APPENDIX 8-1

PEAT STABILITY RISK ASSESSMENT REPORT

Clonberne Wind Farm
Peat Stability Risk Assessment (PSRA)

Client	**MKO**
Document Ref.	20021-R-01-03
Project Title	Clonberne Wind Farm
Date	09/04/2024

Project Title:	Clonberne Wind Farm
Report Title:	Clonberne Wind Farm Peat Stability Risk Assessment (PSRA)
Document Reference:	20021-R-01-03

Client:	MKO
Ultimate Client:	Clonberne Windfarm Ltd.
Confidentiality	Client Confidential

REVISION HISTORY

Rev	Date	Reason for Issue	Originator	Checker	Reviewer	Approver
00	27/07/2022	First Issue	IPP	NOB/EA	LB	LB
01	19/01/2024	Update to reflect updated layout	CE	SC	PQ	PQ
02	26/02/2024	Update to address MKO comments	CE	SC	PQ	JOD
03	09/04/2024	Update to address final MKO comments	CE	SC	PQ	JOD

DISCLAIMER

Gavin & Doherty Geosolutions Ltd. (GDG) has prepared this report for the sole use of MKO (hereafter the “Client”) in accordance with the terms of a contract between the Client and GDG. No other warranty, express or implied, is made as to the professional advice contained in the report or any other services provided by GDG. This report is confidential to the Client and may not be shared with or relied upon by any other party without the prior and express written agreement of GDG. GDG assumes no liability or duty of care to any third party in respect of or arising out of or in connection with this report and/or the professional advice contained within.

REVISION SUMMARY

Rev	Date	Section(s)	Detail of Change
01	19/01/2024	All	Revision to account for updated layout.
02	26/02/2024	All	Revision to address MKO Comments
03	09/04/2024	All	Revision to address final MKO comments

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

EXECUTIVE SUMMARY

MKO commissioned Gavin and Doherty Geosolutions (GDG) to undertake a Peat Stability Risk Assessment (PSRA) for the proposed Clonberne Wind Farm (the "Proposed Project). A peat stability assessment is required in accordance with planning guidelines compiled by the Department of the Environment, Heritage and Local Government (DoEHLG), where peat is present on a proposed wind farm development.

The purpose of this report is to outline the potential for peat instability at the Proposed Project and to outline a quantitative peat stability risk assessment rating in line with the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (PLHRAG, Scottish Government, 2017) for the proposed permanent development footprint.

The peat stability risk assessment findings showed that the site has an acceptable margin of safety and low risk of peat failure and is suitable for the proposed renewable energy development.

Consultation with published GSI maps and the observations from site investigations indicate that a large proportion of the site consists of cut-over Raised Peat. Peat is mapped across the site, aside from small areas at the far eastern, southern and western site boundaries. Recorded peat thicknesses range from 0-6.65m across the site. In total, 67% of recorded peat thicknesses were under 1m, and 85% were under 2m. Areas of deep peat of >2m in thickness have been recorded near T07 and T11, and also along access tracks in the northern and central portions of the site.

A desk study, site walkovers, ground investigation campaigns, stability analyses and a risk assessment were carried out to assess the risks posed by peat failures within the Proposed Project site. The risks were assessed following the principles in Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive, 2017).

The stability analysis aims to determine the Factor of Safety (FoS) of the peat slopes. The FoS provides a direct measure of the degree of stability of a peat slope. A FoS of less than 1.0 indicates that a slope is unstable; a target FoS for slopes is 1.3 or greater.

A risk assessment was carried out considering the FoS value calculated in the stability analysis and other factors that could influence peat stability, considering how damaging a peat slide would be to this site's environment.

The wind farm elements (turbines, substation and construction compounds) of the Proposed Project were found to have acceptable safety factors and risk levels against peat instability. One small area, referred to as a safety buffer (see Appendix L), has been highlighted and will have restricted construction activities. Forty-six small areas across the Proposed Project have been identified as peat stockpile restriction areas and should not be used to place peat or spoil. The proposed permanent development footprint avoids these areas, aside from a few areas discussed in greater detail in Section 4.6.3.

1 INTRODUCTION

1.1 BACKGROUND

Gavin and Doherty Geosolutions (GDG) was commissioned in June 2019 by MKO to undertake a Peat Stability Risk Assessment (PSRA) for the proposed Clonberne wind farm site, hereafter referred to as "the Proposed Project". The Proposed Project layout is presented in Appendix A.

1.2 STATEMENT OF AUTHORITY

GDG has been involved in many wind farm developments in both Ireland and the UK at various stages of development, i.e. preliminary feasibility, planning, peat stability assessment, design and construction. In addition to this, the GDG team, made up of engineering geologists, geomorphologists, geotechnical engineers and environmental scientists, has developed expertise in landslide hazard mapping, including leading a recent national landslide hazard mapping pilot study which included extensive landslide runout and hazard mapping and calculation in Irish blanket peat.

GDG brings together state of the art research and direct industry experience and offers a bespoke engineering service, delivering the most progressive, reliable, and efficient designs across a wide variety of projects and technical areas, including providing forensic engineering and expert witness services to the Insurance and Legal sectors. Our clients include large civil engineering contractors, renewable energy developers, semi-state bodies and engineering and environmental consulting firms.

GDG has been involved in many wind farm developments in both Ireland and the UK at various stages of development, i.e. preliminary feasibility, planning, peat stability assessment, design and construction. The GDG team, made up of engineering geologists, geomorphologists, geotechnical engineers and environmental scientists, has developed expertise in the design and construction of developments in areas of peat.

The members of the GDG team involved in this assessment include:

- **Paul Quigley – Project Director**. Paul is a Chartered Engineer with over 26 years of experience in geotechnical engineering and a UK Registered Engineering (RoGEP) Advisor. He has worked on a wide variety of projects for employers, contractors and third parties, gaining a range of experience, including earthworks for major infrastructure schemes in Ireland and overseas, roads, tunnelling projects, flood protection schemes, retaining wall and basement projects, ground investigations and forensic reviews of failures. Paul is adept at designing creative solutions for complex problems and has published numerous peer-reviewed technical papers. He has also acted as an independent expert for several legal disputes centred on ground-related issues. He is a reviewer for the ICE Geotechnical Engineering Journal, a member of the Eurocode 7 review panel at NSAI and a former Chairman of the Geotechnical Society of Ireland.
- **John O'Donovan**. John leads the onshore renewable sector at GDG. He completed his PhD at Imperial College, investigating the use of DEM to model wave propagation techniques to measure small-strain soil stiffness. After completing the PhD, John spent 2.5 years working with BH's Ground Engineering Group. He has over ten years of experience in engineering and seven years in his current role. At GDG, John manages onshore wind farm projects and solar farm projects. John specialises in dealing with difficult ground conditions and providing robust designs for projects in peatland areas. John also works on the landfall and onshore aspects of offshore windfarms, including cable routing and onshore substation foundation design.

- **Stephen Curtis**. Stephen is a Senior Engineering Geologist on the onshore renewables team. He has over seven years of experience in both site investigation contracting and geotechnical consultancy environments. He is Chartered with the Institute of Geologists of Ireland (IGI) and the European Association of Geographers. Stephen has worked on multiple renewable energy projects, primarily solar and wind farm projects in Ireland and the UK, for over four years. He has been involved in the feasibility study, planning, design and construction stages of wind and solar farm developments, focusing on geotechnical risk management and mitigation for construction in upland peat areas and Irish glacial ground conditions.
- **Chris Engleman**. Chris is a Geologist with a Master's degree in Geological Sciences from the University of Leeds. He has four years of industry experience within the onshore renewables sector and the field of geological mapping with a particular focus on Quaternary geology, predominantly working on projects for peat stability and management, ground investigation, rock and soil logging, GIS mapping and geotechnical design. Chris has worked on several renewable energy projects, particularly wind and solar, for over two years. Chris supervised site investigation works at the Proposed Project in 2023.
- **Brian McCarthy**. Brian is a Civil Engineer within the infrastructure team in GDG with two years of post-graduate experience. Brian holds a Master's degree in Civil, Structural and Environmental Engineering from University College Cork and is a member of the Institution of Engineers of Ireland. Brian has worked on various renewable energy and infrastructural projects in Ireland and the UK and has carried out peat probing on several projects throughout Ireland. Brian lead peat probing site investigation works at the Proposed Project in 2023.
- **Efstathia Chioti**. Efstathia is a Geotechnical Engineer within the structures team in GDG with 2 years of industry experience. Since joining GDG, Efstathia has completed geotechnical design work on various projects, including retaining wall design, shallow foundation design and earthworks, and ground movement assessment in Ireland and the UK. She has strong technical skills within geotechnical design. Efstathia lead peat probing site investigation works at the Proposed Project in 2023.
- **Daniel Murphy.** Daniel is a Graduate Engineer working in both the GDG Infrastructure team and the Structures team. He has a Masters' degree in Civil Structural and Environmental Engineering from University College Cork and has been working with GDG since graduating in 2022. Daniel has worked on a variety of Temporary Works and Permanent Works design projects in Ireland and the UK. Daniel has carried out site inspections, visual assessments of slopes, peat probing and water sampling on a number of projects throughout Ireland. Daniel carried out peat probing at the Proposed Project in 2023.

1.3 PROPOSED PROJECT

The Proposed Project is located approximately 14km northeast of Tuam and approximately 6.5km southeast of Dunmore in Co. Galway. The approximate location of the centre of the site is X554464, Y756549 in Irish Transverse Mercator (ITM). The proposed site covers approximately 353 hectares (Appendix A, Figure A- 1).

