**

3. At turbine location T**03** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 4.50m	+6
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+0.5
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0
G	Representative Peat Strength in range 13kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		8

Preliminary Peat Landslide Risk is 8

Potential Exposure Risk is 1.5 (Minor w/c within 500m)
This equates to a **Hazard Ranking of 12** and places turbine construction at this location in the **MEDIUM RISK Category.**

4. At turbine location **T04** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 1.60m	+1
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H8	0
G	Representative Peat Strength in range 14kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3.5

Preliminary Peat Landslide Risk is 3.5

Potential Exposure Risk is 2 (Minor w/c within 200m)
This equates to a **Hazard Ranking of 7** and places turbine construction at this location in the **LOW-RISK Category.**

5. At turbine location **T05** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 0.40m	0
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H1	0
G	Representative Peat Strength in range 20kPa	0
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		1.5

Preliminary Peat Landslide Risk is 1.5

Potential Exposure Risk is 1.5 (Minor w/c within 500m)
This equates to a **Hazard Ranking of 2.25** and places turbine construction at this location in the **NEGLIGIBLE RISK Category.**

6. At turbine location **T06** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 1.20m	+1
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+0.5
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0

F	Representation Peat degradation in range H2	0
G	Representative Peat Strength in range 20kPa	0
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		2

Preliminary Peat Landslide Risk is 2

Potential Exposure Risk is 1 (No sensitive receptor within relevant buffer)
This equates to a **Hazard Ranking of 2** and places turbine construction at this location in the **NEGLIGIBLE RISK Category.**

7. At turbine location **T07** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 1.60m	+1
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0
G	Representative Peat Strength in range 14kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3.5

Preliminary Peat Landslide Risk is 3.5

Potential Exposure Risk is 1 (No sensitive receptor within relevant buffer)
This equates to a **Hazard Ranking of 3.5** and places turbine construction at this location in the **NEGLIGIBLE RISK Category.**

8. At turbine location **T08** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 2.20m	+2
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+0.5
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H6	0
G	Representative Peat Strength in range 29kPa	0
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3

Preliminary Peat Landslide Risk is 3

Potential Exposure Risk is 1.5 (Minor w/c within 500m)

This equates to a **Hazard Ranking of 4.5** and places turbine construction at this location in the **LOW-RISK Category.**

9. At turbine location **T09** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 2.00m	+2
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+0.5
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H6	0
G	Representative Peat Strength in range 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		4

Preliminary Peat Landslide Risk is 4

Potential Exposure Risk is 1. 5 (Minor w/c within 500m)
This equates to a **Hazard Ranking of 6** and places turbine construction at this location in the **LOW-RISK Category.**

10. At turbine location **T10** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 1.80m	+1
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0
G	Representative Peat Strength in range 12kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3.5

Preliminary Peat Landslide Risk is 3.5

Potential Exposure Risk is 1 (No sensitive receptor within relevant buffer)
This equates to a **Hazard Ranking of 3.5** and places turbine construction at this location in the **NEGLIGIBLE RISK Category.**

11. At turbine location **T11** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 0.60m	+0.5
B	Maximum gradient is in range <3º to horizontal	0
C	Drainage issues	+1

D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H5	0
G	Representative Peat Strength in range 11kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3

Preliminary Peat Landslide Risk is 3

Potential Exposure Risk is 2.5 (Minor watercourse within 100m)
This equates to a **Hazard Ranking of 7** and places turbine construction at this location in the **LOW-RISK Category.**

12. At location **SUBSTATION** the following assessment of HAZARD was made:

Item	Description of Key Indicator	Factor
A	Maximum peat thickness recorded in construction zone was 2.60m	+2
B	Maximum gradient is in range <5º to horizontal	0
C	Drainage issues	+1
D	Evidence of relic peat landforms	0
E	No sonic activity within 500m. Negligible seismic activity.	0
F	Representation Peat degradation in range H7	0
G	Representative Peat Strength in range 20kPa	0
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		3.5

Preliminary Peat Landslide Risk is 3.5

Potential Exposure Risk is 2 (Minor w/c within 200m)
This equates to a **Hazard Ranking of 7** and places turbine construction at this location in the **LOW-RISK Category.**

An assessment of risk was also carried out for the proposed site tracks as follows: -

13. For site tracks between the **Site Entrance 1 and T01**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 4.5m	+3
C	Risk of drainage issues from saturated ground	+0.5
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5**

Preliminary Peat Landslide Risk is 5

Potential Exposure Risk is 2.5. (Minor watercourse within 100m)

This equates to a **Hazard Ranking of 12.5** and places site track construction at this location in the **MEDIUM RISK** Category

14. For site tracks between the **T01 to T02**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 4.5m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5.5**

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 2.5. (Crosses minor watercourse)

This equates to a **Hazard Ranking of 13.75** and places site track construction at this location in the **MEDIUM RISK** Category

15. For site tracks between the **Site Entrance 3 to T04**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 4.5m	+3
C	Risk of drainage issues from saturated ground	+0.5
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5**

Preliminary Peat Landslide Risk is 5

Potential Exposure Risk is *2.5*. (Minor watercourse within 100m)

This equates to a **Hazard Ranking of 12.5** and places site track construction at this location in the **MEDIUM RISK** Category

16. For site tracks between the **T04 and T03**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0

B	Max peat thickness in vicinity = 3.5m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5.5**

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 2. (Minor watercourse within 200m)

This equates to a **Hazard Ranking of 11** and places site track construction at this location in the **MEDIUM RISK** Category

17. For site tracks between the **T06 to T07**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 2.8m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 20-60kPa	0
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**4.5**

Preliminary Peat Landslide Risk is 4.5

Potential Exposure Risk is 1.5. (Minor watercourse within 500m)

This equates to a **Hazard Ranking of 6.75** and places site track construction at this location in the **LOW-RISK** Category

18. For site tracks between the **Spur at T05 to Spur at T07**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 3.5m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0

Sum		**5.5**

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 1.5. (Minor watercourse within 500m)

This equates to a **Hazard Ranking of 8.25** and places site track construction at this location in the **LOW-RISK** Category

19. For site tracks between **T07 and Site Entrance 4**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 2.7m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5.5**

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 1. (No sensitive receptor within relevant buffer)

This equates to a **Hazard Ranking of 5.5** and places site track construction at this location in the **LOW-RISK** Category

20. For site tracks between the **Site Entrance 5 and the Substation**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 2.8m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 2.5. (Crosses minor watercourse)

This equates to a **Hazard Ranking of 13.75** and places site track construction at this location in the **MEDIUM RISK** Category

21. For site tracks between the **Substation and T11**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 2.0m	+3
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**5.5**

Preliminary Peat Landslide Risk is 5.5

Potential Exposure Risk is 2.5. (Crosses minor watercourse)

This equates to a **Hazard Ranking of 13.75** and places site track construction at this location in the **MEDIUM RISK** Category

14. For site tracks between the **Spur at T11 to T08**, the following assessment of HAZARD was made:

Item	Description Of Key Indicator	Factor
A	Maximum gradient is in range <3º to horizontal	0
B	Max peat thickness in vicinity = 1.8m	+1
C	Risk of drainage issues from forestry	+1
D	No relic peat landforms	0
E	No sonic activity within 250m. Negligible seismic activity.	0
F	Representation Peat degradation in range H2 – H8	0
G	Peat strength 10 - 19kPa	+1
H	Annual Precipitation (>1250mm)	+0.5
I	Peat Landslide History (>5km)	0
Sum		**3.5**

Preliminary Peat Landslide Risk is 3.5

Potential Exposure Risk is 2.5. (Minor watercourse within 100m of site track)

This equates to a **Hazard Ranking of 8.75** and places site track construction at this location in the **LOW-RISK** Category

The above Hazard Rankings have been determined by analysis of site-specific ground conditions at the proposed Carrigeen Wind Farm site in accordance with the guidelines outlined by The Scottish Executive & Halcrow Group Ltd in "*Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments*", April 2017.

1.4 RECOMMENDATIONS

Construction mitigation (specified in Table 7.27), where applied in full, will further reduce the hazard rankings recorded in Tables 7.24A / 7.24B to those indicated in Tables 7.28 / 7.28A.

1.3.1 Construction Mitigation of Risk

General Constraints and Anecdotal Evidence

Analysis of the historic conditions following peat landslides indicates that the following main factors generally trigger slope failures:

1. Excessive quantities of spoil loaded onto sensitive peat covered sloping ground. (In such cases the gradient of the slope should be no more than an average of 5 degrees to the horizontal). Where peat is not of a sensitive nature, it will be possible to load spoil onto slopes up to a maximum of 10 degrees to the horizontal.

2. The angle of repose of the cut face of excavations is all too often found to be too high, sometimes 70 – 80 degrees to the horizontal. Battering back the sides of an excavation to approx. 45 degrees helps to reduce the potential for slippage, which will significantly reduce the potential for peat movement.

3. The consequences of peat landslide can be identified as Damage to Machinery, Damage or Loss of Access Track, Damage to Site Drainage, Site Works Damaged, Death or Injury to Personnel or Degradation to the Environment.

4. A contingency plan is to be compiled and will be enacted should peat movement occur.

1.3.2 Prevention of Peat Slide and Bog Burst

Application of the following procedures will have the effect of reducing the Hazard Ranking associated with Peat Instability:

1. Excavated spoil will not be deposited on the down slope or up slope edges of the adjacent peat. This spoil will instead be deposited on the two flanks either side of the excavation (where gradient is least) and spread in such a way as to limit the surcharge pressure on sensitive peat.

2. Bog Burst is recognised to be a difficult condition to mitigate against. Bog Burst tends to occur within deep peat (> 2.50m) after very heavy or prolonged precipitation. To ward against this possibility the design of turbine bases should be engineered to ensure that excavations do not cut into deep peat (>2.50m). It is however considered acceptable, where slopes are less than 5 degrees, that floating roads may be placed within peat cover exceeding 2.50m depth.

3. The hardstanding areas surrounding the turbine bases will be designed in a manner such that crane loadings can be transferred directly onto the competent strata underlying the peat. In order to facilitate these works it will be necessary to undertake limited excavations. To ensure effective sidewall support during these operations the contractor will adopt an approved engineering solution (such as sheet piling) to maintain sidewall stability at all times.

4. Movement can often occur during or following severe rainstorm events, particularly when following a prolonged dry spell. Extra vigilance will be maintained at such times, during construction.

5. All slopes are to be regularly checked for development of tension cracks (caused by desiccation), indicative of slope movement.

6. Extra care will be taken where the peat has previously been tilled. Attention should be paid to any historic turbary nature of a site.

7. Method statements will be followed at all times. Where modification is required, this will be agreed by the supervising engineer.

8. Slopes will not be undercut or excavations left unsupported for periods in excess of 24 hours. Excavations are to be backfilled as soon as practicable. Excavation and filling operations shall be coordinated to minimise the time an excavation remains opened.

9. Pore water pressure within excavations should be kept low at all times by draining deliberate or intentional sumps at regular intervals. This is to prevent ponding of water within excavations which can in turn increase hydraulic heads locally and potentially lead to instability.

10. The potential for Peat Landslide will be monitored regularly during the construction works, by means of regular site visits and assessments, by a suitably qualified and experienced professional.

11. Only experienced and competent contractors will be appointed to carry out the construction works. Low ground bearing pressure machinery shall be used for transport of construction materials in sensitive areas. It is also recommended that the less sensitive areas are completed first to allow suitable construction practices to be established before works commence in the more difficult areas.

12. Site staff will also undergo induction training to learn about the risks associated with working on “upland environments” and procedures aimed at reducing Peat Landslide risk.

13. Sufficient time should be allowed to carry out the works in a safe and timely manner.

1.3.3 Spoil Disposal

Spoil will invariably be generated during excavations for foundations at turbines and along new access roads.

Minimisation of the production of this spoil will be treated as a high priority, but it is nevertheless expected that there will be in the region of 365,943 m^3 of peat soils and glacial till excavated during site works, 352,316m3 of which will remain on-site.

Analysis of peat depths recorded along proposed site tracks and turbine locations indicates a range of 0.00m to 4.50m across the development area with an average peat depth of 1.45m within the construction zone.

Assuming average peat depth prevails across the construction footprint, the volume of peat (or organic soils) extracted is estimated to be approximately 180,879 m^3.

The volume of drift / glacial till / rippable weathered rock to be extracted is estimated to be approximately 185,064 m^3 and the amount of rock aggregate extractable will be approximately 240,000m3.

Spoil types will be treated separately. Rock, glacial soils and peat will be separated during excavation and these two types of spoil will be disposed of generally as follows:

A *Glacial soils will be deposited directly on top of other glacial soils. This will require the removal of peat where present to facilitate the process.*

B *Peat can be disposed of either on top of glacial soils, on top of inactive peat or on top of the "Acrotelm" where the "Top Mat" has been removed.*

1. Glacial and peat spoil disposal will take place at two main locations; 1) to the rear of the turbine infrastructure to a maximum height of 1.5m where constraint permits (Refer to **Figure SD1**), 2) within the Borrow Pits following extraction of rock aggregate and 3) side cast to form peat swales along the edges of suitable portions of the access road network (c. 3km) and to form a berm around three edges of the Substation Compound, where constraints permit.

2. It is intended that spoil movements will be minimised by retaining the material within or immediately adjacent to the construction footprint of the structure from whence it was excavated, before removing it for final placement at either of the two Borrow Pits.

3. Temporary Spoil Stockpiling at the main structures will be around the constructed turbine hardstands. All stockpiles will be maintained for the duration of this temporary storage, with silt / clay soils being covered to negate potential silt-laden run-off entering watercourses.

4. Spoil will be deposited, in layers of 0.50m and will not exceed a total thickness of 3.00m, unless contained by suitably designed berms as will be the case at the wo borrow pits following completion of extraction works.

5. Spoil will only be deposited on slopes of < 5 degrees to the horizontal and greater than 10m from the top of a cutting. The exact location of such areas will be determined on consultation with the

geotechnical specialist.

6. A Peat Stability Register will record the location of each Spoil Disposal Site used and regular weekly assessment will be made by the construction manager or other suitably qualified individual.

7. Once disposal is complete the disposal sites will be re-vegetated with the "Top Mat" removed at the commencement of disposal operations. Upon commencement of the restoration phase guidance from a suitably qualified ecologist will be sought to provide a suitable methodology and programme of maintenance for the restored areas.

1.3.4 Adjustment factors for Hazard due to adoption of Mitigation Measures:

Table 7.27 – Hazard – Risk Reducing factors

Risk Reduction Factor	Scale of Risk	Hazard
A	-0.50	Limiting of construction during periods of heavy rainfall
B	-0.50	Direct support of peat faces at excavation locations
C	-0.50	Battering back of peat faces to 45 degrees within 100m of proposed works
D	-1.00	Specialised Engineered drainage solution
E	-0.50	Use of machinery with low ground bearing pressure for the transport of spoil and fill
F	-0.50	Staff Induction and regular program of surveillance by external geotechnical engineer

The reduction in risk due to the above measures is discussed below, and the Hazard Rankings have been updated for each location; refer to Tables 7.28 / 7.28A.

1.3.5 Post-Mitigation

Implementation of the mitigation measures contained within the previous section (Table 7.27 – Hazard – Risk Reducing Factors) allows the optimal level of risk to be attained for the construction of Carrigeen Wind Farm .

[Continued overleaf]

Table 7.28 – Hazard Ranking for each turbine location following Mitigation Measures

Turbine Location	Pre-Mitigation			Risk Reduction Factors[8]						Post-Mitigation		
	Hazard	Exposure	HAZARD RANKING	A (-0.5)	B (-0.5)	C (-0.5)	D (-1.00)	E (-0.5)	F (-0.5)	Hazard	Exposure	HAZARD RANKING
T01	8	2	**16**	Y	Y	Y	Y	Y	Y	4.5	2	**9**
T02	3	2.5	**7.5**	Y	Y	Y	-	-	Y	1	2.5	**2.5**
T03	8	1.5	**12**	Y	Y	Y	-	Y	Y	5.5	1.5	**8.25**
T04	3.5	2	**7**	Y	Y	Y	-	-	Y	1.5	2	**3**
T05	1.5	1.5	**2.25**	-	-	-	-	-	Y	1	1.5	**1.5**
T06	2	1	**2**	-	-	-	-	-	Y	1.5	1	**1.5**
T07	3.5	1	**3.5**	-	-	-	-	-	Y	3	1	**3**
T08	3	1.5	**4.5**	-	-	Y	-	-	Y	2	1.5	**3**
T09	4	1.5	**6**	Y	-	Y	-	Y	Y	2	1.5	**3**
T10	3.5	1	**3.5**	-	-	-	-	-	Y	3	1	**3**
T11	3	2.5	**7**	Y	-	Y	-	-	Y	1.5	2.5	**3.75**
SUBSTATION	3.5	2	**7**	Y	-	Y	-	Y-	Y	1.5	2	**3**

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Table 7.28A – Hazard Ranking for each stretch of new site access track following Mitigation Measures

Access Track Section	Pre-Mitigation			Risk Reduction Factors						Post-Mitigation		
	Hazard	Exposure	HAZARD RANKING	A (-0.5)	B (-0.5)	C (-0.5)	D (-1.00)	E (-0.5)	F (-0.5)	Hazard	Exposure	HAZARD RANKING
Site Entrance 1 to T01	5	2.5	**12.5**	Y	Y	Y	-	Y	Y	2.5	2.5	**6.25**
T01 to T02	5.5	2.5	**13.75**	Y	Y	Y	-	Y	Y	3	2.5	**7.5**
Site Entrance 3 to T04	5	2.5	**12.5**	Y	Y	Y	-	Y	Y	2.5	2.5	**6.25**
T04 to T03	5.5	2	**11**	Y	Y	Y	-	Y	Y	3	2	**6**
Spur to T05 to T06	4.5	1.5	**6.75**	Y	-	Y	-	-	Y	3	1.5	**4.5**
T06 to T07	5.5	1.5	**8.25**	Y	Y	Y	-	-	Y			**5.25**

[8] Refer to Table 7.27 for explanation of the Risk Reduction Factors (A – F)

T07 to Site Entrance 4	5.5	1	**5.5**	Y	-	Y	-	Y	Y	3.5	1	**3.5**
Site Entrance 5 to Substation	5.5	2.5	**13.75**	Y	Y	Y	-	Y	Y	3	2.5	**7**
Substation to T11	5.5	2.5	**13.75**	Y	Y	Y	-	Y	Y	3	2.5	**7**
Spur at T11 to T08	3.5	2.5	**8.75**	Y	Y	Y	-	-	Y	1.5	2.5	**3.75**

G DO NOTHING IMPACT

Were the Project not to take place there would be a slight reduction in the hazard associated with peat landslide for the Site. Contributory factors to peat instability can be split into two forms: -

1. Natural and pre-existing conditions, e.g. rainfall, existing slopes, existing peat thickness etc. and relative position in relation to sensitive receptors.
2. Man-made intervention, e.g. cutting into slopes, placement of foundations within soils, loadings imposed on peat and mineral soils by access track construction, spoil deposition and changes to the hydrological regime caused by new drainage.

The hazard associated with man-made interventions is in addition to the "Baseline Hazard" resulting from the natural and pre-existing conditions. As a result, the hazard of peat instability is greatest during the construction phase but also remains to a lesser degree during the lifetime of the project.

"Baseline Hazards" associated with natural or pre-existing conditions are not neutral and can be expected to continue throughout the lifetime of proposed development. and essentially equate to the "Do Nothing Impact", discussed here.

H POTENTIAL IMPACTS OF THE DEVELOPMENT

1.1 CONSTRUCTION PHASE

1.1.1 Earthworks Activities

Implementation of the Project will result in the removal of peat in parts of the site to facilitate excavation for the construction of access roads and platforms for the wind turbines to a competent stratum or bedrock suitable for the emplacement of foundations.

Ground conditions vary across the site with varying depths of peat cover. At the proposed turbine bases, excavation required is anticipated to be in excess of 3.50m to a suitable competent bearing stratum.

1.1.2 Potential for Bog Failure

Consideration has been given to the potential for all forms of bog failure at the Carrigeen Renewable Energy Development site. These mass movements of peat can take the form of either bog burst or bog slide. Historical evidence suggests that raised bogs are more prone to bog bursts while bog slides are more common on blanket bogs, however it is noted that there is no historical or visually identifiable evidence of peat landslides or ground instability at this particular development site.

Peat failures generally occur either during or immediately after periods of heavy rainfall. Failures are especially likely to occur where there is a break of slope at the edge of an upland plateau of peat. Records indicate that bog bursts can naturally occur on shallow slope angles of less than 5 degrees while bog slides appear to occur on slopes that are steeper than 5 degrees. It is important to note that at such low angles the cause of failure is less associated with the actual topographic gradient and more to do with hydrostatic pressure, i.e. the water volume contained within. Peat movement on such low gradients tend to be initiated by a rupture within the peat body and not at contact between the peat base and the underlying formation.

Following well documented bogslides on the slopes of Dooncarton and Barnachuille mountains, Co. Mayo in September 2003 and at Derrybrien, Co. Galway in October 2003, the potential for bog failure has come to the fore in consideration of planning for renewable energy development. At Derrysallagh Wind Farm located on the Sligo / Roscommon border a peat landslide event in December 2016 resulted in a fatality. Significantly, a natural peat landslide originating on Shass Mountain near Drumkeeran, Co. Leitrim occurred in June 2020 severely impacting a downstream bridge structure. Another well documented peat landslide event was also recorded at Meenbog Wind Farm, Co. Donegal during November 2020 during wind farm construction.

Research into the history of bogslide occurrence in Ireland, over the last 200 years, indicates that the majority of bogslides have occurred on the blanket bogs in the west where rainfall is highest. Here, bogslides tend to be more frequent during the autumn and winter months.

In these cases, the following criteria are considered to be contributory factors to bogslide occurrence:

(a) Slope is the single most important factor for blanket bogs. Bog slides are especially likely to occur where there is a break in slope at the edge of an upland plateau of blanket peat, providing a line of weakness. While initial failure is likely to be slippage (translational or rotational faults) semi-fluid to fully fluid behaviour is the main movement mechanism downslope. Slope gradient imparts kinetic energy to the sliding material.

(b) The depth of peat and its relationship to humification (the degree to which the fibre structure of the peat has decayed), pore water pressure, shear vane strength and other parameters generally indicates that the deeper the peat profile the more unstable it is. Exact depth thresholds for stability are not feasible due to the variability of peat environments (raised bog, blanket bog or fen habitats) and their site-specific conditions. However, as a rule of thumb peat of depths greater than >1.5m is significantly more vulnerable to instability than thinner peat at <1.5m depth, and peat thickness of ≤0.5m is usually capable of long-term self-support.

(c) The pattern of recent precipitation at a site over the last c. 30 years, such as intense localised rainfall (or melting snow), is an important trigger mechanism.

(d) Antecedent weather conditions such as drought conditions are also identified as a contributing factor. In the case of the landslides at Dooncarton and Barnachuille in September 2003 and at Derrybrien October 2003, short intense periods of heavy rainfall followed an exceptionally dry late summer. Historically, the Owenmore bogslide in Erris, Co. Mayo (1819) was also preceded by two months of drought. Sustained dry conditions leads to high soil moisture deficit (SMD). This dries the blanket peat, causing shrinkage and appearance of desiccation cracks.

(e) Some bogslides are caused by excessive interference – e.g. opening of turf banks, opening deep drains on blanket bog. All drains should be perpendicular to slope contour not parallel to it.

Finally, the following items are noted:

1. Geological structural features generally play no part in bogslide occurrence.
2. Bogslides are prone in certain upland locations due to their peculiar topography, ground composition and hydrology. When a slide occurs, it acts as a safety valve to restore equilibrium.
3. The most destructive bogslides involve the combination of slide materials with floodwaters, diluting the peat and mud in waterways and accelerating the velocity of the debris flow.

1.1.3 Water Quality

The following impacts both likely and potential are identified:

Suspended solids release during excavations

In a renewable energy development, it is the construction phase that poses the highest risk to the site's hydrology, in particular to the quality of surface water due to generally poor aquifer conditions on high elevation terrain. The main excavations for the Project are situated on high elevation terrain, so it is possible that during excavation works, storage and re-use of materials, suspended solids could be entrained by sustained rainfall and surface water runoff.

The most vulnerable areas to surface water quality deterioration are (a) access road crossings of man-made drains and (b) turbine hardstand and infrastructure development at moderate gradient slopes proximal to existing waterways.

Some of the man-made drains have moderate gradients cut out, which need to be taken into account if constructing new access tracks. This is considered to be short-term and temporary but could have a significant negative impact. With appropriate environmental engineering controls and measures, this impact will be negated and mitigated against.

Risk of pollution from hydrocarbons

The second pollutant of concern during the construction phase of the project is the potential spillage and release of hydrocarbons from plant equipment and associated transfer stations during the construction phase. An accidental hydrocarbon spillage would have a significant negative impact on bogland habitat and water quality at the site.

Temporary sanitation

A temporary site office, service area and sanitation will be required for the construction stage of the development. Associated with this facility is the potential risk of water and soil contamination by wastewater release or chemical contamination of water and soil from temporary sanitation facilities. The level of risk posed is dependent on the type and location of facilities that are put in place.

The Water Framework Directive (WFD) highlights that all groundwater has a value irrespective of whether it occurs in a major or minor aquifer. Groundwater also contributes and maintains the surface water network and as a result its contamination should be mitigated against.

1.2 OPERATIONAL PHASE

1.2.1 Change to Hydrological Regime

The rate and amount of surface water run-off from the site will increase as a function of the replacement of vegetation, peat and sub-soils cover (which absorb rainfall) in parts of the site with a concrete / aggregate hardstand at turbine locations, and aggregate mix for proposed access tracks.

1.2.2 Water Quality

A potential impact on water aspects of the environment may arise during the operational phase of the development if regular maintenance, monitoring and auditing of mitigation structures and procedures are not undertaken during the lifetime of the project.

I MITIGATION MEASURES

1.1 CONSTRUCTION PHASE MITIGATION

1.1.1 Earthworks Activities

The removal of soils will be unavoidable in places, but every effort should be made to ensure that the amount of sub-soils to be removed is kept to a minimum in order to limit the impact on the geotechnical and hydrological balance of the site.

It is noted that the "natural hydrology" of parts of the site may have been significantly altered by land drainage, however measures will be emplaced to minimise any additional changes to the existing site hydrology resulting from the construction of the renewable energy development.

During the construction works, the excavation, storage and re-use of excavated materials have the potential to, directly or indirectly, negatively impact on water quality. Appropriate engineering controls, such as the installation of a drainage system with settlement / stilling ponds, silt traps, check dams and interceptor drains, will be carried out in tandem with, and where possible, prior to, any excavation work to mitigate potential impacts. In relation to construction works, the most important aspects of these recommendations involve:

1. Deep excavations at turbine base locations in order to construct turbine foundations and shallower excavations for the hardstandings to support crane loadings.

2. Construction of 5,325m of new site roads and the upgrade of 6,382m of existing site roads.

3. Some of the proposed site tracks are located within existing forestry for which peat thickness could not be assessed during the ground investigation campaign. Once the forestry has been felled, and ahead of construction, further construction stage peat investigation will be undertaken and the findings of this peat assessment report updated. Although, the majority of the new site tracks proposed will be constructed within the natural mineral soils using tradition methods, where peat thickness is less than 1.5m, "floated road" construction will also be employed where peat thickness exceeds 1.5m or to fulfil another geotechnical purpose.

4. Removal / transport of "waste" peat and glacial spoil, temporary stockpiling within the footprint of each structure where constraints permit and following re-use, long-term storage of excess material within the Borrow Pits.

To allow for detailed design of foundations additional construction stage site investigations may be undertaken ahead of construction. This could involve further intrusive (geotechnical), and non-intrusive (geophysical) investigations undertaken to further understand the behaviour of both extant soils and

underlying rock formations within the construction footprint, the findings of which will be employed to optimise engineering design.

These recommendations will be included in the Contractor's contract of works, who should be experienced in construction within peat environments. In addition, a construction environmental management plan will be in operation to check equipment, materials storage and transfer areas, drainage structures and their attenuation ability on a regular basis. The purpose of this management control is to ensure that the measures in place are operating effectively, prevent accidental leakages, and identify potential breaches in the protective retention and attenuation network during earthworks operations.

1.1.2 Potential for Bog Failure

Site investigations and assessment of the Project site indicate that the site is a low risk for peat landslide, slope failure or mass movements.

Applying the precautionary principle however, the following procedures are recommended as best-practise mitigation measures to avoid slope instability at renewable energy development sites.

- The contractor's methodology statement should be reviewed and approved by a suitably qualified geotechnical engineer with experience in peat environments prior to site operations.
- Any excavations that may tend to undermine the up-slope component of a peat and / or unstable sub-soils slope should be sufficiently supported by buttress, frame or rampart to resist lateral slippage.
- In areas where peat soils are to be excavated, machinery of a sufficient size to complete the works will be employed. Excessively heavy plant machinery will not be used in these areas. This measure is intended to avoid large vibrations disturbing the peat substrate.
- Drainage management measures will be installed to effectively drain grounds in tandem with access track construction. Such drains should be positioned at an oblique angle to slope contours to ensure ground stability. Drains on areas of the site with minimal risk of bog failure as identified by site investigations can be positioned at a more acute angle to the slope contour in order to reduce the velocity of surface water drainage.
- Due to peat's fluid-like properties, all peat excavated should be immediately removed from sloping sites. If peat is required for reinstatement, then acrotelm peat (<1.3m shallow, living layer) should be moved to a lower elevation part of the site that is characterised by near-horizontal slopes, is >100m away from any significant break of slope and is >50m away from drains and streams.
- If additional materials are required for the construction process, after exhausting excavated materials during road and infrastructure construction, additional materials may be acquired from external sources. Wherever possible any imported aggregates should consist of a similar geo-chemistry to the local geology of the site. It should be noted that this is dependent on the quality and variety of aggregate supplied by available quarries.

- From evidence (landslides in Mayo and Galway), excessively wet periods should be avoided in terms of scheduling significant excavations in peat substrates.
- Adherence to additional site-specific mitigation detailed in Tables 7.28 and 7.28A and referenced in Table 7.27.

1.1.3 Water Quality

During the construction phase, surface water drainage is generally found to be more at risk to water quality change than groundwater, where the majority of documented pollution events tend to involve suspended solids from sediment flows. The following mitigation measures are recommended to protect surface water and, to a lesser degree, groundwater quality

1.1.4 Groundwater Dewatering

Any water ingress that may be encountered in the upper weathered zone of the bedrock during the construction phase should be intercepted by a toe drain and diverted to an existing artificial drainage channel and attenuation before release.

The design of the drainage takes into account factors of slope stability and where possible should be sealed at the base.

1.2 OPERATIONAL PHASE MITIGATION

1.2.1 Change to Hydrological Regime

It is understood that stilling ponds and interceptors will be removed following the completion of construction works. Therefore, consideration should be given to the engineered design of roadside drains, the hardstanding areas and improved access roads to take the capacity of additional surface run-off arising from the proposed development.

Appropriate design will prevent both ***(a) hydraulic loading*** of the existing surface water network and ***(b) provide sufficient attenuation of suspended solids*** prior to outfall to the natural drainage network to maintain the existing environments baseline chemistry. Surface water flows in all existing waterways and drainage should not be impeded in any way by the proposed development. Access tracks that intercept existing waterways should have suitably designed culverts installed to maintain baseline flows, large enough to accommodate peak flow of a one in 100-year return period.

1.2.2 Water Quality

The following measures are recommended to mitigate pollution to surface waters and groundwaters during the lifetime of the project.

A regular programme of environmental site maintenance for the drainage network and drainage culverts to ensure their performance to standards at the site. Some changes in the drainage network may be required as a result of unanticipated changes in the hydrological regime at the site during the operation phase of the project.

If fuelling has occurred on site, the fuel tanks and oil interceptor used at the fuel transfer area should be removed by a suitably qualified contractor. An audit of ground and water conditions immediately under and around the transfer area is recommended to investigate whether any leakage has occurred to the hydrological system and whether some clean-up measures are required. Aside from the use of lubricant oils at the substation (low volume), any fuels stored on site will be kept within a bunded area that will have a capacity of at least 110% of the volume stored.

The substation compound is likely to require substation transformer cooling oil or gas. This should be stored in containers within a safe part of the substation compound, minimising accidental leakage and / or fire hazards. Consideration should also be given to a "bunded" area for the oil. Similarly, any other potentially harmful substances used to service the substation should be stored in an environmentally safe manner to mitigate impact to the soils and water.

J RESIDUAL IMPACTS OF THE DEVELOPMENT

Residual impacts that are most likely to occur at the Project site during the construction phase would be as follows:

There will be a change in ground conditions at the site with the replacement of natural materials such as peat, sub-soils and possibly bedrock by concrete, sub-grade and surfacing materials. This is a direct permanent change to the materials composition at the site.

Limited temporary decrease in water quality on a local level is likely to arise from the release of suspended solids and sediments during the excavation and construction process, particularly following rainfall events after a sustained dry period. This local deterioration in water quality will subsequently be reduced naturally by dilution and by managed mitigation prior to exiting from the site boundary to main catchments. Where construction works take place within 200m of areas subsequently determined to be of particular environmental sensitivity, additional measures will be put in place to retain suspended solids and negate their migration further. The Construction Environmental Management Plan contain details for the arrangements to be applied in this case

Residual impacts that are most likely to occur at the Wind Farm Site during the operational phase would be as follows:

Changes in ground surfacing including areas of new hardstands will impact on the hydrology of the site and may result in increased run-off of rainwater and increased drainage discharge. It is assumed this should not have a significant impact on the hydrology of the site.

The drainage infrastructure that will be emplaced as part of the roads and turbines development will also change the subsurface hydrology by replacing a natural diffuse drainage system with line interceptors and point discharges to buffered outfalls. Careful design of this drainage to mimic natural conditions will mitigate negative impacts of artificial drainage.

The potential for Peat Landslide can be expected to reduce following the end of the life of the renewable energy development and the decommissioning of the structures. This reduction in risk can be attributed to reduced static and dynamic loads at decommissioned structures and reduced traffic loads on the site track network.

K MONITORING

All drainage systems should be properly maintained at regular intervals.

Slopes, disposal sites and roads should be inspected regularly.

Regular analysis of watercourses should be undertaken.

All activity on site and at boundaries should be monitored and a register kept.

Only authorised and suitably qualified personnel on-site – strictly controlled access at all times.

The site should be inspected audited regularly.

L CONCLUSION

Successful adherence to the mitigation measures contained within this report allows the optimal level of risk to be attained for the Carrigeen Renewable Energy Development, with respect to Peat Landslide Hazard and the prevailing Soils and Geology regime.