The Proposed Project Description is detailed in Chapter 4 of the Environmental Impact Assessment Report (EIAR), which includes the works subject to a proposed planning application for An Bord Pleanála in relation to the Proposed Wind Farm Site.

The Proposed Wind Farm Site will comprise the elements listed below:

1. 11 No. wind turbines and associated hardstand areas;
    a. Tip Height of 180m
    b. Rotor Diameter of 162m
    c. Hub Height of 99m
2. A 35-year operational life from the date of full commissioning of the wind farm and subsequent decommissioning;
3. Upgrade of existing tracks/ roads and provision of new site access roads, junctions, and hardstand areas;
4. All works associated with the provision of a new permanent site entrance off the R328 Regional Road in the townland of Killavoher;
5. 2 no. Temporary construction compounds;
6. 1 no. Borrow pit;
7. Peat, Spoil and Overburden Management Areas;
8. 1 no. permanent 220kV electrical substation which will be constructed in the townland of Cloonarkan. The proposed electrical substation consists of a two-storey control building with welfare facilities, all associated electrical plant and equipment, battery storage system, security fencing, all associated underground cabling, wastewater holding tank and all ancillary works and equipment;
9. Underground electrical (33kV) and communications cabling from the proposed wind turbines to the proposed 220kV substation;
10. All works associated with the connection of the Proposed Project to the national electricity grid, via the provision of the underground electrical cabling (220kV) to the existing 220kV overhead line in the townland of Laughil;
11. The provision of 2 no. new interface towers to facilitate the connection to the existing overhead line;
12. Provision of 1 no. joint bays, communication chambers and earth sheath links along the underground electrical cabling route;
13. Reinstatement of the road or track surface above the proposed cabling trench along existing roads and tracks;
14. Junction Accommodation works to facilitate turbine delivery;
15. Site Drainage;
16. Peatland Enhancement
17. Tree Felling;
18. Operational stage site signage; and
19. All associated site development works and apparatus

The Proposed Project has been designed with an operational life of 35 years, at the end of which it can be decommissioned. The Applicant is therefore seeking a ten-year permission and a 35-year operational life from the Proposed Project's commissioning date.

Refer to Chapter 4 of the EIAR for a detailed description of the development.

This report examines the conditions at the Proposed Project Site, located within the EIAR Site Boundary as defined in Chapter 1 of the EIAR, and does not analyse the transport delivery route. The transport delivery route has not been included in this report as no peat stability risk is expected along the route. Works on the transport delivery route are not expected to be carried out in peat material and will not require excavating or placing significant amounts of material (See Figure G- 2 in Appendix G). The '*Proposed Project'* or '*Site'* in this report refers to the core of the Proposed Project as defined in Chapter 4 of the EIAR. Methodologies for the construction of turbines and infrastructure elements and management of peat are considered in detail in EIAR Appendix 4-2 Peat and Spoil Management Plan. Piled foundations will be used as an alternative to gravity base foundations where the ground conditions require it. Gravity foundations will be utilised at T1-T4 with precast piles the only alternative being considered at these locations.

1.4 OVERVIEW OF PEAT LANDSLIDES

1.4.1 PEAT LANDSLIDE TYPES

The literature typically refers to two general groups of peat landslides: peat slides and bog bursts. Some descriptions of each type are provided in Table 1-1.

Table 1-1: Peat landslide types.

Characteristics	Peat slide	Bog burst
Outstanding characteristic	Shallow translational failures	Particularly fluid failures without necessarily a clear scar margin. The liquefied basal material is expelled through surface tears followed by settlement of the overlying mass.
Mechanism	Shear failure along discrete shear surfaces, typically at the peat-substrate interface	Subsurface creep, swelling
Peat depth	≤ 2 m	≥ 1.5 m
Slope angle	5 – 15° (moderate)	2 – 10° (gentle), where deeper peat is more likely
Spatial distribution	Scotland, England and Wales	Ireland

The slope angle within the Proposed Project Site ranges from zero to a maximum gradient of 22°, as identified in localised areas along peat cuttings. The majority of the site is largely flat-lying. The site topography is discussed in further detail in Section 2.7. Evidence of large past landslides has not been identified within the proposed wind farm site and the near surroundings on the available Google Earth imagery (available from 2010 onwards), nor during the fieldwork. An area of potential instability has been identified at the margins of a drain in the southeast corner of the area proposed for rewetting as part of the Proposed Peatland Enhancement. This instability is discussed in more detail in Section 2.6. This does not necessarily mean that landslides have never occurred at the wind farm site. Geomorphological features associated with peat landslides (peat slides and bog bursts) are typically softened with time through erosion, drying, and re-vegetation (Feldmeyer-Christe & Küchler, 2002; Mills, 2003). Additionally, human activity (e.g., grassland activity and deforestation) may hamper the identification of possible landslides.

1.4.2 CONTROLS OF PEAT INSTABILITY

The spatial and temporal occurrence of landslides, including peat landslides, is controlled by *conditioning* and *triggering factors*. The conditioning factors explain the spatial distribution of landslides and are related to the inherent properties of the terrain, such as soil type, slope angle, curvature (convex/concave) of the slopes, and drainage.

The triggering factors explain the frequency of landslides. They can be distinguished between fast and slow triggers:

- Fast triggers:
    - Intense rainfall (the most frequent trigger);
    - Snowmelt (very frequent trigger; Warburton, 2022);
    - Rapid ground accelerations (e.g. from blasting rock);
    - Undercutting of peat by natural processes (e.g. fluvial) or man-made; or
    - Loading the peat.

- Slow triggers:
    - Low intensity but constant rainfall;
    - Afforestation / Deforestation (wildfires, pollution-induced vegetation change); or
    - Weathering (physical, chemical, biological).

Slow triggers can start landslides by themselves and can also act as *preparatory factors* for fast triggers by lowering their threshold to start landslides.

1.4.3 PRE-FAILURE INDICATORS

The presence of conditioning factors and low-pace triggers before failure is often indicated by ground conditions, features, and morphologies that can be identified remotely or during fieldwork by the geomorphologist or through basic monitoring techniques.

According to the updated guidelines provided by the Scottish Executive (2017), the following critical features are indicative of the susceptibility or proneness to failure in peat environments:

- Presence of historical and recent failure scars and debris;
- Presence of features indicative of tension (e.g. cracks);
- Presence of features indicative of compression (e.g. ridges, thrusts, extrusion features);
- Evidence of peat creep (typically associated with tension and compression features);
- Presence of subsurface drainage networks or water bodies;
- Presence of seeps and springs;
- Presence of artificial drains or cuts down to substrate;
- Presence of drying and cracking features;
- The concentration of surface drainage networks;
- Presence of soft clay with organic staining at the peat and (weathered) bedrock interface; and
- Presence of iron pans or similar hardened layers in the upper part of the mineral substrate.

Other evidence of peat instability unrelated to landslides has been considered, namely quaking peat in horizontal areas with very low bearing capacity.

1.5 PEAT STABILITY RISK ASSESSMENT WORKFLOW

GDG has carried out the PSRA for the Proposed Project Site following the principles set out in the *Proposed electricity generation developments: peat landslide hazard best practice guide* (Scottish

Executive, 2017). This guide has been used in this report as it provides best practice methods to identify, mitigate, and manage peat slide hazards and associated risks concerning consent applications for electricity generation projects.

Figure 1-1 shows a workflow diagram showing the general methodology for the PSRA. The methodology can be summarised into the following steps:

1. Completion of the desk study, including:
    - Geology and Quaternary sediments (subsoils);
    - Soils;
    - Moisture;
    - Hydrogeology;
    - Multi-temporal aerial / Satellite imagery;
    - Topography;
    - Landslide inventories and landslide susceptibility;
    - Hydrology;
    - Land cover and land use;
2. Relevant academic literature and publications. Undertaking a walkover and fieldwork to:
    - Carry out geo-investigations, especially concentrated at the proposed infrastructure areas, including peat probing, hand shear vane testing, and trial pitting;
    - Record geological and geomorphological features, including exposures of the soil profile and evidence of peat instability; and
    - Record hydrologic and vegetation features.
3. Risk assessment, including:
    - Interpolation of the peat probe values and generation of the peat depth map;
    - Creation of the Factor of Safety (FoS) maps using a deterministic approach (Bromhead, 1986) for drained and undrained conditions;
    - Qualitative hazard assessment by combining the FoS with observations of the peat condition identified both on aerial imagery and during fieldwork.
    - Qualitative consequences assessment;
    - Calculation of the peat landslide risk by multiplying hazards and consequences;
    - Classification of the risk values into four classes:
        - Negligible;
        - Low;
        - Medium; and
        - Serious.
4. Proposal of actions required for each infrastructure element.