Table 7.29 Summary of all Soils and Geology Related Impacts / Constraints including Peat Landslide Hazard following Mitigation

Hazard Ref:	Soils and Geology Hazard	Hazard Ranking
A	**Superficial Soils – Impact on Excavations and Foundations** Superficial soils are composed of organic peat bog mantling tills (mineral soils) derived from sedimentary rock. Weak organic soils are thin to deep, extending to depths of up to 4.50m at the turbine infrastructure and along portions of the site track network. Excavations, where kept open for an extended period of time will require side wall support. Stability can be expected to deteriorate during wet weather when waterlogged, stockpiled soils will swell and could become unstable on or at slopes of 10 degrees to the horizontal. For this reason, stockpiling will be limited to lands sloping at <10 degrees. Major structures will use either a standard Gravity Base Foundations which will be placed at an average depth of 3.5m and 5m below existing ground level or in the case of T01 and T03 a deep foundation transferring loads onto the underlying rock formation.	**LOW**
B	**Superficial Soils – Impact on Track / Road Construction** Peat stability assessment has identified organic soil (peat) thickness of >1.50m was recorded at 21.3% of the peat probe positions with the wind farm landholding. 1.50m is the upper threshold for the suitability of traditional excavated access track construction. In the case of wind farm element 59.4% of the new access track network (approx.. 3,161m) could be better constructed using "floated" road methods.	**LOW**
C	**Potential Adverse Effects on Geological Heritage / Sensitive Features** The Carrigeen Renewable Energy Development is not located within an audited Site of Geological Heritage or an EPA Protected Area, nor is it sufficiently connected to other sites outside the development boundary for these to be at significantly affected. Consequently, there is a Low hazard of direct impact from Peat Landslide to either existing geological heritage or sensitive environments.	**LOW**
D	**Potential Peat Instability (With Mitigation)** Peat stability and Landslide Hazard Assessment has indicated Low hazard of instability at turbine T01 and T03 following the application of mitigation. Similarly, Low hazard of instability applies for access track network post mitigation, with the exception of the sections between the Substation to T11 and from T11 to T08, which will be Negligible hazard.	**LOW to NEGLIGIBLE**

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DRAWINGS

General Site Location Plan ***Figures P1 & P2***
Solid Geology ***Figure A1 and A1-1***
Superficial Geology ***Figure A2 and A2-1***
Groundwater Vulnerability ***Figure A3 and A3-1***
Groundwater Resources ***Figure A4 and A4-1***
Karst, Wells and Springs ***Figure A5***
Active Quarries ***Figure A6***
Protected Sites ***Figure A7***
Landslide Susceptibility ***Figure A8 and A8-1***
Landslide Events Map Figure ***A9 and A9-1***
Bedrock Aggregate Potential Map Figure ***A10 and A10-1***
Proposed Wind Farm Layout Plan ***F2507-01***
Site Investigation Layout Plan ***Figure L1***
Classed Plot of Peat Depth ***Figure D1***
Contoured Plot of Peat Depth ***Figure D2***
Contoured Plot of Ground Surface Elevation ***Figure D3***
Contoured Plot of Ground Slope Gradient ***Figure D4***
Post Plot of Von Post ***Figure D5***
Post Plot of Shear Strength ***Figure D6***
Proposed Spoil Deposition and Floated Track Arrangements Figure ***SD1***

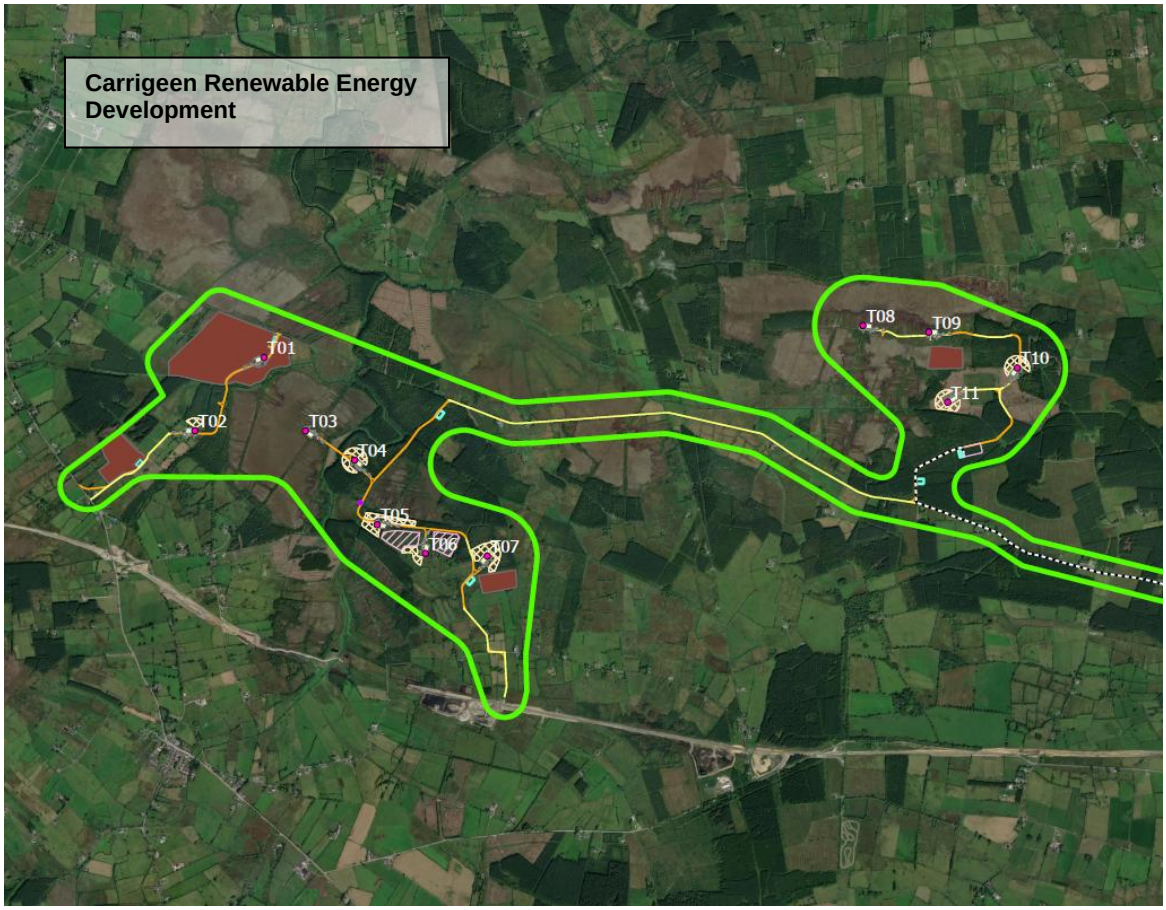
APPENDICES

A Numerical Assessment of Sites Where Peat is a Key Constituent
B Analytical Analysis
C Peat Probing Data
D Von Post Classification and Shear Strength Information
E Peat Slide Risk Assessment – "Preventative Action: A Guide for Workers"

DRAWINGS

General Site Location Plan Solid Geology **Figures P1 & P2**	1 x A4
Soils and Geology **Figure A1 (2nr)**	2 x A4
Superficial Geology **Figure A2 (2nr)**	2 x A4
Groundwater Vulnerability **Figure A3 (2nr)**	2 x A4
Groundwater Resources **Figure A4 (2nr)**	2 x A4
Superficial Aquifer Potential **Figure A5 (1nr)**	1 x A4
Quarries and Mineral Occurrences **Figure A6 (1nr)**	1 x A4
Protected Areas (SAC etc. and Geological Sites.) **Figure A7 (2nr)**	1 x A4
Landslide Susceptibility **Figure A8 (2nr)**	2 x A4
Local Recorded Landslide Events **Figure A9 (2nr)**	2 x A4
Crushed Aggregate Resource Mapping **Figure A10 (2nr)**	2 x A4
Site Location Plan	1 x A4
Classed Plot of Peat Thickness Overlaid On Background Plot **Figure D1**	3 x A3
Contoured Plot of Peat Thickness Overlaid On Background Plot **Figure D2**	3 x A3
Contoured Plot of Ground Surface Elevation **Figure D3**	1 x A3
Contoured Plot of Ground Slope Gradient **Figure D4**	1 x A3
Post Plot of Von Post Classification **Figure D5**	1 x A3
Post Plot of Peat Shear Strength **Figure D6**	1 x A3
Floated Track and Spoil Deposition Proposals **Figure SD1**	1 x A3

P1 - General Location Plan



P2 – Wind Farm Layout Plan

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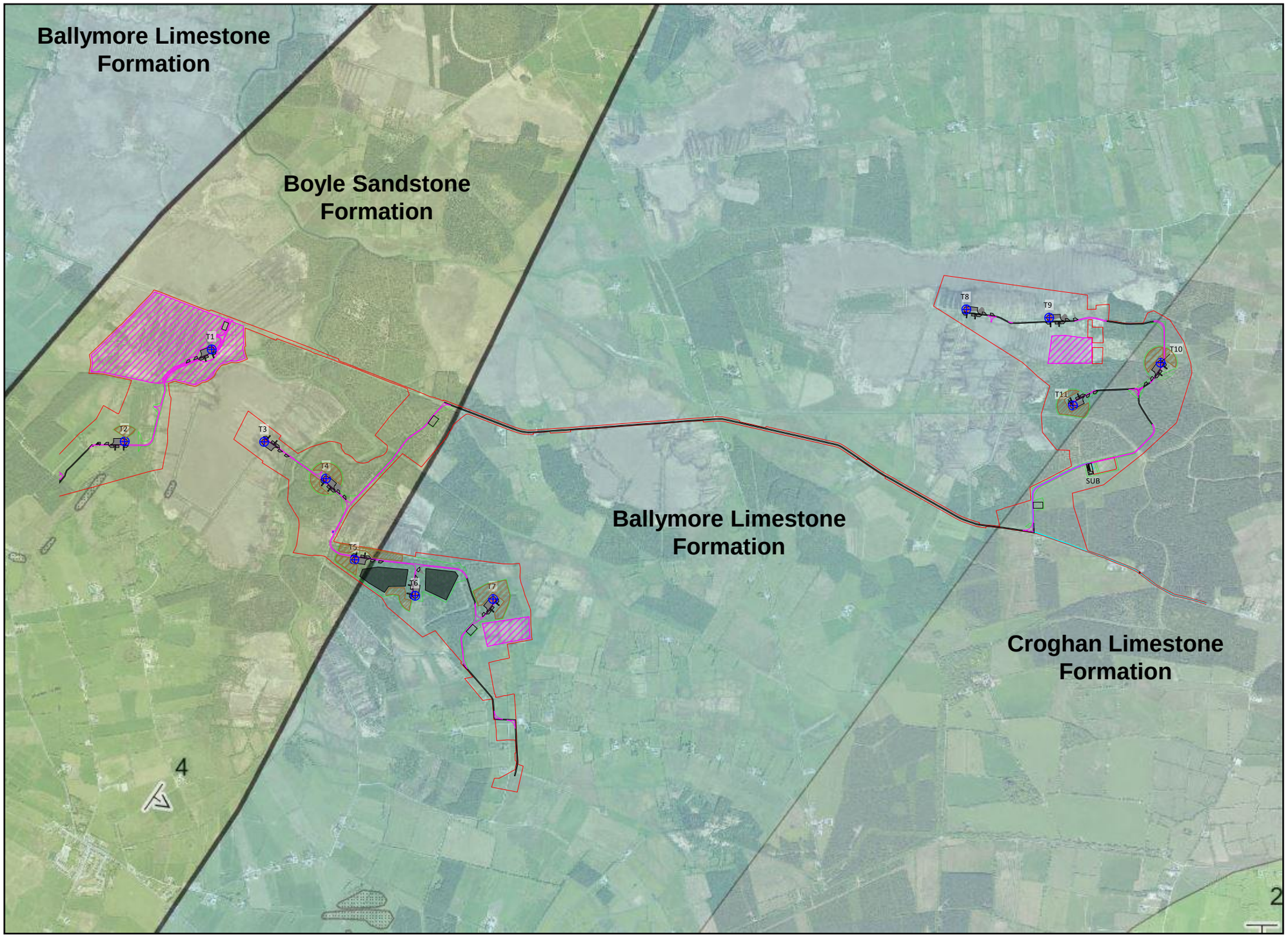

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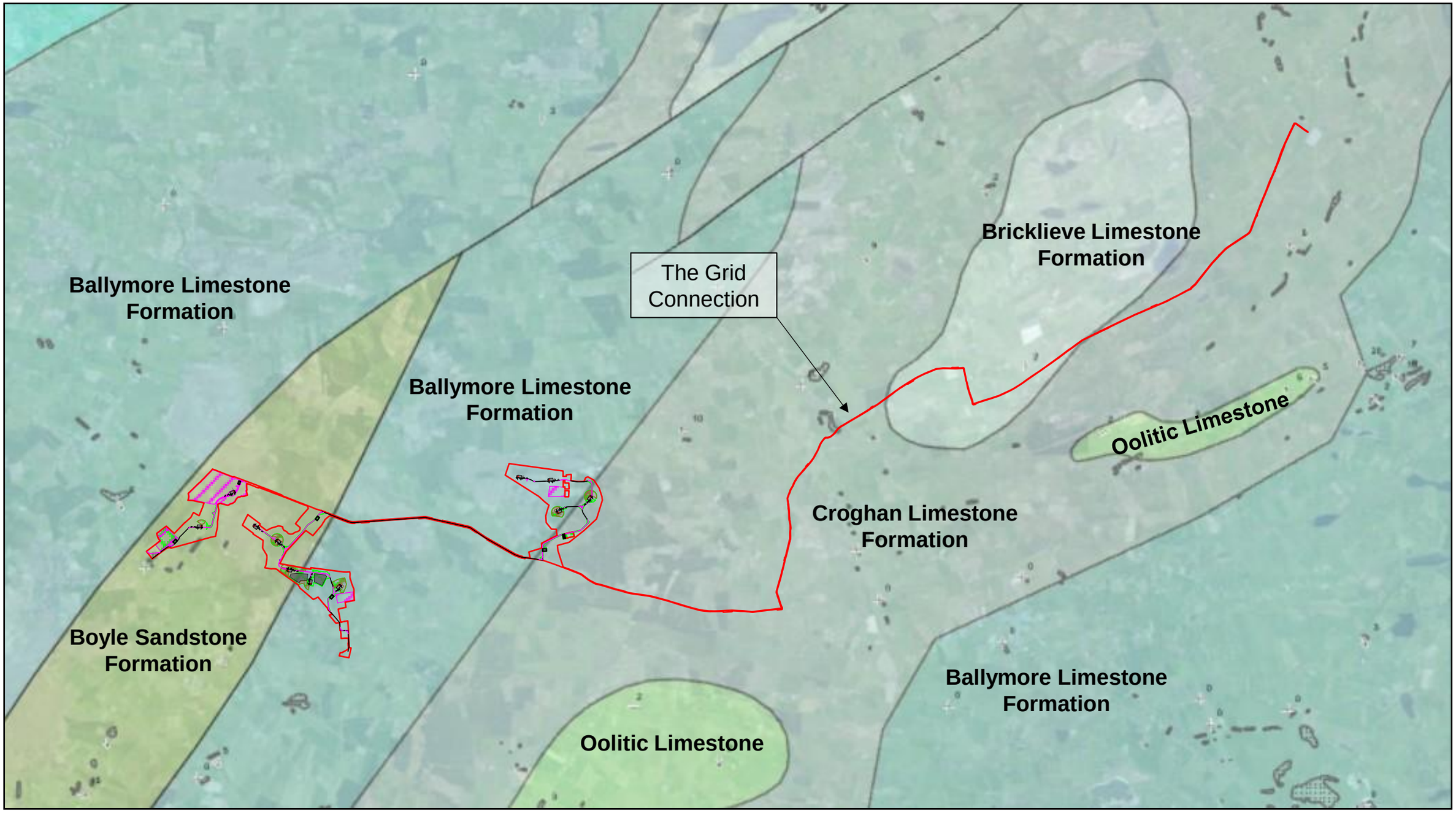

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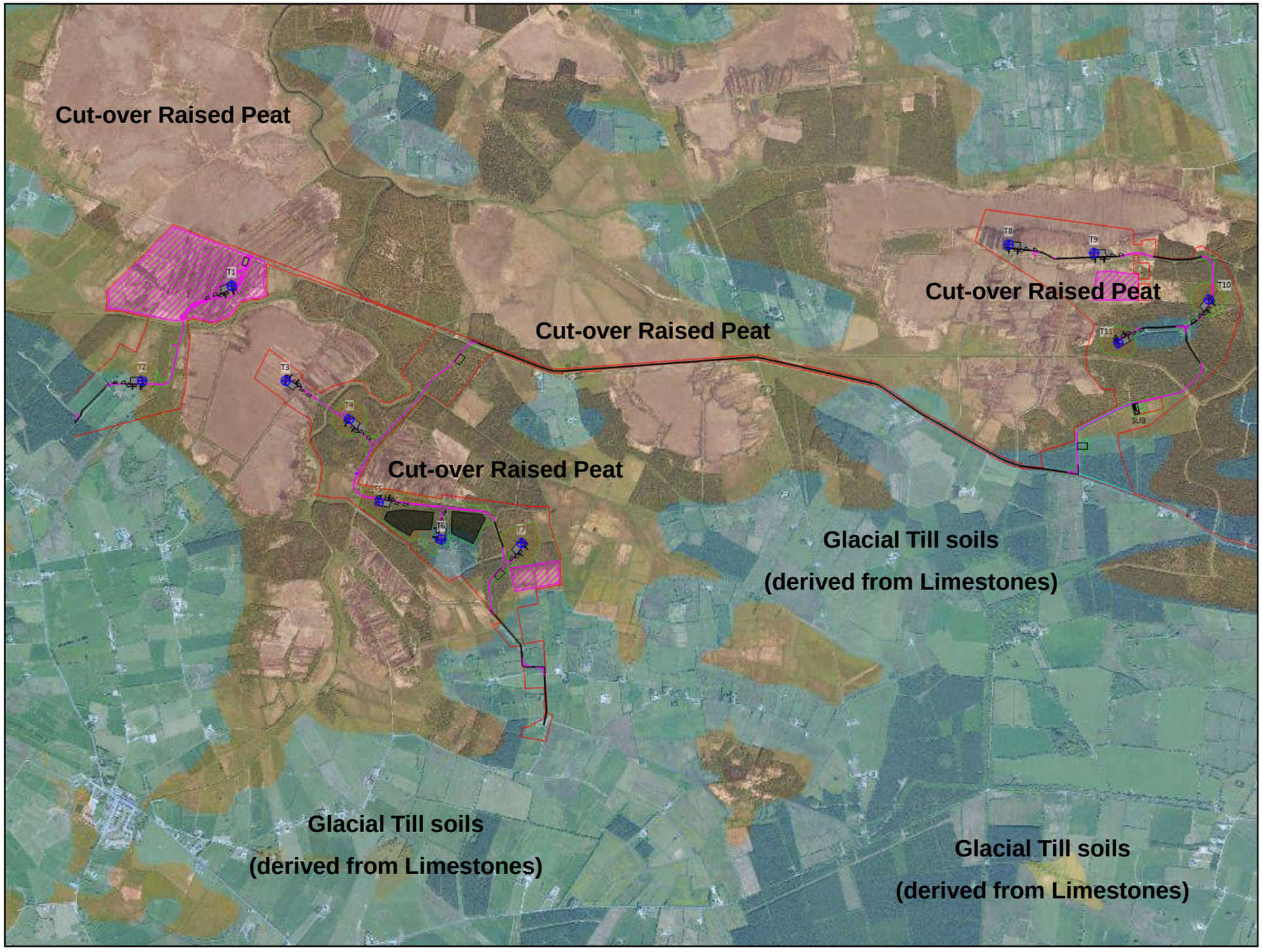
Soils and Geology Assessment

GSI – Superficial Geology



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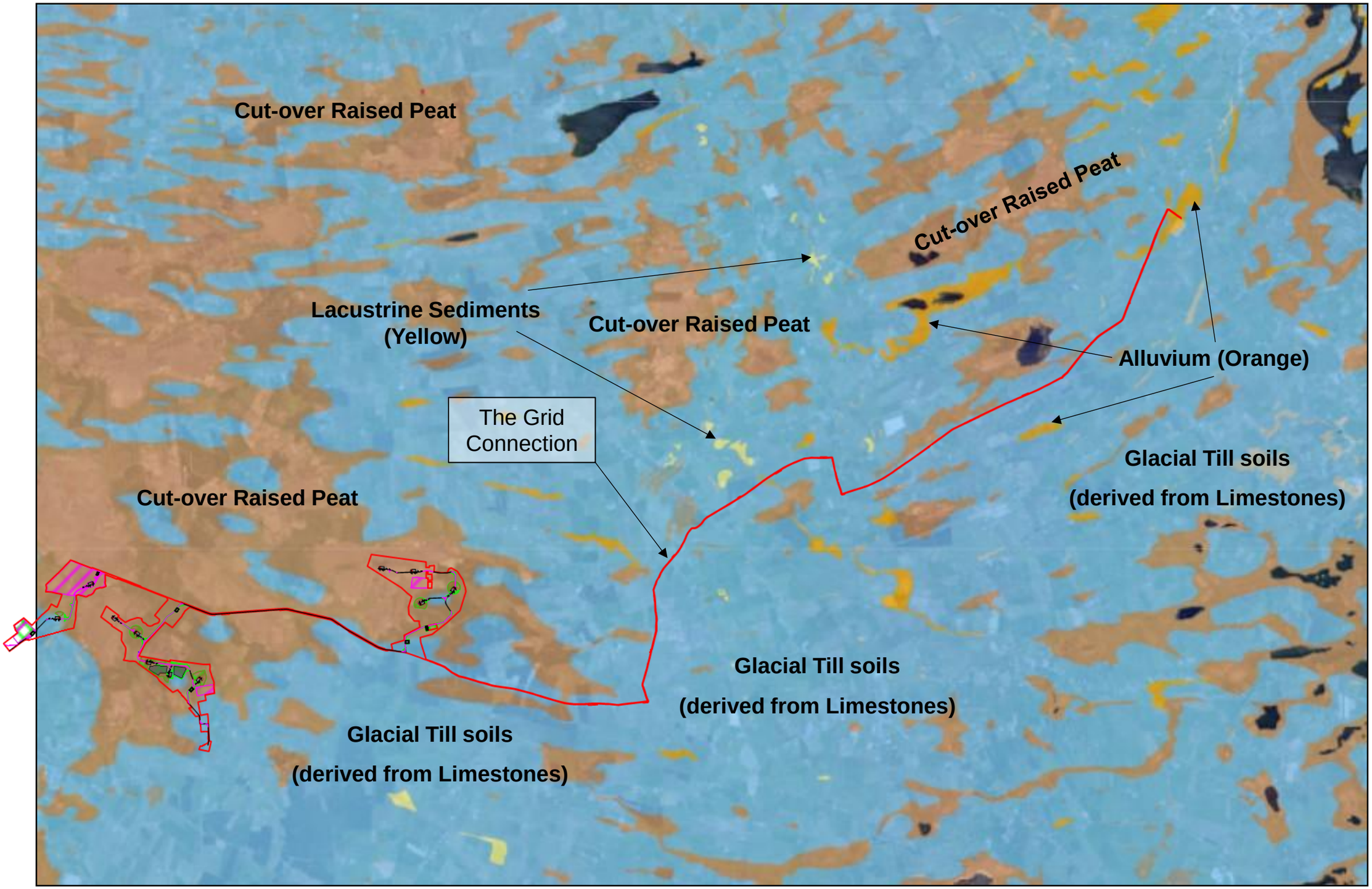

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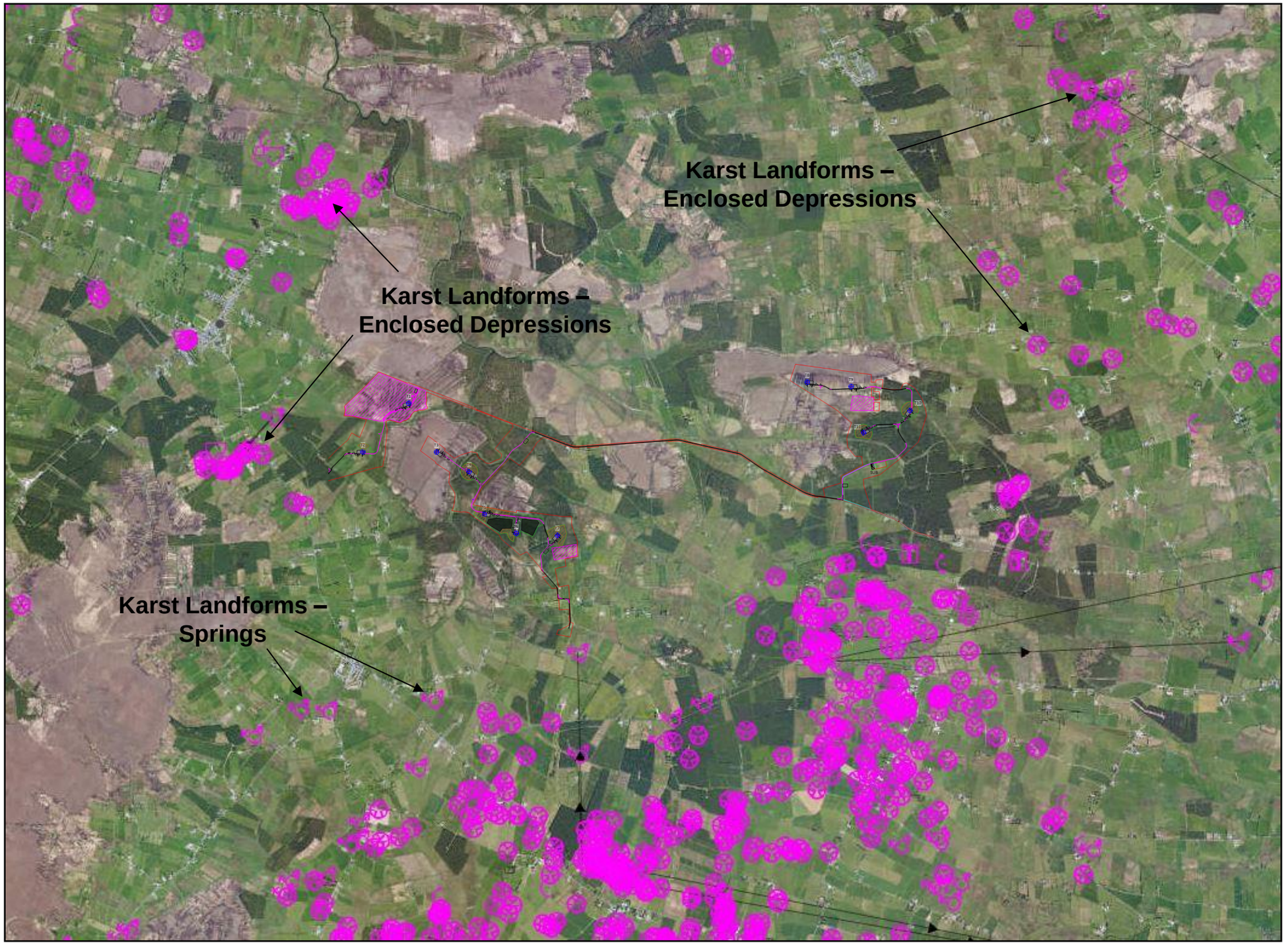

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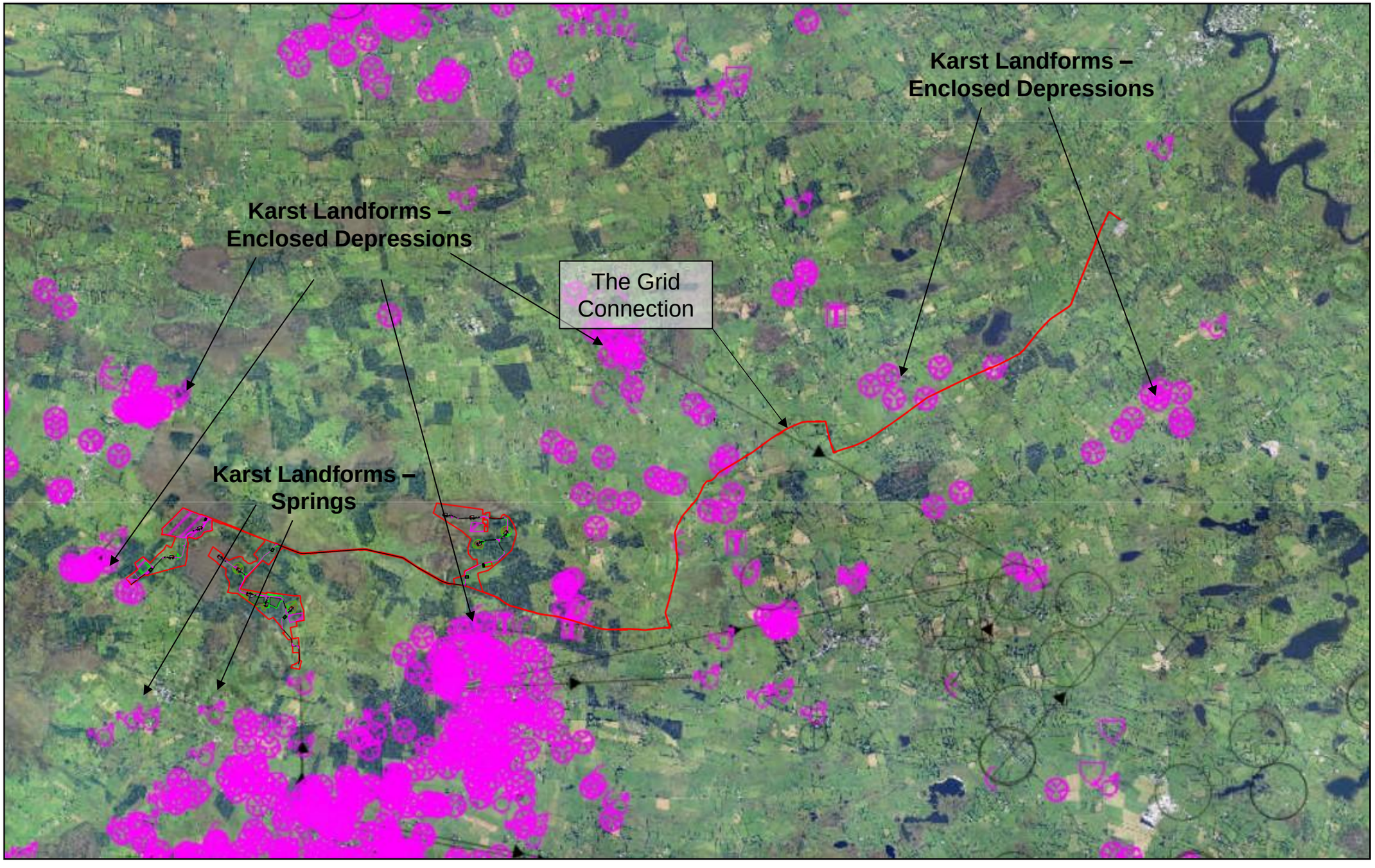

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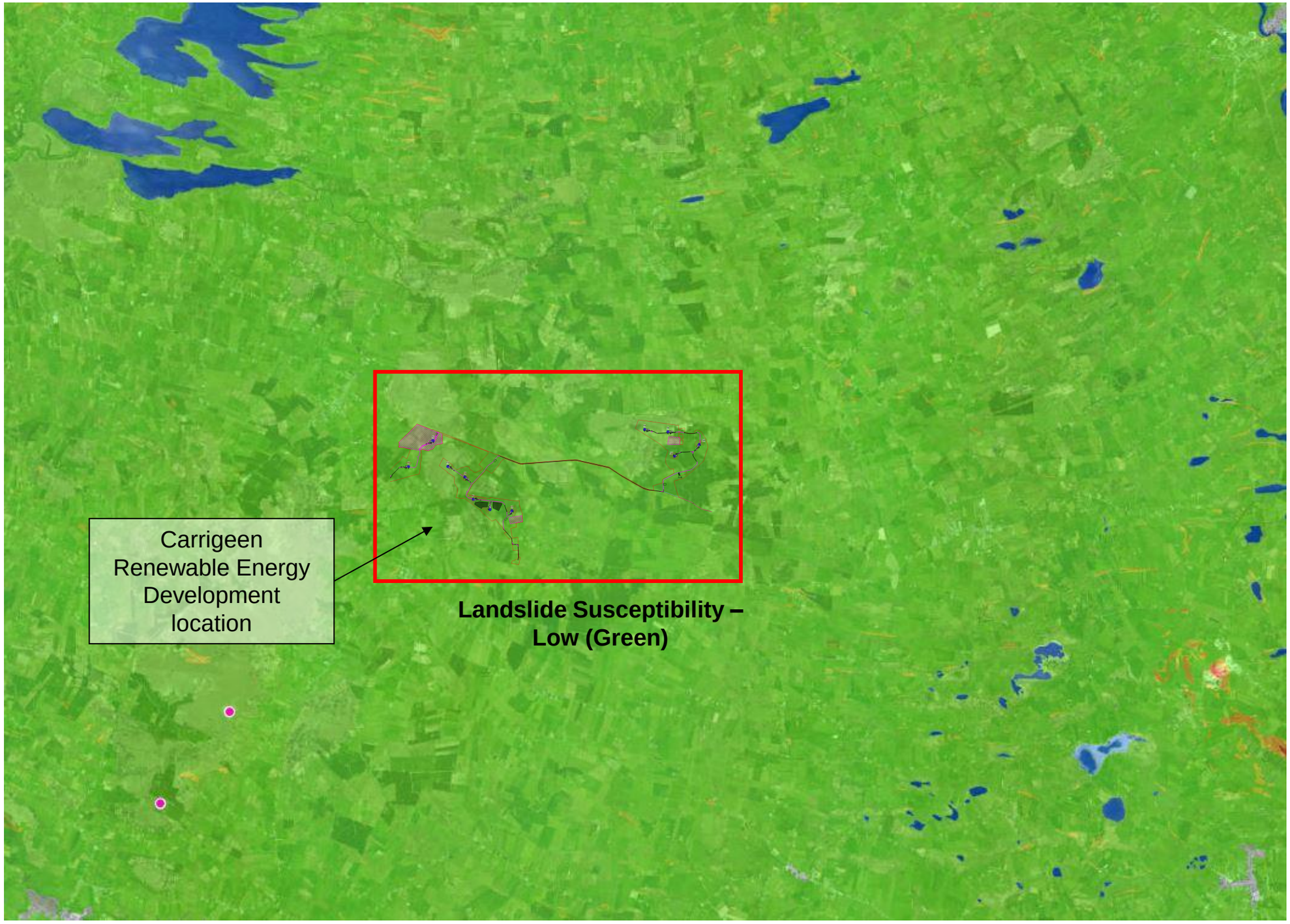

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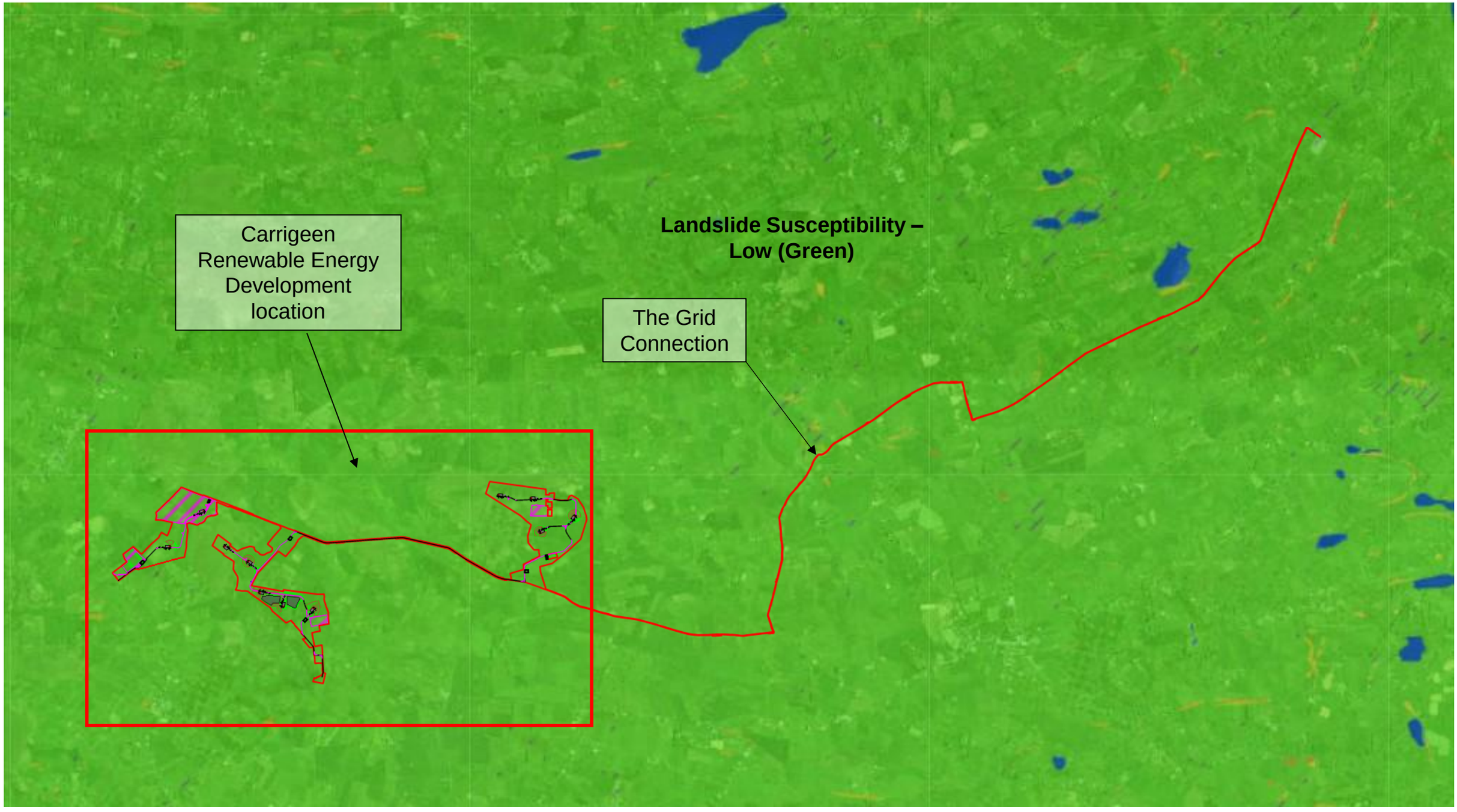
GSI – Landslide Susceptibility