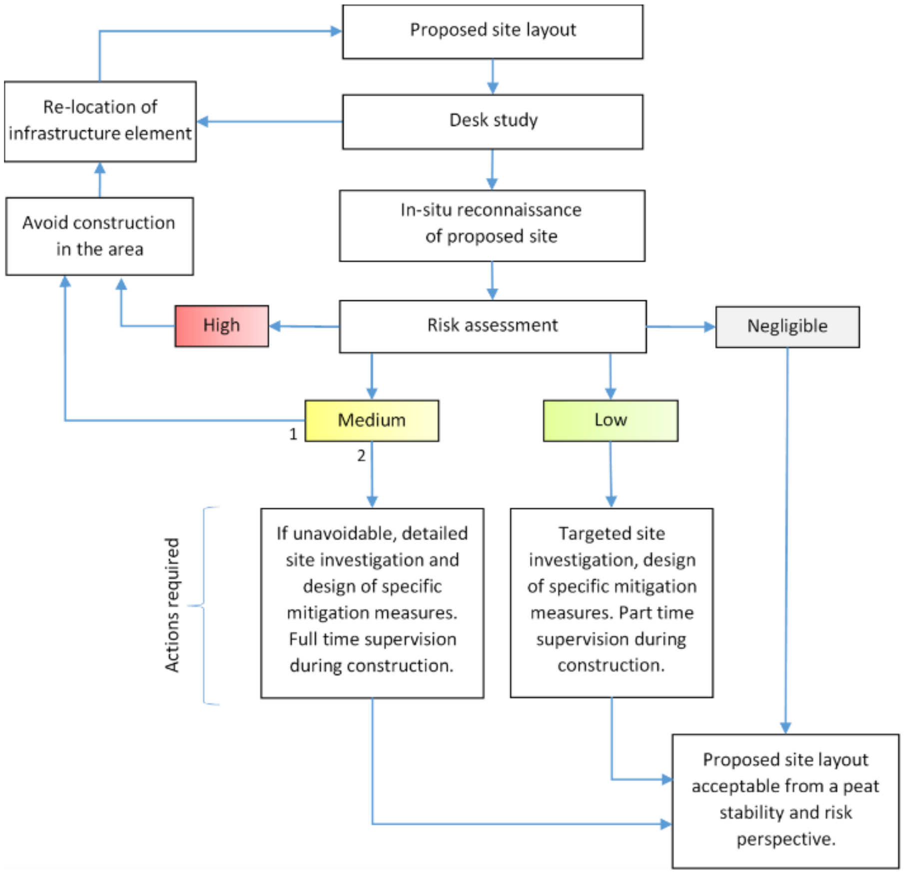


Figure 1-1: Workflow of the PSRA methodology for the acceptability of the proposed site layout (Scottish Executive, 2017).

2 DESK STUDY

For a preliminary site suitability analysis and background knowledge of local peat stability and ground conditions, the following aspects have been considered:

1. Geology and Quaternary sediments (subsoils);
2. Soils;
3. Moisture;
4. Hydrogeology;
5. Multi-temporal aerial / Satellite imagery;
6. Topography;
7. Landslide inventories and landslide susceptibility;
8. Hydrology;
9. Land cover and land use;
10. Relevant academic literature and publications.

2.1 BEDROCK GEOLOGY

According to the GSI bedrock geological map of Ireland at 1:100,000 scale (GSI, 2020a) (Figure B- 1), the bedrock under the wind farm site is limestone of the Burren Formation. Pale grey packstones and wackestones typify this formation but also contain intervals of dark cherty limestones, often associated with oolitic grainstones. No GSI borehole data is available for the Proposed Project.

As limestones dominate the underlying geology of the site, karstic features may be present and present additional risks. According to GSI mapping, a spring is located at the west end of the wind farm area, north of T7. Other karst features, namely enclosed depressions and turloughs, are situated beyond the limits of the development area, at about 2km West of the site boundary.

2.2 QUATERNARY SEDIMENTS

The map of Quaternary sediments at 1:50,000 scale shown in Figure B- 2 in Appendix B (GSI, 2021) shows that the wind farm site is located primarily on cut-over raised peat. Cut-over raised peat consists of discreet, raised, dome-shaped masses of peat that have had part of their peat volume removed by anthropogenic peat harvesting methods. Parts of the site area consist of uncut raised peat bog, surrounded by cut-over peat. These raised bog areas are located between T1 and T3, to the east of T7, and in the area proposed for peatland enhancement between T10 and T11.

Alluvium deposits are not mapped within the site boundary; however, some form of alluvium is expected to be present adjacent to most of the minor watercourses that cross the site.

Pockets of Till derived from limestones are mapped throughout Proposed Project, largely corresponding with small ridge features mapped by the GSI as drumlins. Glacial till consists of typically over consolidated sediments directly deposited by glacial action and can vary between cohesive clays and sands and gravels. A small patch of gravels derived from limestones is mapped near T04. The proposed borrow pit is also mapped as underlain by gravels derived from limestones.

2.3 SOIL COMPOSITION

The Irish soil map at a 1:250,000 scale is shown in Figure C- 1 in Appendix C (EPA, Teagasc, & Cranfield University, 2018). The Proposed Project Site is covered mainly by:

- Peat (soil association 1xx)

- Coarse loamy drift with limestone (soil association 1100q)
- Coarse loamy over calcareous gravels (Soil Association 1150a).

It is noted that the presence or absence of peat cover in the regional scale maps (Figure B- 2 and Figure C- 1) must not be taken as exact. The depth and extent of peat deposits may vary over short distances as a function of local underlying geology, past and ongoing geomorphological activity, and management history. Therefore, these maps have been complemented by peat probes and field observations described in Section 3.

2.4 MOISTURE

Water reaching a slope can produce the following processes:

- Lubrication. It reduces friction along rock or soil discontinuities (joints or stratification) (Wu, 2003). In clay soils, lubrication is due to water that produces a repulsion or separation between the clay particles.
- Softening. It mainly affects the physical properties of filler materials in fractures and fault planes in rocks.
- Pore pressure. Water in soil pores exerts pressure on soil particles, changing the effective pressure and the shear strength. The negative impact of pore pressure changes is particularly evident in partially saturated or unsaturated soils, where the increase in moisture content causes the development of a wetting front that converts beneficial negative suction stresses within the capillary structure of the soil to a fully saturated positive pore pressure. When soil is saturated, capillary stresses and adhesion between particles diminish, and, as a result, soil shear strength decreases.
- Confined water pressures. The confined underground water acts as an uplifting pressure on the impermeable layers, decreasing the shear strength and producing hydrostatic pressures on the layers where permeability changes. These lifting stresses can cause material deformation or failure, and pore pressure decreases soil resistance.
- Fatigue failure due to fluctuations in the water table. Some landslides occur in episodes of rain with lower intensity than previous ones. This phenomenon is explained by Santos et al. (1997) as a case of soil fatigue due to cyclical pore pressures. In temperate climates, seasonal temperature variations can lead to slight variations in the water table. These changes are much more significant in tropical climates (Xue & Gavin, 2008).
- Washing away of cement material. The groundwater flow can remove the soluble cement (e.g. calcium carbonate) from the soil and, thus, decreases the cohesion and the friction angle. This process is usually progressive.
- Density increase. The presence of water in soil pores increases the bulk density and weight of the materials in the slope. Therefore, shear stress increases, and the slope safety factor decreases.
- Internal hydraulic forces. The movement of groundwater currents creates hydrodynamic pressure on the ground in the direction of flow. This force acts as a destabilizing element on the groundmass and can appreciably decrease the safety factor of the slope. The hydrodynamic or seepage/flow force can also cause the movement of the particles and the destruction of the soil mass (piping).

- Collapse. Collapsible soils (alluvial soils deposited very rapidly and wind soils or loess) are very sensitive to changes in humidity. When water content increases, their volume decreases, and the microstructure collapses.
- Desiccation cracks. Changes in humidity can cause cracking, and these cracks can determine the extension and location of the surface of failure and have a significant effect on the safety factor or possibility of sliding.
- Piping in clays. Some clayey soils disperse and lose their cohesion when saturated. The result can be the total collapse of the soil structure and the activation of landslides.
- Chemical weathering: Processes of ion exchange, dissolution, hydration, hydrolysis, corrosion, oxidation, reduction, and precipitation (Wu, 2003).
- Erosion. The detachment, dragging, and deposition of soil particles by water flows modifies the relief and the stresses on slopes and can produce the activation of a landslide, especially when erosion undercuts slopes.

The *Normalized Difference Moisture Index Colorized* GIS service or the United States Geological Survey (USGS) has been used to estimate levels of moisture in the soil across the Proposed Project site. This service is based on the analysis of multispectral Landsat 8[1] OLI images. Using data processing, the raw digital number (DN) values for each Landsat band are transformed to scaled (0 - 10000) apparent reflectance values, and then, the Normalised Difference Moisture Index is obtained using Equation 2.4-1 (Gao, 1996):

$$\text{NDMI} = (\text{Band } 5^{2} - \text{Band } 6^{3}) / (\text{Band } 5 + \text{Band } 6) \qquad \textbf{Equation 2.4-1}$$

Figure D- 1 in Appendix D illustrates the levels of estimated soil moisture across the Proposed Project Site as calculated by the above method. Wetlands and other vegetated areas with high levels of moisture appear as dark blue. Regions of lower moisture values are represented as light blue and green. The map indicates that the Proposed Project site as a whole displays a high moisture content.

2.5 HYDROGEOLOGY

According to the GSI Bedrock Aquifer map (2018), shown inFigure E- 1 in Appendix E, the entirety of the Proposed Project is underlain by a Regionally Important Aquifer – Karstified (conduit). This aquifer is classed as capable of supporting large public water supplies sufficient to support a large town.

The GSI Subsoil Permeability map (2018), shown in Figure E- 2 in Appendix E, indicates that almost the entirety of the site is of low permeability. A small area close to T03 is currently unmapped, and the proposed borrow pit ranges from medium to high permeability.

2.6 MULTITEMPORAL AERIAL/SATELLITE IMAGERY

The aerial / satellite imagery used for this report is the ESRI orthophoto (OTF) and the Google Earth multitemporal imagery (2009 onwards). This imagery has been used to:

---

[1] Landsat 8 includes 8-band multispectral scenes at 30-meter resolution which are typically used for mapping and change detection of agriculture, soils, moisture, vegetation health, water-land features and boundary studies.

[2] Near Infrared (NIR)

[3] Short Wave Infrared 1 (SWIR1)

- Identify the presence of existing failure scars and the extent of debris runout;
- Identify pre-conditioning factors for failure (where visible at the resolution of the imagery);
- Identify evidence of other pre-development ground conditions of relevance to ground works but not exclusively associated with landslides, including vegetation cover, drainage regime and dominant drainage pathways; and
- Identify evidence for land management practices that can influence ground conditions (e.g., burning, artificial drainage, peat cutting, forestry). Figure 2-1 and Figure 2-2illustrate examples of peat cutting and the evolution of the peat extent from 2009 to 2023 due to peat harvesting in the sector of T7 and T10-T11, respectively (2009 shown in green, 2016 shown in blue, 2018 shown in yellow, and 2023 shown in red). In particular, it must be noted that peat harvesting in proximity to T07 has moved areas of deep peat away from the T07 turbine location since the date of the topo capture used in the peat stability calculations (2017).

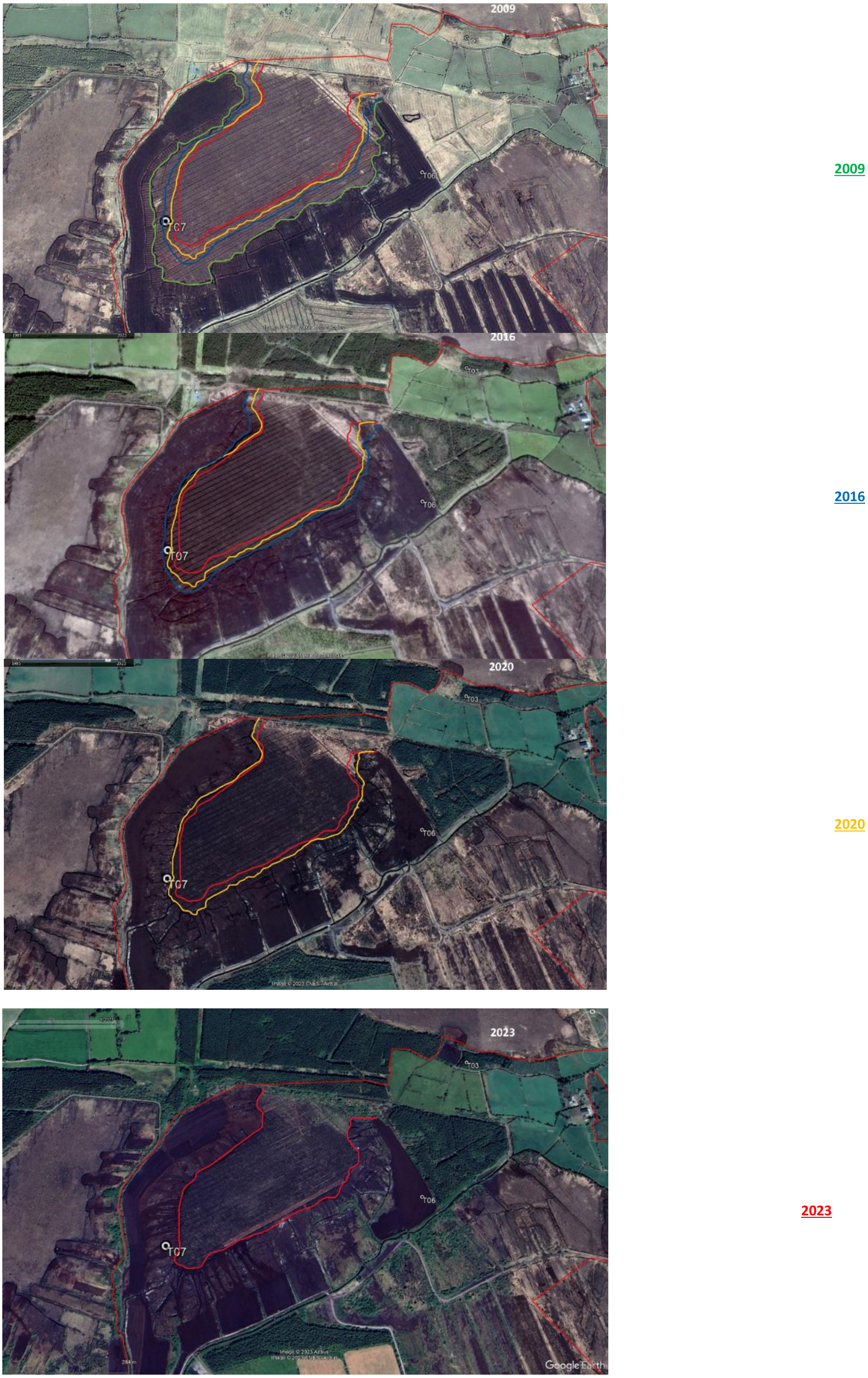


Figure 2-1: Peat cuts and harvesting at T07, showing the retreat of peat cuts from the turbine location (Google Earth, 2009-2023).

Note: Google Earth imagery from 2009 to 2023. Green line: 2009. Blue line: 2016. Yellow line: 2020. Red line: 2023.

Figure 2-2: Peat cuts and harvesting in the T10-T11 zone (Google Earth, 2009-2023).

Note: Google Earth imagery from 2009 to 2023. Green line: 2009. Blue line: 2016. Purple line: 2023.

It is noted that the time-lapse of the available imagery is too short to identify old peat instability evidence that may have been eroded or re-vegetated with time or changes in land management.

A potential existing failure has been identified at the southeast corner of the area proposed for peatland enhancement, as seen in Figure 2-3. Minor tension cracks suggesting a potential partial failure of the peat cut margin are identified in this location. The aerial imagery analysis suggests that these features are associated with desiccation and drying out of the peat in this location.

Figure 2-3: Possible minor failure at the southern edge of the area proposed for peatland enhancement as part of the Proposed Peatland Enhancement Area (ESRI World Imagery, 2020).

2.7 TOPOGRAPHY

A Digital Terrain Model derived from Bluesky (2017) orthophoto data was used for the topographical analysis and is shown in Figure 2-4 and Figure F- 1 in Appendix F.

The topography of the site is largely low-lying and flat, with low NW-SE oriented ridges mapped by the GSI as drumlins running across the site. The peat bogs on site occupy generally flat depressions between the drumlins, with raised peat bog areas forming topographic highs relative to areas of cut-over peat. The topography of the site can be described as flat to undulating raised bog plain. The elevation varies between 63 mOD to 87 mOD (meters above ordnance datum). Slope angles across the site range from 0-22° (Figure F- 2 in Appendix F), however the vast majority of the site has a slope angle of <1°. Higher slope angles >5° are found only in isolated areas alongside drainage ditches, peat cuts, and alongside the margins of low ridge features, identified as drumlins, 100m SE of T3 and 70m South of T9. No peat is identified at the drumlin locations close to T3 or T9.

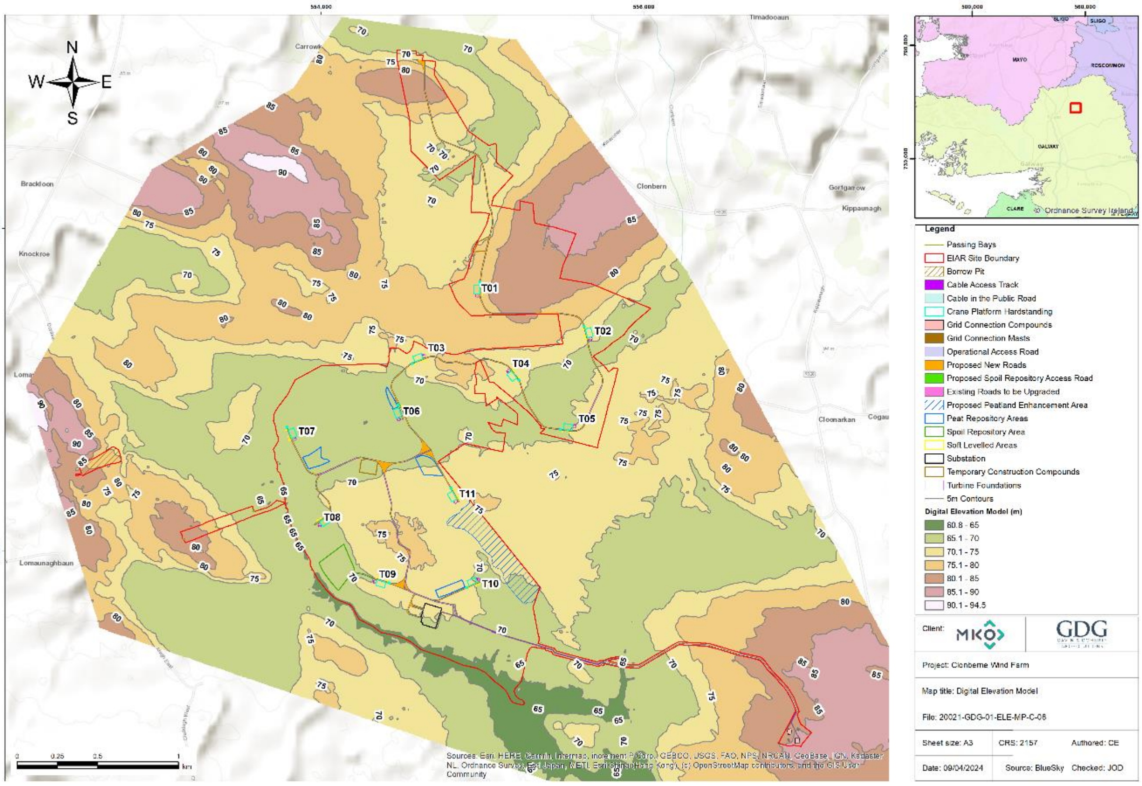


Figure 2-4: Digital Elevation Model for the Proposed Project, (Bluesky, 2017).