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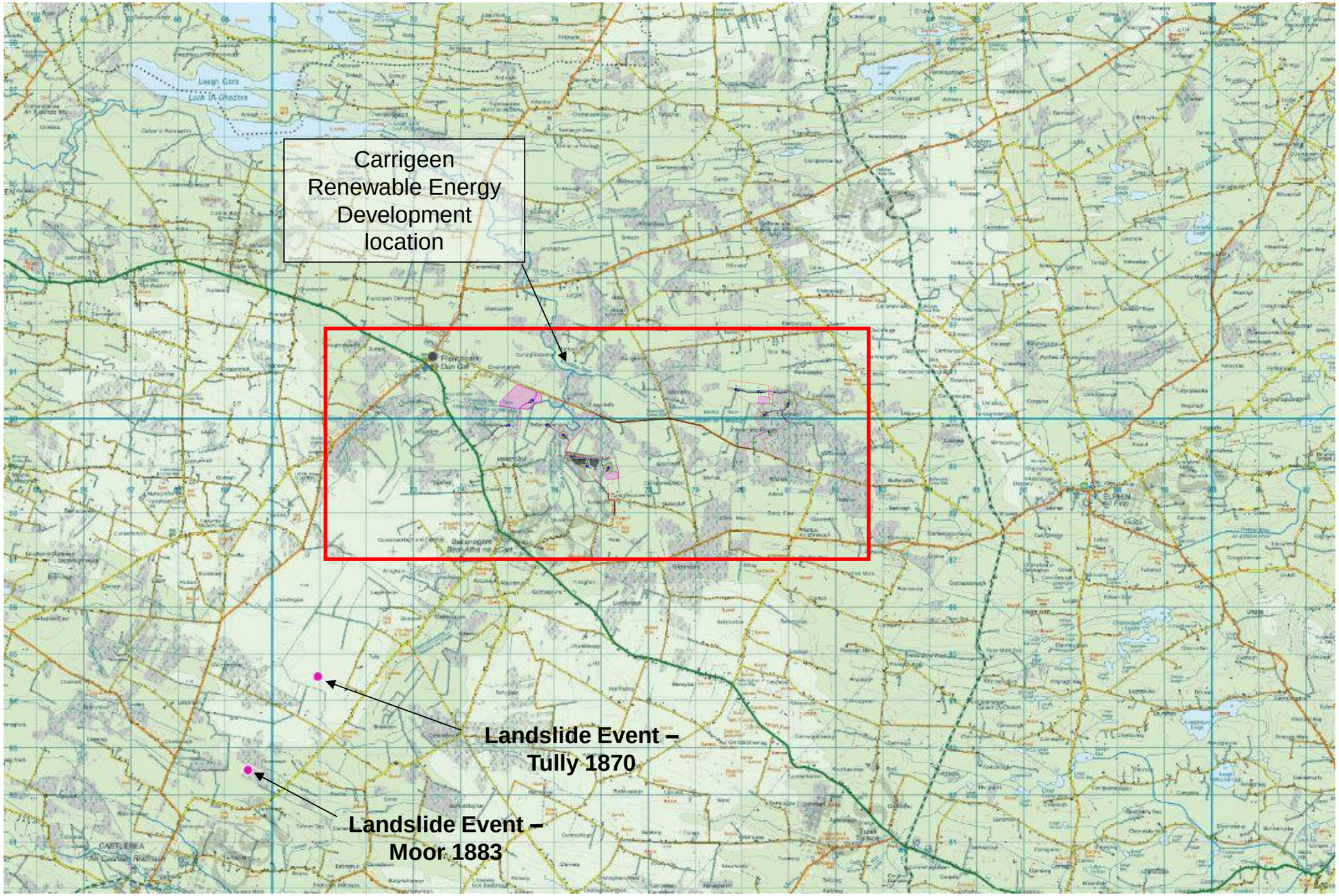
GSI – Recorded Landslide Events



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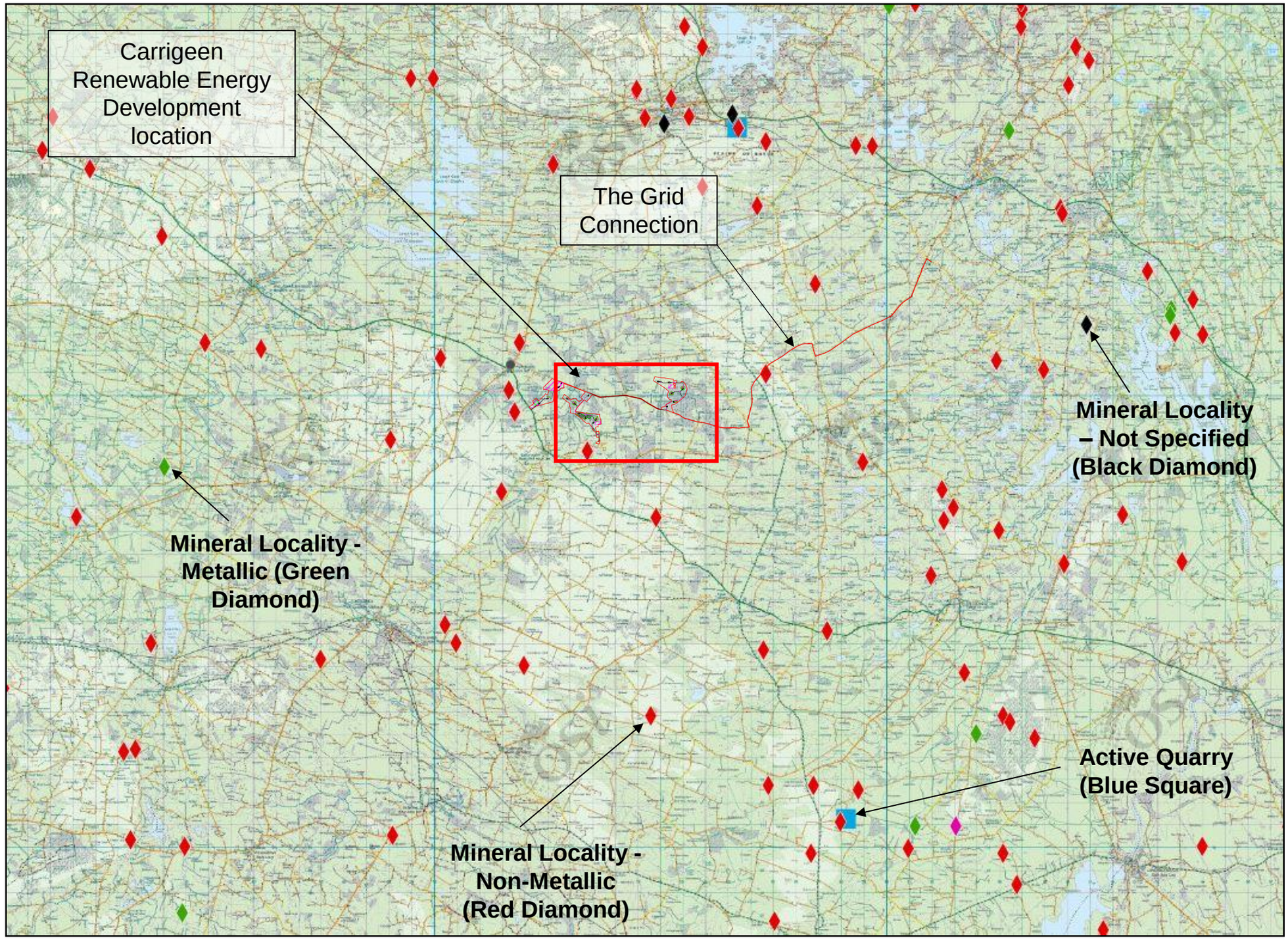

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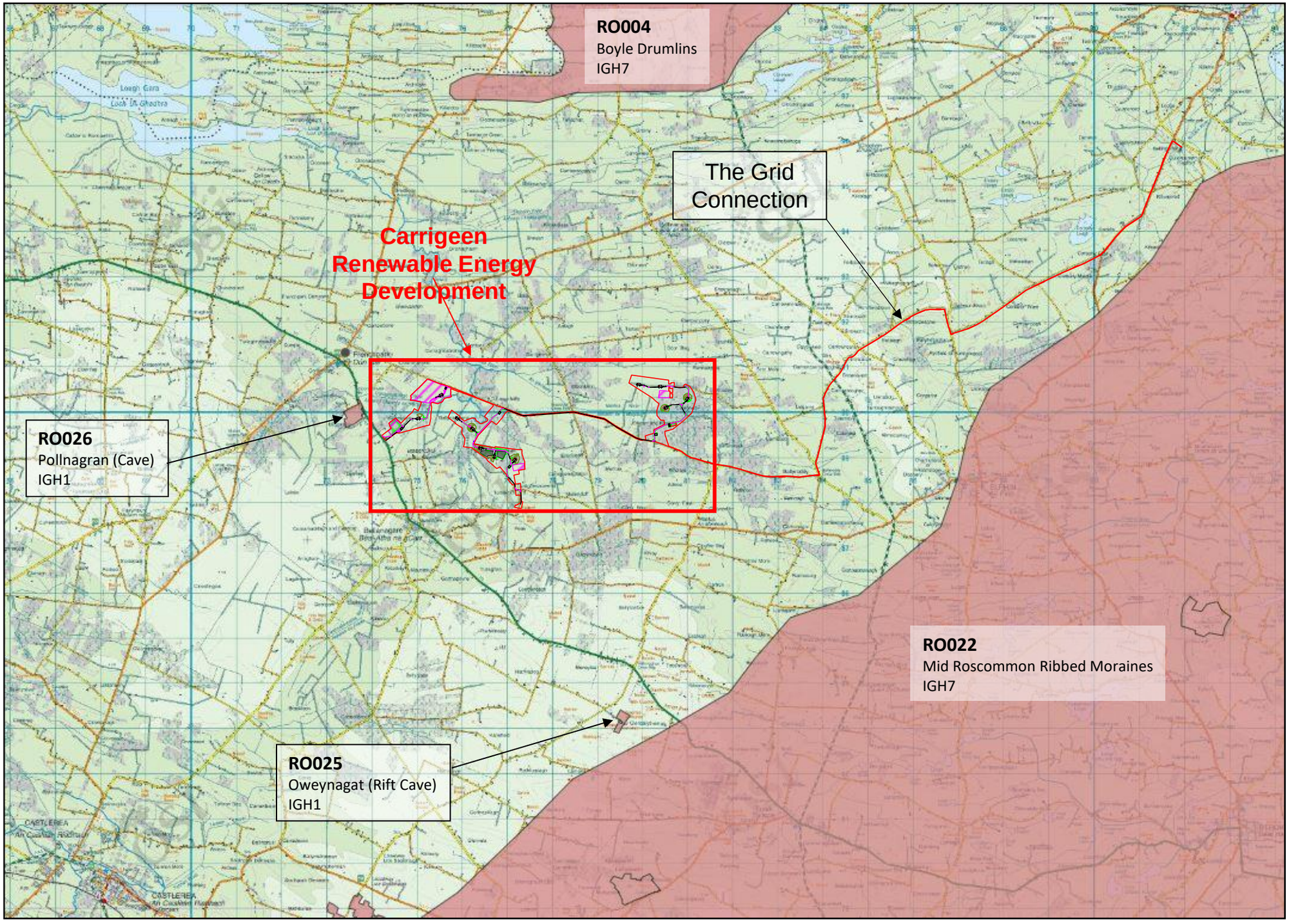

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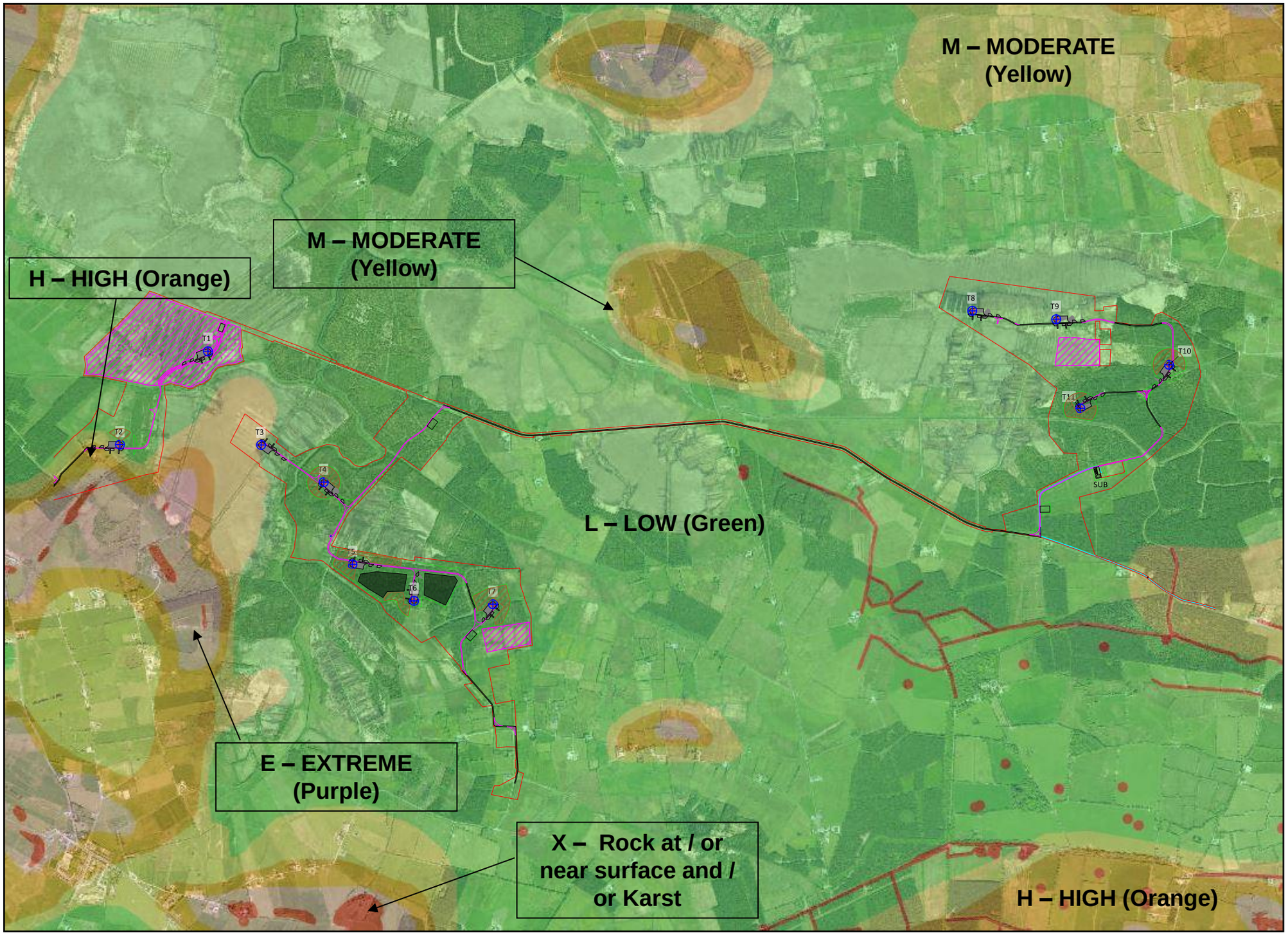
GSI – Groundwater Vulnerability



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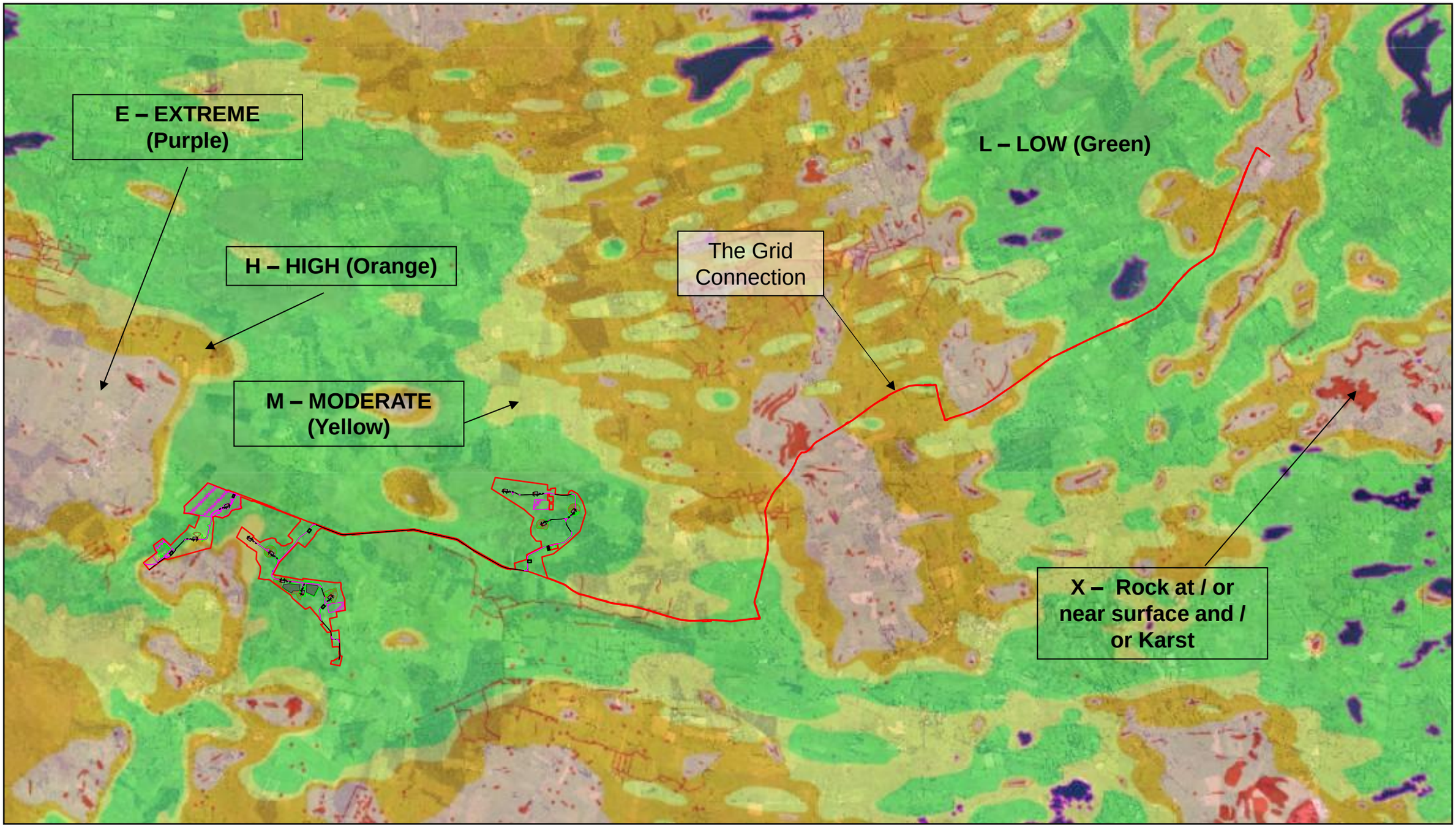
GSI – Groundwater Vulnerability



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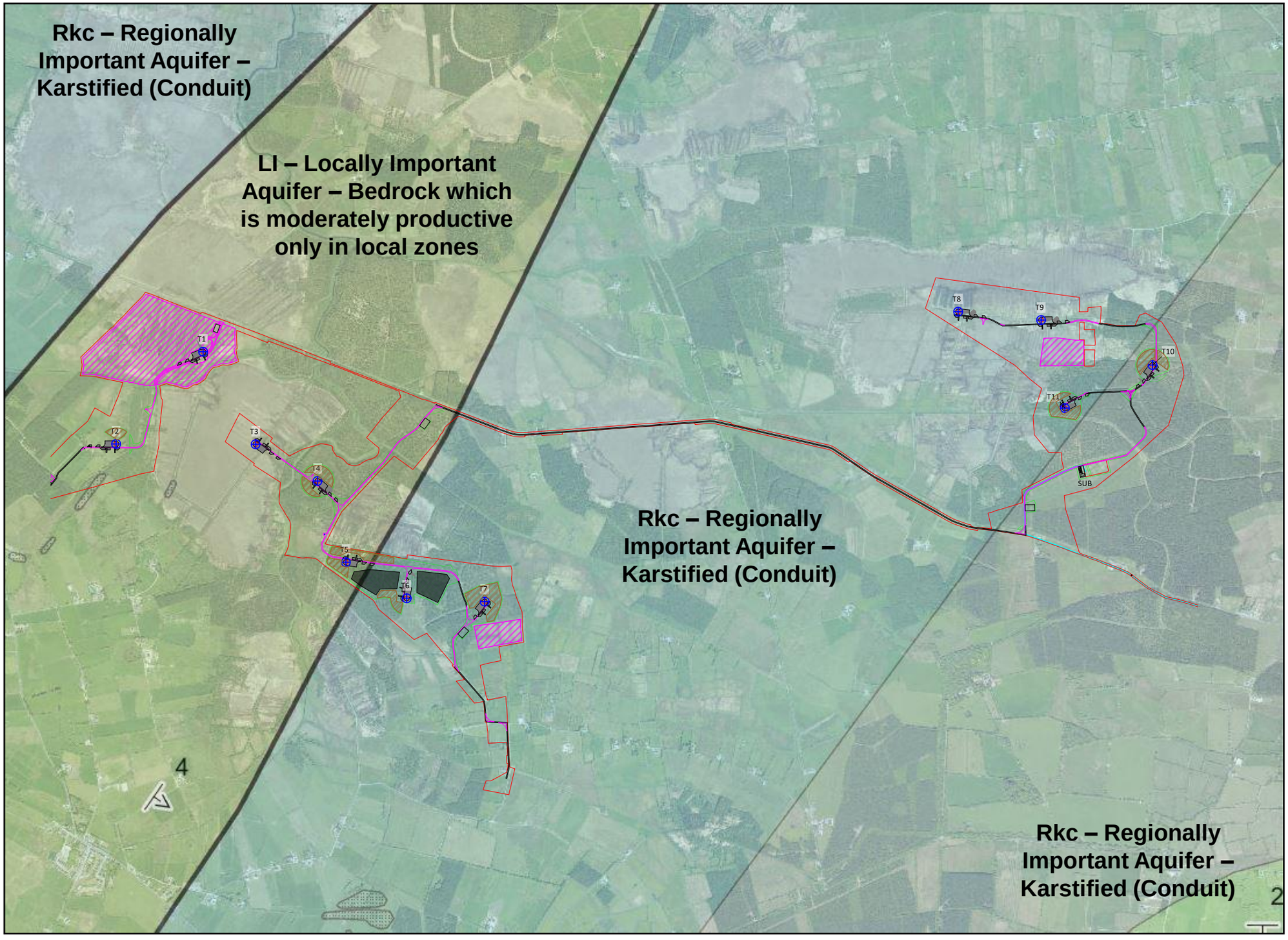
2278-24 Carrigeen Renewable Energy Development, Co. Roscommon
Soils and Geology Assessment

GSI – Groundwater Resources / Bedrock Aquifer Potential



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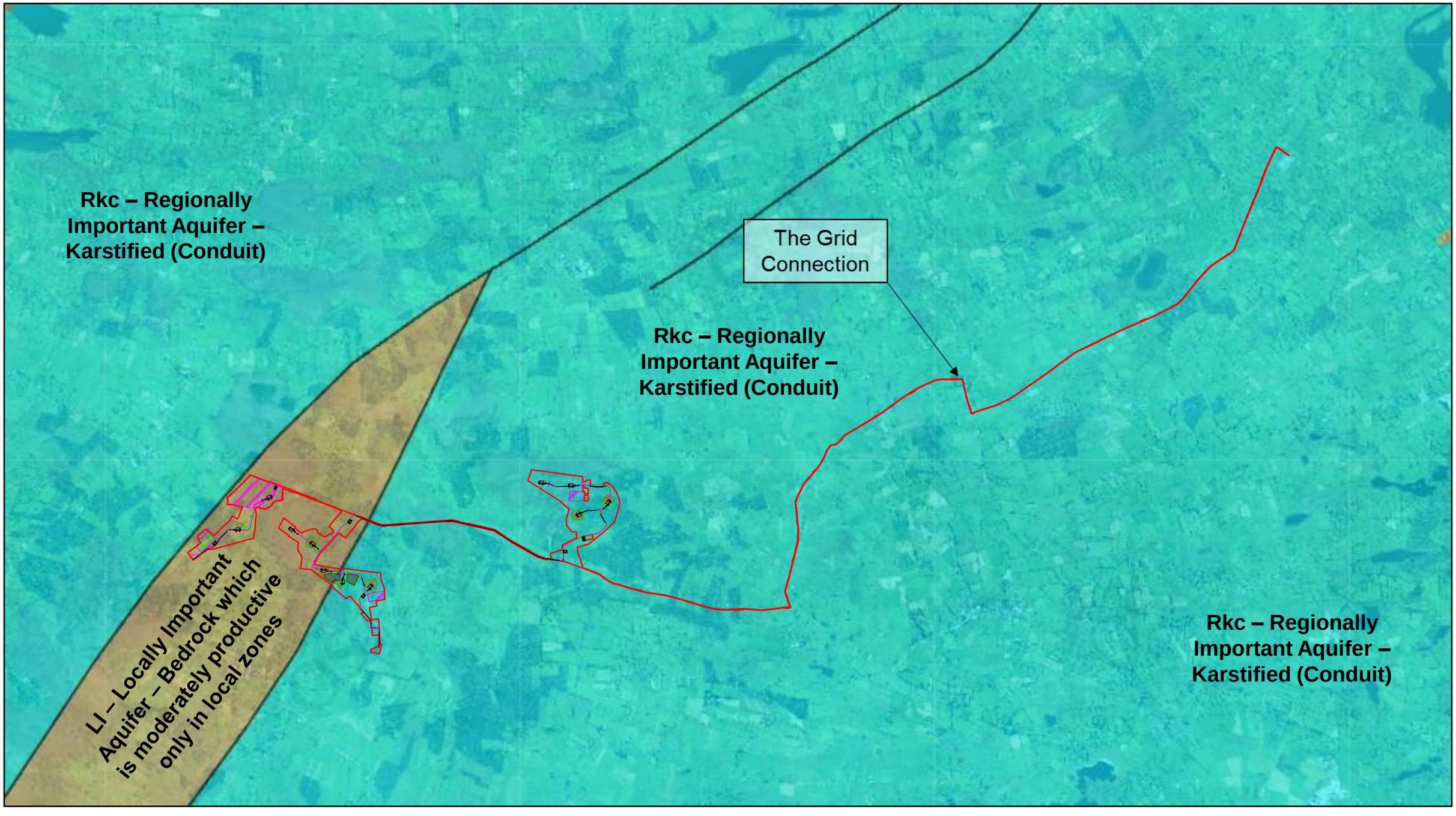
GSI – Groundwater Resources / Bedrock Aquifer Potential



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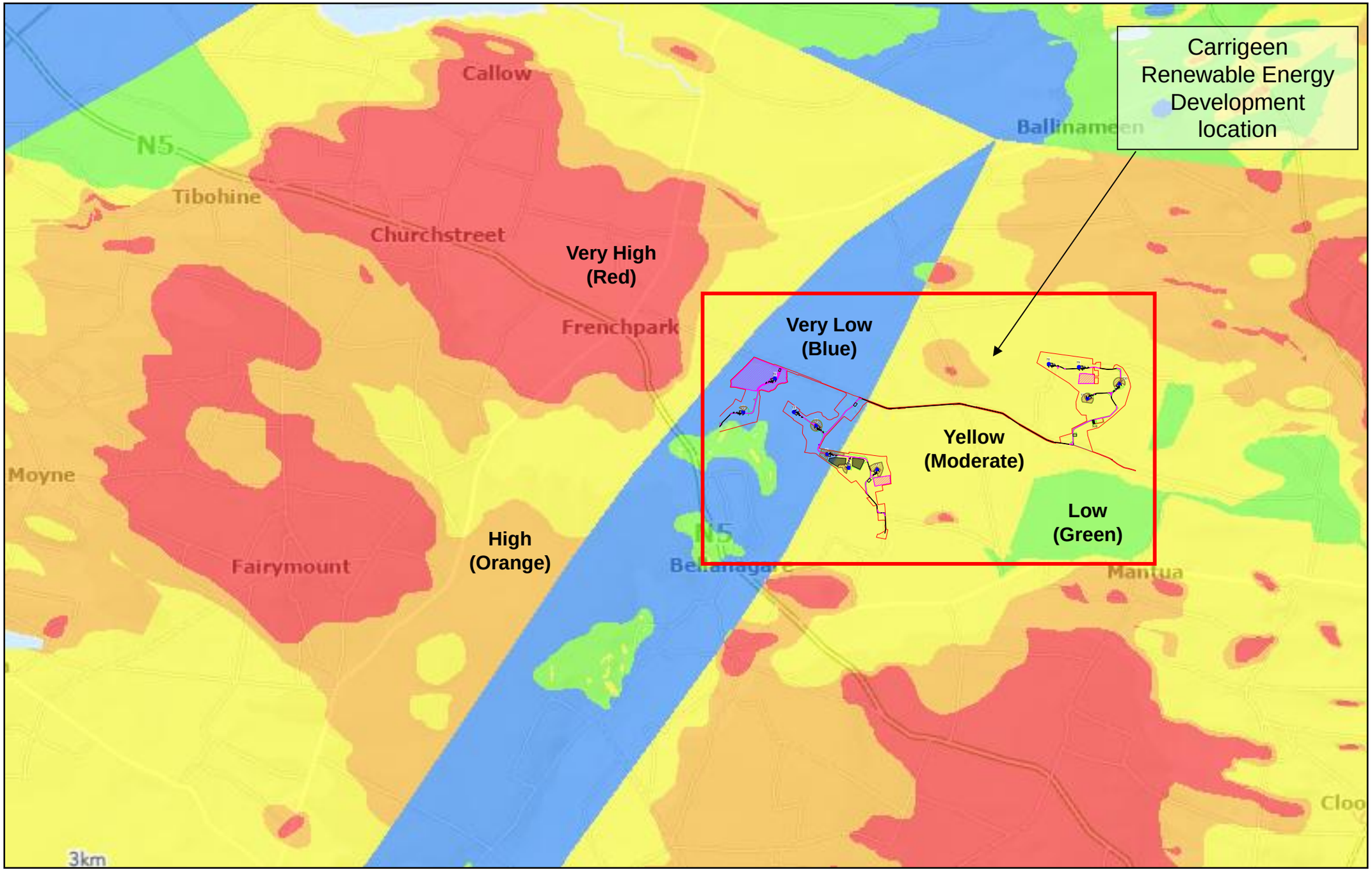
2278-24 Carrigeen Renewable Energy Development, Co. Roscommon
Soils and Geology Assessment

GSI – Bedrock Aggregate Potential



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Geological Survey of Ireland Online Mapping Database Bedrock Aggregate Potential

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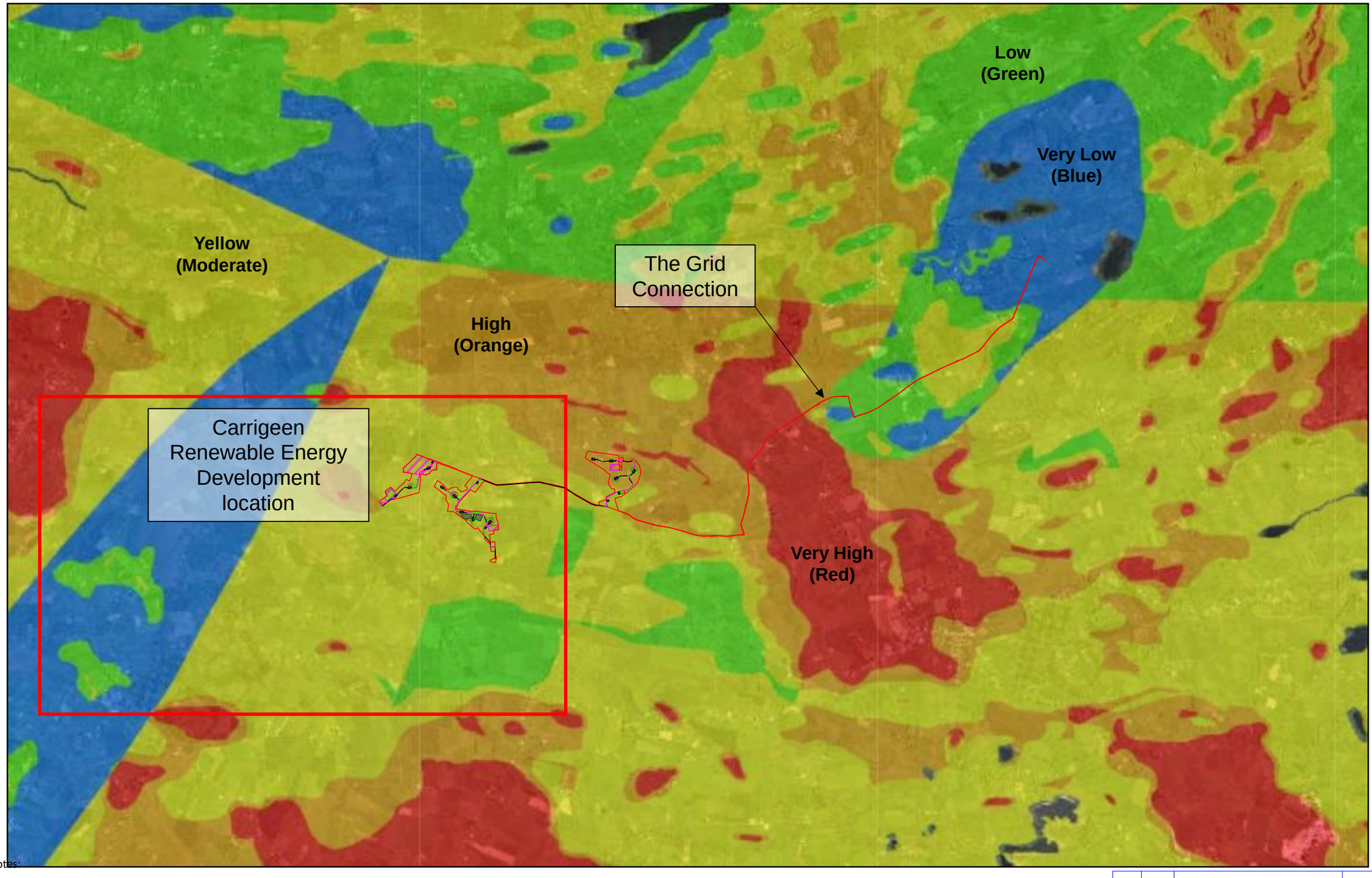
GSI – Bedrock Aggregate Potential