2.8 SLOPE INSTABILITY MAPPING

The GSI landslide inventory (GSI, 2022a), the multi-temporal aerial / satellite imagery, the DEM, the landslide susceptibility map (GSI, 2016), and the rainfall information of Met Éireann data 1981-2010 have been used for this part of the desk study.

Figure G- 2 in Appendix G depicts the spatial relationship between records of previous landslide events (GSI, 2022a, 2022b) and rainfall across Ireland from the Met Éireann (2018) average annual rainfall dataset. The study area is in a region of moderately high rainfall and relatively flat topography. According to the GSI landslide inventory (GSI, 2022), the closest landslide is located around 5.3 km northeast of the closest turbine (T01) and around 3.9km from the site boundary. The area of the peat slide was not recorded, but it is recorded to have occurred in 1873 and “moved quickly first and continued slowly for 11 days” (Praeger, 1893). This landslide resulted in the peat "burying three farmhouses and covering about 300 acres of pasture and arable land, 6 feet deep". Little other information is available, but this location appears to be a relatively flat, deep raised peat bog, and therefore, the failure mechanism was likely a margin rupture (Warburton et al. 2004) triggered bog burst event caused by the extraction of peat from the raised bog due to steep cuttings (7-9m high), removing toe support for the high raised bog. Figure 2-5 shows the location and visible evidence of this bog burst event. Much of the outflow area has been modified and cut away subsequent to the event. However, the source area is still visible on the aerial imagery. A series of crescentic failure scarps are visible, though eroded and revegetated (a common occurrence on old peat failure features – i.e. Feldmeyer-Christe & Küchler, 2002; Mills, 2003).

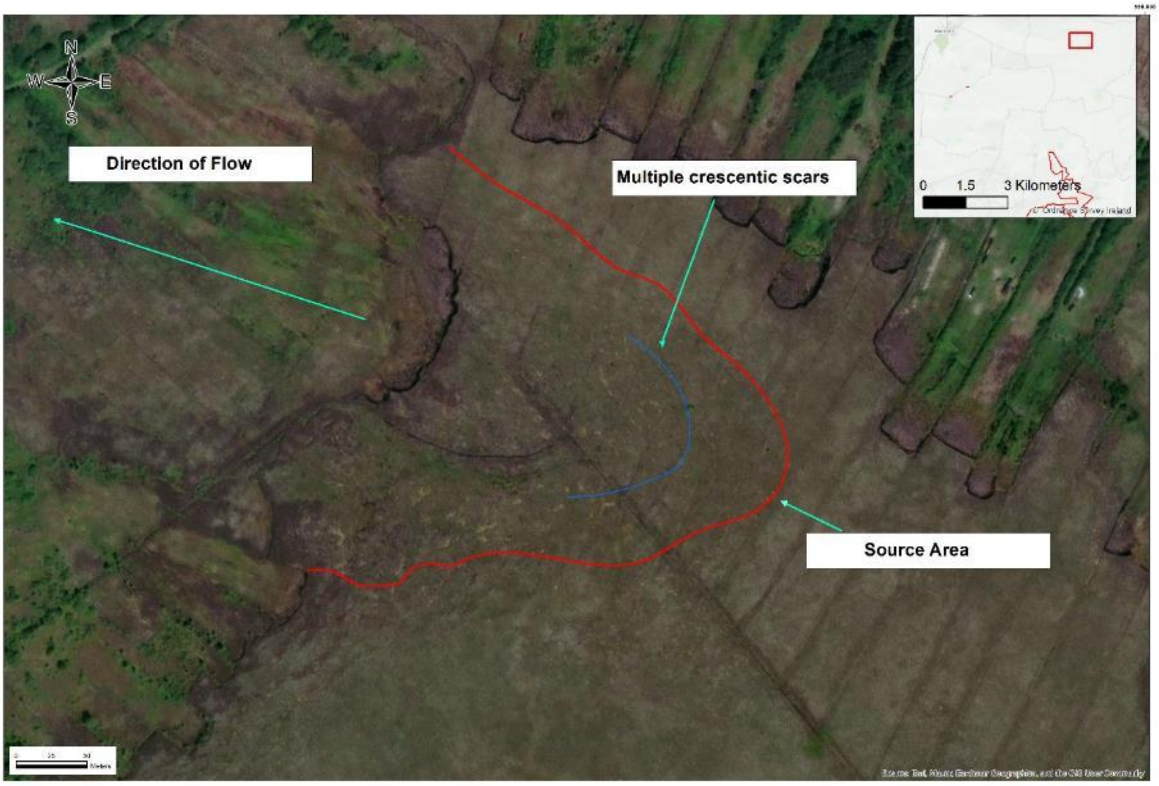


Figure 2-5: Evidence for the bog burst recorded by the GSI at Dunmore, 3km from the EIAR boundary (ESRI World Imagery, 2023).

Figure G- 1 in Appendix G illustrates the landslide susceptibility (GSI, 2016) across the Proposed Project Site. This map was obtained by using an empirical probabilistic method at a regional scale and should provide input into site-specific scale engineering studies. Most of the site is mapped as having low susceptibility due to the low slope angles encountered. Small zones of moderately low susceptibility are mapped at the site's west, east, and north ends, where no developments are proposed. The field visits of the geotechnical team support that most of the site is stable.

2.9 HYDROLOGY

According to the Ordnance Survey Ireland (OSi) shapefiles of rivers, lakes, and catchments/basins (Figure H- 1), the site is located within the watershed of two catchments (*Sinking 020* and *Levally Stream 010*). The erosive potential of the fluvial network at this location is likely to be low. T2 and T6 are located quite close (at 50 m or less) to a minor watercourse labelled as *Timadooaun*. The rest of the projected elements (e.g., turbines, borrow pits, etc.) are located more than 50m from any water course.

2.10 LAND COVER AND LAND USE

According to the Corine Land cover map shown in Figure I- 1 in Appendix I, the surrounding landscape of the proposed site comprises mixed forest, peat bog, pastures and mixed agriculture. Land use within the site is mixed, with peat cutting and agricultural land dominating.

3 SITE RECONNAISSANCE AND GROUND INVESTIGATION

GDG conducted a site reconnaissance as part of the assessment, comprising four walk-over inspections (February 2020, March 2020, May 2023, and September 2023) to record geomorphological features concerning the Proposed Project, peat depths, and peat strength. An indication of the site conditions (harvested peat, peat bogs, wetlands, and forestry) with flat topography is shown in Figure 3-1 and Figure 3-2. Access was limited to some areas, in particular, the area proposed for peatland enhancement in between T10 and T11, limiting the number of peat probes taken in this area.

Figure 3-1: Harvested peat close to T11.

Figure 3-2: Peat cuts 100m east of T10.

Seven ground investigations (GI) were carried out on the site:

1) MKO (May 2019): 21 peat probes
2) GDG (February 2020): 47 peat probes and 7 hand shear vanes.
3) GDG (February 2020): 15 trial pits.
4) GDG (March 2020): 47 peat probes.
5) MKO (May-June 2021): 5 open hole boreholes.
6) GDG (May 2023): 40 peat probes and 3 shear vanes.
7) GDG (September 2023): 39 peat probes and 4 shear vanes.

In summary, intrusive ground investigations were carried out at a total of 229 locations. The site investigation locations (Figure J- 1 to Figure J- 3 in Appendix J) considered the following criteria:

- Spatial distribution of the proposed infrastructure;
- Distance between probe points to avoid interpolation of peat depths across large distances;
- Changes in slope angle, as peat depths are likely to be shallower on steeper slopes;
- Changes in vegetation, which can reflect changes in peat condition;
- Changes in hydrological conditions; and
- Changes in land use.

No evidence of any previous landslides or peat instability indicators, as described in Section 1.4.3, were identified during the walkovers.

A raster map was created in GIS software presenting the interpolated peat depth across a site from the peat probe points using the Inverse Distance Weighted (IDW) method. This interpolated raster of peat depth is represented in Figure J- 4 to Figure J- 6 in Appendix J.

Table J- 1 to Table J- 15 in Appendix J presents the observations made at the proposed infrastructure. The trial pit logs can be seen in Appendix J.

3.1 GROUND INVESTIGATION SUMMARY AND PEAT CONDITIONS

The ground investigations indicate that the ground conditions at the site comprise predominantly areas of cut-over raised peat of up to 6.65m in depth, with patches of glacial till in the north, centre, and south of the site. Trial pit locations (Appendix J-1) suggest that the peat is typically underlain by granular or cohesive glacial material, with trial pits encountering stiff gravelly clays, gravelly sands, and sandy gravels beneath the peat, or beneath topsoil in several locations. Petersen Drilling Services Ltd. additionally carried out five boreholes for the purpose of the hydrological assessment (Chapter 9 of the EIAR). These boreholes encountered a similar mix of cohesive and granular glacial tills, and all encountered bedrock between 6m bgl and 16m bgl.

The peat thickness encountered by intrusive investigations across the site varies from 0m to a maximum of 6.65m, with an average of 1.68m recorded. Most of the site contains little to no peat, with T1-T4 and T9 being located in areas of no peat, underlain by cohesive or granular glacial tills. Much of the remaining proposed infrastructure, including T5-T7, T10-T11, and the construction compounds, are located in areas of cut-over peat, where turbary peat harvesting has removed significant quantities of peat, reducing peat thicknesses. T08 is located in an area of forestry, planted over peat of up to 2.16m thickness.