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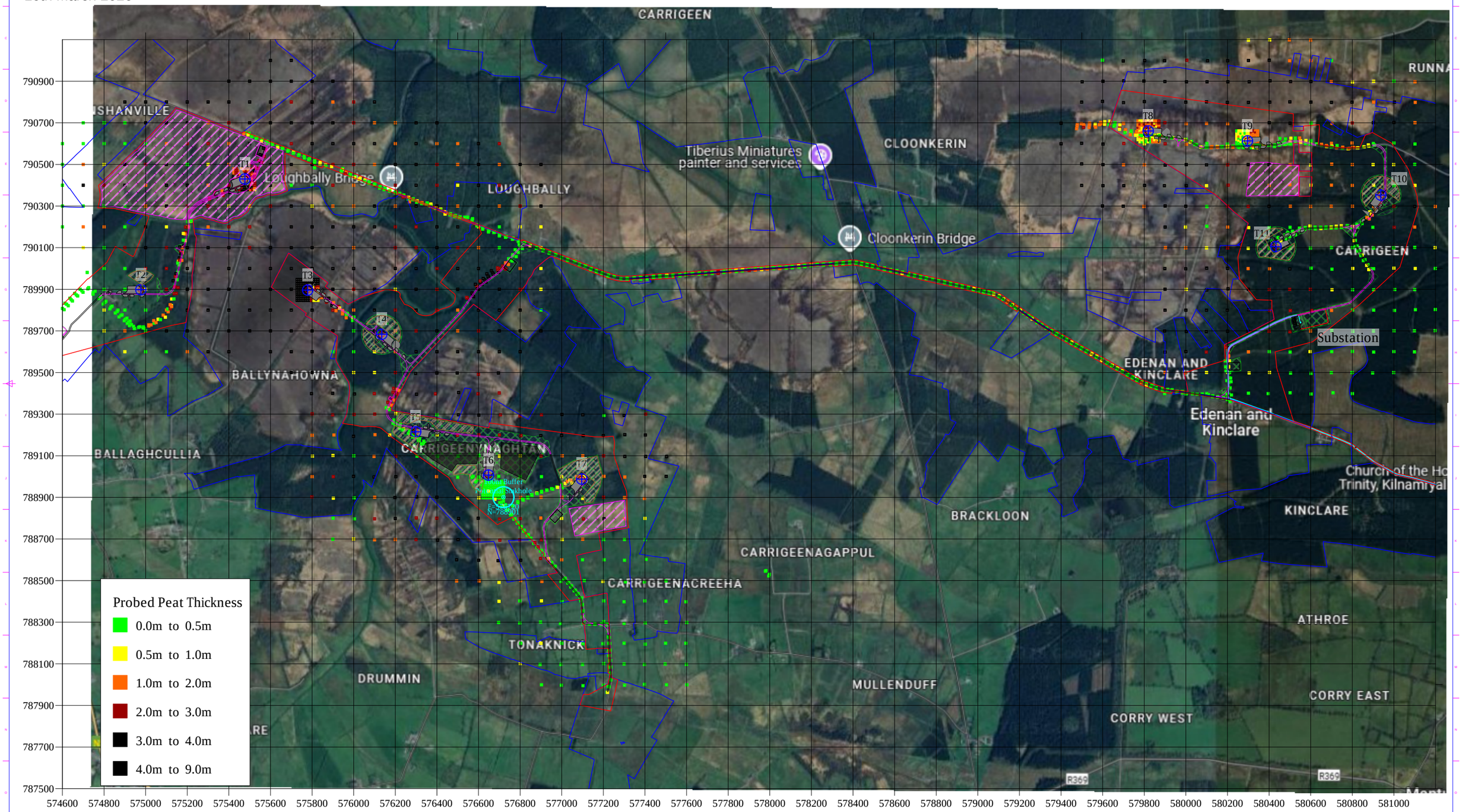
	2	

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Contoured Peat Thickness Plot

10th March 2026



Probed Peat Thickness

- 0.0m to 0.5m
- 0.5m to 1.0m
- 1.0m to 2.0m
- 2.0m to 3.0m
- 3.0m to 4.0m
- 4.0m to 9.0m

KEY

Red-line Boundary

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

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JW	JW	JM 10/03/2026	2278-24 D1	10/03/2026	1 : 6,000

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Carrigeen Renewable Energy Development - PLHA

Post Plot of Probed Peat Thickness

Edition 7

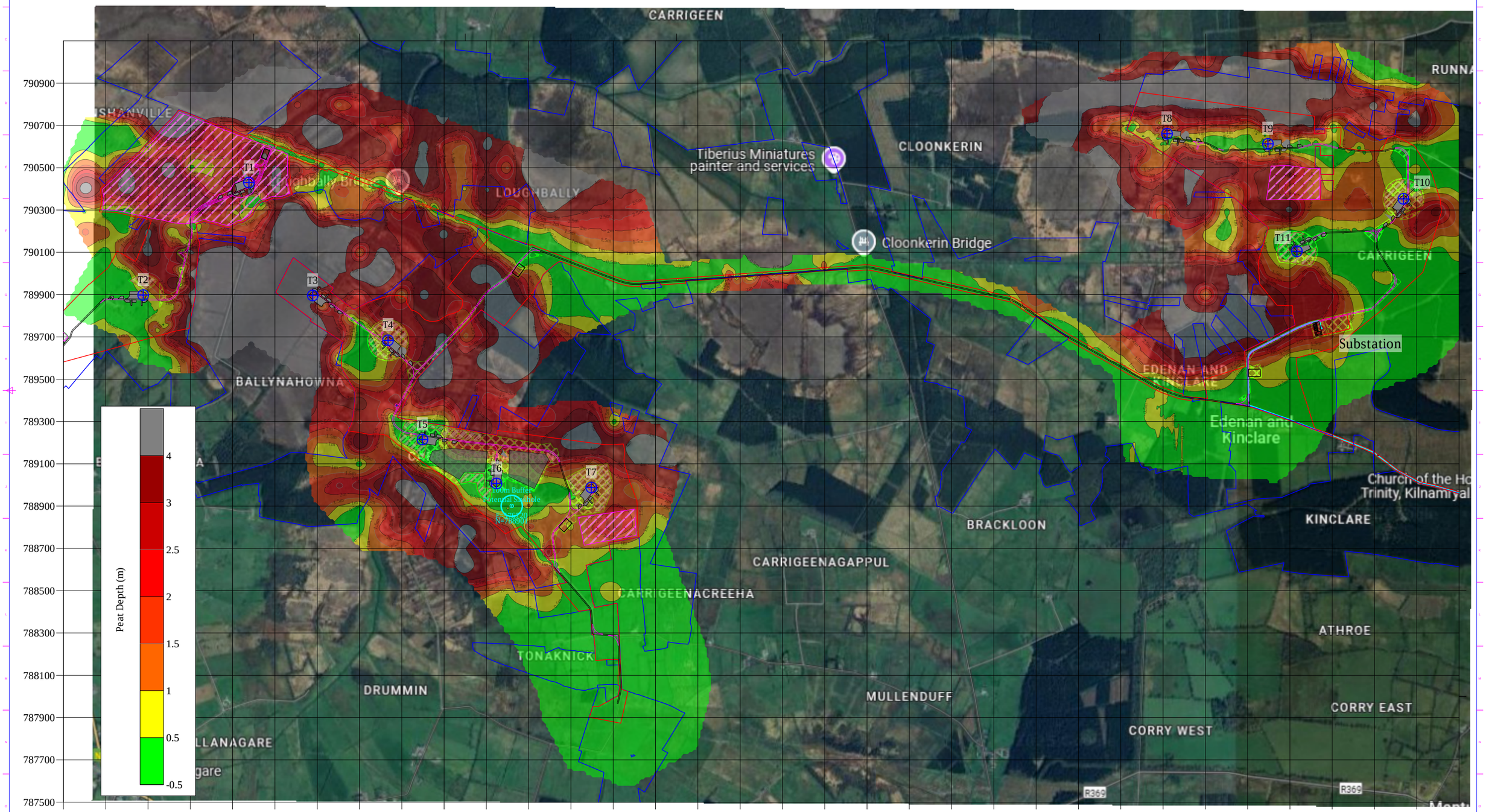
Sheet A3

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Contoured Peat Thickness Plot

10th March 2026



KEY

Red-line Boundary

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

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JW	JW	JM 10/03/2026	2278-24 D2	10/03/2026	1 : 17,500

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Carrigeen Renewable Energy Development - PLHA

Contoured Plot of Probed Peat Thickness

Edition 7

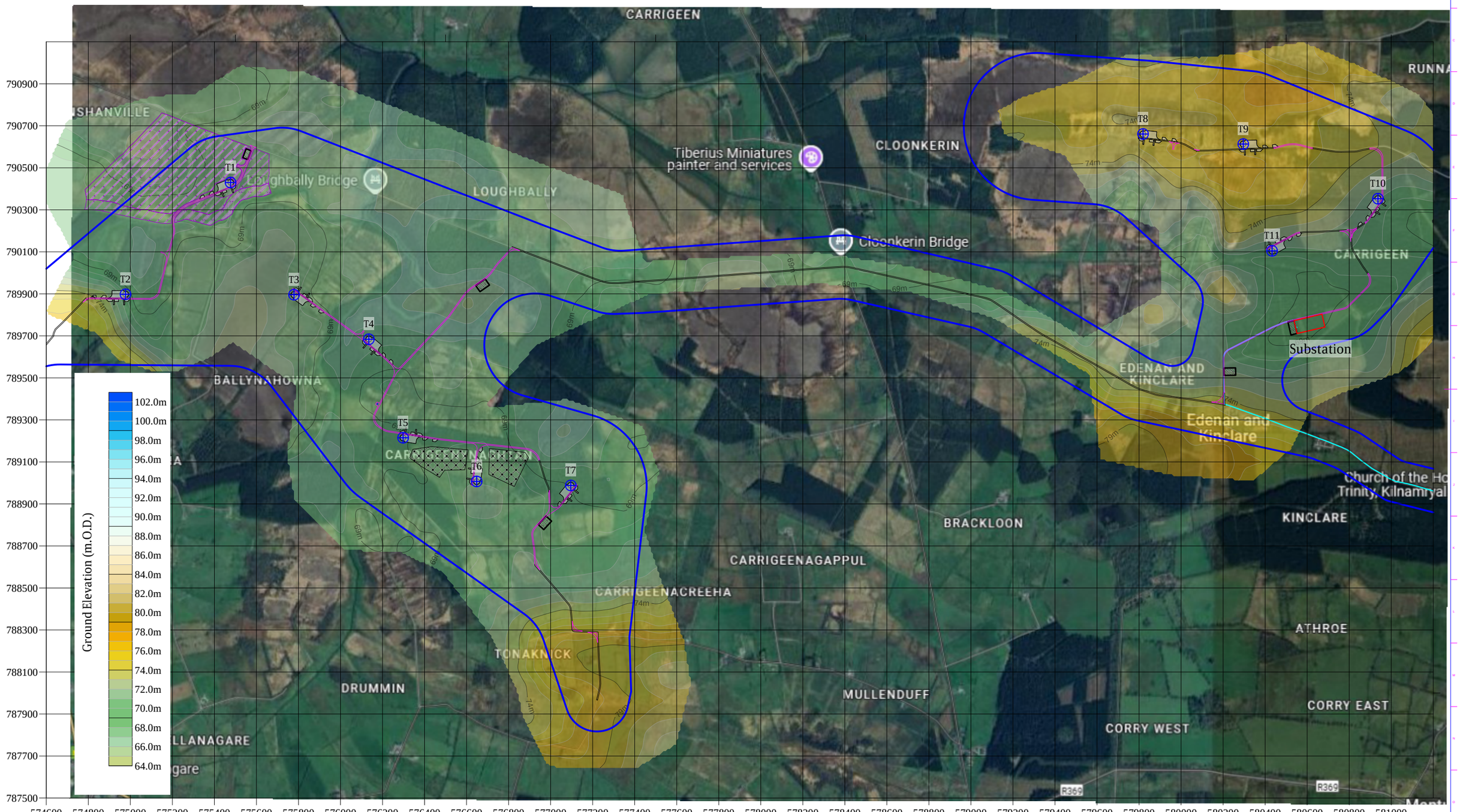
Sheet A3

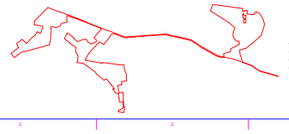
2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Ground Elevations Variation

10th March 2026





Red-line Boundary

KEY

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
JR	JW	JM 10/03/2026	2278-24 D3	10/03/2026	1 : 17,500

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Carrigeen Renewable Energy Development - PLHA

Contoured Plot of Ground Elevations (2m Data)

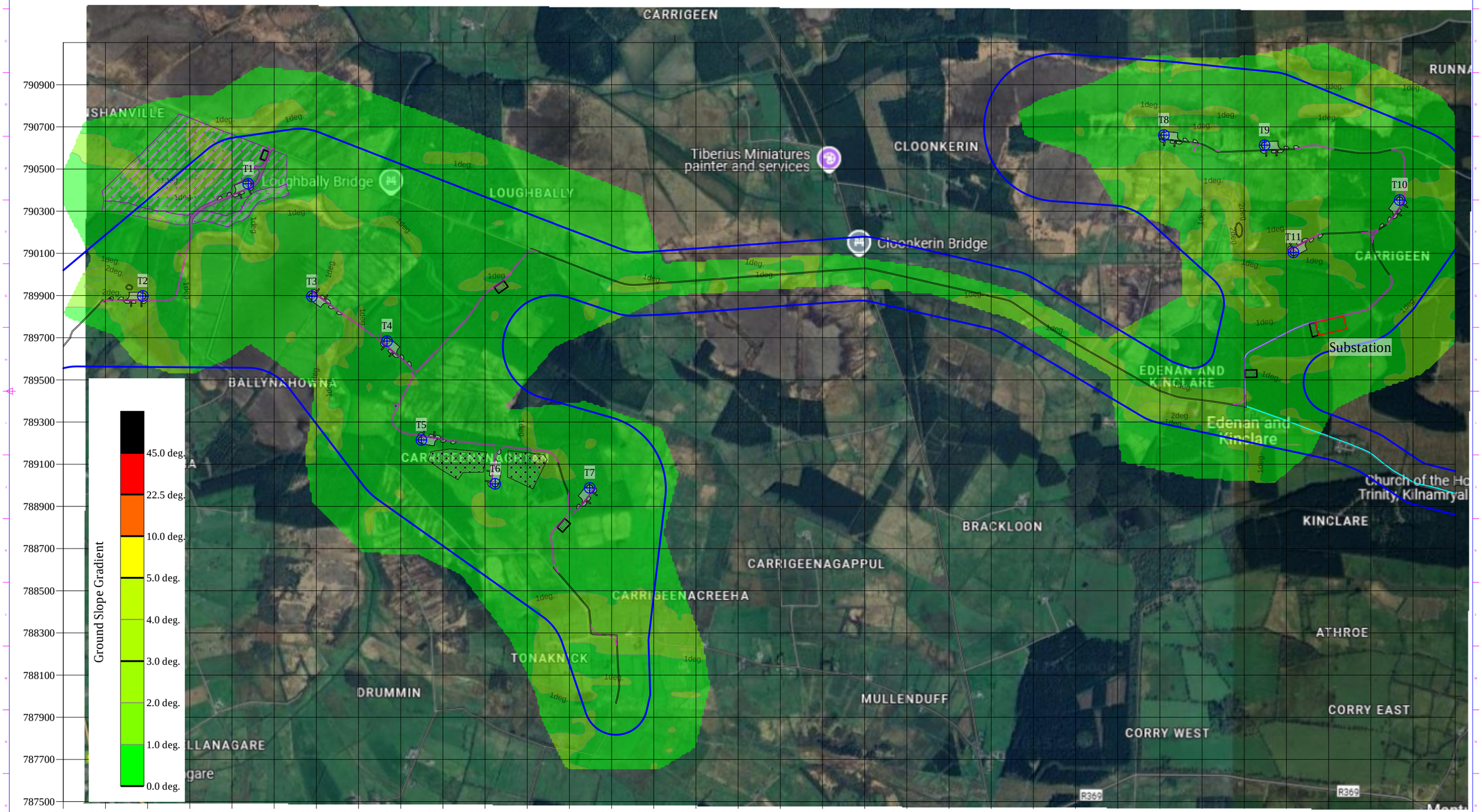
Edition	Sheet
7	A3

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Ground Slope Gradient Variation

10th March 2026



KEY

Red-line Boundary

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
JR	JW	JM 10/03/2026	2278-24 D4	10/03/2026	1 : 17,500

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Carrigeen Renewable Energy Development - PLHA

Contoured Plot of Ground Slopes (2m data)

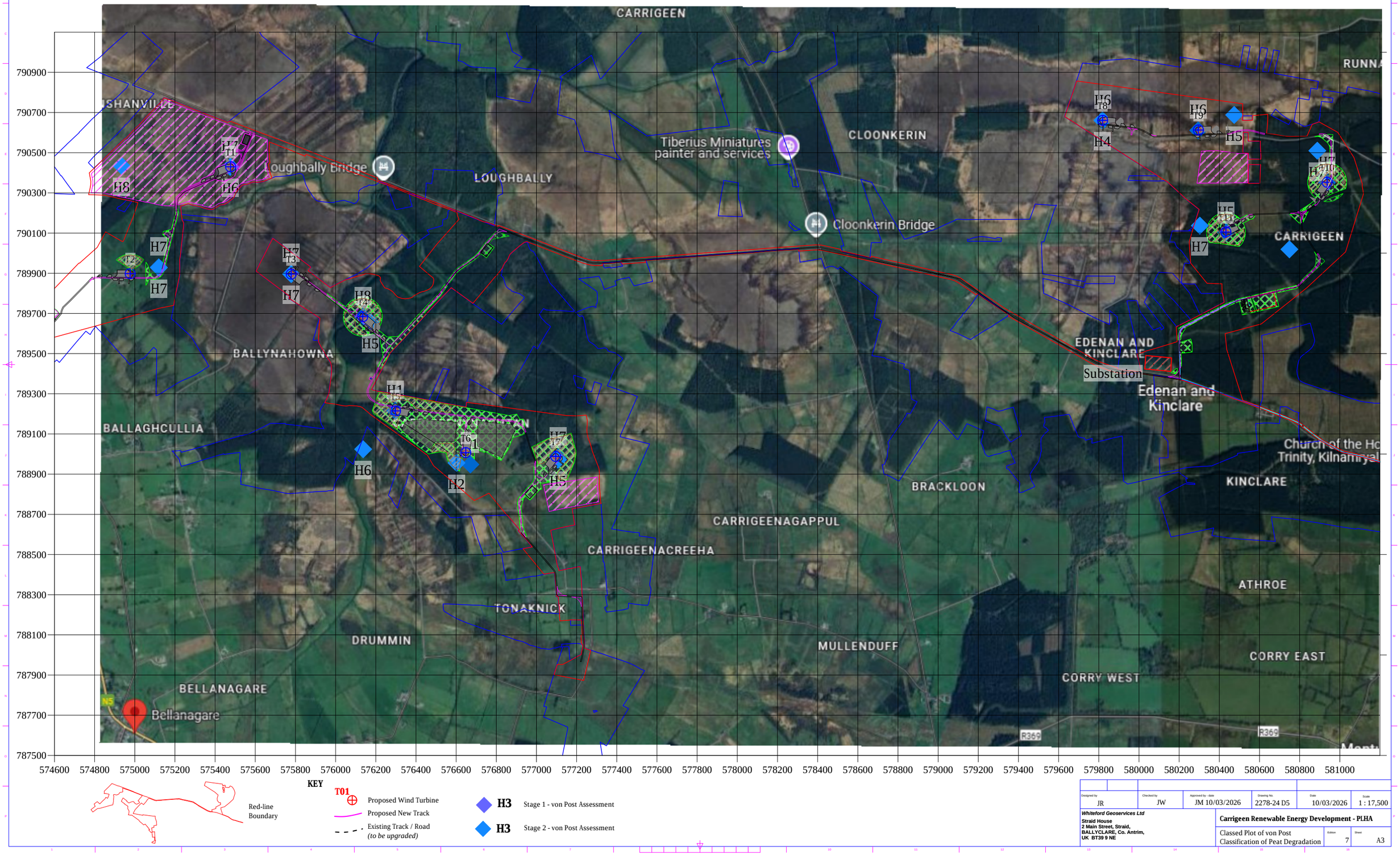
Edition 7 | Sheet A3

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Classed Plot of Peat Degradation Classification

10th March 2026



KEY

Red-line Boundary

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

H3 Stage 1 - von Post Assessment

H3 Stage 2 - von Post Assessment

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JR	JW	JM 10/03/2026	2278-24 D5	10/03/2026	1 : 17,500

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Carrigeen Renewable Energy Development - PLHA

Classed Plot of von Post Classification of Peat Degradation

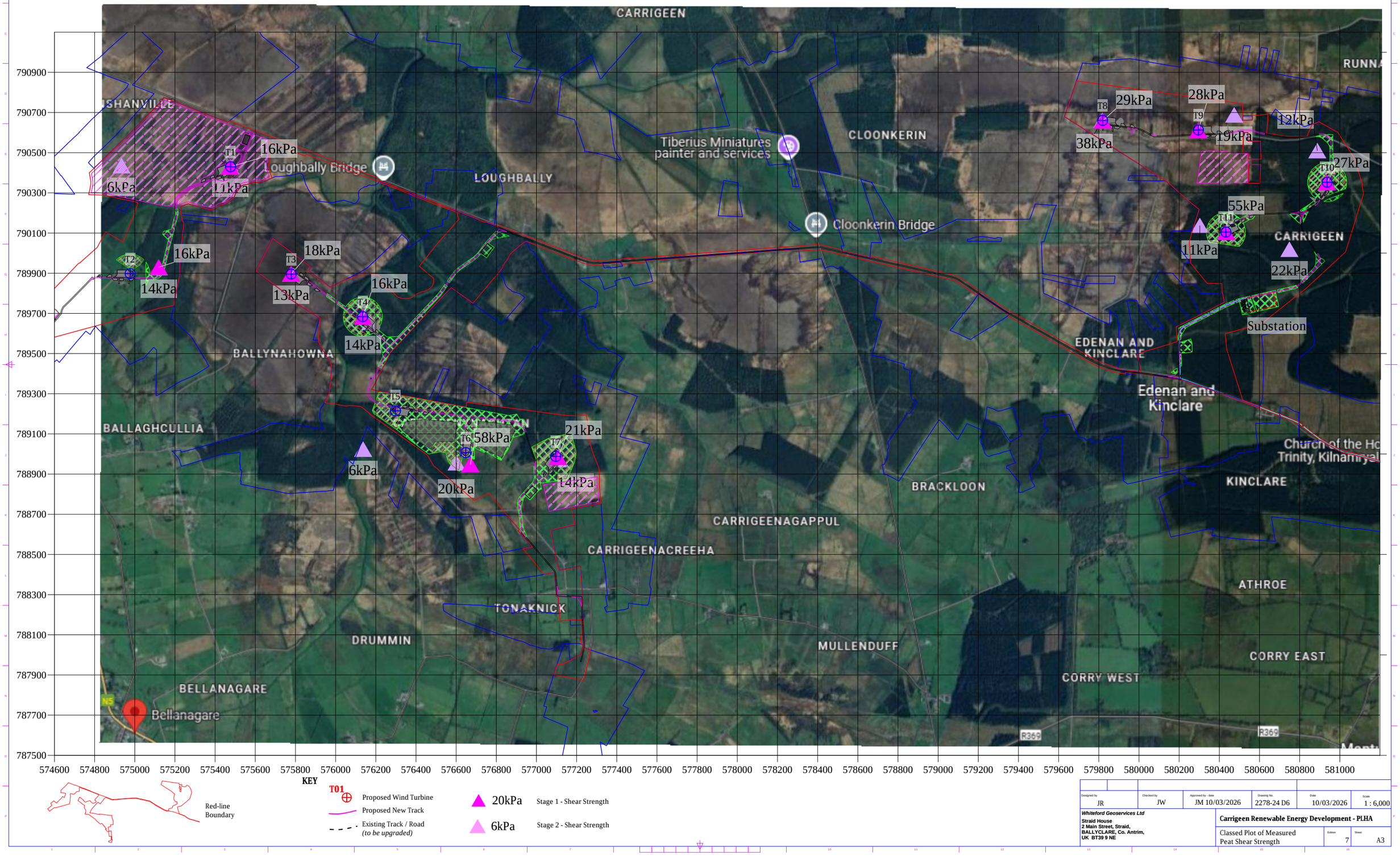
Edition 7 | Sheet A3

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Classed Plot of Measured Shear Strength

10th March 2026



KEY

Red-line Boundary

T01 Proposed Wind Turbine

Proposed New Track

Existing Track / Road *(to be upgraded)*

20kPa Stage 1 - Shear Strength

6kPa Stage 2 - Shear Strength

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JR	JW	JM 10/03/2026	2278-24 D6	10/03/2026	1 : 6,000

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Carrigeen Renewable Energy Development - PLHA

Classed Plot of Measured Peat Shear Strength

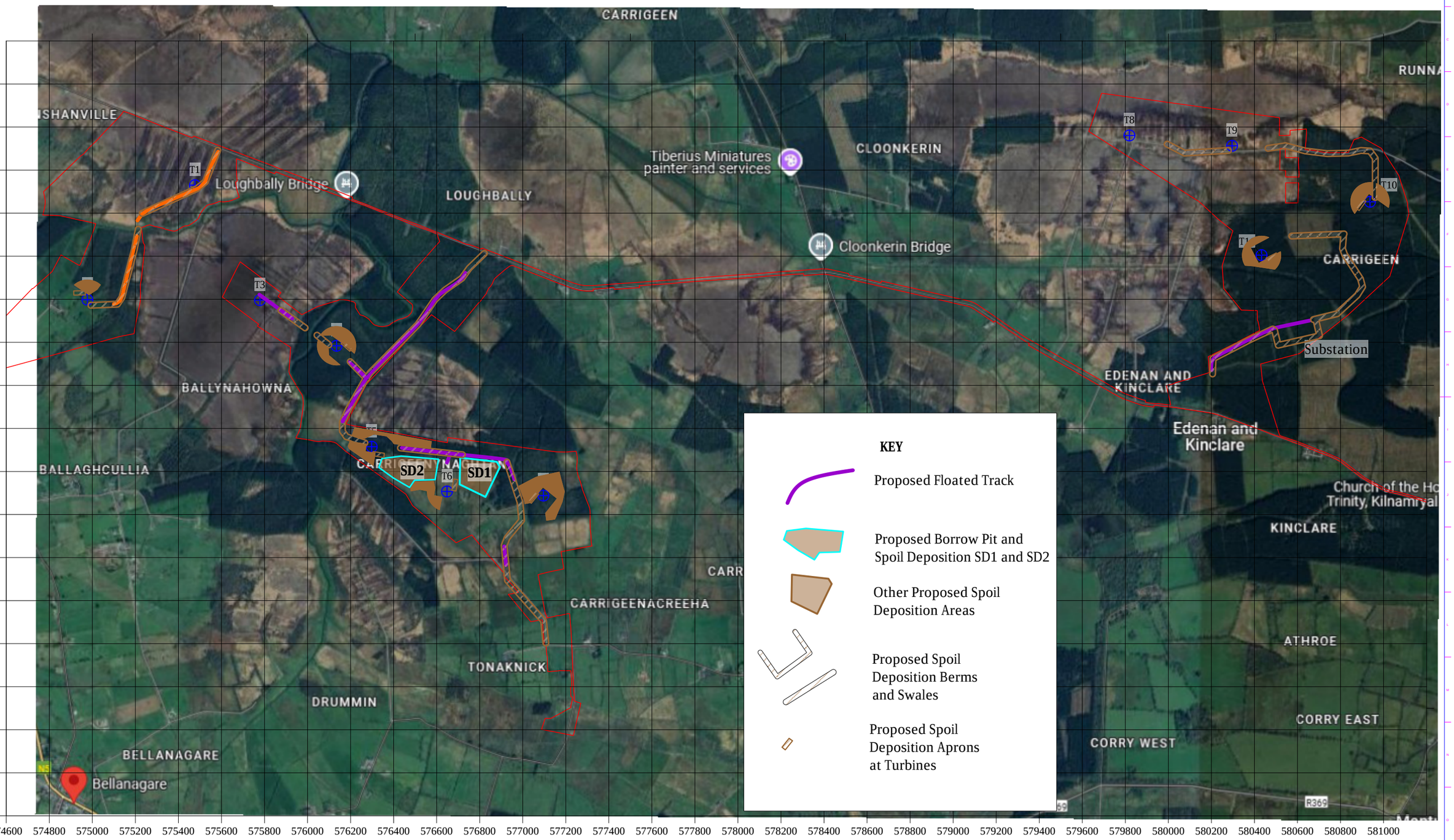
Edition 7 | Sheet A3

2278-24 Carrigeen Renewable Energy Development - Soils and Geology Assessment

Turbine Layout: Dated 11-02-2026

Peat Landslide Hazard Assessment Works - Floated Track and Spoil Deposition Proposals

10th March 2026



KEY

- Proposed Floated Track
- Proposed Borrow Pit and Spoil Deposition SD1 and SD2
- Other Proposed Spoil Deposition Areas
- Proposed Spoil Deposition Berms and Swales
- Proposed Spoil Deposition Aprons at Turbines

Designed by	Checked by	Approved by - date	Drawing No.	Date	Scale
JW	JW	JM 10/03/2026	2278-24 D2A	10/03/2026	1 : 17,500

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Carrigeen Renewable Energy Development - PLHA

Floated Track and Spoil Deposition Proposals

Edition 7

Sheet A3

APPENDIX A

Numerical Assessment of Sites Where Peat is a Key Constituent	2 x A4

Numerical Analysis of Key Indicators to Determine HAZARD for the Purposes of Peat Slide Risk Evaluation

Guidance Notes: Controlled Circulation Only Confidential

HAZARD is essentially the apportioning of risk where certain factors contribute to the triggering of a peat slide.

Since peat instability is caused by a number of factors it is necessary to apply factors to each contributing element.

The following key indicators are the predominant causes of peat slides:-

1. Peat Thickness
2. Topography (i.e steepness of ground in the vicinity of the construction zone)
3. Drainage Issues
4. Historic, Active or Incipient Peat Landforms
5. Sonic / Seismic Activity (e.g. Quarrying, blasting etc.)
6. Degradation of Peat (i.e. Von Post classification)
7. Rate of Annual Precipitation recorded by Met Eirrean in 2023
8. Shear Strength of Peat (i.e Vane test data)
9. Peat Landslide History (GSI records / significant events)

For the purposes of assessment all factors are deemed to be additive and severity of certain factors yields a higher contribution to HAZARD.

e.g. Peat thickness of 3.10m; slope id 8º and Drainage Issues (forestry) are SIGNIFICANT

Minimum HAZARD = +4 +2 +1 = 7

The table below illustrates the Factors associated with the Key Indicators for the proposed development at Carrigeen Renewable Energy Development.

Item	Key Indicator	Numerical HAZARD Factor
1	Peat Thickness less than 0.5m	0
1	Peat Thickness. (0.5 – 1.0m)	+0.5
2	Peat Thickness (>1.0 – 2.0m)	+1
3	Peat Thickness. (> 2.0m to 3.0m)	+2
4	Peat Thickness – Floated Site Track (>1.50m)	+3
5	Peat Thickness at Infrastructure (> 3.0m to 4.0m “Firm”)	+4
6	Peat Thickness at Infrastructure (>4.0m to 5.0m “Firm”)	+6
7	Peat Thickness at Infrastructure (>3.0m “Quaking”)	+10
8	Topography. Slopes of < 3º to horizontal	0
9	Topography. Slopes of 3º to 5º to horizontal	+1
10	Topography. Slopes of > 5º < 10º to horizontal	+2
11	Topography. Slopes of > 10º < 22.5º to horizontal	+3
12	Topography. Slopes of > 22.5º to horizontal	+4

13	Drainage Issues: Areas of forestry either already felled or due to be felled to facilitate construction	+1
14	Drainage Issues: Water table at or near the surface; standing water / ephemeral lakes within construction zone	+0.5
15	Drainage Issues: Concentrated drainage network evident in vicinity	+0.5
16	Relic Peat Landforms present in vicinity of construction zone (1). Eroded peat hags, tension cracks, peat banks (0 – 1.5m height) present within construction zone	+1
17	Relic Peat Landforms present in vicinity of construction zone (2). Peat substrate cut for peat harvesting, pipe pipes, “bog holes”, peat detachment evident	+2
18	Sonic / Seismic Activity. (Quarrying / Piling within 1000m, blasting within 1000m, earthquake risk etc.)	+1
19	H9 –H10 Von Post Classification of Peat Degradation	+1
20	H0 –H2 Von Post Classification of Peat Degradation Where very low rates of degradation are present this tends to correspond to a highly organic silty clay soil and as such these soils exhibit a much-reduced risk of instability.	- 0.5
21	Vane Test Classification Of Shear Strength = < 5kPa (Variants exist)	+3
22	Vane Test Classification Of Shear Strength = <10kPa	+2
23	Vane Test Classification Of Shear Strength = <20kPa	+1
24	Vane Test Classification Of Shear Strength = >60 at 1.5m depth	-0.5
25	Annual Precipitation: Low (<1100mm)	0
26	Annual Precipitation: Moderate (>1100mm <1250mm)	+0.25
27	Annual Precipitation: High (>1250mm <1300mm)	+0.5
28	Annual Precipitation: Very High (<1350mm)	+0.75
29	Peat Landslide History (5km radius): None recorded	0
30	Peat Landslide History (5km radius): < 5 recorded	+0.25
31	Peat Landslide History (5km radius): <10 recorded	+0.5
32	Peat Landslide History (5km radius): Major incident recorded	+1

Table X1 – Numerical Calculation of Risk Parameters

APPENDIX B

Analytical Analysis	4 x A4

Analytical Analysis

The following analysis uses an analytical approach to determine factors of safety to quantify the risks of peat slides and local rotational failure or engulfment of excavations occurring. A separate qualitative risk assessment is described in the report followed by a Discussion of these analyses. The findings of each will be used to establish overall risks of peat movement occurring at various locations across the site.

The Scottish Guidance suggests the application of Infinite Slope Stability Analysis be employed to gauge the stability of peat on slopes and determination of the relevant Factor of Safety (FoS).

The analysis is based on a theoretical infinite slope which considers the resistance to failure (dependent on shear strength) and the active gravitational force (dependent on peat depth, weight and slope).

The minimum required FoS for stable slopes is 1.3, as specified in BS 6031:2009: Code of Practice for Earthworks (BSI, 2009). Where undrained parameters are used a FoS of 1.5 is preferable.

For this purpose, the following modified formula, (Bromhead, 1986) is proposed:-

$$FoS = \frac{Cu + (\gamma - m\gamma_w) z \cos^2 \alpha \tan \phi'}{\gamma z \sin \alpha \cos \alpha}$$

where

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Saturated Material (kN/m^3) (Use[1] 12kN/m^3 for undrained condition. For dry peat, 10kN/m^3)

m = height of water table as a fraction of peat depth (m)

γ_w = Unit Weight of Water (kN/m^3)

ϕ = Angle of internal friction (deg)

z = Depth to Failure plane (Assumed depth of peat) (m)

α = Slope angle (deg)

However, the inclusion of the modification for water table fluctuation has the effect of increasing the factor of safety when the water level rises. Ultimately the peat slope is most vulnerable when water is not present, and the density of the peat material is at its highest.

For this purpose, the basic form of the equation has been employed and the most conservative value of density for the peat, (approximately 15kN/m^3 -for the undrained condition, where it has a relatively high clay content and 10kN/m3 for the dry condition), has been considered.

In an effort to mimic the most extreme and unstable conditions that could possibly exist, higher values of density have been considered, which in turn return the most limiting values.

[1] Taken from “Physical Properties of Irish Peats”, Galvin, L. F., 1976 Table 1

Infinite Slope Analysis

The formula used in this analysis to determine the FoS, for the undrained condition for a given slope, weight and strength of material (Bromhead, 1986), is therefore as follows:

$$FoS = \frac{Cu}{\gamma z \, Sin\alpha \, Cos\alpha}$$

Where,

FoS = Factor of Safety

C_u = Undrained Shear Strength (kPa)

γ = Bulk Unit Weight of Material (kN/m^3) – assumed, for saturated peat, to be at 12kN/m^3 .

z = Depth to Failure plane (Max depth of peat measured in vicinity of turbine) (m)

α = Slope angle (deg)

The maximum slope at the proposed turbine positions has been employed for the calculations and the results are as summarised in the table below:

LOCATION	Max Slope (°)	z (m)	Undrained Condition		Dry Condition	
			Cu[2] (kPa)	Factor of Safety Sliding	Cu (kPa)	Factor of Safety Sliding[3]
T01	3	4.5	11	**3.90**	5	**1.77**
T02	3	0.7	14	**31.89**	5	**11.39**
T03	3	4.5	13	**4.61**	5	**1.77**
T04	3	1.6	14	**13.95**	5	**4.98**
T05	3	0.4	20	**79.72**	5	**19.93**
T06	3	1.2	20	**26.57**	5	**6.64**
T07	3	1.6	14	**13.95**	5	**4.98**
T08	3	2.2	29	**21.02**	5	**3.62**
T09	3	2.0	19	**15.15**	5	**3.99**
T10	3	1.8	12	**10.63**	5	**4.43**
T11	3	0.6	11	**29.23**	5	**13.29**
Substation	3	2.0	20	**15.94**	5	**3.99**

Table A – Analytical Assessment of Infinite Slope Stability

[2] Minimum in-situ test values used

[3] Dry peat immediately followed by saturation – "worst case scenario"

Stability of Excavations in Peat

As an additional observation it is useful to consider the stability of excavations within the peat at the site of proposed cuttings and / or excavations. The following formula allows a determination of the maximum height of a vertical slope that should be considered when excavating in peat soils.

a) Maximum height of vertical excavated faces:

The maximum height of an excavated vertical peat or soil face can be determined using Coulomb's expression for critical vertical height,

$$Hc = \frac{4Cu}{\gamma} . \frac{cos\varphi}{1 - sin\varphi}$$

Where

Hc = Critical Vertical Height (m)
C_u = Undrained Shear Strength (kPa)
γ = Bulk Unit Weight of Material (kN/m^3)
φ = Angle of Internal Friction of Material (°)

Taking the most conservative approach, a zero angle of internal friction (ϕ=0°) and the lowest shear strength (measured at a proposed turbine location during dry conditions) of 5kPa with a materials partial safety factors of 1.3 applied to it, the **safe vertical height = 1.28m**.

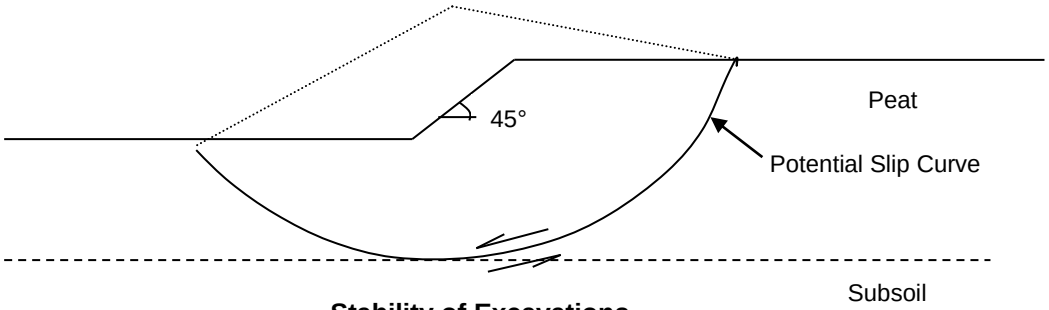
This estimate of safe vertical height is taken into consideration in the risk assessment, construction method statements and mitigation measures. Based on the above analysis, it is likely that the cut faces of peat, with height is in excess of this figure, will require support at certain locations, either by battering back to 45° for shallower faces or use of sidewall support / plating in the case of deep excavations for hard-standings. The excavation of peat will therefore have to be managed in order to mitigate against local peat face or slope failure.

b) Rotational failure of battered back slopes:

Although this is not specifically considered in the Scottish Guidance, assessment of the potential stability of the face of a battered back excavation enables the engineer to determine the level of risk appropriate to excavations.

It should be noted that local rotational failure is not restricted to sloping areas and can also occur on flat areas. This can result in engulfment of excavations which is a significant risk hazard and presents additional construction difficulties.

The theory is based on the short-term stability of excavations and involves dividing the peat mass into vertical slices and determining the overall horizontal and moment equilibrium about a potential slip curve tangential to the base of the peat (see diagram below) by equating the active and resisting forces along that curve. A Factor of Safety is therefore determined for both horizontal equilibrium and moment equilibrium. The lower of these values is tabulated in Table B.



Stability of Excavations

The analysis of the stability of excavations in peat was conducted to assess the potential risk of failure. In theory local failure is likely to occur where the Factor of Safety (FoS) is less than 1, but locations with a FoS of less than 1.3 should be given due attention.

The analysis is based on the following equilibrium equations [Bishop, 1955]:

$$FoS = \frac{\sum_1^n c_u \Delta b sec^2 \alpha}{\sum_1^n \Delta W tan\alpha}$$ (Horizontal equilibrium)

$$FoS = \frac{\sum_1^n c_u \Delta b sec\alpha}{\sum_1^n \Delta W sin\alpha}$$ (Moment equilibrium)

where Δb, ΔW and α are the width, weight and slope (of slip face to horizontal) of each vertical slice taken through the slip curve diagram above.

For 45 degree cut faces, within the maximum peat depth encountered at the proposed development site, the following undrained rotational stability FoS has been calculated.

ID	Cu (kPa)	Max Face Height Considered[4]	Factor of Safety Rotational Failure
T01	11	4.5	>1.3
T02	14	0.7	>1.3
T03	13	4.5	>1.3
T04	14	1.6	>1.3
T05	20	0.4	>1.3
T06	20	1.2	>1.3
T07	14	1.6	>1.3
T08	29	2.2	>1.3
T09	19	2.0	>1.3
T10	12	1.8	>1.3
T11	11	0.6	>1.3
Substation	20	2.0	>1.3

Table B – Analytical Assessment of Stability of Excavations

Undrained factors of safety are in excess of 1.3. By battering back of the peat faces to slopes of 45° will render the risk of peat instability to be LOW to NEGLIGIBLE for the peat strengths and slopes measured at the proposed Carrigeen Renewable Energy Development.

[4] Maximum height used relates to the maximum height only within the construction zone. i.e. where excavations are likely to take place.

APPENDIX C

Peat Probing Data	53 x A4

Carrigeen Renewable Energy Development PLHRA

Probed Peat Depth **J/N: 2278/24**

Client: Carraigin Power Ltd

Date: 02/02/2026

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
574600	790200	0.20	1
574600	790300	0.40	2
574600	790400	0.10	3
574600	790500	0.10	4
574600	790600	0.20	5
574700	790700	0.10	6
574700	790600	0.40	7
574700	790500	1.80	8
574700	790400	5.30	9
574700	790300	0.40	10
574700	790200	1.70	11
574700	790100	0.90	12
574800	790100	0.10	13
574800	790200	1.30	14
574800	790300	0.30	15
574800	790400	2.70	16
574800	790500	0.70	17
574800	790600	0.10	18
574800	790700	0.20	19
574900	790800	6.30	20
574900	790700	0.30	21
574900	790600	0.10	22
574900	790500	4.10	23
574900	790400	5.40	24
574900	790300	0.10	25
574900	790200	0.20	26
574900	790100	2.60	27
574900	790000	0.10	28
574800	790000	0.30	29
574800	789900	0.10	30
574800	789800	0.50	31
574800	789700	0.90	32
574900	789600	0.90	33
574900	789700	1.40	34
574900	789800	0.20	35
574900	789900	0.10	36
575000	789600	0.20	37

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575000	789700	0.30	38
575000	789800	0.30	39
575000	789900	0.70	40
575000	790000	2.40	41
575000	790100	4.50	42
575000	790200	4.50	43
575000	790300	1.80	44
575000	790400	1.90	45
575000	790500	2.40	46
575000	790600	0.40	47
575000	790700	3.20	48
575000	790800	5.00	49
575100	790800	5.60	50
575100	790700	8.10	51
575100	790600	1.70	52
575100	790500	5.40	53
575100	790400	3.20	54
575100	790300	3.80	55
575100	790200	0.50	56
575100	790100	2.00	57
575100	790000	2.50	58
575100	789900	2.10	59
575100	789800	1.20	60
575100	789700	3.10	61
575100	789600	0.30	62
575200	789600	1.90	63
575200	789700	4.50	64
575200	789800	4.50	65
575200	789900	4.50	66
575200	790000	4.50	67
575200	790100	4.50	68
575200	790200	4.50	69
575200	790300	2.50	70
575200	790400	4.10	71
575200	790500	0.30	72
575200	790600	2.10	73
575200	790700	4.90	74
575200	790800	8.60	75
575300	790800	7.50	76
575300	790700	1.80	77
575300	790600	2.60	78
575300	790500	0.80	79
575300	790400	1.30	80
575300	790300	2.00	81
575300	790200	1.80	82
575300	790100	4.50	83

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575300	790000	4.50	84
575300	789900	4.50	85
575300	789800	4.50	86
575300	789700	4.50	87
575300	789600	4.50	88
575400	789600	5.40	89
575400	789700	7.20	90
575400	789800	5.40	91
575400	789900	7.20	92
575400	790000	5.40	93
575400	790100	5.00	94
575400	790200	2.20	95
575400	790300	0.90	96
575400	790400	2.70	97
575400	790500	1.30	98
575400	790600	1.70	99
575400	790700	2.00	100
575400	790800	7.30	101
575400	790900	7.30	102
575500	790900	9.00	103
575500	790800	8.30	104
575500	790700	5.00	105
575500	790600	3.70	106
575500	790500	2.00	107
575500	790400	3.10	108
575500	790300	0.90	109
575500	790200	2.00	110
575500	790100	2.80	111
575500	790000	7.20	112
575500	789900	7.20	113
575500	789800	7.20	114
575500	789700	7.20	115
575600	789600	4.50	116
575600	789700	4.50	117
575600	789800	4.50	118
575600	789900	4.50	119
575600	790000	4.50	120
575600	790100	4.50	121
575600	790200	4.50	122
575600	790300	2.80	123
575600	790400	4.70	124
575600	790500	4.60	125
575600	790600	1.00	126
575600	790700	4.90	127
575600	790800	5.50	128
575600	790900	7.60	129

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575600	791000	7.50	130
575700	791000	6.30	131
575700	790900	4.70	132
575700	790800	2.70	133
575700	790700	3.60	134
575700	790600	2.70	135
575700	790500	4.00	136
575700	790400	0.40	137
575700	790300	6.30	138
575700	790200	7.20	139
575700	790100	7.20	140
575700	790000	7.20	141
575700	789900	6.80	142
575700	789800	6.80	143
575700	789700	5.40	144
575700	789600	7.20	145
575700	789500	7.20	146
575800	789500	4.50	147
575800	789600	4.50	148
575800	789700	4.50	149
575800	789800	4.50	150
575800	789900	3.00	151
575800	790000	4.50	152
575800	790100	4.50	153
575800	790200	4.50	154
575800	790300	0.90	155
575800	790400	0.30	156
575800	790500	4.90	157
575800	790600	4.90	158
575800	790700	5.10	159
575800	790800	3.60	160
575800	790900	4.50	161
575900	790900	4.90	162
575900	790800	1.20	163
575900	790700	4.10	164
575900	790600	3.80	165
575900	790500	2.00	166
575900	790400	2.10	167
575900	790300	1.10	168
575900	790200	5.40	169
575900	790100	5.40	170
575900	790000	4.00	171
575900	789900	3.70	172
575900	789800	2.80	173
575900	789700	3.60	174
575900	789600	0.20	175

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575900	789500	2.80	176
576000	789500	0.90	177
576000	789600	0.10	178
576000	789700	0.10	179
576000	789800	1.80	180
576000	789900	2.20	181
576000	790000	4.50	182
576000	790100	1.00	183
576000	790200	4.50	184
576000	790300	1.30	185
576000	790400	1.40	186
576000	790500	2.90	187
576000	790600	3.60	188
576000	790700	2.90	189
576000	790800	2.10	190
576100	790800	3.80	191
576100	790700	1.90	192
576100	790600	3.60	193
576100	790500	1.90	194
576100	790400	3.60	195
576100	790300	3.50	196
576100	790200	3.10	197
576100	790100	4.50	198
576100	790000	5.40	199
576100	789900	3.50	200
576100	789800	3.10	201
576100	789700	4.50	202
576100	789600	0.70	203
576100	789500	0.80	204
576200	789500	2.60	205
576200	789600	1.60	206
576200	789700	1.70	207
576200	789800	2.80	208
576200	789900	0.90	209
576200	790000	3.60	210
576200	790100	2.80	211
576200	790200	2.70	212
576200	790300	1.60	213
576200	790400	2.70	214
576200	790500	3.00	215
576200	790600	1.80	216
576200	790700	1.80	217
576300	790700	3.60	218
576300	790600	4.50	219
576300	790500	4.50	220
576300	790400	4.00	221

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576300	790300	3.60	222
576300	790200	2.90	223
576300	790100	2.80	224
576300	790000	3.10	225
576300	789900	4.50	226
576300	789800	3.30	227
576300	789700	2.80	228
576300	789600	3.20	229
576400	789600	4.50	230
576400	789700	4.50	231
576400	789800	2.60	232
576400	789900	2.80	233
576400	790000	2.80	234
576400	790100	3.10	235
576400	790200	4.50	236
576400	790300	3.20	237
576400	790400	2.70	238
576400	790500	2.10	239
576400	790600	1.80	240
576400	790700	4.00	241
576500	790600	1.30	242
576500	790500	1.40	243
576500	790400	0.80	244
576500	790300	1.10	245
576500	790200	3.00	246
576500	790100	2.70	247
576500	790000	3.60	248
576500	789900	3.00	249
576500	789800	1.50	250
576500	789700	1.30	251
576500	789600	3.10	252
576600	789600	5.40	253
576600	789700	2.60	254
576600	789800	4.50	255
576600	789900	4.50	256
576600	790000	6.10	257
576600	790100	1.40	258
576600	790200	0.50	259
576600	790300	4.00	260
576600	790400	4.20	261
576600	790500	3.10	262
576600	790600	4.50	263
576700	790600	2.70	264
576700	790500	1.30	265
576700	790400	2.70	266
576700	790300	1.50	267

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576700	790200	0.10	268
576700	790100	0.10	269
576700	790000	2.70	270
576700	789900	4.50	271
576700	789800	4.50	272
576700	789700	4.50	273
576700	789600	4.50	274
576800	789600	4.50	275
576800	789700	4.50	276
576800	789800	5.20	277
576800	789900	2.10	278
576800	790000	1.50	279
576800	790100	0.30	280
576800	790200	0.50	281
576800	790300	2.70	282
576800	790400	3.80	283
576800	790500	5.50	284
576900	790500	5.00	285
576900	790400	4.50	286
576900	790300	4.50	287
576900	790200	0.50	288
576900	790100	0.50	289
576900	790000	0.50	290
576900	789900	0.60	291
576900	789800	0.30	292
576900	789700	3.10	293
576298	789496	4.50	294
576400	789498	4.50	295
576498	789498	3.10	296
576600	789491	2.80	297
576696	789498	4.50	298
576700	789402	2.30	299
576598	789398	2.10	300
576504	789404	4.00	301
576393	789398	2.30	302
576302	789396	3.40	303
576206	789404	2.10	304
576099	789399	2.50	305
576004	789397	3.40	306
575899	789400	3.10	307
575797	789399	3.00	308
575800	789302	2.70	309
575899	789297	2.40	310
576002	789298	2.40	311
576101	789300	2.50	312
576203	789303	0.50	313

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576307	789297	0.10	314
576400	789297	0.30	315
576503	789297	3.00	316
576602	789295	3.20	317
576705	789297	2.30	318
576799	789291	2.30	319
576902	789297	2.20	320
577001	789298	3.30	321
577101	789297	4.00	322
577203	789294	0.10	323
577300	789294	3.20	324
577403	789300	2.70	325
577402	789200	4.50	326
577303	789201	4.50	327
577200	789197	3.70	328
577103	789197	5.00	329
576999	789198	4.90	330
576899	789197	3.50	331
576804	789197	2.80	332
576700	789200	2.90	333
576602	789201	2.70	334
576498	789198	2.80	335
576401	789200	0.90	336
576304	789200	0.40	337
576173	789200	0.70	338
576102	789201	1.70	339
575999	789194	4.00	340
575905	789200	1.10	341
575800	789198	1.00	342
575802	789098	0.90	343
575900	789101	0.70	344
576001	789100	0.10	345
576098	789097	1.60	346
576203	789098	2.70	347
576304	789098	0.10	348
576403	789098	0.20	349
576502	789098	0.10	350
576602	789101	0.40	351
576700	789098	0.90	352
576801	789100	0.90	353
576901	789098	2.40	354
577003	789100	1.80	355
577101	789100	1.00	356
577201	789100	2.70	357
577303	789097	4.00	358
577403	789097	4.00	359

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577504	789097	4.00	360
577502	789001	3.40	361
577399	789001	3.10	362
577303	788998	1.10	363
577203	789001	1.60	364
577100	788999	1.50	365
576999	788999	0.90	366
576902	788999	0.30	367
576801	788999	0.40	368
576697	789001	0.30	369
576602	788998	0.30	370
576500	788996	0.20	371
576398	788999	1.80	372
576300	788999	4.50	373
576203	788999	4.50	374
576098	788998	3.60	375
575999	789001	3.00	376
575902	788999	2.70	377
575800	788999	1.80	378
575799	788902	2.00	379
575902	788896	0.90	380
576002	788898	0.30	381
576101	788901	1.30	382
576198	788899	3.20	383
576303	788902	4.50	384
576400	788901	4.00	385
576500	788896	0.90	386
576602	788898	0.90	387
576702	788896	1.10	388
576802	788899	1.30	389
576901	788901	1.10	390
577001	788901	1.00	391
577101	788895	0.90	392
577201	788901	2.10	393
577302	788899	1.70	394
577397	788895	1.10	395
577400	788799	0.50	396
577302	788797	1.90	397
577203	788797	3.00	398
577104	788796	2.10	399
576999	788799	0.90	400
576899	788801	1.20	401
576801	788797	2.30	402
576701	788795	2.30	403
576598	788800	3.70	404
576504	788798	4.50	405

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576399	788800	2.80	406
576301	788801	2.10	407
576200	788798	3.10	408
576100	788797	2.20	409
576003	788797	0.20	410
575901	788800	0.20	411
575900	788699	0.10	412
575999	788700	0.90	413
576100	788696	1.20	414
576200	788697	1.40	415
576300	788697	2.50	416
576403	788694	3.60	417
576502	788697	4.00	418
576601	788696	2.60	419
576702	788694	2.90	420
576798	788696	2.70	421
576902	788696	2.50	422
577003	788697	0.90	423
577101	788699	1.00	424
577202	788697	0.40	425
577301	788697	0.40	426
577401	788697	0.20	427
577406	788602	0.10	428
577302	788598	0.10	429
577204	788600	0.10	430
577100	788600	0.30	431
577000	788600	1.00	432
576898	788607	2.20	433
576803	788598	3.00	434
576694	788596	3.10	435
576601	788598	3.70	436
576495	788600	4.50	437
576495	788498	1.50	438
576603	788498	1.30	439
576699	788492	0.50	440
576803	788500	1.10	441
576905	788496	1.10	442
576996	788496	0.30	443
577109	788500	0.40	444
577198	788496	0.90	445
577306	788494	0.10	446
577397	788494	0.30	447
577501	788498	0.40	448
577597	788398	0.30	449
577501	788401	0.20	450
577399	788403	0.30	451

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577299	788398	0.10	452
577202	788403	0.20	453
577091	788403	0.20	454
577002	788398	0.10	455
576903	788403	0.50	456
576798	788403	0.40	457
576699	788401	0.50	458
576696	788299	0.40	459
576798	788296	0.20	460
576898	788301	0.20	461
576994	788294	0.30	462
577102	788294	0.30	463
577202	788303	0.20	464
577299	788294	0.30	465
577401	788296	0.20	466
577501	788301	0.20	467
577601	788299	0.40	468
577597	788199	0.20	469
577499	788199	0.30	470
577401	788194	0.10	471
577299	788199	0.20	472
577198	788197	0.20	473
577102	788197	0.20	474
577000	788199	0.30	475
576900	788199	0.50	476
576803	788199	0.40	477
576801	788101	0.50	478
576896	788097	0.40	479
576996	788097	0.20	480
577100	788097	0.20	481
577202	788101	0.10	482
577299	788099	0.10	483
577397	788097	0.30	484
577497	788099	0.20	485
577599	788097	0.20	486
577601	787999	0.30	487
577503	787999	0.20	488
577397	788001	0.10	489
577302	787997	0.20	490
577200	787997	0.20	491
577102	787995	0.20	492
576998	787997	0.10	493
576903	787999	0.10	494
579898	789399	0.30	495
580001	789397	0.10	496
580100	789399	0.20	497

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580197	789397	0.20	498
580301	789401	0.10	499
580396	789399	0.10	500
580501	789403	0.10	501
580602	789397	0.10	502
580707	789403	0.30	503
580800	789399	0.40	504
580999	789500	0.10	505
580898	789498	0.20	506
580798	789500	0.40	507
580699	789499	0.30	508
580601	789496	0.30	509
580503	789497	0.40	510
580402	789500	0.50	511
580304	789498	0.80	512
580203	789500	0.80	513
580099	789500	0.90	514
579997	789498	1.00	515
579900	789500	1.80	516
579900	789598	4.00	517
580000	789600	4.00	518
580098	789598	2.70	519
580205	789599	2.50	520
580301	789599	1.30	521
580401	789600	0.40	522
580501	789598	0.10	523
580597	789600	0.90	524
580701	789600	0.30	525
580800	789602	0.30	526
580903	789598	0.10	527
581000	789600	0.10	528
581099	789599	0.20	529
581198	789702	0.10	530
581099	789701	0.40	531
581001	789701	0.20	532
580902	789699	0.10	533
580803	789698	0.20	534
580701	789702	0.30	535
580599	789699	1.60	536
580500	789696	2.10	537
580400	789698	2.80	538
580300	789698	4.60	539
580201	789698	4.00	540
580098	789696	4.50	541
580002	789697	4.50	542
579898	789699	4.50	543

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579900	789800	4.50	544
580000	789800	4.50	545
580099	789800	4.50	546
580199	789800	4.50	547
580302	789802	3.80	548
580403	789799	2.40	549
580502	789797	2.90	550
580605	789799	2.00	551
580700	789799	1.00	552
580802	789801	0.20	553
580903	789800	0.10	554
581003	789799	0.10	555
581103	789802	0.30	556
581199	789803	0.40	557
581201	789898	0.10	558
581100	789899	0.40	559
581004	789899	0.10	560
580903	789898	0.40	561
580802	789898	0.20	562
580702	789898	0.70	563
580598	789900	2.70	564
580499	789900	2.90	565
580401	789899	2.80	566
580301	789900	4.00	567
580203	789902	4.00	568
580100	789896	4.00	569
580002	789899	0.90	570
579900	789900	4.00	571
579899	790000	4.00	572
579999	789999	4.00	573
580100	790002	4.00	574
580200	790001	4.00	575
580299	790000	1.70	576
580402	789999	1.20	577
580500	789998	3.00	578
580602	790001	0.40	579
580702	789996	0.10	580
580802	790000	0.60	581
580902	789999	0.10	582
581000	790001	0.50	583
581103	790000	0.50	584
581199	790000	0.20	585
581198	790100	0.80	586
581100	790101	0.20	587
580999	790099	0.10	588
580902	790098	0.30	589

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580801	790100	0.10	590
580700	790100	0.10	591
580599	790098	0.20	592
580502	790097	0.20	593
580401	790097	0.10	594
580300	790097	0.90	595
580201	790099	2.80	596
580099	790099	0.90	597
579999	790099	1.70	598
579902	790100	1.30	599
579900	790199	4.50	600
579998	790199	0.90	601
580101	790203	0.10	602
580201	790199	1.80	603
580302	790197	0.70	604
580401	790197	0.10	605
580501	790198	0.10	606
580597	790200	0.10	607
580700	790200	0.10	608
580801	790200	0.10	609
580899	790198	0.20	610
581001	790198	2.80	611
581100	790199	1.20	612
581199	790298	1.20	613
581100	790298	3.50	614
581000	790299	2.30	615
580902	790299	1.10	616
580801	790299	1.50	617
580699	790299	1.60	618
580600	790298	1.50	619
580502	790299	1.30	620
580400	790299	4.50	621
580300	790298	2.90	622
580201	790299	2.70	623
580101	790298	0.30	624
579999	790299	3.50	625
579900	790300	4.00	626
579798	790298	1.10	627
579699	790299	4.00	628
579599	790300	4.00	629
579499	790399	4.00	630
579602	790398	4.00	631
579702	790398	3.20	632
579802	790399	3.50	633
579897	790398	4.00	634
580002	790398	3.30	635

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580099	790398	0.80	636
580203	790400	2.30	637
580301	790398	3.50	638
580401	790399	1.50	639
580500	790403	1.30	640
580601	790400	0.90	641
580700	790400	1.50	642
580800	790399	1.30	643
580902	790400	0.70	644
581001	790399	0.20	645
581101	790399	0.50	646
581200	790399	0.30	647
581200	790499	0.30	648
581100	790501	0.10	649
580999	790499	0.70	650
580900	790499	0.50	651
580800	790499	1.20	652
580701	790502	1.40	653
580600	790497	0.50	654
580501	790498	1.60	655
580400	790499	3.70	656
580300	790499	3.20	657
580201	790498	2.90	658
580099	790498	4.00	659
580002	790499	4.00	660
579900	790497	4.00	661
579800	790498	1.60	662
579700	790498	1.20	663
579602	790499	4.00	664
579499	790503	4.00	665
579400	790599	3.80	666
579499	790602	4.20	667
579602	790598	3.40	668
579702	790601	2.80	669
579800	790599	0.70	670
579900	790599	2.20	671
580003	790597	1.30	672
580101	790601	0.10	673
580199	790598	0.40	674
580303	790597	0.90	675
580401	790599	0.10	676
580498	790598	0.10	677
580600	790598	0.10	678
580700	790602	1.10	679
580799	790603	1.30	680
580901	790601	0.10	681

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
581000	790603	0.10	682
581101	790598	0.10	683
581201	790598	0.30	684
581200	790697	0.90	685
581101	790701	1.70	686
581000	790702	4.50	687
580901	790701	3.80	688
580800	790699	2.70	689
580702	790697	1.80	690
580602	790698	0.10	691
580501	790698	4.50	692
580401	790701	4.50	693
580302	790699	4.50	694
580201	790696	1.10	695
580099	790697	1.80	696
580002	790696	1.80	697
579899	790701	2.30	698
579798	790701	1.00	699
579700	790697	1.40	700
579600	790697	1.20	701
579498	790696	1.70	702
579400	790698	4.50	703
579499	790800	4.50	704
579599	790803	4.50	705
579700	790797	4.50	706
579800	790802	4.50	707
579899	790800	4.50	708
579999	790800	4.50	709
580099	790801	4.50	710
580199	790798	4.50	711
580301	790798	4.50	712
580403	790800	4.50	713
580500	790801	3.60	714
580601	790800	3.70	715
580700	790798	3.20	716
580799	790800	4.50	717
580902	790800	1.50	718
581003	790800	4.00	719
581103	790798	1.00	720
581101	790897	1.80	721
581000	790901	0.10	722
580902	790900	0.80	723
580801	790896	0.70	724
580699	790898	1.60	725
580601	790898	4.50	726
580503	790898	4.50	727

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580405	790902	4.50	728
580304	790897	4.50	729
580202	790897	4.50	730
580102	790897	4.50	731
580003	790897	4.50	732
579899	790898	4.50	733
579798	790901	4.50	734
579702	790902	4.50	735
579602	790900	4.50	736
579501	790897	4.50	737
579599	791001	0.10	738
579699	790997	3.10	739
579802	791000	3.00	740
579898	790998	4.30	741
580004	791001	2.10	742
580104	790998	4.50	743
580201	790998	4.50	744
580301	791000	4.50	745
580401	791001	4.50	746
580498	790998	1.00	747
580601	791000	1.90	748
580700	791000	0.10	749
580600	791097	1.10	750
580497	791098	1.30	751
580403	791098	0.70	752
580301	791097	0.90	753
575424	790379	2.70	754
575424	790389	3.10	755
575424	790399	4.50	756
575424	790409	4.50	757
575424	790419	3.30	758
575424	790429	4.50	759
575424	790439	3.70	760
575424	790449	3.80	761
575424	790459	1.80	762
575424	790469	1.80	763
575424	790479	1.80	764
575434	790479	2.70	765
575434	790469	2.50	766
575434	790459	2.90	767
575434	790449	2.30	768
575434	790439	0.30	769
575434	790429	1.90	770
575434	790419	2.30	771
575434	790409	2.70	772
575434	790399	2.50	773

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575434	790389	2.60	774
575434	790379	2.50	775
575444	790379	2.30	776
575444	790389	3.00	777
575444	790399	2.70	778
575444	790409	2.70	779
575444	790419	2.90	780
575444	790429	2.20	781
575444	790439	2.60	782
575444	790449	3.10	783
575444	790459	2.40	784
575444	790469	2.00	785
575444	790479	2.00	786
575454	790479	1.80	787
575454	790469	1.00	788
575454	790459	2.10	789
575454	790449	1.80	790
575454	790439	2.00	791
575454	790429	2.30	792
575454	790419	2.50	793
575454	790409	2.50	794
575454	790399	2.50	795
575454	790389	2.60	796
575454	790379	2.10	797
575464	790379	3.30	798
575464	790389	2.90	799
575464	790399	3.00	800
575464	790409	2.70	801
575464	790419	2.60	802
575464	790429	2.50	803
575464	790439	2.90	804
575464	790449	2.20	805
575464	790459	1.00	806
575464	790469	1.60	807
575464	790479	1.80	808
575474	790479	2.10	809
575474	790469	1.70	810
575474	790459	2.10	811
575474	790449	2.00	812
575474	790439	2.00	813
575474	790429	2.40	814
575474	790419	2.00	815
575474	790409	3.60	816
575474	790399	3.80	817
575474	790389	4.50	818
575474	790379	4.50	819

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575484	790379	4.60	820
575484	790389	4.20	821
575484	790399	4.40	822
575484	790409	4.50	823
575484	790419	4.50	824
575484	790429	3.60	825
575484	790439	2.00	826
575484	790449	3.80	827
575484	790459	3.00	828
575484	790469	2.70	829
575484	790479	2.80	830
575494	790479	2.30	831
575494	790469	1.40	832
575494	790459	2.60	833
575494	790449	2.70	834
575494	790439	2.30	835
575494	790429	3.90	836
575494	790419	3.90	837
575494	790409	4.50	838
575494	790399	4.40	839
575494	790389	3.00	840
575494	790379	3.90	841
575504	790379	1.80	842
575504	790389	3.10	843
575504	790399	2.80	844
575504	790409	1.90	845
575504	790419	2.80	846
575504	790429	2.60	847
575504	790439	1.90	848
575504	790449	2.10	849
575504	790459	2.70	850
575504	790469	3.00	851
575504	790479	2.70	852
575514	790479	2.90	853
575514	790469	4.50	854
575514	790459	2.60	855
575514	790449	1.80	856
575514	790439	2.00	857
575514	790429	1.80	858
575514	790419	2.70	859
575514	790409	1.60	860
575514	790399	2.30	861
575514	790389	3.30	862
575514	790379	2.40	863
575524	790379	0.60	864
575524	790389	1.80	865

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575524	790399	2.80	866
575524	790409	2.50	867
575524	790419	2.40	868
575524	790429	3.00	869
575524	790439	2.20	870
575524	790449	2.10	871
575524	790459	1.60	872
575524	790469	4.50	873
575524	790479	4.00	874
575728	789847	4.50	875
575728	789857	4.50	876
575728	789867	4.50	877
575728	789877	4.50	878
575728	789887	4.50	879
575728	789897	4.50	880
575728	789907	4.50	881
575728	789917	4.50	882
575728	789927	4.50	883
575728	789937	4.50	884
575728	789947	4.50	885
575738	789947	4.50	886
575738	789937	4.50	887
575738	789927	4.50	888
575738	789917	4.50	889
575738	789907	4.50	890
575738	789897	4.50	891
575738	789887	4.50	892
575738	789877	4.50	893
575738	789867	4.50	894
575738	789857	4.50	895
575738	789847	4.50	896
575748	789847	4.50	897
575748	789857	4.50	898
575748	789867	4.50	899
575748	789877	4.50	900
575748	789887	4.50	901
575748	789897	4.50	902
575748	789907	4.50	903
575748	789917	4.50	904
575748	789927	4.50	905
575748	789937	4.50	906
575748	789947	4.50	907
575758	789947	4.50	908
575758	789937	4.50	909
575758	789927	4.50	910
575758	789917	4.50	911

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575758	789907	4.50	912
575758	789897	4.50	913
575758	789887	4.50	914
575758	789877	4.50	915
575758	789867	4.50	916
575758	789857	4.50	917
575758	789847	4.50	918
575768	789847	3.80	919
575768	789857	3.90	920
575768	789867	4.50	921
575768	789877	4.50	922
575768	789887	4.50	923
575768	789897	4.50	924
575768	789907	4.50	925
575768	789917	4.50	926
575768	789927	4.50	927
575768	789937	4.50	928
575768	789947	4.50	929
575778	789947	4.50	930
575778	789937	4.50	931
575778	789927	4.50	932
575778	789917	4.50	933
575778	789907	4.50	934
575778	789897	4.50	935
575778	789887	4.50	936
575778	789877	4.50	937
575778	789867	4.50	938
575778	789857	3.90	939
575778	789847	3.60	940
575788	789847	3.60	941
575788	789857	4.10	942
575788	789867	3.90	943
575788	789877	4.50	944
575788	789887	4.50	945
575788	789897	4.50	946
575788	789907	4.50	947
575788	789917	4.50	948
575788	789927	4.50	949
575788	789937	4.50	950
575788	789947	4.50	951
575798	789947	4.50	952
575798	789937	4.50	953
575798	789927	4.50	954
575798	789917	4.50	955
575798	789907	4.50	956
575798	789897	3.60	957

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575798	789887	3.20	958
575798	789877	4.50	959
575798	789867	2.80	960
575798	789857	2.70	961
575798	789847	2.00	962
575808	789847	0.70	963
575808	789857	1.80	964
575808	789867	1.00	965
575808	789877	1.20	966
575808	789887	0.90	967
575808	789897	0.90	968
575808	789907	0.70	969
575808	789917	0.60	970
575808	789927	3.30	971
575808	789937	3.30	972
575808	789947	4.50	973
575818	789947	4.50	974
575818	789937	4.50	975
575818	789927	3.80	976
575818	789917	3.00	977
575818	789907	2.70	978
575818	789897	2.70	979
575818	789887	2.40	980
575818	789877	0.60	981
575818	789867	0.90	982
575818	789857	0.90	983
575818	789847	0.90	984
575828	789847	0.80	985
575828	789857	1.80	986
575828	789867	1.10	987
575828	789877	1.20	988
575828	789887	0.70	989
575828	789897	2.00	990
575828	789907	1.10	991
575828	789917	2.40	992
575828	789927	3.60	993
575828	789937	4.50	994
575828	789947	4.50	995
576621	788898	0.20	996
576621	788908	0.10	997
576621	788918	0.10	998
576621	788928	0.10	999
576621	788938	0.10	1000
576621	788948	0.20	1001
576621	788958	0.10	1002
576621	788968	0.10	1003

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576621	788978	0.10	1004
576631	788978	0.10	1009
576631	788968	0.10	1010
576631	788958	0.10	1011
576631	788948	0.10	1012
576631	788938	0.10	1013
576631	788928	0.10	1014
576631	788918	0.10	1015
576631	788908	0.10	1016
576631	788898	0.20	1017
576641	788898	0.10	1018
576641	788908	0.10	1019
576641	788918	0.10	1020
576641	788928	0.20	1021
576641	788938	0.10	1022
576641	788948	0.10	1023
576641	788958	0.10	1024
576641	788968	0.10	1025
576641	788978	0.10	1026
576651	788978	0.10	1031
576651	788968	0.10	1032
576651	788958	0.10	1033
576651	788948	0.10	1034
576651	788938	0.10	1035
576651	788928	0.10	1036
576651	788918	0.10	1037
576651	788908	0.10	1038
576651	788898	0.10	1039
576661	788898	0.10	1040
576661	788908	0.10	1041
576661	788918	0.10	1042
576661	788928	0.10	1043
576661	788938	0.10	1044
576661	788948	0.10	1045
576661	788958	0.10	1046
576661	788968	0.10	1047
576661	788978	0.10	1048
576671	788968	0.10	1054
576671	788958	0.10	1055
576671	788948	0.20	1056
576671	788938	0.10	1057
576671	788928	0.10	1058
576671	788918	0.10	1059
576671	788908	0.20	1060
576671	788898	0.10	1061
576681	788898	0.10	1062