The frequency of different peat thicknesses is shown in Figure 3-3. In total, 69.9% of recorded peat thicknesses were under 1m, and 85.6% were under 2m.

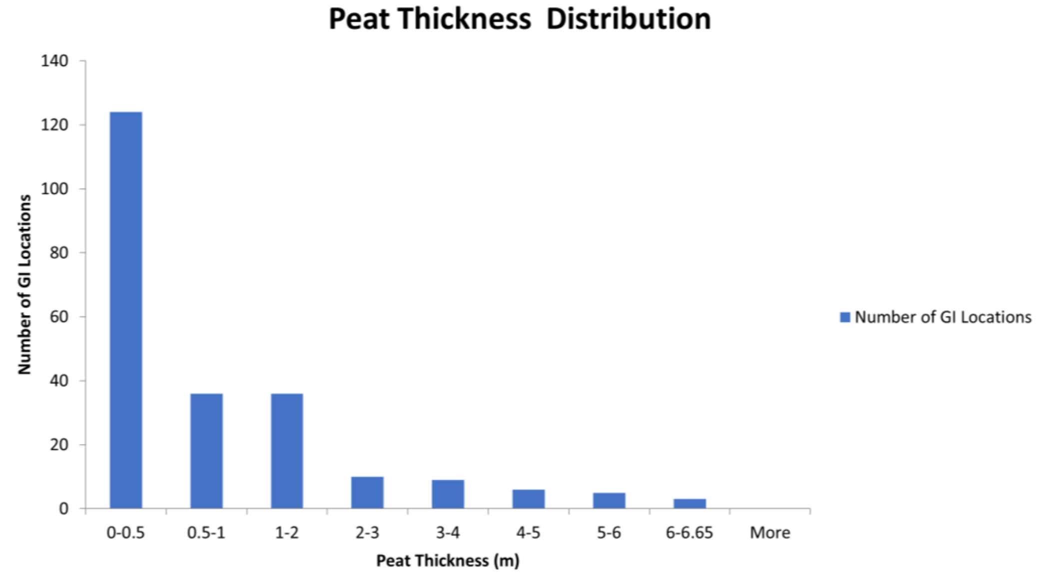


Figure 3-3: Histogram of peat thickness results across the site.

Laterally extensive regions of >2m in depth were encountered in high raised bog settings, particularly to the east of T07, south of T11, northeast of T10, west of T6, and between T01 and T3. These areas of deep peat are restricted to discrete raised bogs, which have been avoided by all major infrastructure locations. The depths encountered are considered moderate to deep in places, with probes identifying peat thicknesses of up to 6.65m.

The walkover indicated that the peat was being cut in several areas and had drained significantly, with the observed peat classified as the catotelm. The surface condition of the peat is varied, with some areas having bare peat at the surface where cutting is active, as shown in Figure 3-1 and Figure 3-2, and some areas of un-cut peat capped by heather, with visible acrotelm. A large variation in the level of decomposition and humification was observed throughout the peat body. However, this generally appeared to increase with depth. Most of the peat material identified at the site is logged as fibrous and pseudo-fibrous, indicating that it is of a higher strength material and will be suitable for landscaping and reinstatement adjacent to proposed infrastructure locations. Hand shear vanes were carried out in 14 locations across the site, ranging from 18-70kPa.

4 PEAT STABILITY ASSESSMENT

The peat stability assessment is one of the inputs required for the peat hazard assessment and risk calculation. This section presents:

- A review of the general approaches to assess peat stability;
- The concept of Factor of Safety (FoS);
- The methodology adopted for this report and the parameters required; and
- The resulting FoS delineates safety buffers and peat stockpile restricted areas.

4.1 MAIN APPROACHES TO ASSESS PEAT STABILITY

The main approaches for assessing peat stability for wind farm developments include the following:

1) Qualitative geomorphological judgement; and
2) Quantitative assessment:
    i) Empirical probabilistic approach.
    ii) Physically based deterministic approach (Factor of Safety – FoS).

Approach 1 is subjective and thus not adopted for this study. Approach 2a is objective and quantitative but is more appropriate for land planning and decision-making studies at a regional scale. Additionally, the method does not provide an engineering indication of physical stability as Approach 2b does. In this report, the peat stability assessment is carried out by using Approach 2b: deterministic (FoS) approach (Bromhead, 1986).

4.2 THE FACTOR OF SAFETY (FOS) CONCEPT

The factor of safety is a measure of the stability of a slope. For any slope, the degree of stability depends on the balance between the landslide driving forces (weight of the slope) and its inherent shear strength, illustrated in Figure 4-1.

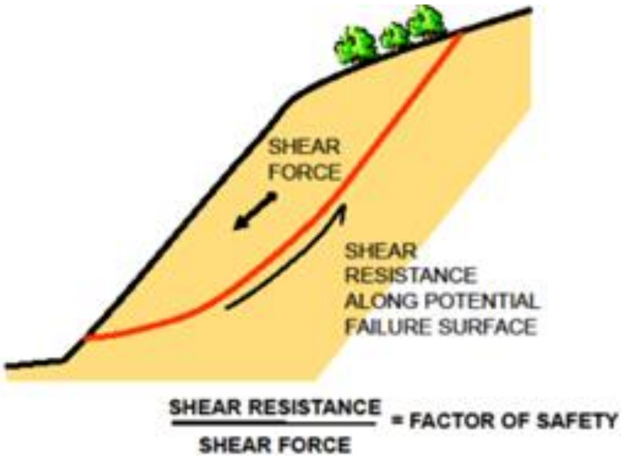


Figure 4-1: Balance of forces in a slope (Scottish Executive, 2017).

Therefore, the factor of safety provides a direct measure of the degree of stability of a slope by the ratio of the shear resistance along a potential surface of failure and the landslide driving forces acting on such surface. Multiple potential surfaces of failure are possible, but the FoS assigned to a slope is that of the surface of failure with the lowest value of FoS.

- FoS < 1 indicates a slope is unstable and prone to failure.
- FoS = 1 indicates a slope is theoretically stable but not safe.
- FoS ≥ 1.3 indicates the acceptable safety threshold. The previous code of practice for earthworks BS 6031:1981 (BSI, 1981) provided advice on the design of earthworks slopes. It stated that for a first-time failure with a good standard of site investigation, the design FoS should be greater than 1.3. This way, the slope is stable and safe.

As a general guide, the FoS limits for peat slopes assumed in this report are summarised in Table 4-1.

Table 4-1: Factor of Safety limits assumed in this report.

Factor of Safety limits	Slope stability
FoS < 1	Unstable
1 ≤ FoS <1.3	Stable but not safe
FoS ≥ 1.3	Stable and safe

Eurocode 7 (EC7) (IS EN 1997-1:2005) is now the reference document and basis for design geotechnical engineering works. The design philosophy used in EC7 applies partial factors to soil parameters, actions and resistances. Unlike the traditional FoS approach, EC7 does not provide a direct measure of stability, as global factors of safety are not used.

Therefore, to provide a direct measure of the peat stability across the site, the previous FoS method has been used for this assessment rather than EC7 partial factors.

4.3 METHODOLOGY ADOPTED AND PARAMETERS

The stability of a peat slope depends on several factors working in combination, namely the slope angle, the peat's shear strength, the peat, the depth of the peat, the pore water pressure and the loading conditions. An adverse combination of these factors could potentially result in peat failure. An adverse value of one of the factors mentioned above alone is unlikely to result in peat failure. The infinite slope model (Skempton and DeLory, 1957) combines these factors to determine a safety factor for peat sliding in the study area. This model is based on a translational slide, which is a reasonable representation of the dominant mode of movement for peat failures.

To determine the stability of the peat slopes in the study area, undrained (short-term stability during construction) and drained (long-term stability during operation) analyses have been carried out.

4.3.1 UNDRAINED CONDITIONS

The undrained loading condition applies in the short term during construction and until construction-induced pore water pressures dissipate.

Undrained shear strength values (c_u) for peat are used for the total stress analysis. Based on the findings of the Derrybrien failure, undrained loading during construction was found to be the critical failure mechanism.

Among the shear strength values obtained by GDG by using the hand shear vane tests in the proposed site, the lowest registered value was 18 kPa. However, based on GDG’s experience in the assessment of similar blanket peats and values reviewed in the literature, a more conservative value of 5 kPa has been adopted for the undrained shear strength (C_u). The Shear Vane testing was carried out in the summer and is not considered to be representative of undrained winter conditions. This has been considered when selecting the design c_u value. The formula used to determine the factor of safety for the undrained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c_u}{\gamma z sin\alpha cos\alpha} \qquad \text{Equation 4.3-1}$$

Where,

F = Factor of Safety;

c_u = Undrained strength (5 kPa in the study area);

γ = Bulk unit weight of the material (assumed 10 kN/m^3);

z = Depth to failure plane assumed as the depth of peat (this is the interpolated raster of peat depth); and

α = Slope angle (in each pixel of 1 m. This is obtained from the 1-m DEM provided by the Client).

4.3.2 DRAINED CONDITIONS

The drained loading condition applies in the long term. The condition examines the effect of the change in groundwater level as a result of rainfall on the existing stability of the natural peat slopes.

A drained analysis requires effective cohesion (c’) and effective friction angle (ø’) values for the calculations. These values can be difficult to obtain because of the disturbance experienced when sampling peat and the difficulties in interpreting test results due to the excessive strain induced within the peat. A review of published information on peat was undertaken to determine suitable drained strength values. Table 4-2 shows a summary of the drained parameters used in published literature. Based on GDG’s experience in the assessment of similar raised peats and the values reviewed in the literature, it was considered appropriately conservative to use design values below the averages, namely c’ = 4 kPa and ø’ = 25°.

The formula used to determine the factor of safety for the drained condition in the peat (Bromhead, 1986) is as follows:

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2 \alpha \tan \phi'}{\gamma z \sin \alpha \cos \alpha} \qquad \text{Equation 4.3-2}$$

Where,

F = Factor of Safety;

c’ = Effective cohesion (4 kPa);

γ = Bulk unit weight of the material (10 kN/m^3);

z = Depth to failure plane assumed as the depth of peat (this is the interpolated peat depth);

γ_w = Unit weight of water (9.81 kN/m^3);

h_w = Height of the water table above the failure plane (= *z,* i.e. surface level);

α = Slope angle (in each pixel. This is obtained from the 1-m contour lines provided by the Client);

ø’ = Effective friction angle (25°).

Table 4-2: Effective cohesion and friction angle values from the literature

Reference	Cohesion, c' (kPa)	Friction Angle, ø'
Hanrahan et al. (1967)	5 to 7	36 to 43
Rowe and Mylleville (1996)	2.5	28
Landva (1980)	2 to 4	27.1 to 32.5
Landva (1980)	5 to 6	-
Carling (1986)	6.5	0
Farrell and Hebib (1998)	0	38
Farrell and Hebib (1998)	0.61	31
Rowe, Maclean and Soderman (1984)	3	27
McGreever and Farrel (1988)	6	38
McGreever and Farrel (1988)	6	31
Hungr and Evans (1985)	3.3	-
Madison et al. (1996)	10	23
Dykes and Kirk (2006)	3.2	30.4
Dykes and Kirk (2006)	4	28.8
Warburton et al (2003)	5	23.9
Warburton et al (2003)	8.74	21
Entec (2008)	3.8	36.8
Komatsu et al (2011)	8	34
Zhang and O'Kelly (2014)	0	28.9 to 30.3

Several general assumptions were made as part of the analysis:

1. Peat depths are based on the maximum peat depths recorded in each probe from the walkover surveys.
2. The slope angles derived from the DEM (BlueSky, 2017), as outlined in Section 2.7, accurately represent slope angles on site.
3. The surface of failure is assumed to be parallel to the ground surface.
4. The peat stability is calculated in pixels of 5m across the fringe containing information on peat depth and the proposed infrastructure.

Two surcharging conditions are considered for the stability analysis:

- No surcharging load; and
- Surcharging load of 10 kPa, equivalent to 1 m of stockpiled or side-cast peat.

4.4 FoS Results

The factors of safety obtained for the two different conditions (undrained and drained) and for the two surcharge scenarios (no surcharge and 1 m of peat surcharge (10kPa)) are presented in both table format and map format.

Table K- 1 and Table K- 2 in Appendix K show the FoS calculation process in the proposed turbine sites for undrained and drained conditions, respectively. The FoS calculation for the rest of the sites, i.e. the proposed substation, temporary construction compounds, and existing and upgraded access roads (more than 5000 pixels of 5 m), has been carried out semi-automatically in GIS by implementing Equation 4.3-1 and Equation 4.3-2 in the GIS raster calculator.

4.4.1 FoS for Undrained Conditions

The spatial distribution of the FoS values calculated for undrained conditions (no surcharge) is shown in Figure K- 1 to Figure K- 3 in Appendix K. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values between 1 and 1.3 (yellow: stable but not safe). A small number of pixels within and beside T7 show FoS values <1 (red: not stable).

These risk areas are caused by localised factors, which have been examined in more detail in Section 4.5. Where required, additional mitigation, including exclusion zones and peat storage restriction areas, have been scheduled which the designer and contractor must adhere to at the construction stage.

4.4.2 FoS for Undrained Condition and Surcharge of 10 kPa

Figure K- 4 to Figure K- 6 in Appendix K depict the spatial distribution of the FoS values calculated for undrained conditions and with a 10 kPa surcharge. The 10kPa simulated the placement of 1m of peat material on the ground surface. In terms of the factor of safety results, the undrained condition with the 10kPa surcharge is considered to be the critical stability scenario. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values between 1 and 1.3 (yellow: stable but not safe). A small number of pixels within and beside T7 and PRA 3 show FoS values <1 (red: not stable).

These risk areas are caused by localised factors which have been examined in more detail in Section 4.5. Where required additional mitigation, including exclusion zones and peat storage restriction areas have been scheduled which the designer and contractor must adhere to at the construction stage.

4.4.3 FoS for drained conditions

The spatial distribution of the FoS values calculated for undrained conditions (no surcharge) is shown in Figure K- 7 to Figure K- 9 in Appendix K. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values between 1 and 1.3 (yellow: stable but not safe). A small number of pixels within and beside T7 show FoS values <1 (red: not stable).

These risk areas are caused by localised factors which have been examined in more detail in Section 4.5. Where required additional mitigation, including exclusion zones and peat storage restriction areas have been scheduled which the designer and contractor must adhere to at the construction stage.

4.4.4 FoS for Drained Condition and Surcharge of 10 kPa

The spatial distribution of the FoS values calculated for undrained conditions (no surcharge) is shown in Figure K- 10 to Figure K- 12 in Appendix K. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas beside the cable access track and the T7 hardstand which show FoS values between 1 and 1.3 (yellow: stable but not safe).

These risk areas are caused by localised factors which have been examined in more detail in Section 4.5. Where required additional mitigation, including exclusion zones and peat storage restriction areas have been scheduled which the designer and contractor must adhere to at the construction stage.

4.5 ASSESSMENT AND INTERPRETATION OF FOS RESULTS

The interpretation of the factor of safety analysis and accurate assessment of the peat stability conditions is a semi-automated approach that combines the developed polygon areas of the FoS results, areas of risk identified during the site walkovers, and potential risk areas identified from the examination of peat depths and site topography. It is noted that the results from all FoS analyses (drained/undrained, with and without surcharge) are used, highlighting any areas indicative as having a FoS of less than 1.3 in the worst-case surcharged condition with 10kPa. These areas were then cross-examined with the observations from the site visits and topographic models.

This analysis was used throughout the development process to aid in the siting and design of the Proposed Project layout including turbines, hardstands, and other key infrastructure locations. The undrained scenario with a 1m peat surcharge has been considered as the critical scenario. However, the FoS of all elements of the site was examined in both the drained and undrained conditions.

The foundation and hardstand at T7 overlap with an area of FoS <1 in the undrained and drained scenarios without surcharge. This area of low FoS is linear, running N-S and then W-E along a peat-cutting face. This low FoS is driven by locally thick peat (up to 5m thick) and locally steep slope angles calculated at peat cuttings. Analysis of the aerial imagery (Section 2.6) suggests that the present peat-cutting face is, in reality, 30m further east than the locally steep slope angles derived from the topo data. This suggests that peat cutting in the area has progressed since the topo was captured and that the peat-cutting face no longer crosses the T7 foundation or hardstand, reducing the risk at this location. This is confirmed by site observations, which show that the peat cut face no longer interacts with the turbine location, as seen in Figure 4-2.

As the low FoS in this location is driven by a high slope angle calculated at the peat-cut face, this significantly reduces the potential risk. The proposed piled foundation at this turbine and excavation of the locally shallower peat (~1.5m) at the hardstand will eliminate the peat hazard in this location, with careful peat management and peat cutting slope angle reinstatement subject to the local stability modelling as part of the contractor's detail design.

Much of the Proposed Project Site contains flat-lying, deep peat with active peat cutting. Steep peat cuttings of <1m generate low factors of safety but are considered to be generally of low landslide risk. Raised bog environments like this site may be susceptible to bog burst type failures, which can occur at very low slope angles and may not be fully quantified by the FoS calculation, as they are driven by hydrological factors rather than slope-driven. For this reason, the locations need to be assessed on-site and ‘ground-truthed’ to identify true hazards. GDG site walkovers identified no evidence of significant bog burst features; however, as described in Section 2.6, a small area of possible past failure at the peat margin was identified.

Figure 4-2: View looking east across the proposed T7 location showing the high peat cut face in the background.

The lack of evidence for historical bog bursts does not preclude the possibility that these may occur. Further inspection will be required during the detailed design and construction stage to inspect for peat instabilities, including bog burst features. This will be carried out by the detail Designer and Contractors team. The design team shall develop their own inspection and testing criteria to satisfy and de-risk the possibility of peat landslides at these locations. A new topographic survey will be required to capture recent changes to the peat body generated by cutting activities since the capture of the DEM used in this study (2017), and a construction stage PSRA will be required to capture this.

4.5.1 ASSESSMENT OF PEAT STABILITY AT THE GRID CONNECTION ROUTE

Peat stability at the grid connection route is considered separately as part of the peat stability risk assessment calculation outlined in Section 6, with results outlined in Table M- 16. In general, no global peat stability risk has been identified at this location. A small section of FoS <1.3 has been identified close to the grid connection route. However, it has been determined that it is generated by localised drainage and peat bank factors described in further detail in section 4.6.3.

4.6 SAFETY BUFFER ZONES AND PEAT STOCKPILE RESTRICTION AREAS

From the site reconnaissance and the calculations of the FoS for the peat slopes, a series of safety buffer zones and peat stockpile restriction (PSR) areas are proposed and presented in Figure L- 1 to Figure L- 3 in Appendix L.

4.6.1 SAFETY BUFFER ZONES

From the site reconnaissance and the calculations of the FoS for the peat slopes, a series of safety buffer zones and peat stockpile restriction (PSR) areas are proposed and presented Figure L- 1 to Figure L- 3 in Appendix L.