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576681	788908	0.10	1063
576681	788918	0.10	1064
576681	788928	0.10	1065
576681	788938	0.10	1066
576681	788948	0.10	1067
576681	788958	0.20	1068
576681	788968	0.10	1069
576691	788968	0.10	1076
576691	788958	0.10	1077
576691	788948	0.20	1078
576691	788938	0.10	1079
576691	788928	0.10	1080
576691	788918	0.10	1081
576691	788908	0.10	1082
576691	788898	0.10	1083
576701	788898	0.10	1084
576701	788908	0.10	1085
576701	788918	0.10	1086
576701	788928	0.10	1087
576701	788938	0.10	1088
576701	788948	0.10	1089
576701	788958	0.10	1090
576701	788968	0.10	1091
576711	788978	0.10	1097
576711	788968	0.10	1098
576711	788958	0.10	1099
576711	788948	0.10	1100
576711	788938	0.10	1101
576711	788928	0.10	1102
576711	788918	0.10	1103
576711	788908	0.10	1104
576711	788898	0.10	1105
576721	788898	0.10	1106
576721	788908	0.10	1107
576721	788918	0.20	1108
576721	788928	0.10	1109
576721	788938	0.10	1110
576721	788948	0.10	1111
576721	788958	0.10	1112
576721	788968	0.10	1113
579770	790619	0.60	1118
579770	790629	0.90	1119
579770	790639	0.10	1120
579770	790649	0.80	1121
579770	790659	0.90	1122
579770	790669	1.80	1123

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579770	790679	2.70	1124
579770	790689	1.80	1125
579770	790699	1.80	1126
579770	790709	1.40	1127
579780	790709	0.70	1128
579780	790699	1.80	1129
579780	790689	2.50	1130
579780	790679	1.80	1131
579780	790669	1.90	1132
579780	790659	0.60	1133
579780	790649	1.70	1134
579780	790639	0.10	1135
579780	790629	1.00	1136
579780	790619	0.90	1137
579780	790609	0.60	1138
579790	790609	0.40	1139
579790	790619	0.50	1140
579790	790629	1.10	1141
579790	790639	0.10	1142
579790	790649	1.70	1143
579790	790659	1.80	1144
579790	790669	0.90	1145
579790	790679	0.90	1146
579790	790689	1.60	1147
579790	790699	1.90	1148
579790	790709	0.90	1149
579800	790709	1.70	1150
579800	790699	1.40	1151
579800	790689	2.70	1152
579800	790679	1.90	1153
579800	790669	1.30	1154
579800	790659	1.60	1155
579800	790649	0.70	1156
579800	790639	0.10	1157
579800	790629	0.60	1158
579800	790619	0.50	1159
579800	790609	0.50	1160
579810	790609	0.40	1161
579810	790619	0.40	1162
579810	790629	0.50	1163
579810	790639	0.10	1164
579810	790649	1.70	1165
579810	790659	2.00	1166
579810	790669	0.90	1167
579810	790679	2.10	1168
579810	790689	2.80	1169

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579810	790699	1.90	1170
579810	790709	1.00	1171
579820	790709	0.90	1172
579820	790699	2.40	1173
579820	790689	1.90	1174
579820	790679	2.00	1175
579820	790669	1.90	1176
579820	790659	0.90	1177
579820	790649	1.50	1178
579820	790639	0.10	1179
579820	790629	0.70	1180
579820	790619	0.80	1181
579820	790609	0.60	1182
579830	790609	0.10	1183
579830	790619	0.10	1184
579830	790629	0.10	1185
579830	790639	0.30	1186
579830	790649	0.40	1187
579830	790659	1.30	1188
579830	790669	2.20	1189
579830	790679	1.00	1190
579830	790689	1.60	1191
579830	790699	1.50	1192
579830	790709	1.10	1193
579840	790709	0.90	1194
579840	790699	2.70	1195
579840	790689	2.50	1196
579840	790679	1.00	1197
579840	790669	0.50	1198
579840	790659	1.00	1199
579840	790649	0.30	1200
579840	790639	0.10	1201
579840	790629	0.50	1202
579840	790619	1.00	1203
579840	790609	1.80	1204
579850	790609	1.40	1205
579850	790619	0.50	1206
579850	790629	0.60	1207
579850	790639	0.10	1208
579850	790649	0.10	1209
579850	790659	0.90	1210
579850	790669	1.90	1211
579850	790679	0.90	1212
579850	790689	2.10	1213
579850	790699	0.90	1214
579850	790709	1.30	1215

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579860	790709	1.30	1216
579860	790699	1.00	1217
579860	790689	1.80	1218
579860	790679	0.90	1219
579860	790669	1.70	1220
579860	790659	0.90	1221
579860	790649	1.60	1222
579860	790639	0.10	1223
579860	790629	0.60	1224
579860	790619	0.70	1225
579860	790609	1.30	1226
579870	790609	1.20	1227
579870	790619	0.90	1228
579870	790629	1.00	1229
579870	790639	0.10	1230
579870	790649	0.60	1231
579870	790659	1.90	1232
579870	790669	2.10	1233
579870	790679	2.50	1234
579870	790689	1.30	1235
579870	790699	2.10	1236
579870	790709	2.00	1237
580245	790591	0.10	1241
580245	790601	0.10	1242
580245	790611	0.10	1243
580245	790621	0.70	1244
580245	790631	0.70	1245
580245	790641	0.90	1246
580245	790651	0.90	1247
580245	790661	0.30	1248
580255	790661	0.90	1249
580255	790651	0.90	1250
580255	790641	0.80	1251
580255	790631	1.00	1252
580255	790621	0.10	1253
580255	790611	0.60	1254
580255	790601	0.10	1255
580255	790591	0.10	1256
580255	790581	0.10	1257
580265	790591	0.10	1263
580265	790601	0.10	1264
580265	790611	0.90	1265
580265	790621	0.20	1266
580265	790631	0.70	1267
580265	790641	0.70	1268
580265	790651	0.30	1269

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580265	790661	0.90	1270
580275	790661	0.70	1271
580275	790651	0.90	1272
580275	790641	0.50	1273
580275	790631	0.20	1274
580275	790621	0.10	1275
580275	790611	0.60	1276
580275	790601	0.10	1277
580275	790591	0.10	1278
580285	790591	0.10	1285
580285	790601	0.10	1286
580285	790611	0.90	1287
580285	790621	0.90	1288
580285	790631	1.00	1289
580285	790641	0.90	1290
580285	790651	0.10	1291
580285	790661	0.30	1292
580295	790661	0.90	1293
580295	790651	0.80	1294
580295	790641	0.90	1295
580295	790631	0.90	1296
580295	790621	0.60	1297
580295	790611	0.50	1298
580295	790601	0.10	1299
580295	790591	0.10	1300
580305	790581	0.40	1306
580305	790591	0.10	1307
580305	790601	0.50	1308
580305	790611	1.40	1309
580305	790621	1.30	1310
580305	790631	1.00	1311
580305	790641	0.90	1312
580305	790651	0.80	1313
580305	790661	0.90	1314
580315	790661	1.80	1315
580315	790651	2.00	1316
580315	790641	1.50	1317
580315	790631	1.40	1318
580315	790621	1.30	1319
580315	790611	1.70	1320
580315	790591	0.10	1322
580315	790581	0.40	1323
580325	790581	0.50	1328
580325	790591	0.10	1329
580325	790611	1.90	1331
580325	790621	1.80	1332

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580325	790631	1.90	1333
580325	790641	1.80	1334
580325	790651	1.80	1335
580325	790661	2.00	1336
580335	790661	1.60	1337
580335	790651	2.20	1338
580335	790641	1.80	1339
580335	790631	1.90	1340
580335	790621	1.70	1341
580335	790611	1.90	1342
580335	790591	0.10	1344
580335	790581	0.40	1345
580345	790581	0.80	1350
580345	790591	0.10	1351
580345	790611	1.00	1353
580345	790621	2.00	1354
580345	790631	0.80	1355
580345	790641	1.80	1356
580345	790651	1.00	1357
580345	790661	1.70	1358
579477	790684	1.80	1359
579478	790692	1.40	1360
579475	790672	1.90	1361
579510	790688	1.90	1362
579507	790694	1.20	1363
579508	790678	2.10	1364
579536	790690	1.60	1365
579537	790698	1.80	1366
579535	790678	1.40	1367
579563	790686	1.20	1368
579564	790695	0.90	1369
579566	790679	1.30	1370
579587	790693	1.30	1371
579591	790702	1.30	1372
579584	790691	1.40	1373
579611	790698	1.20	1374
579610	790706	0.60	1375
579609	790693	0.80	1376
579633	790698	1.40	1377
579635	790708	0.70	1378
579630	790691	0.10	1379
579658	790688	0.10	1380
579659	790700	0.10	1381
579654	790684	0.10	1382
579682	790677	2.00	1383
579683	790690	0.60	1384

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579681	790669	0.90	1385
579709	790660	0.80	1386
579710	790667	1.00	1387
579707	790653	0.10	1388
579736	790649	0.90	1389
579737	790661	0.30	1390
579736	790645	0.10	1391
579763	790645	1.00	1392
579763	790658	1.00	1393
579765	790641	0.90	1394
579757	790644	1.10	1395
579759	790640	0.90	1396
579733	790643	1.30	1397
579787	790639	0.10	1398
579823	790640	0.60	1399
579818	790641	0.10	1400
579851	790640	0.10	1401
579851	790639	0.70	1402
579880	790635	1.20	1403
579874	790639	0.10	1404
579905	790632	0.30	1405
579896	790633	0.40	1406
579937	790628	0.70	1407
579932	790628	0.10	1408
579971	790624	0.70	1409
579969	790621	0.30	1410
580001	790621	0.10	1411
579997	790619	0.60	1412
580027	790611	0.10	1413
580021	790608	0.50	1414
580051	790595	0.10	1415
580043	790596	0.10	1416
580076	790583	0.10	1417
580072	790584	0.90	1418
580102	790583	0.10	1419
580097	790582	0.10	1420
580125	790586	1.20	1421
580122	790581	1.30	1422
580151	790586	0.70	1423
580152	790583	1.60	1424
580175	790586	0.10	1425
580172	790585	0.10	1426
580202	790587	0.50	1427
580199	790585	0.90	1428
580226	790588	0.10	1429
580226	790583	1.00	1430

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580252	790589	0.10	1431
580250	790586	0.10	1432
580277	790590	0.10	1433
580276	790581	0.20	1434
580301	790590	0.10	1435
580299	790585	1.00	1436
580326	790590	0.10	1437
580320	790589	1.00	1438
580353	790590	0.10	1439
580353	790587	0.10	1440
580378	790592	1.00	1441
580373	790592	0.90	1442
580403	790596	0.60	1443
580399	790592	0.10	1444
580428	790594	0.10	1445
580426	790586	0.10	1446
580453	790597	0.40	1447
580449	790593	0.10	1448
580479	790599	0.80	1449
580473	790596	0.10	1450
580503	790598	0.10	1451
580490	790600	0.10	1452
580443	790602	0.10	1453
580452	790625	0.10	1454
580468	790602	0.10	1455
580475	790606	0.10	1456
580479	790623	0.10	1457
580476	790596	0.10	1458
580501	790608	0.60	1459
580505	790626	0.60	1460
580500	790598	0.10	1461
580526	790614	0.40	1462
580526	790627	0.30	1463
580527	790606	0.20	1464
580551	790614	0.70	1465
580547	790627	1.10	1466
580552	790607	0.50	1467
580575	790607	0.10	1468
580577	790615	0.80	1469
580575	790600	0.10	1470
580599	790604	0.50	1471
580601	790614	0.30	1472
580596	790598	0.10	1473
580628	790597	0.10	1474
580628	790599	0.30	1475
580652	790593	0.20	1476

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580652	790597	1.00	1477
580677	790586	0.90	1478
580676	790591	1.40	1479
580702	790588	0.60	1480
580699	790584	0.10	1481
580725	790580	1.10	1482
580727	790591	0.10	1483
580753	790578	0.20	1484
580754	790583	1.10	1485
580780	790575	0.90	1486
580785	790577	1.20	1487
580806	790581	1.80	1488
580802	790582	1.00	1489
580827	790580	0.80	1490
580824	790579	0.90	1491
580854	790584	0.40	1492
580857	790585	0.60	1493
580877	790594	0.50	1494
580879	790588	0.80	1495
580906	790593	0.10	1496
580907	790593	0.10	1497
580932	790309	1.30	1498
580934	790308	1.50	1499
580923	790319	1.60	1500
580910	790290	2.60	1501
580912	790282	0.90	1502
580909	790299	1.80	1503
580891	790262	0.70	1504
580896	790257	1.50	1505
580884	790272	0.60	1506
580874	790242	0.90	1507
580881	790238	1.00	1508
580870	790245	1.00	1509
580847	790216	0.40	1510
580844	790222	0.30	1511
580824	790198	0.10	1512
580822	790211	0.40	1513
580798	790198	0.10	1514
580802	790202	0.50	1515
580774	790200	0.10	1516
580776	790206	0.20	1517
580747	790197	0.30	1518
580747	790205	0.50	1519
580722	790195	0.30	1520
580723	790203	0.60	1521
580698	790194	0.20	1522

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580698	790199	0.90	1523
580672	790194	0.30	1524
580674	790199	0.30	1525
580649	790192	0.60	1526
580648	790198	0.40	1527
580622	790190	0.20	1528
580621	790199	0.40	1529
580597	790193	0.10	1530
580596	790204	0.50	1531
580571	790189	0.10	1532
580574	790197	0.30	1533
580548	790184	0.10	1534
580546	790194	0.10	1535
580520	790170	0.70	1536
580527	790162	0.00	1537
580512	790179	0.30	1538
580496	790160	0.40	1539
580498	790153	0.30	1540
580489	790172	0.40	1541
580479	790152	0.40	1542
580482	790142	0.30	1543
580475	790161	0.40	1544
580453	790138	0.10	1545
580457	790132	0.60	1546
580443	790149	0.20	1547
580427	790122	0.10	1548
580439	790116	0.30	1549
580414	790131	0.20	1550
580813	790162	0.10	1551
580805	790165	0.10	1552
580815	790135	0.40	1553
580808	790134	0.50	1554
580823	790108	0.30	1555
580815	790106	0.20	1556
580836	790086	0.30	1557
580826	790084	0.30	1558
580847	790064	0.50	1559
580841	790062	0.30	1560
580861	790042	0.10	1561
580853	790038	0.10	1562
580875	790018	0.30	1563
580869	790015	0.50	1564
580887	789999	0.40	1565
580879	789995	0.70	1566
580208	789372	0.10	1567
580198	789374	0.10	1568

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
580213	789360	0.10	1569
580207	789396	0.10	1570
580219	789392	0.20	1571
580205	789426	0.10	1572
580213	789426	0.40	1573
580207	789454	0.10	1574
580197	789461	0.30	1575
580217	789456	0.40	1576
580209	789474	0.20	1577
580215	789473	0.10	1578
580201	789501	0.50	1579
580193	789506	0.10	1580
580210	789500	0.40	1581
580201	789525	0.90	1582
580191	789527	0.40	1583
580206	789528	0.80	1584
580201	789556	0.80	1585
580189	789556	0.20	1586
580209	789556	0.90	1587
580203	789575	1.10	1588
580200	789579	2.30	1589
580206	789580	1.30	1590
580200	789621	3.00	1591
580194	789622	2.70	1592
580203	789607	1.50	1593
576165	789329	0.90	1594
576156	789331	0.10	1595
576171	789322	0.30	1596
576178	789351	2.50	1597
576164	789357	2.40	1598
576182	789343	1.80	1599
576184	789375	2.50	1600
576175	789377	2.50	1601
576196	789367	1.80	1602
576198	789400	2.30	1603
576189	789406	2.80	1604
576207	789397	2.70	1605
576206	789419	1.60	1606
576192	789424	2.40	1607
576218	789414	1.00	1608
577218	787963	0.10	1609
577220	787963	0.50	1610
577224	787991	0.10	1611
577228	787990	0.30	1612
577231	788024	0.10	1613
577236	788022	0.10	1614

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577232	788053	0.10	1615
577236	788056	0.10	1616
577232	788084	0.20	1617
577236	788084	0.10	1618
577230	788115	0.20	1619
577235	788116	0.30	1620
577226	788140	0.40	1621
577232	788139	0.20	1622
577225	788166	0.10	1623
577232	788166	0.30	1624
577226	788199	0.30	1625
577231	788198	0.30	1626
577223	788259	0.10	1627
577227	788257	0.30	1628
577218	788286	0.10	1629
577218	788291	0.10	1630
577189	788288	0.10	1631
577191	788294	0.10	1632
577159	788290	0.10	1633
577159	788294	0.10	1634
577133	788291	0.10	1635
577133	788295	0.40	1636
577101	788295	0.10	1637
577109	788299	0.10	1638
577099	788325	0.30	1639
577103	788327	0.40	1640
577098	788353	0.20	1641
577102	788355	0.40	1642
577096	788383	0.10	1643
577099	788385	0.10	1644
577088	788412	0.10	1645
577095	788417	0.10	1646
577074	788434	0.10	1647
577079	788437	0.10	1648
577060	788451	0.20	1649
577065	788454	0.10	1650
577043	788469	0.10	1651
577047	788475	0.10	1652
577029	788488	0.10	1653
577033	788492	0.20	1654
577011	788507	0.10	1655
577016	788511	0.10	1656
577995	788522	0.30	1657
577998	788530	0.10	1658
577979	788545	0.10	1659
577982	788548	0.10	1660

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576963	788565	0.10	1661
576969	788569	0.10	1662
576948	788584	0.10	1663
576952	788587	0.10	1664
576931	788603	0.10	1665
576936	788605	0.70	1666
576913	788622	0.10	1667
576917	788624	0.10	1668
576898	788642	0.30	1669
576902	788645	0.40	1670
576881	788659	0.10	1671
576886	788662	2.90	1672
576865	788679	0.10	1673
576871	788683	2.30	1674
576848	788700	0.10	1675
576852	788704	0.30	1676
576834	788717	0.10	1677
576840	788721	0.10	1678
576816	788737	0.10	1679
576820	788742	0.10	1680
576800	788755	0.10	1681
576805	788760	0.20	1682
576786	788776	0.10	1683
576790	788777	0.10	1684
576770	788795	0.10	1685
576775	788797	0.40	1686
576754	788816	0.10	1687
576759	788818	0.10	1688
576734	788838	0.10	1689
576742	788841	0.10	1690
576763	788861	0.10	1691
576766	788859	0.10	1692
576788	788879	0.10	1693
576790	788875	0.10	1694
576812	788891	0.10	1695
576815	788887	0.10	1696
576836	788901	0.10	1697
576838	788897	0.10	1698
576856	788913	0.10	1699
576857	788908	0.10	1700
576880	788921	0.50	1701
576882	788918	0.10	1702
576903	788929	0.30	1703
576903	788925	0.10	1704
576928	788935	0.40	1705
576929	788934	0.10	1706

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576951	788942	0.10	1707
576957	788939	0.40	1708
576976	788950	0.30	1709
576980	788948	0.70	1710
576997	788957	0.40	1711
576998	788963	0.10	1712
577003	788947	0.10	1713
577017	788967	0.80	1714
577027	788976	1.20	1715
577039	788983	0.90	1717
577044	788982	1.20	1718
577049	788969	0.80	1719
577072	788989	1.40	1720
577071	788999	1.50	1721
577077	788980	1.40	1722
577088	788989	1.30	1723
577088	789000	1.60	1724
577094	788985	1.10	1725
577111	788997	1.20	1726
577110	789001	0.90	1727
577111	788981	1.10	1728
576719	788860	0.70	1729
576711	788855	0.10	1730
576730	788865	0.10	1731
576711	788877	0.40	1732
576702	788875	0.10	1733
576720	788882	0.10	1734
576693	788900	0.20	1735
576679	788891	0.50	1736
576697	788908	0.10	1737
576673	788918	0.10	1738
576665	788917	0.10	1739
576679	788925	0.10	1740
576656	788935	0.10	1741
576648	788931	0.80	1742
576660	788943	0.20	1743
576634	788949	0.30	1744
576628	788943	0.20	1745
576636	788957	0.20	1746
576617	788967	0.20	1747
576614	788960	0.10	1748
576616	788976	0.20	1749
576593	788983	0.10	1750
576586	788975	0.40	1751
576596	788986	0.10	1752
576574	789001	0.20	1753

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576568	788996	0.20	1754
576341	789160	0.20	1755
576326	789157	0.10	1756
576337	789170	0.10	1757
576311	789178	0.40	1758
576314	789172	0.40	1759
576317	789182	0.30	1760
576284	789199	0.10	1761
576284	789190	0.30	1762
576284	789198	0.10	1763
576267	789211	0.30	1764
576263	789207	0.20	1765
576269	789218	0.10	1766
576240	789229	0.80	1767
576237	789224	0.10	1768
576221	789245	0.20	1769
576222	789231	0.20	1770
576224	789250	0.30	1771
576204	789251	0.30	1772
576199	789249	0.20	1773
576204	789256	0.20	1774
576193	789260	0.10	1775
576189	789256	0.10	1776
576194	789272	0.10	1777
577224	788229	0.20	1778
577229	788226	0.20	1779
574600	789808	0.20	1781
574593	789812	0.10	1782
574608	789802	0.10	1783
574620	789828	0.10	1784
574612	789833	0.10	1785
574628	789821	0.10	1786
574642	789850	0.10	1787
574636	789857	0.20	1788
574648	789844	0.10	1789
574667	789873	0.10	1790
574659	789880	0.10	1791
574673	789868	0.10	1792
574693	789893	0.10	1793
574685	789900	0.10	1794
574699	789886	0.10	1795
574722	789902	0.10	1796
574726	789908	0.20	1797
574719	789981	0.10	1798
574748	789885	0.10	1799
574757	789891	0.10	1800

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
574747	789877	0.10	1801
574780	789862	0.10	1802
574784	789869	0.10	1803
574774	789856	0.10	1804
574803	789837	0.10	1805
574809	789842	0.10	1806
574796	789829	0.10	1807
574833	789815	0.10	1808
574839	789819	0.10	1809
574828	789806	0.10	1810
574863	789793	0.10	1811
574867	789800	0.20	1812
574854	789786	0.10	1813
574881	789774	0.10	1814
574887	789777	0.20	1815
574872	789767	0.20	1816
574902	789756	0.20	1817
574910	789761	0.10	1818
574897	789749	0.10	1819
574918	789743	0.10	1820
574925	789748	0.10	1821
574912	789736	0.10	1822
574929	789731	0.10	1823
574932	789730	0.10	1824
574922	789725	0.10	1825
574947	789712	0.10	1826
574942	789722	0.20	1827
574945	789711	0.30	1828
574966	789717	0.40	1829
574972	789720	0.10	1830
574994	789713	0.40	1832
574989	789719	0.10	1833
574988	789714	0.30	1834
575015	789724	1.50	1835
575015	789729	1.70	1836
575026	789729	1.50	1837
575041	789737	0.40	1838
575039	789749	1.80	1839
575050	789740	1.00	1840
575060	789755	1.50	1841
575060	789756	0.60	1842
575071	789754	0.30	1843
575090	789772	2.40	1844
575084	789776	1.10	1845
575095	789766	0.60	1846
575108	789792	1.90	1847

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575106	789805	0.40	1848
575118	789807	2.70	1849
575124	789822	0.90	1850
575118	789826	1.10	1851
575125	789817	1.20	1852
575130	789853	2.80	1853
575125	789853	0.80	1854
575136	789854	0.30	1855
575142	789880	2.80	1856
575137	789879	2.70	1857
575147	789880	2.30	1858
575141	789913	2.10	1859
575138	789911	2.10	1860
575156	789908	2.70	1861
576328	790316	1.30	1863
576327	790312	0.20	1864
576353	790315	0.10	1865
576350	790308	0.20	1866
576371	790309	0.70	1867
576369	790299	0.30	1868
576396	790293	1.80	1869
576393	790289	0.30	1870
576419	790285	0.50	1871
576419	790281	0.40	1872
576441	790272	0.80	1873
576439	790262	0.70	1874
576465	790263	0.20	1875
576463	790258	0.10	1876
576488	790254	0.30	1877
576486	790250	0.30	1878
576511	790248	0.40	1879
576508	790245	0.30	1880
576548	790246	0.10	1881
576534	790246	0.20	1882
576571	790239	0.30	1883
576569	790232	0.20	1884
576592	790210	0.20	1885
576593	790205	0.10	1886
576620	790197	0.30	1887
576620	790189	0.20	1888
576650	790183	0.20	1889
576648	790176	0.10	1890
576676	790175	0.10	1891
576674	790173	0.10	1892
576701	790162	0.10	1893
576700	790157	0.20	1894

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576733	790154	0.10	1895
576730	790150	0.10	1896
576766	790146	0.10	1897
576763	790141	0.20	1898
577314	789953	0.30	1899
577314	789950	0.10	1900
577348	789956	0.10	1901
577348	789951	0.10	1902
577379	789957	0.10	1903
577379	789949	0.10	1904
577409	789957	0.20	1905
577410	789950	0.10	1906
577441	789965	0.10	1907
577441	789958	0.10	1908
577471	789967	0.30	1909
577472	789960	0.10	1910
577505	789968	0.60	1911
577503	789963	0.40	1912
577535	789968	0.10	1913
577537	789963	0.20	1914
577568	789970	0.10	1915
577568	789965	0.10	1916
577596	789974	0.30	1917
577596	789969	0.10	1918
577628	789979	0.10	1919
577628	789973	0.10	1920
577661	789980	0.20	1921
577660	789973	0.40	1922
577692	789978	0.30	1923
577691	789974	0.10	1924
577722	789983	0.30	1925
577723	789976	0.10	1926
577752	789985	2.70	1927
577752	789977	2.80	1928
577781	789991	0.30	1929
577779	789981	0.10	1930
577808	789993	0.40	1931
577808	789985	1.90	1932
577838	789994	0.60	1933
577839	789985	0.20	1934
577869	789994	0.60	1935
577868	789989	0.40	1936
577900	789995	0.40	1937
577901	789991	2.40	1938
577930	790000	0.40	1939
577930	789993	1.80	1940

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577959	790002	0.30	1941
577961	789995	0.50	1942
577988	790004	0.10	1943
577988	789998	1.50	1944
578017	790004	0.20	1945
578019	790000	0.30	1946
578048	790007	0.30	1947
578048	790000	1.90	1948
578079	790007	0.10	1949
578079	790002	0.10	1950
578108	790011	0.30	1951
578108	790004	0.10	1952
578139	790012	0.50	1953
578140	790007	0.30	1954
578167	790017	0.10	1955
578168	790009	0.10	1956
578198	790020	1.60	1957
578198	790014	0.10	1958
578228	790022	0.10	1959
578227	790018	0.10	1960
578258	790021	0.20	1961
578258	790017	0.10	1962
578291	790024	0.30	1963
578291	790019	0.20	1964
578321	790026	0.30	1965
578320	790020	0.10	1966
578353	790029	0.10	1967
578352	790020	0.10	1968
578384	790033	0.10	1969
578384	790026	0.10	1970
575479	790653	0.10	1972
575472	790647	1.40	1973
575497	790649	0.10	1974
575492	790642	0.50	1975
575511	790637	0.20	1976
575509	790632	0.10	1977
575535	790630	0.10	1978
575530	790623	0.10	1979
575560	790621	0.10	1980
575556	790611	0.70	1981
575583	790612	0.30	1982
575582	790606	0.10	1983
575610	790599	0.40	1984
575608	790596	0.40	1985
575634	790589	0.20	1986
575635	790581	0.70	1987

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575659	790579	0.10	1988
575656	790575	0.10	1989
575686	790569	0.20	1991
575683	790564	0.10	1992
575711	790560	0.70	1993
575710	790554	0.20	1994
575735	790544	0.20	1995
575738	790548	0.30	1996
575762	790540	0.40	1997
575763	790531	0.30	1998
575787	790528	0.40	1999
575783	790523	0.10	2000
575813	790518	0.30	2001
575812	790510	0.10	2002
575839	790510	0.50	2003
575838	790503	0.90	2004
575865	790497	0.70	2005
575866	790491	0.20	2006
575894	790490	0.70	2007
575812	790484	0.20	2008
576791	790135	0.10	2010
576791	790130	0.30	2011
576822	790124	0.10	2012
576820	790121	0.10	2013
576849	790112	0.30	2014
576848	790109	0.50	2015
576880	790101	0.10	2016
576878	790097	0.20	2017
576911	790090	0.10	2018
576910	790085	0.10	2019
576941	790077	0.10	2020
576939	790074	0.10	2021
576972	790069	0.30	2022
576971	790065	0.40	2023
577000	790052	0.10	2024
576999	790052	0.10	2025
577028	790044	0.20	2026
577028	790039	0.20	2027
577064	790036	0.30	2029
577061	790033	0.30	2030
577085	790020	0.20	2031
577085	790018	0.20	2032
577115	790016	0.30	2033
577112	790011	0.20	2034
577141	790000	0.10	2035
577138	789994	0.20	2036

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577166	789990	0.10	2037
577166	789983	0.10	2038
577196	789979	0.30	2039
577193	789976	0.10	2040
577225	789969	0.10	2041
577221	789960	0.10	2042
577252	789962	0.20	2043
577250	780956	0.10	2044
577284	780957	0.10	2045
577284	789951	0.10	2046
575947	790480	0.40	2048
575944	790475	0.60	2049
575941	790470	0.40	2050
575940	790463	0.20	2051
575964	790462	1.30	2052
575960	790455	2.00	2053
575984	790452	0.40	2054
575982	790445	0.30	2055
576006	790442	0.40	2056
576004	790437	0.70	2057
576031	790434	0.90	2058
576026	790429	0.50	2059
576054	790425	0.90	2060
576052	790419	0.30	2061
576075	790416	0.30	2062
576073	790409	0.10	2063
576102	790407	0.10	2064
576099	790402	0.20	2065
576127	790394	0.30	2067
576125	790386	0.10	2068
576151	790387	0.10	2069
576146	790379	0.10	2070
576176	790378	0.60	2071
576172	790372	0.40	2072
576201	790368	0.20	2073
576200	790362	0.30	2074
576221	790361	0.40	2075
576221	790357	0.20	2076
576241	790353	0.30	2077
576237	790343	2.30	2078
576264	790342	0.50	2079
576262	790332	0.40	2080
576286	790335	0.30	2081
576284	790330	0.10	2082
576305	790325	0.70	2083
576303	790319	0.10	2084

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
576328	790316	1.30	2086
576327	790312	0.20	2087
576353	790315	0.10	2088
576350	790308	0.20	2089
576371	790309	0.70	2090
576369	790299	0.30	2091
576396	790293	1.80	2092
576393	790289	0.30	2093
576419	790285	0.50	2094
576419	790281	0.40	2095
576441	790272	0.80	2096
576439	790262	0.70	2097
576465	790263	0.20	2098
576463	790258	0.10	2099
576488	790254	0.30	2100
576486	790250	0.30	2101
576511	790248	0.40	2102
576508	790245	0.30	2103
576548	790246	0.10	2104
576534	790246	0.20	2105
576571	790239	0.30	2106
576569	790232	0.20	2107
576592	790210	0.20	2108
576593	790205	0.10	2109
576620	790197	0.30	2110
576620	790189	0.20	2111
576650	790183	0.20	2112
576648	790176	0.10	2113
576676	790175	0.10	2114
576674	790173	0.10	2115
576701	790162	0.10	2116
576700	790157	0.20	2117
576733	790154	0.10	2118
576730	790150	0.10	2119
576766	790146	0.10	2120
576763	790141	0.20	2121
577314	789953	0.30	2122
577314	789950	0.10	2123
577348	789956	0.10	2124
577348	789951	0.10	2125
577379	789957	0.10	2126
577379	789949	0.10	2127
577409	789957	0.20	2128
577410	789950	0.10	2129
577441	789965	0.10	2130
577441	789958	0.10	2131

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
577471	789967	0.30	2132
577472	789960	0.10	2133
577505	789968	0.60	2134
577503	789963	0.40	2135
577535	789968	0.10	2136
577537	789963	0.20	2137
577568	789970	0.10	2138
577568	789965	0.10	2139
577596	789974	0.30	2140
577596	789969	0.10	2141
577628	789979	0.10	2142
577628	789973	0.10	2143
577661	789980	0.20	2144
577660	789973	0.40	2145
577692	789978	0.30	2146
577691	789974	0.10	2147
577722	789983	0.30	2148
577723	789976	0.10	2149
577752	789985	2.70	2150
577752	789977	2.80	2151
577781	789991	0.30	2152
577779	789981	0.10	2153
577808	789993	0.40	2154
577808	789985	1.90	2155
577838	789994	0.60	2156
577839	789985	0.20	2157
577869	789994	0.60	2158
577868	789989	0.40	2159
577900	789995	0.40	2160
577901	789991	2.40	2161
577930	790000	0.40	2162
577930	789993	1.80	2163
577959	790002	0.30	2164
577961	789995	0.50	2165
577988	790004	0.10	2166
577988	789998	1.50	2167
578017	790004	0.20	2168
578019	790000	0.30	2169
578048	790007	0.30	2170
578048	790000	1.90	2171
578079	790007	0.10	2172
578079	790002	0.10	2173
578108	790011	0.30	2174
578108	790004	0.10	2175
578139	790012	0.50	2176
578140	790007	0.30	2177

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
578167	790017	0.10	2178
578168	790009	0.10	2179
578198	790020	1.60	2180
578198	790014	0.10	2181
578228	790022	0.10	2182
578227	790018	0.10	2183
578258	790021	0.20	2184
578258	790017	0.10	2185
578291	790024	0.30	2186
578291	790019	0.20	2187
578321	790026	0.30	2188
578320	790020	0.10	2189
578353	790029	0.10	2190
578352	790020	0.10	2191
578384	790033	0.10	2192
578384	790026	0.10	2193
578416	790031	0.10	2195
578415	790026	0.20	2196
578442	790026	0.10	2197
578440	790018	0.30	2198
578468	790020	0.30	2199
578467	790015	0.10	2200
578495	790016	0.40	2201
578493	790009	0.20	2202
578524	790006	0.30	2203
578521	790004	0.40	2204
578551	790003	0.10	2205
578552	789995	0.10	2206
578581	789995	0.10	2207
578580	789988	0.10	2208
578611	789990	0.30	2209
578610	789983	0.40	2210
578638	789983	0.10	2211
578636	789976	0.50	2212
578668	789975	0.30	2214
578667	789969	0.10	2215
578697	789969	0.10	2216
578695	789964	0.30	2217
578725	789962	0.10	2218
578725	789956	0.10	2219
578754	789957	0.30	2220
578751	789950	0.10	2221
578782	789949	0.40	2222
578812	789941	0.20	2224
578841	789937	0.30	2226
578840	789931	0.40	2227

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
578869	789931	0.10	2228
578869	789924	0.10	2229
578898	789922	0.20	2230
578897	789918	0.20	2231
578925	789918	0.40	2233
578925	789910	0.20	2234
578955	789911	0.30	2235
578953	789905	0.10	2236
578982	789905	0.70	2237
578978	789897	0.10	2238
579007	789899	0.10	2239
579003	789892	0.40	2240
579030	789892	0.10	2241
579027	789885	0.10	2242
579054	789888	0.30	2243
579054	789880	0.10	2244
579074	789883	0.30	2245
579077	789876	0.70	2246
579103	789869	0.60	2247
579102	789864	0.40	2248
579124	789854	0.70	2249
579120	789852	0.10	2250
579144	789843	1.20	2252
579141	789837	1.00	2253
579167	789826	0.90	2254
579161	789824	0.10	2255
579184	789815	1.10	2256
579180	789809	0.10	2257
579205	789800	0.70	2258
579199	789797	0.10	2259
579221	789784	0.10	2261
579246	789774	0.20	2262
579241	789771	0.10	2263
579262	789764	0.10	2264
579261	789757	0.50	2265
579288	789745	0.10	2266
579284	789739	0.10	2267
579308	789730	0.10	2268
579331	789715	0.10	2271
579328	789712	0.10	2272
579356	789701	0.10	2273
579352	789696	0.20	2274
579380	789687	0.10	2275
579376	789682	0.40	2276
579404	789674	0.20	2277
579401	789671	0.10	2278

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579427	789660	0.10	2279
579426	789655	0.10	2280
579452	789647	0.90	2281
579449	789639	0.10	2282
579476	789635	0.10	2283
579472	789629	0.10	2284
579500	789620	0.30	2285
579496	789614	0.20	2286
579524	789604	0.40	2287
579520	789600	0.30	2288
579549	789592	0.60	2290
579545	789587	0.50	2291
579572	789579	0.50	2292
579569	789573	0.10	2293
579597	789565	0.30	2294
579595	789557	0.50	2295
579623	789547	0.40	2296
579621	789546	0.10	2297
579646	789535	0.50	2298
579642	789532	0.20	2299
579671	789522	0.80	2300
579669	789517	0.30	2301
579695	789509	0.70	2302
579694	789504	0.20	2303
579721	789491	0.10	2304
579718	789488	0.10	2305
579746	789479	0.10	2306
579742	789474	0.20	2307
579767	789467	0.10	2309
579764	789462	0.10	2310
579790	789456	0.10	2311
579787	789452	1.20	2312
579810	789446	0.20	2313
579810	789440	0.70	2314
579836	789439	0.10	2315
579831	789432	0.40	2316
579857	789428	0.20	2317
579857	789423	0.10	2318
579888	789423	0.10	2319
579887	789416	0.10	2320
579913	789419	0.10	2321
579911	789415	0.10	2322
579934	789417	0.20	2323
579931	789414	0.10	2324
579958	789410	0.20	2325
579957	789407	0.10	2326

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
579983	789409	0.20	2328
579983	789402	0.20	2329
580002	789402	0.10	2330
580003	789401	0.40	2331
580032	789398	0.20	2333
580054	789396	0.10	2334
580079	789397	0.10	2336
580078	789394	0.10	2337
580109	789393	0.10	2338
580129	789388	0.10	2340
580128	789384	0.10	2341
580153	789384	0.10	2342
580153	789381	0.10	2343
580180	789380	0.10	2344
580180	789378	0.10	2345
580200	789378	0.10	2346
580200	789370	0.10	2347
575586	790600	0.10	2349
575598	790597	0.10	2350
575577	790604	0.10	2351
575574	790574	2.20	2352
575581	790568	2.70	2353
575567	790578	4.10	2354
575558	790544	4.50	2355
575570	790538	2.90	2356
575550	790547	4.30	2357
575551	790514	3.40	2358
575560	790508	2.80	2359
575544	790519	2.20	2360
575532	790482	2.40	2361
575540	790481	2.80	2362
575522	790487	2.20	2363
575438	790393	3.20	2364
575439	790388	2.60	2365
575433	790404	3.60	2366
575402	790372	4.50	2367
575404	790366	3.50	2368
575398	790384	3.90	2369
575372	790360	2.30	2370
575373	790351	2.00	2371
575368	790373	1.80	2372
575336	790353	2.80	2373
575340	790345	4.50	2374
575335	790366	2.40	2375
575307	790341	2.90	2376
575306	790332	2.50	2377

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575278	790316	4.50	2379
575285	790313	3.30	2380
576268	790320	1.90	2381
576805	790104	0.30	2382
576811	790096	0.30	2383
576795	790115	0.40	2384
576784	790083	0.20	2385
576793	790077	0.20	2386
576776	790091	0.30	2387
576764	790061	0.10	2388
576781	790057	0.20	2389
576764	790066	0.40	2390
576752	790042	0.10	2391
576761	790036	0.10	2392
576745	790047	0.40	2393
576736	790026	1.60	2394
576744	790019	1.50	2395
576730	790027	1.40	2396
576722	790002	2.30	2397
576731	789997	2.50	2398
576716	790012	2.30	2399
576693	789992	2.90	2400
576697	789981	3.70	2401
576691	790003	2.80	2402
576668	789979	3.90	2403
576672	789972	4.40	2404
576662	789989	4.30	2405
576646	789963	4.10	2406
576650	789954	4.50	2407
576640	789974	4.50	2408
576630	789945	4.50	2409
576636	789935	4.50	2410
576623	789952	4.50	2411
576611	789931	3.60	2412
576617	789923	4.40	2413
576607	789940	2.90	2414
576592	789915	2.90	2415
576594	789902	3.80	2416
576585	789924	3.90	2417
576571	789877	3.10	2418
576576	789865	3.50	2419
576569	789882	3.30	2420
576546	789858	2.90	2421
576543	789861	2.60	2423
575848	789873	2.90	2425
575856	789875	2.90	2426

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575846	789860	1.60	2427
575873	789846	3.40	2428
575880	789857	3.00	2429
575869	789838	2.50	2430
575897	789831	3.50	2431
575903	789836	1.90	2432
575895	789822	3.00	2433
575926	789812	2.80	2434
575928	789818	2.50	2435
575915	789797	1.90	2436
575932	789810	0.90	2437
575947	789798	1.00	2438
575946	789782	1.00	2439
575965	789778	0.20	2440
575970	789784	0.20	2441
575964	789763	1.50	2442
575996	789763	0.50	2443
576001	789767	0.10	2444
575995	789750	0.10	2445
575217	790227	0.50	2447
575220	790229	0.30	2448
575202	790225	0.10	2449
575201	790202	1.50	2450
575204	790199	1.00	2451
575192	790199	2.50	2452
575191	790172	2.70	2453
575189	790166	1.60	2454
575181	790168	0.90	2455
575185	790134	4.50	2456
575191	790134	0.90	2457
575181	790136	0.40	2458
575185	790111	4.50	2459
575175	790100	1.80	2460
575164	790104	4.50	2461
575171	790076	4.50	2462
575176	790076	1.90	2463
575168	790078	2.50	2464
575169	790070	4.20	2466
575174	790039	1.00	2467
575158	790035	0.80	2468
575162	790051	4.10	2469
575160	790017	0.40	2470
575154	790026	0.40	2471
575162	790040	2.10	2472
575155	789981	0.40	2473
575146	789975	3.80	2474

Easting (ITM)	Northing (ITM)	Peat Depth (m)	Ref
575143	789961	2.80	2475
575151	789946	0.10	2476
575132	789941	3.60	2477

APPENDIX D

Von Post Classification and Shear Strength Information	3 x A4

Carrigeen Renewable Energy Development - Peat Shear Strength

I.D.	Geographic Coordinates		Vane test (kPa)					Peat Thickness(m)
	Easting	Northing	0.0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	Minimum	
T1	575474	790429	16	17	17	18	16kPa	3.6
T2	575119	789930	16	38			16kPa	0.3
T3	575778	789897	20	18	22	29	18kPa	2.8
T4	576136	789683	16	19	32	28	16kPa	1.5
T5	576297	789215						0.1
T6	576671	788948	58				58kPa	0.1
T7	577107	788984	21	52			21kPa	0.9
T8	579316	790698						
T9	579820	790659	46	38	29		29kPa	1.4
T10	580295	790611	28	30	84		28kPa	0.7
T11	580936	790352	28	27	29		27kPa	1.6
T12	580434	790104	55				55kPa	0.6
SS	580100	789470	No Peat				N/A	N/A
X1	574934	790435	24	6	11	15	6kPa	4.5
X2	575476	790430	11	20	H24	H23	11kPa	3
X3	575120	789928	14	H16	H18	H16	14kPa	2.9
X4	575779	789896	15	H16	H13	H14	13kPa	3.2
X5	576173	789656	14	15	H49	H120	14kPa	2.3
X6	576137	789024	18	6	H21	H19	6kPa	3
X7	576602	788956	20				20kPa	0.3
X8	577107	788972	14	15			14kPa	1.6
X9	579818	790661	38				38kPa	0.9
X10	580474	790688	31	19	20	21	19kPa	2
X11	580888	790510	12				12kPa	0.8
X12	580303	790137	11	43			11kPa	1.3
X13	580749	790019	22				22kPa	0.1

Carrigeen Renewable Energy Development - Peat Degradation

I.D.	Geographic Coordinates		Peat Characteristics					Peat Thickness(m)
	Easting	Northing	0.0 - 0.5m	0.5 - 1.0m	1.0 - 1.5m	1.5 - 2.0m	Maximum	
T1	574934	790435	H7	H7	H7	H7	H7	3.6
T2	575476	790430	H7				H7	0.3
T3	575120	789928	H7	H6	H6	H6	H7	2.8
T4	575779	789896	H5	H7	H8	H8	H8	1.5
T5	576173	789656					H1	0.1
T6	576137	789024					H1	0.1
T7	576602	788956	H7	H7			H7	0.9
T8	577107	788972						
T9	579818	790661	H6	H6	H6		H6	1.4
T10	580474	790688	H6	H6	H6		H6	0.7
T11	580888	790510	H7	H7	H7		H7	1.6
T12	580303	790137	H5				H5	0.6
SS	580749	790019	No Peat				N/A	N/A
X1	574934	790435	H6	H7	H7	H9	H9	4.5
X2	575476	790430	H5	H5	H6	H8	H8	3
X3	575120	789928	H6	H6	H7	H8	H8	2.9
X4	575779	789896	H5	H5	H6	H9	H9	3.2
X5	576173	789656	H4	H5	H5	H5	H5	2.3
X6	576137	789024	H4	H5	H5	H8	H8	3
X7	576602	788956	H2				H2	0.3
X8	577107	788972	H4	H5	H5		H5	1.6
X9	579818	790661	H3	H4			H4	0.9
X10	580474	790688	H3	H4	H5	H5	H5	2
X11	580888	790510	H7	H7			H7	0.8
X12	580303	790137	H7	H7			H7	1.3
X13	580749	790019	H1				H1	0.1

Carrigeen Renewable Energy Development - Peat Degradation

Notes:

Peat Characteristics

H1 - Completely undecomposed peat; only clear water can be squeezed from peat.

H2 - Almost undecomposed; mud free peat; water squeezed from peat is almost clear.

H3 - Very little decomposition; very slightly muddy peat; water squeezed from peat is muddy

H4 - Poorly decomposed; somewhat muddy peat; water squeezed from peat is muddy; residue is muddy but shows structure of peat.

H5 - Somewhat decomposed;muddy growth structure discernible but distinct; some peat passes through fingers when squeezed; compressed residue is muddy.

H6 - Somewhat decompsed; muddy; growth structure indistinct; less than one-third of peat passes through fingers when squeezed; residue very muddy.

H7 - Well decomposed; very muddy; growth structure indistinct; about one-half of peat passes through fingers when squeezed; exuded liquid has a "pudding-like" consistency.

H8 - Well decomposed; growth structure very indistinct; about two-thirds of peat passes through fingers when squeezed; residue consists mainly of roots and resistant fibers.

H9 - Almost completely decomposed; peat is mud-like; almost no growth structure can be seen; almost all of peat passes through the fingers when squeezed.

H10 - Completely decomposed; no discernible growth structure; entire peat mass passes through the fingers when squeezed.

APPENDIX E

Peat Slide Risk Assessment –	46 x A4
"Preventative Action: A Guide for Workers"	

Peat Slide Risk

Preventative Action

A Guide For Workers

WHITEFORD
GEOSERVICES

22nd September 2009

John Whiteford

Whiteford Geoservices Ltd

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com

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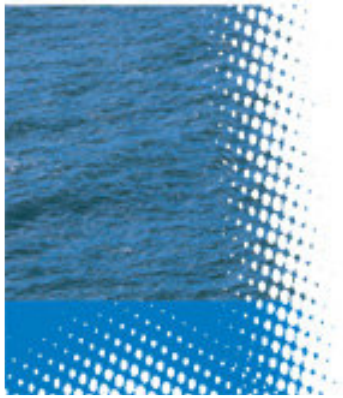

[A] Introduction - What Is Peat?

[B] Why Is Peat So Unstable?

[C] Whiteford *Geoservices*

How Can We Help?

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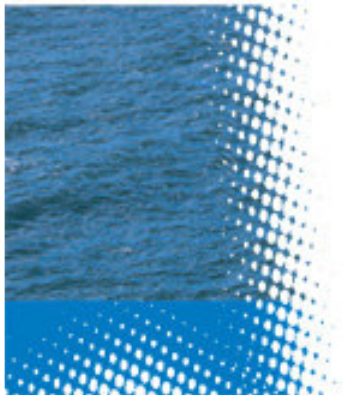

[A] Introduction - What Is Peat?

1. Where Does Peat Come From?
2. What Is Peat Composed Of?
3. Is There A High Potential For Instability In Peat?
4. Do I Have A Baseline Peat Site? – Should I Be Worried?

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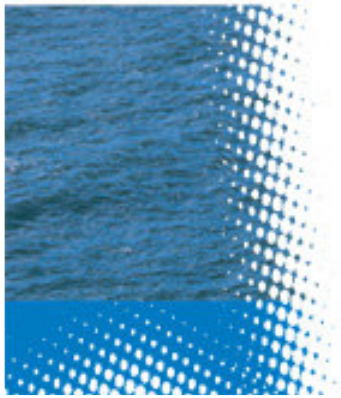

A1 Where Does Peat Come From?

- Organic soil derived from plant remains; shrubs, herbaceous vegetation and degradable parts of trees
- Deposited over extended period of time in temperate latitudes
- Prevalent only in regions of high rainfall

A1 Where Does Peat Come From?

- Often moves as a mass to cover large tracts of uplands areas
- Can form naturally up to 4m in thickness, but can migrate / flow to thicknesses well in excess of this figure.
- Extensively mined / extracted for use as fuel source, particularly in the nineteenth and early part of the twentieth centuries

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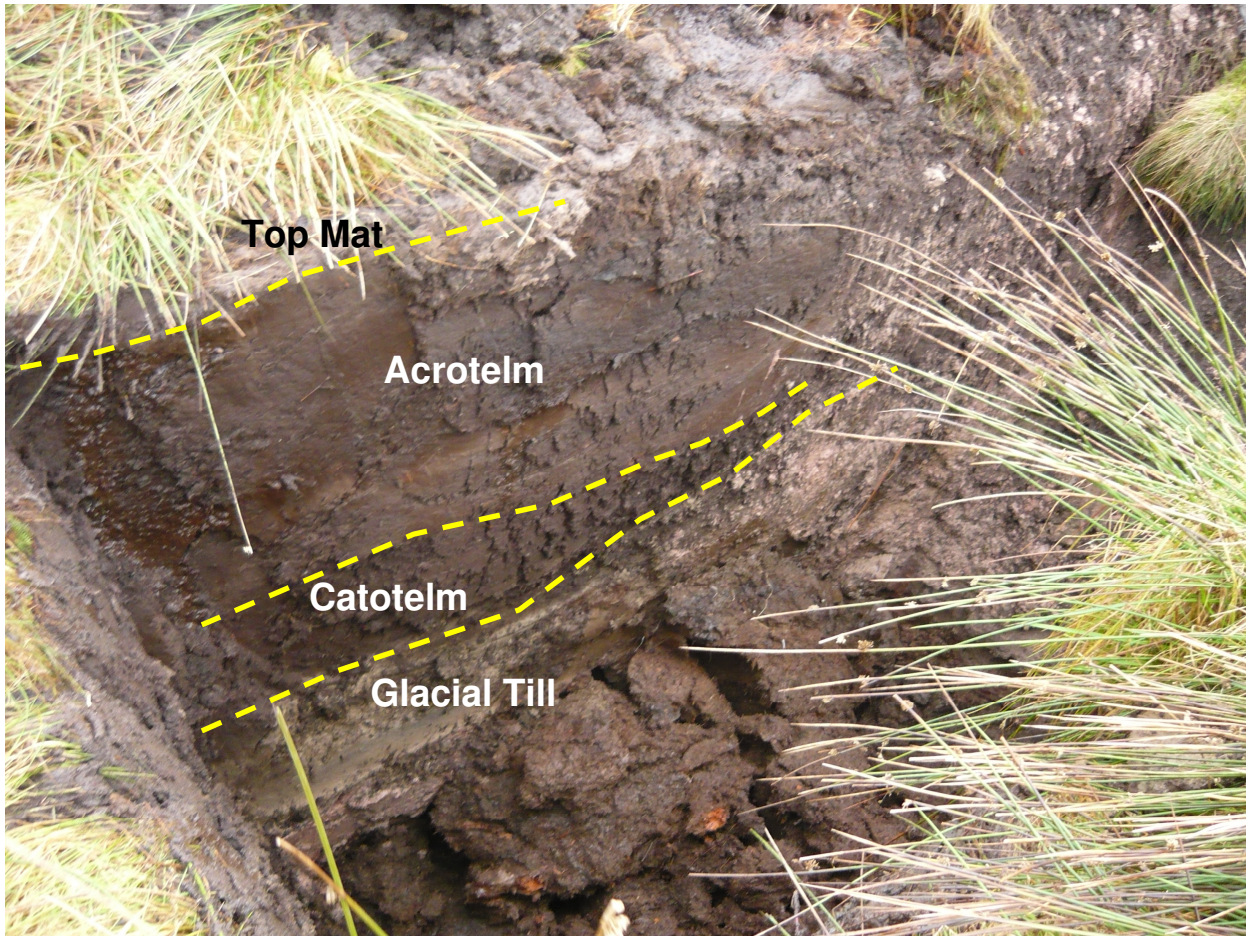
A2 What Is Peat Composed Of?



A2 What Is Peat Composed Of?

Contains generally three distinct parts

TOP MAT

- Living vegetation
- Herbaceous Plants, grasses, moss and lichens
- Moderate shear strength

ACROTELM

- Decomposing peat; highly fibrous
- Periodically saturated; high permeability
- Moderately to low shear strength, 0.2 – 1.3m thick

CATOTELM

- Completely decomposed peat; pseudo-amorphous to amorphous
- Permanently saturated; low permeability
- Very low shear strength; occurs below 1.3m depth

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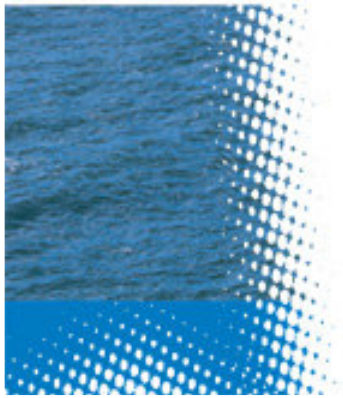

A3 Is There A High Potential For Instability In Peat?

- **YES**
- ***WHY?***
- **PEAT IS HIGHLY SENSITIVE TO A HOST OF FACTORS:-**

1. *Changes in slope*
2. *Changes in drainage patterns*
3. *Dewatering / desiccation*
4. *Loading*
5. *Cutting*
6. *Variations in rainfall*
7. *Vibration / Seismic / Sonic Activity*
8. *Propagation of local impacts*

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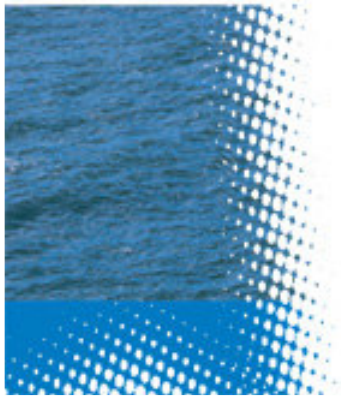

A4 Do I Have A "Baseline Peat" Site?

What is a "Baseline Peat" site?

- One where peat is present to such a level that it represents a peatland habitat and as such is highly sensitive to environmental change.

Simple Test

- A site should be designated "Baseline Peat" if the average peat thickness is 0.5m or more.

Should I Be Worried?

- ***No***

Concerned?

- ***Probably***

Informed?

- ***MOST DEFINITELY!***

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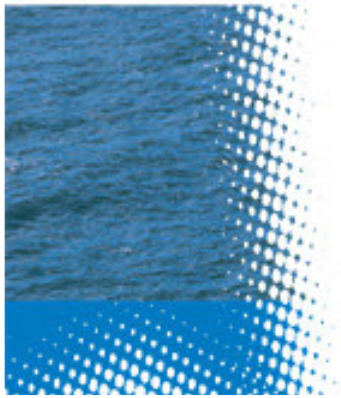

A4 To Be Informed Is To Be Prepared

Main Issues With Peat Sites

- Slope Failure; Peat Slide or Bog Burst
- Sensitive Hydrology
- Flora and Fauna
- Contamination Of Water Courses

Information You Should Have

- Desk Study
- Walk Over Assessments
- Peat Probings / Gouge Sampling / Vane Testing

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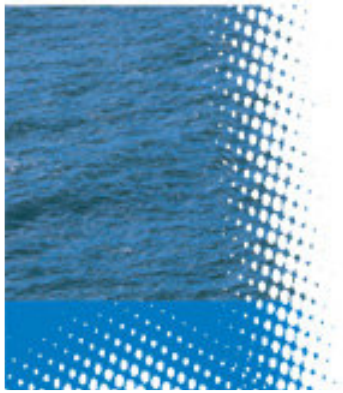

[B] You Should Always Ask The Following Questions About Your Construction Site?

1. Can The Risk Of Peat Slide / Bog Burst Be Averted On My Site During Construction?
2. Why Is Peat So Unstable?
3. What Triggers a Peat Slide / Bog Burst?
4. How Can I Measure Risk At My Site?
5. **What Can I Do To Prevent Peat Slide / Bog Burst?**

B1 Can Bog Burst / Peat Slide Be Averted?

- YES (Potentially, although some sites are unsuitable)
- Mitigation can always be applied to reduce the risk of slope failure from occurring
- However – it can ***never*** be completely ruled out

Bog Burst – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

Peat Slide – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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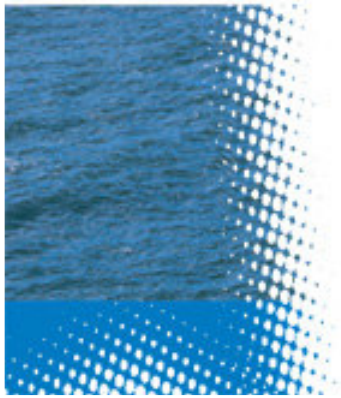

B2 Why Is Peat So Unstable?

- Exists in **Equilibrium of tension and compression** in the Top Mat and Acrotelm
- Any tear / cutting within the surface Mat / Shallow Acrotelm **compromises this shear strength**
- **Catotelm** is highly unstable and only **weakly permeable**
- Water flowing into the acrotelm from above can only flow into the catotelm, but not through it.
- Pore water pressure builds up steadily within the catotelm – water cannot escape – **high hydrostatic pressure**
- Incisions / Cuts into the base of the peat (catotelm layer) can cause a **rapid dewatering** of peat – BOG BURST
- In shallower peat – mechanism is PEAT SLIDE

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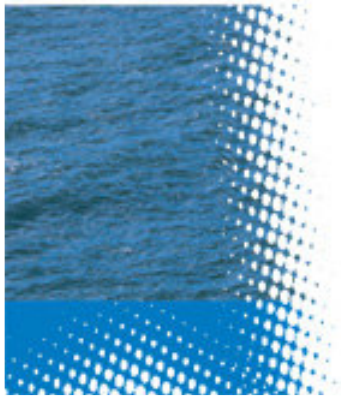

B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Steep Slopes

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B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Deep Peat

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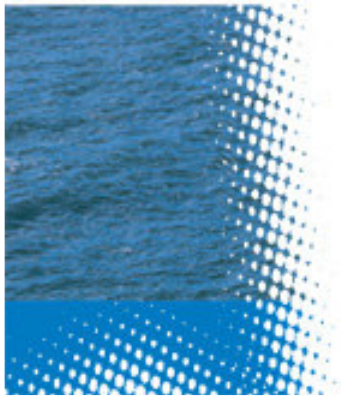

B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Active Peat Instability

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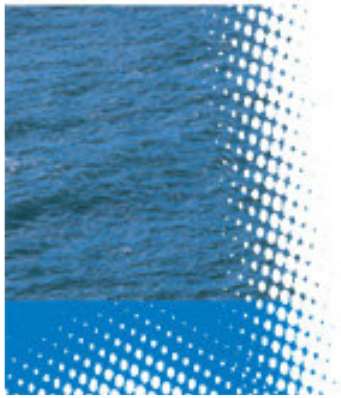

B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

- Incipient Peat Instability
- *Tension Cracks*
- *Peat Creep / Diamond Tears*
- *Peat Pipes*

Tension Cracks – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

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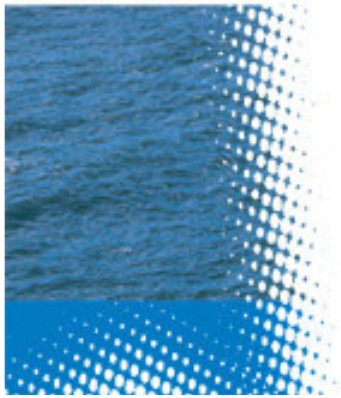
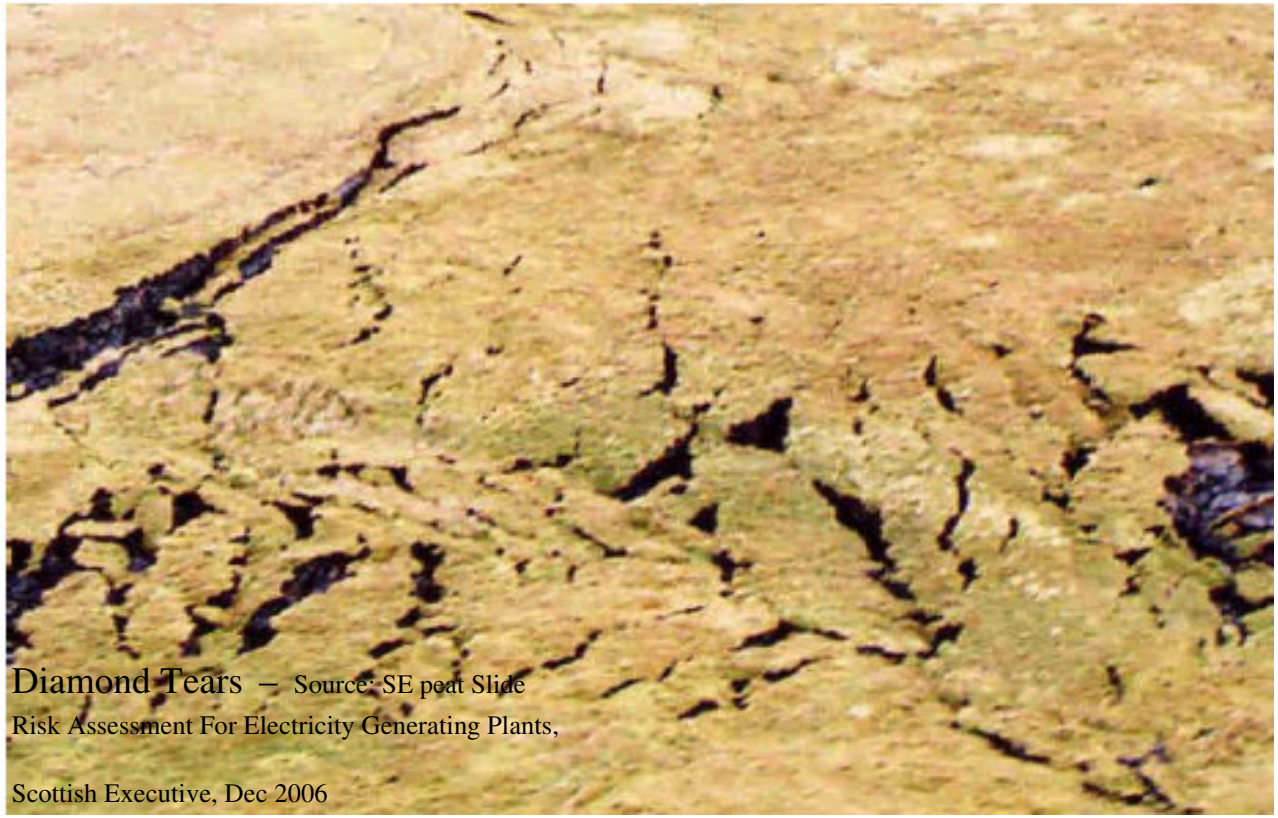


B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Incipient Peat Instability

- *Peat Creep / Diamond Tears*



Diamond Tears – Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Incipient Peat Instability

- *Peat Pipes*

Peat Pipes – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

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B3 What Triggers A Peat Slide / Bog Burst?

Environmental Factors

Relic Peat Instability

•*Landforms*

Peat Thrusts – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

Peat Ridges – Source: SE peat Slide Risk Assessment For Electricity Generating Plants,

Scottish Executive, Dec 2006

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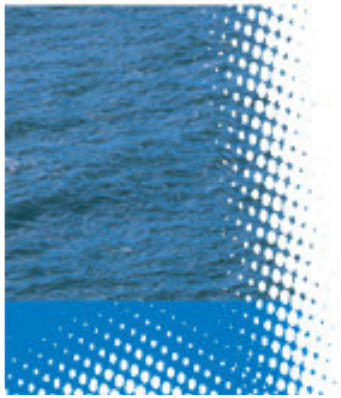

B3 What Triggers A Peat Slide / Bog Burst?

Triggering Incidents

- *Periods Of Rapid / Excessive Rainfall*
- *Changes In Hydrology (e.g. blocking drains etc.)*
- *Excessive Dewatering Of Peat (e.g. highly positive drainage)*
- *Loading Of Peat (e.g. disposal of more than 0.5m of spoil on peat >1.5m thick)*
- *Unloading Of Peat (e.g. cuttings in excess of 1.5m deep)*
- *Excessive Vibrations / Seismic / Sonic Activity (e.g. blasting, rock breaking)*

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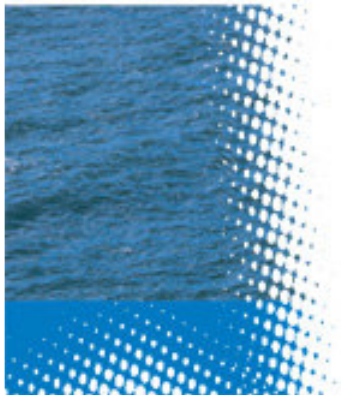

B4 Typical Data That Will Be Available For Your Construction Site?

Ground Investigation

- *Desk Study (e.g. Geological maps, mines / water wells etc.)*
- *Walk Over Assessments (Sinkholes, land slides etc.)*
- *Analysis Of Topographic Data (Slope magnitude / direction)*
- *Measurement Of Peat Thickness (Direct probing)*
- *Measurement Of Peat Strength (Vane test)*
- *Analysis Of Peat Competence (Peat coring – Von post)*

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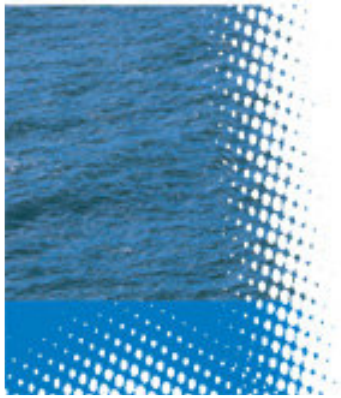


B4 How Can I Measure Risk At My Site?

Typical Topographic Data

Ardmore Wind Farm

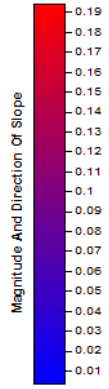
Slope Magnitude & Direction

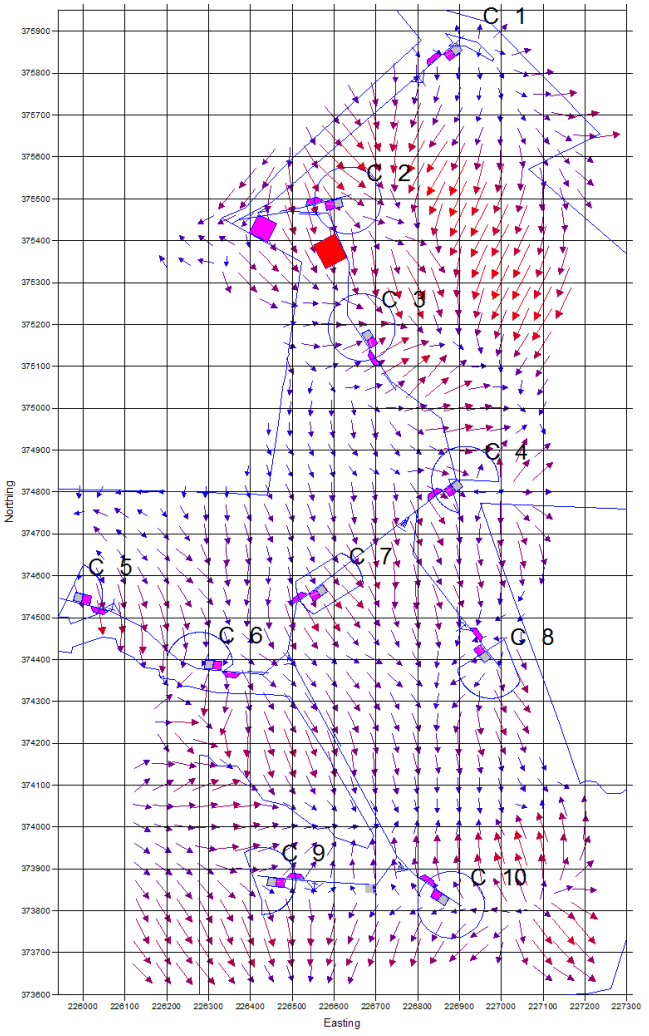
Vector Magnitude & Direction Plot

6th November 2008

NOTES:

1. Gridding carried out using a Kriging Function
2. Grid spacing of 50m applied to produce smoothed contours from collected data
3. Maximum peat depth encountered was 4.6m at E=227647, N=378666





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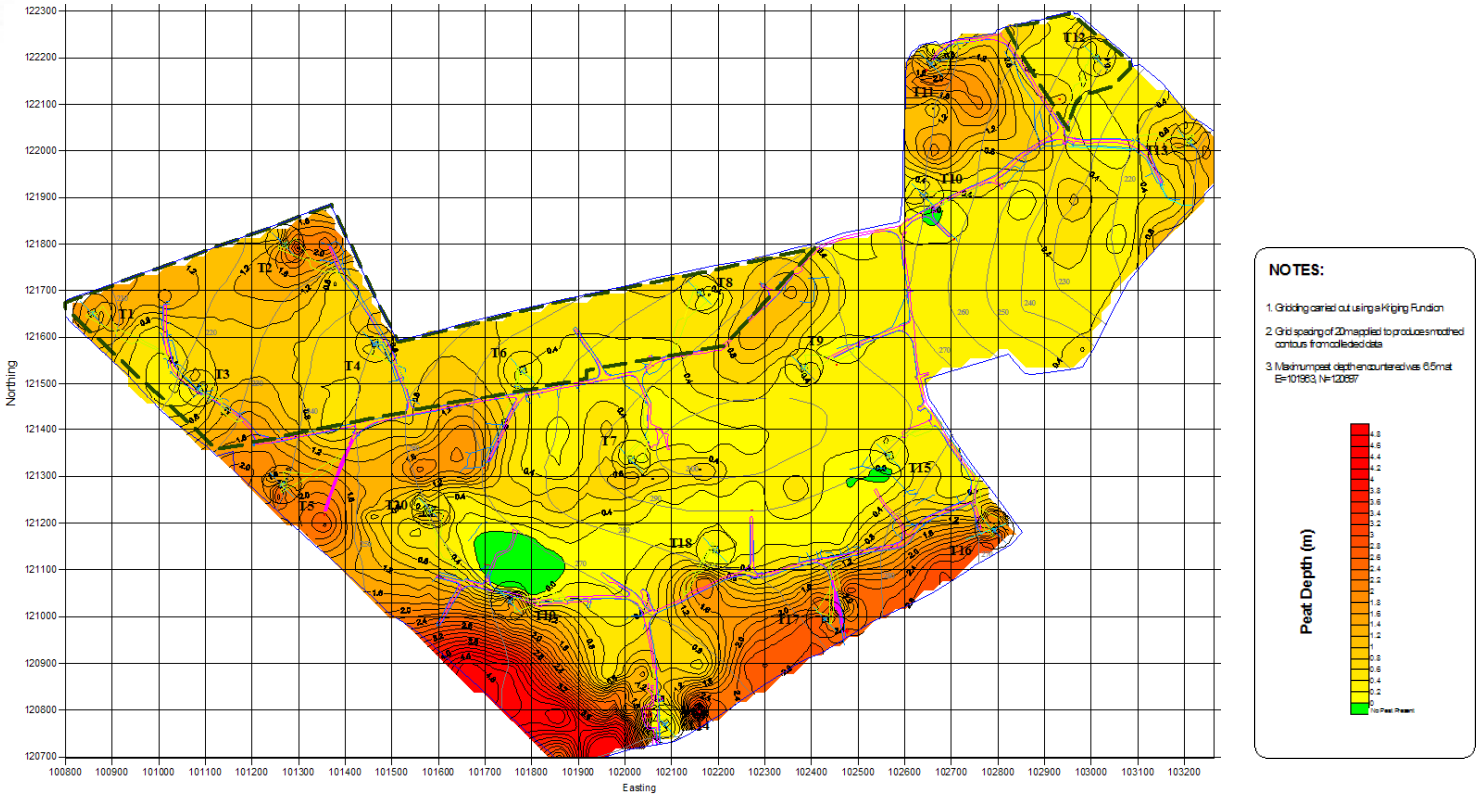
B4 How Can I Measure Risk At My Site?

Typical Peat Thickness Data

Lisnamoyle Wind Farm
Peat Probing Survey

Contoured Peat Thickness (m)
20th December 2008



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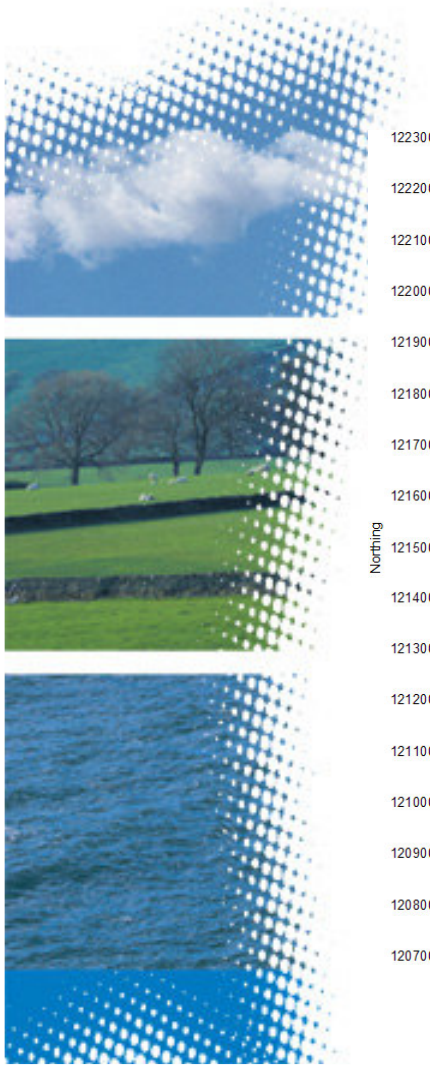
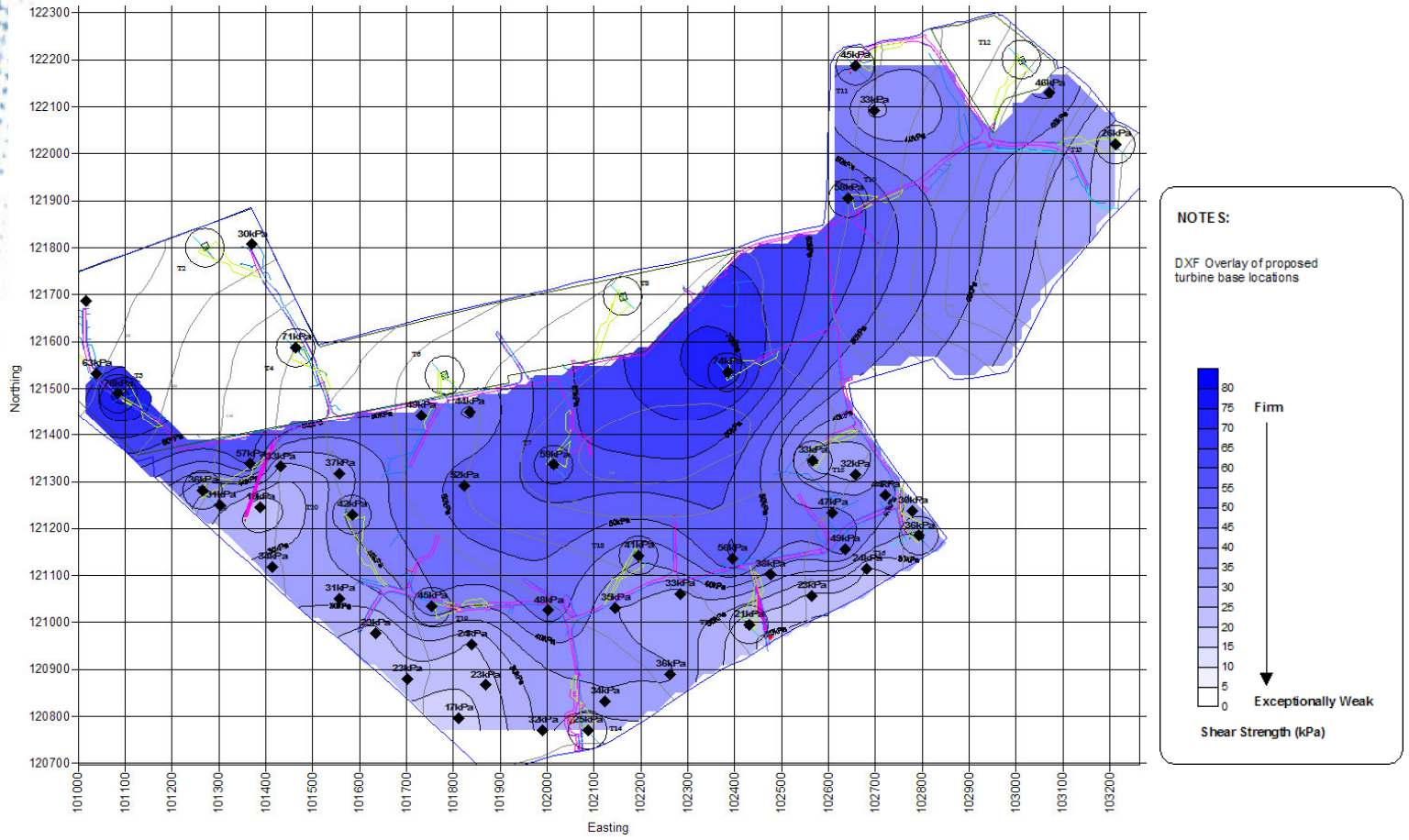
B4 How Can I Measure Risk At My Site?

Typical Analysis Of Peat Strength





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B4 How Can I Measure Risk At My Site?

Typical Analysis Of Peat Competence – Von Post

Von Post Humification Scale - Lisnamoyle Wind Farm

Client : Lisnamoyle Wind Farm Ltd
Location : Virginia, Co. Cavan
Date : 12-13 November 2008

Turbine Locations

ID	Geographic Coordinates		Peat Characteristics														Peat Thickness (m)	Underlying Soil Type
	Easting	Northing	0.3 m	0.6 m	0.9 m	1.2 m	1.5 m	1.8 m	2.1 m	2.4 m	2.7 m	3 m	3.3 m	3.6 m	3.9 m	4 m		
T3	101085	121489	H4														0.27	Silty SAND & GRAVEL
T4	101464	121587	H4	H5													0.45	Sandy, gravelly SILT
T5	101265	121282	H4	H5	H5	H6	H6	H7	H8								2	Silty SAND & GRAVEL
T7	102014	121336	H4														0.25	Sandy, gravelly SILT
T9	102385	121535	n/a														n/a	Sandy SILT
T10	102642	121905	n/a														n/a	Sandy, gravelly SILT
T11	102657	122187	H3	H3	H4												0.9	Sandy, gravelly SILT
T12A	103071	122129	n/a														n/a	SILT
T13	103212	122020	H3	H4													0.6	Sandy, gravelly SILT
T14	102087	120771	H4	H4	H4	H5											1.05	Sandy, gravelly SILT
T15	102566	121345	H3	H3													0.5	Sandy, gravelly SILT
T16	102793	121185	H3	H3	H3	H4	H5	H5	H6								2.05	Sandy CLAY
T17	102430	120996	H3	H4	H4	H4	H5	H5	H6	H6	H7	H7	H7				3.1	Sandy, gravelly SILT
T18	102195	121143	n/a														n/a	SILT
T19	101754	121034	H3	H3	H4	H4											1.2	Silty SAND & GRAVEL
T20	101584	121230	H3	H4	H5												0.95	Sandy, gravelly SILT

Peat Characteristics

Note :
Green refers to new location (original location inaccessible due to very thick forest).

H1 - Completely undecomposed peat; only clear water can be squeezed from peat.
H2 - Almost undecomposed; mud free peat; water squeezed from peat is almost clear.
H3 - Very little decomposition; very slightly muddy peat; water squeezed from peat is muddy
H4 - Poorly decomposed; somewhat muddy peat; water squeezed from peat is muddy; residue is muddy but shows structure of peat.
H5 - Somewhat decomposed; muddy growth structure discernible but distinct; some peat passes through fingers when squeezed; compressed residue is muddy.
H6 - Somewhat decompsed; muddy; growth structure indistinct; less than one-third of peat passes through fingers when squeezed; residue very muddy.
H7 - Well decomposed; very muddy; growth structure indistinct; about one-half of peat passes through fingers when squeezed; exuded liquid has a "pudding-like" consistency.
H8 - Well decomposed; growth structure very indistinct; about two-thirds of peat passes through fingers when squeezed; residue consists mainly of roots and resistant fibers.
H9 - Almost completely decomposed; peat is mud-like; almost no growth structure can be seen; almost all of peat passes through the fingers when squeezed.
H10 - Completely decomposed; no discernible growth structure; entire peat mass passes through the fingers when squeezed.

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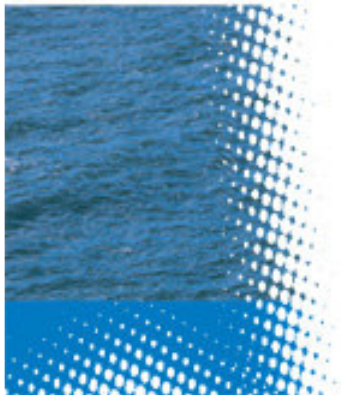

B4 How Can I Measure Risk At My Site?

Calculation Of Risk

- ***Quantitative Risk Assessment***
- ***Degree Of Risk = Likelihood x Effect***
- ***Hazard Ranking = Hazard x Exposure***

Success Depends On Correct Assessment Of HAZARD and EXPOSURE

Your Consultant Will Have Carried This Out Already – Using The Following Data

(Refer to Annex for details)

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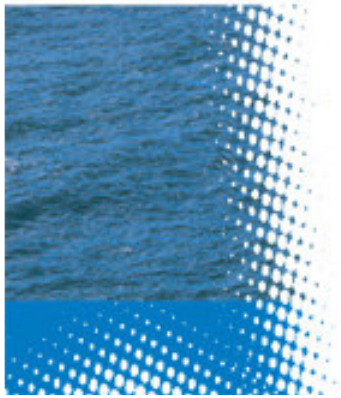

B4 Typical HAZARDS

- *Peat Depth In Excess Of 1.5m (i.e Cutting into the CATOTELM)*
- *Level Peat Overlying Sloping Natural Soils / Rock*
- *Presence Of Particularly Weak Peat*
- *Cuttings in excess of 1.5m*
- *Placement Of "Floating" Roads On Any Thickness Of Peat*
- *Drainage (Positive Drainage Causes Settlement / Negative Drainage Causes Flooding)*
- *Surface Loading Of Peat (Spoil Disposal > 0.5m Thick)*
- *Presence Of Recent, Incipient and Relic Peat Instability*

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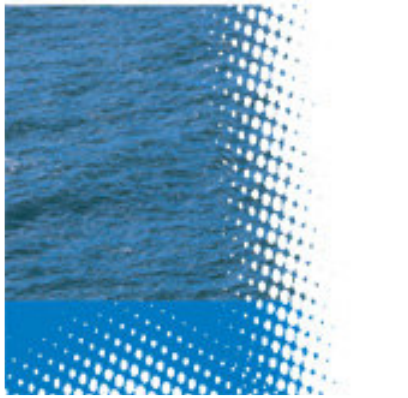

B4 Typical EXPOSURE

- *An Event Likely To Cause Degradation Of Habitat*
- *- Visual Scars*
- *- Blockage Of Site Drainage*
- *- Disruption To Site Construction Works*
- *- Contamination Of Water Courses*
- *- Damage To Construction Infrastructure / Public Infrastructure*
- *- Injury / Death – Wildlife And Farm Animals*
- *- Injury / Death – Workers / General Public*

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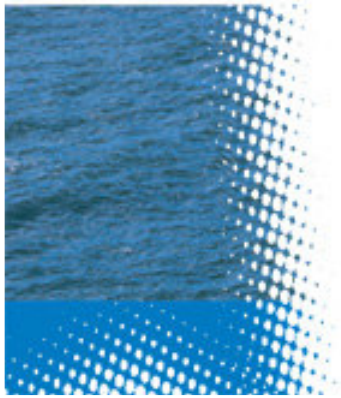

B5 Calculating the Hazard Ranking For Your Site

Typical Breakdown Of Dominant Risk Factors

(External Example – Looking At Effect Of Risk)

Peat Depth (m)	Risk Factor	Slope Angle	Risk Factor	Risk	Risk Factor
> 4.1m	7	12-13˚	7	High	13-14
3.6-4.1m	6	10-11˚	6	Medium/High	11-12
3.1-3.5m	5	7-9°	5	Medium	9-10
2.4-3.0m	4	5-6°	4	Low/Medium	7-8
1.8-2.3m	3	4-5°	3	Low	5-6
1.1-1.7m	2	3-4°	2	Highly Unlikely	3-4
<1m	1	<3°	1	Negligible	1-2

Alfred McAlpine, 2005

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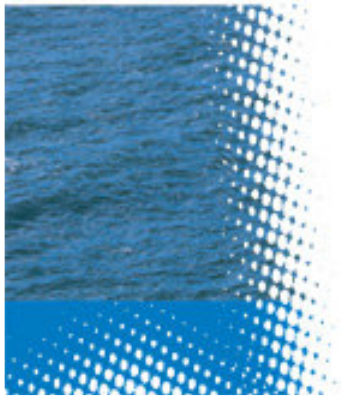

B5 Calculating the Hazard Ranking For Your Site

Typical Assessment Scale Used

Scale	Likelihood	Probability of occurrence
5	Almost certain	> 1 in 3
4	Probable	1 in 10 - 1 in 3
3	Likely	1 in 10^2 - 1 in 10
2	Unlikely	1 in 10^7 - 1 in 10^2
1	Negligible	< 1 in 10^7

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

Scale	*Exposure*	*Impact as % of total project cost or time*
5	Extremely high impact	> 100% of project
4	Very high impact	10% - 100%
3	High impact	4% - 10%
2	Low impact	1% - 4%
1	Very low impact	< 1% of project

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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B5 Calculating the Hazard Ranking For Your Site

Hazard Ranking for each hazard zone		*Action suggested for each hazard zone*
17 - 25	Serious	Avoid project development at these locations
11 - 16	Substantial	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to significant or less
5 - 10	Significant	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations
1-4	Insignificant	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate

Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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B5 Calculating the Hazard Ranking For Your Site

Typical Analysis (External Example)

Influences and Factors	Description	Scoring
Construction Elements	Turbine 24, associated hardstanding and access tracks are likely to be constructed on glacial tills and possibly weathered rock.	
Peat Depth:	0.5 to 1.5m; For scoring purposes peat depths are considered up to 2 m to reflect a conservative scenario.	1.5
Topography:	Mostly moderately sloping (6 to 15°) with negligible changes in grade.	1.5
Evidence of Instability:	No signs of instability observed.	1.0
Surface Hydrology:	Predominantly well-drained.	0.5
Scale:	Peat depths of up to 2m on rolling terrain.	2.25
Exposure:	Potential to impact on Afton Water / Afton Reservoir	2.0

Sensitivity Score = 1.125

Consequence Score = 4.50

Mott MacDonald, 2008

Risk Score = 5.06, Low

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B5 Calculating the Hazard Ranking For Your Site

Typical Risk Classification System Compared To Scottish Executive Guide

Risk Scoring	Risk Category	*Equivalent Hazard Ranking (S.E. Guide)*
> 90	Very High	*Serious*
40 - 90	High	*Substantial*
8 - 40	Medium	*Significant*
0.5 - 8	Low	*Insignificant*
0 - 0.5	Very Low	
0	Negligible (i.e. no significant depths of peat deposits present)	*Negligible*

Mott MacDonald, 2008

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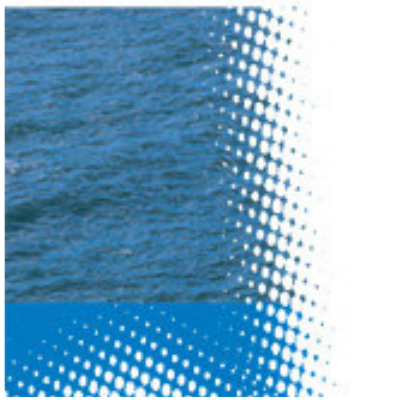
B5 Calculating the Hazard Ranking For Your Site

Typical Risk Assessment Data (External Example)



Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Exposure	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Peat Depth	1.0	0.5	1.5	1.5	1.0	1.5	1.0	1.0	1.5	1.0	1.0	1.0	1.0	1.5
Relief	1.5	2.0	1.0	1.0	1.5	1.0	1.5	1.0	1.5	2.0	1.5	2.0	1.5	1.5
Scale *(Assumed Peat Depth x Relief)*	1.50	1.00	1.50	1.50	1.50	1.50	1.50	1.00	2.25	2.00	1.50	2.00	1.50	2.25
Consequence	**3.00**	**2.00**	**3.00**	**3.00**	**3.00**	**3.00**	**3.00**	**2.00**	**4.50**	**4.00**	**3.00**	**4.00**	**3.00**	**4.50**
Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Peat Depth	1.0	0.5	1.5	1.5	1.0	1.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5
Slope Angle / Gradient	1.00	1.50	1.50	1.00	1.00	1.00	1.50	1.00	1.00	2.00	1.50	2.00	1.00	1.50
Surface Loading	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Changes in Grade	1.0	1.0	1.7	1.4	1.0	1.0	1.0	1.7	1.0	1.0	1.7	1.0	1.0	1.0
Topography *(Slope Gradient x Surface Loading x Changes in Grade)*	1.00	1.50	2.55	1.40	1.00	1.00	1.50	1.70	1.00	2.00	2.55	2.00	1.00	1.50
Evidence	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Drainage	1.0	0.5	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	0.5	1.0	0.5
Surface Hydrology *(=Drainage)*	1.0	0.5	0.5	0.5	1.0	1.0	0.5	0.5	1.0	0.5	0.5	0.5	1.0	0.5
Sensitivity	**1.00**	**0.375**	**1.913**	**1.05**	**1.00**	**1.50**	**0.75**	**0.85**	**1.00**	**1.00**	**1.275**	**1.00**	**1.00**	**1.125**
Area	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Risk Rating Score *(Consequence x Likelihood)*	**3.00**	**0.75**	**5.74**	**3.15**	**3.00**	**4.50**	**2.25**	**1.70**	**4.50**	**4.00**	**3.83**	**4.00**	**3.00**	**5.06**
Qualitative Risk Assigned	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**	**L**

Mott MacDonald, 2008

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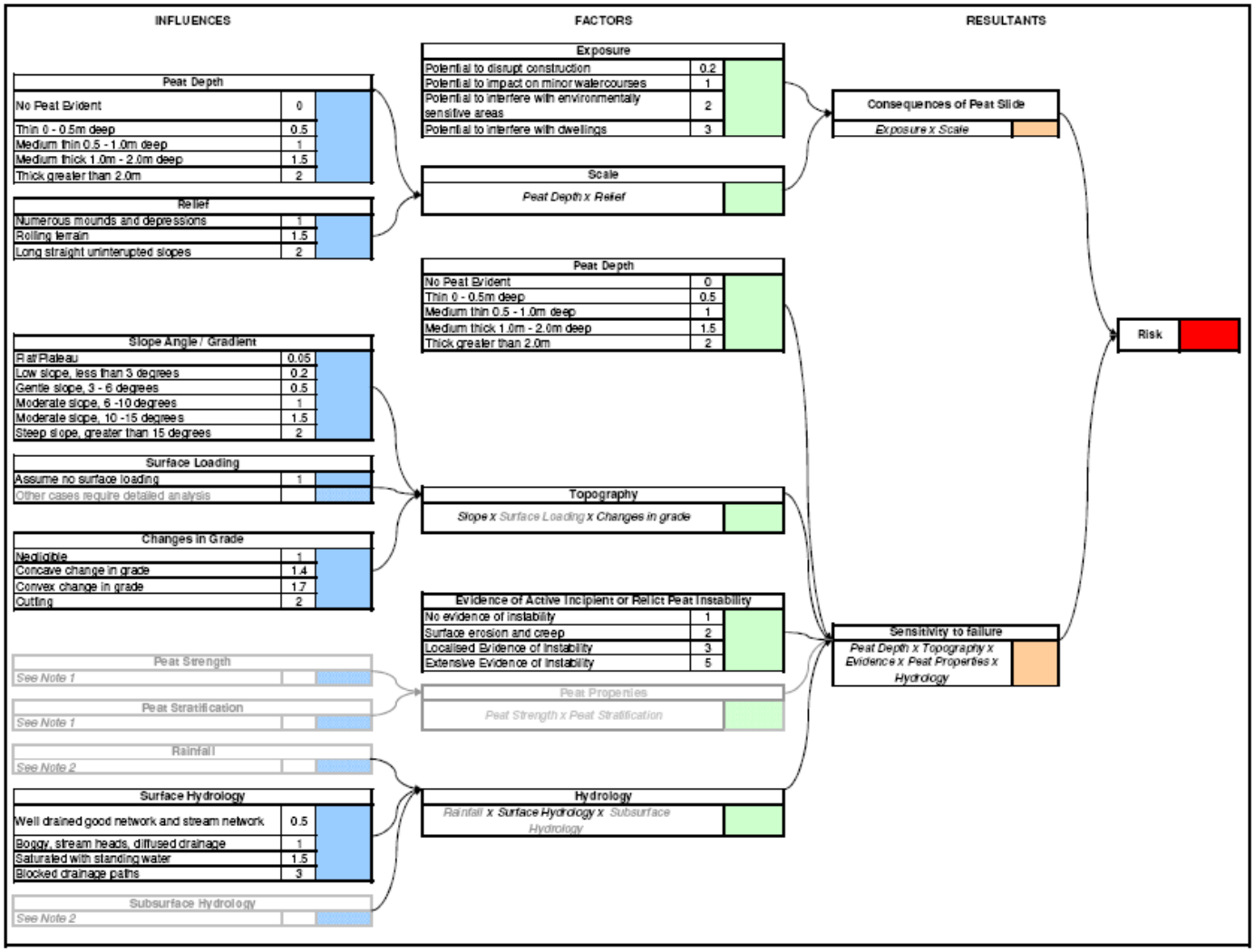
B5 Calculating the Hazard Ranking For Your Site



Mott MacDonald, 2008

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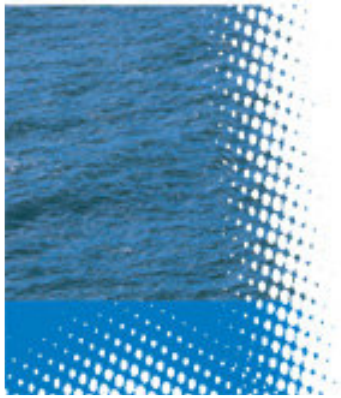

B5 What If Risk Is Calculated To Be…….

INSIGNIFICANT

The Standard Mitigation in the following section will be applicable.

SIGNIFICANT OR SUBSTANTIAL

Is It Possible To Mitigate To An Insignificant Level?

If YES proceed with specific peat slide mitigation in addition to the above.

If NO consider specific peat slide mitigation as well as long term monitoring

SERIOUS

It is unlikely that Serious Levels Of Peat Slide Risk Can Be Mitigated Against In The Current Climate

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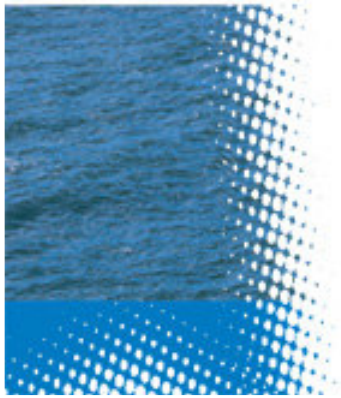

B5 Standard Mitigations And Actions

1. Works should always be **supervised by qualified and experienced site staff.**
2. Refer to your detailed Construction Works Plan.
3. Areas of sensitive peat should be clearly mapped and marked out on site. If possible the area should be taped off.
4. **Peat Instability Register.** A file should be created to record observations on peat stability. This will take the form of a daily inspection sheet, signed off by a suitably qualified person. Typical observations are visual observation of slopes, floated road sections, movement detection systems etc. The system is designed to be transferable.
5. **Movement detection systems**. Lightweight canes can be set in lines within sensitive areas to visually determine peat movement.
6. **Effective emergency plan** for dealing with peat slide events.

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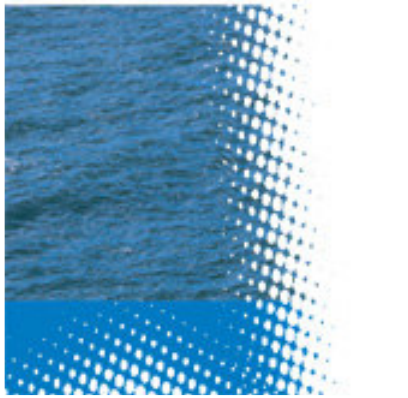


B5 Mitigations

7. **Immediate Stabilisation.** Stockpiles of crushed rock should be kept on site, for rapid mobilisation to stabilise slopes or stop flow reaching sensitive receptors.

8. **Defined peat storage / disposal sites**. These should be planned carefully, drainage specifically designed and clearly defined in terms of disposal thickness.

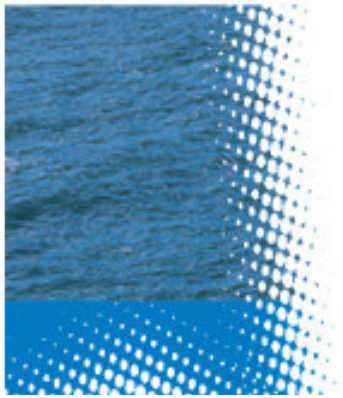
9. In general peat should not be loaded in excess of 0.5m adjacent to excavations unless location specific risk assessment carried out.

10. Drainage Systems must be maintained regularly (Weekly or better)

11. **Catch Wall Fences / Catch Ditches** have been shown to be useful when dealing with stopping small slide before they gather momentum

12. Frequent independent assessment of work practice should be undertaken

13. Regular **analysis of water courses** should be undertaken for indications of sediment infiltration – possible precursor to a peat slide



B5 Mitigations

14. Prior to placement of loads on **bases** / **crane pads etc. these should be tested** to ensure that overloading does not occur – potentially triggering a peat slide

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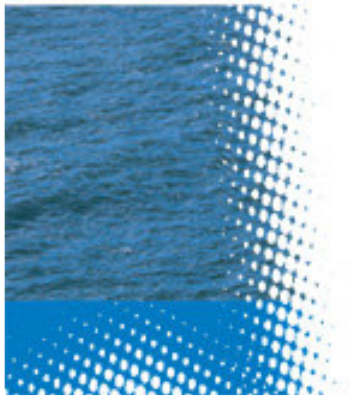
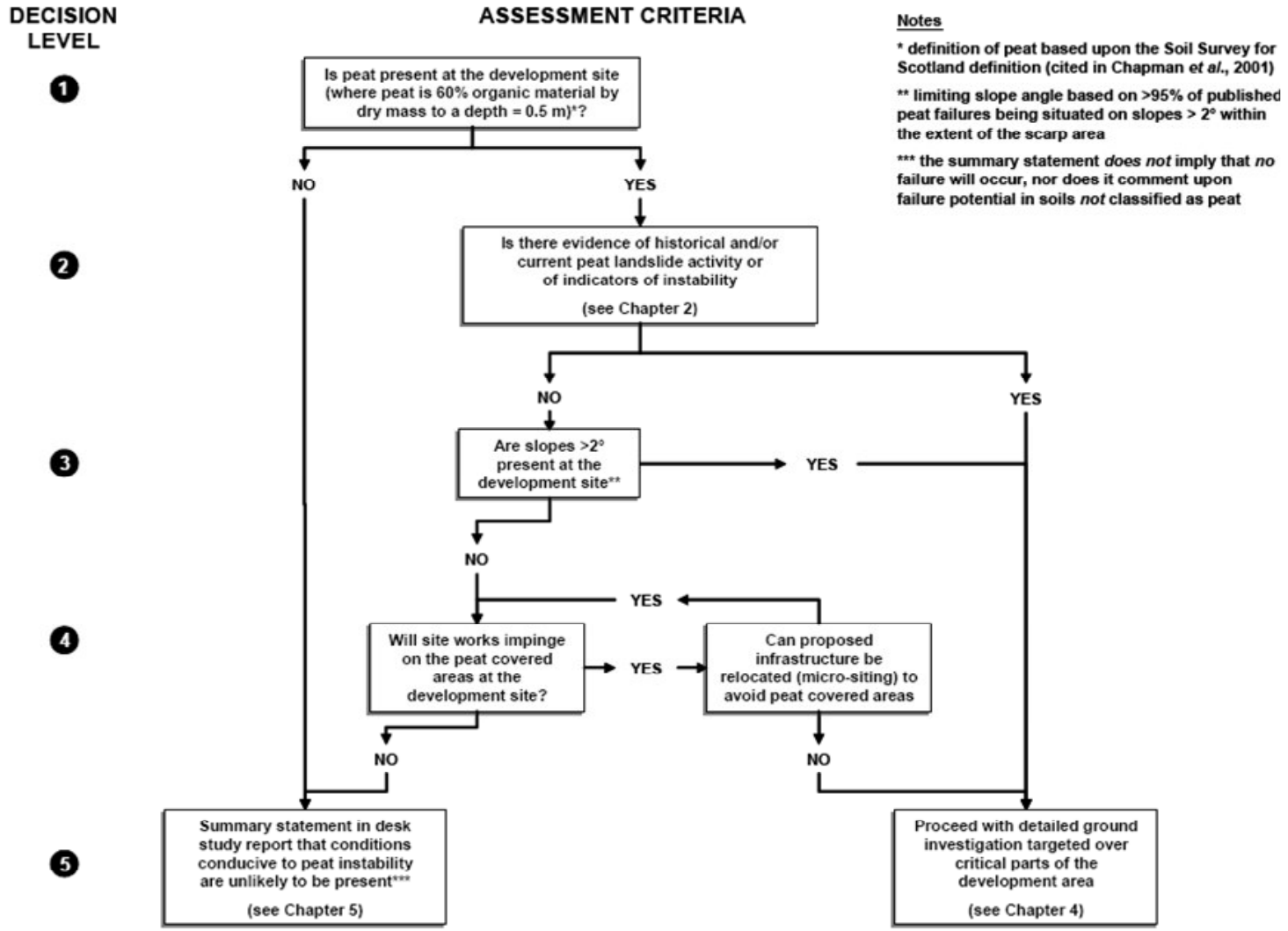


Typical Assessment Procedure That Will Have Been Undertaken At Your Site



Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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ANNEX Additional Reference Documents

John Whiteford (Managing Director)

Whiteford ***Geoservices Ltd***

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com

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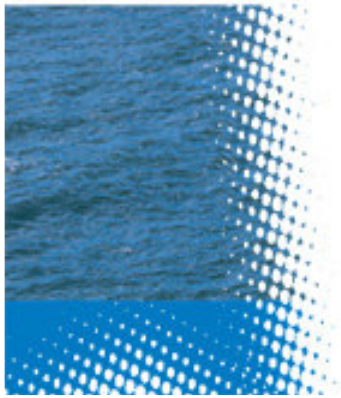

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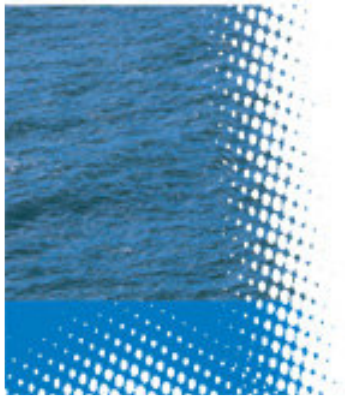

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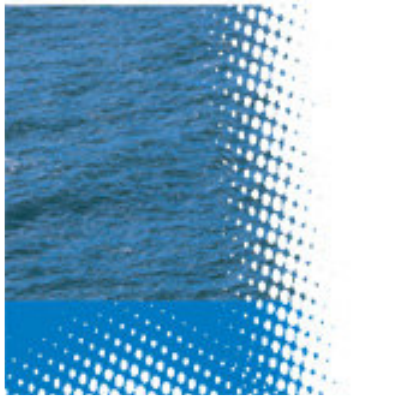
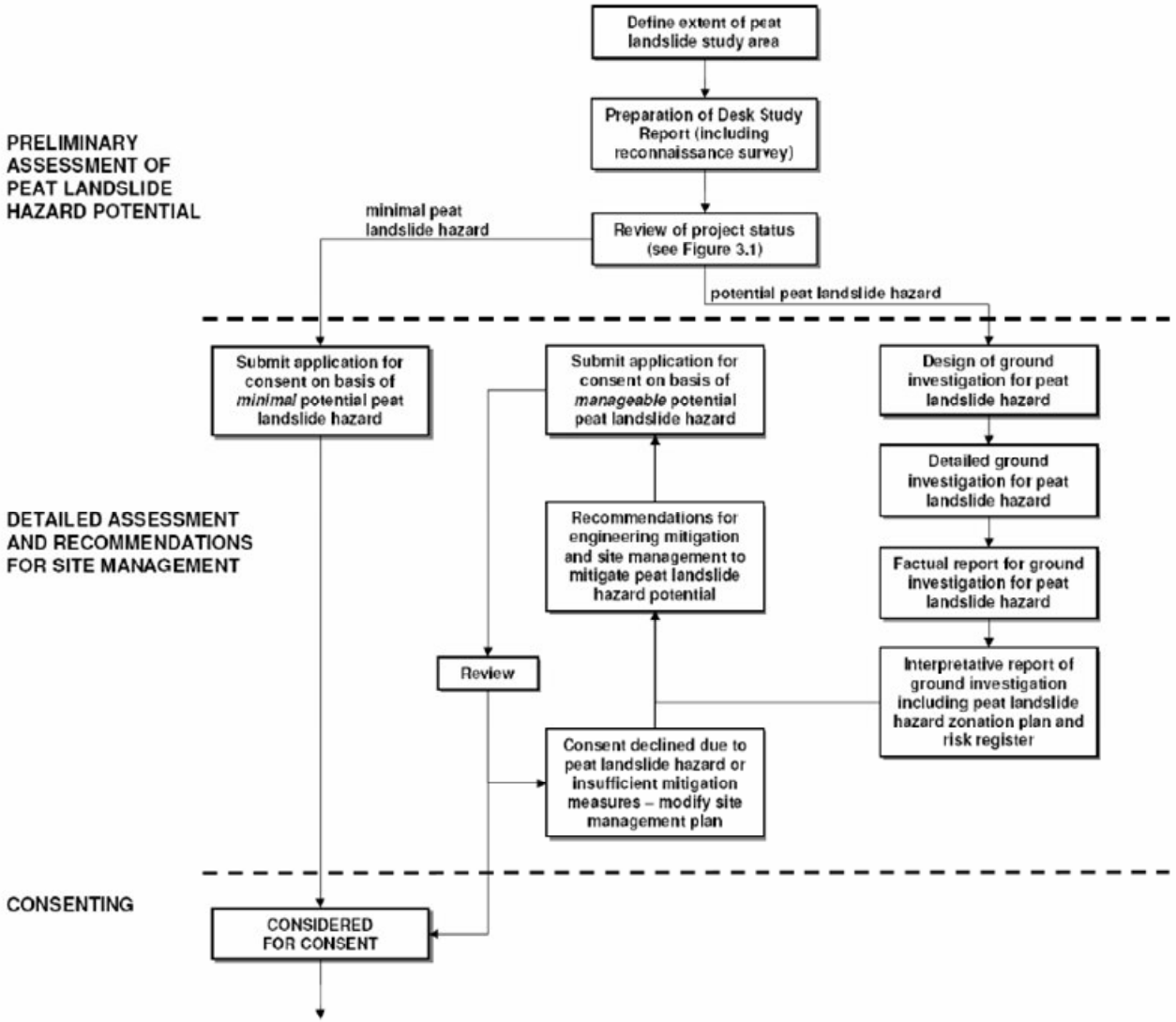


Peat Risk Assessment – Typical Stages That Should Have Been Undertaken Prior To Commencement Of Construction



Source: SE peat Slide Risk Assessment For Electricity Generating Plants, Scottish Executive, Dec 2006

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For Additional Guidance And Support Please Contact Us At:-

Whiteford *Geoservices Ltd*

Straid House, 2 Main Street,

Straid, BALLLYCLARE BT39 9NE

Tel: 0044 (0)28 9334 9351
Fax: 0044 (0)28 9334 9352

Email: john@whitefordgeoservices.com