Safety Buffer zones are areas identified during the development phase of the wind farm layout that are highlighted as possessing a potential instability risk. The development of the safety buffer zones is a semi-automated approach that combines the developed polygon areas of the FoS results, areas of risk identified during the site walkovers, and potential risk areas identified from the examination of peat depths and site topography. It is noted that the results from all FoS analyses (drained/undrained, with and without surcharge) are used, highlighting areas indicative as having a FoS < 1.3 in the worst-case surcharged condition with 10kPa. This analysis was used throughout the development process to aid in the siting and design of the Proposed Project layout and ensure that turbines, hardstands, and other key infrastructure locations are only developed in stable and safe locations. One safety buffer zone was identified, located to the east of T07.

Where the Proposed Project layout and the safety buffer zone have overlapped or are in close proximity, further assessment of the localised risk has been assessed as outlined in Section 4.6.3, and where required, further mitigation measures have been scheduled, such as peat storage restriction areas.

Outside of the Proposed Project layout, where construction is not required as part of the Proposed Project, the safety buffer areas should be treated as peat storage and plant restriction areas and construction activities should not be carried out in these areas without further assessment.

Safety buffer areas are outlined in Appendix L, Figure L- 1 to Figure L- 3.

4.6.2 PEAT STOCKPILE RESTRICTION AREAS

Although the peat stability results and safety buffers have been considered in the design of the wind farm infrastructure, there are some locations where construction is required within a safety buffer zone. The stability assessment results at these locations suggest FoS values <1.3 in the surcharged scenario only and have FoS results >1.0 in the analysis without the surcharge. This suggests that the areas are of a low instability risk in their natural state but are unsuitable for the storage of peat or other materials.

Peat and over burden Storage Restriction (PSR) areas are identified at some access roads and in areas at or adjacent to some turbine hardstands, along with the margins of areas proposed for peatland enhancement.

The risk at these locations can be examined by looking at the geometry of the local slope and the proposed construction methodology, and the hazards can be mitigated with restricted peat placement and the limiting of plant operations within the area.

PSR areas are outlined in Appendix L, Figure L- 1 to Figure L- 3. Certain mitigations must be adhered to within the PSR areas in future stages of the Proposed Project:

- No peat or other materials shall be temporarily or permanently placed in the areas within the PSR zones,
- Any peat excavated in the area shall be immediately removed and placed/ stored in an appropriate storage location as outlined in Appendix 4-2: Peat and Spoil Management Plan,
- Plant used within these areas shall be low ground bearing and only the necessary plant shall be used here. No excessive quantity or size of plant will be stored in these areas.

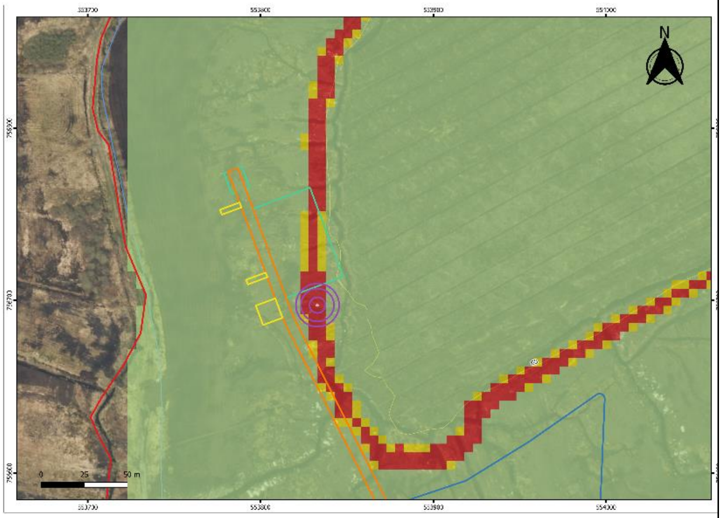
Safety buffer zones are outlined in Appendix LFigure L- 1 to Figure L- 3.

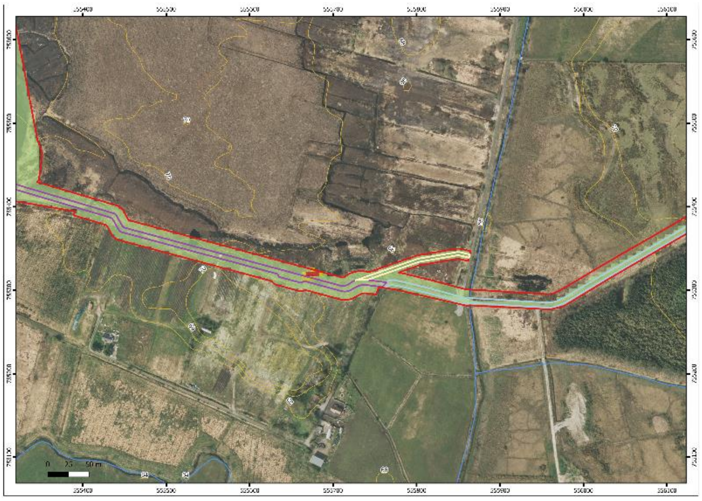
4.6.3 SAFETY BUFFER ZONES AND PEAT STOCKPILE RESTRICTION ZONES

The safety buffer zones and peat stockpile restriction areas are shown in Figure L- 1 to Figure L- 3 in Appendix L. Areas included in the safety buffer zone include:

Areas where key infrastructure encounter safety buffer zones are outlined in Table 4-3:

Table 4-3: Safety buffer zones at key locations.

Risk and mitigation	Undrained surcharged FoS analysis
The area at the hardstand and foundation for T7 suggests a FoS of <1 with the application of a 10kPa surcharge. Based on site observations and a study of aerial imagery it is determined that this region of low FoS is caused by locally deep peat and a steep slope calculated at an existing peat cut face. A study of temporal aerial imagery (Section 2.6) indicates that the peat cut face has migrated east due to continued cutting activities since the capturing of both the topo data and the deepest peat probes at this location. This would indicate that both the locally steep slope and deep peat have migrated eastwards as well. Due to this information, the safety buffer zone in this location has been manually shifted to the east to follow the newly interpreted edge of the peat mass. It is therefore interpreted that the low FoS is not representative of current on-site conditions and does not represent a true hazard at this location. It is also noted that this foundation is proposed to be piled, which will further limit any possible risk at this location. Further mitigation measures include the stabilising of the cutting with excavated material and reinstatement to a natural gradient. Ensuring adequate Drainage and avoidance of drying out the peat, will also improve stability at this location.	

Risk and mitigation	Undrained surcharged FoS analysis
A small section of road interacts with an area of FoS <1.3 in the undrained scenario with 10kPa surcharge. This low factor of safety is assessed to arise from locally deep peat and high slope angles calculated at relict existing peat banks. It is determined that these do not present a global risk of peat failure, **but that the ground should be levelled and stabilised locally prior to construction, and that peat should not be placed in this area.**	
A small section of access road and the cable route with an area of FoS <1.3 in the undrained scenario with 10kPa surcharge. This low factor of safety is assessed to arise from locally deep peat and high slope angles calculated at relict existing peat banks. It is determined that these do not present a global landslide risk. T**he ground should be levelled and stabilised locally prior to construction, and peat should not be placed adjacent to the road in this area.**	

5 ASSESSMENT OF AREAS PROPOSED FOR PEATLAND ENHANCEMENT

The proposed project includes an area of currently drained raised bog, used previously for turbary cutting, which is proposed to be enhanced by rewetting. The purpose of this process is to establish a hydrological regime, which will allow for the regeneration of an area of raised bog. The purpose of this measure is to raise the water table in the drain, and in adjacent areas in order to reduce run-off rates and carbon losses.

The location of the proposed peatland enhancement can be seen in Figure A- 1 in Appendix A. The proposed area consists of a section of raised bog (maximum peat thickness from probes recorded at 3.88m), with parallel drains running NW to SE, roughly every 10-15m across the peat surface. The depth of the existing drains is estimated based on limited site walkovers to be between 0.5-1m. The current condition of the drained peat can be seen in Figure 5-1.

Figure 5-1: Parallel drainage ditches at the north end of the proposed area of peatland enhancement.

5.1 BACKGROUND TO PEATLAND ENHANCEMENT

Peatland enhancement by rewetting has been practiced in both Ireland and the UK over a long period, typically aiming to restore hydrological function, vegetation cover, and active peat-forming vegetation (Alderson, 2019). Peat enhancement on a large scale has been implemented in Ireland since the 1990s, with over 7,200Ha enhanced to date (Bord na Móna, 2023), and Scotland since 2012, under the publicly funded Peatland ACTION programme (Mills and Rushton, 2023), with over 19,000Ha of peatland enhanced since this date. Studies by Kelly and Schouten (2002) and Fernandez et al. (2014) indicate that peatland enhancement by rewetting can be very successful, provided that water levels are maintained within 10cm of the surface. The process is becoming more common in large-scale construction projects similar to the Proposed Project. The main techniques used for the enhancement of peatland areas are:

- Ditch blocking.

- Ditch reprofiling.
- Gully blocking.
- Felling and/or ground smoothing.
- Surface bunding.

Many of these techniques apply only to high elevation blanket bogs with higher slope angles. The techniques best suited to low elevation raised bog settings as found at the Proposed Project are:

- Ditch blocking. This consists of constructing dams either of peat or artificially imported materials to block existing drainage ditches. Best practice, as established by the National Parks & Wildlife Service (NPWS) (Mackin et al., 2017; McDonagh, 1996), is for a minimum of 3 dams or a maximum of 10 dams per 100m of drain. Bord na Móna has used three dams per 100m on raised bog enhancement projects, including Carrickhill, Derryvilla and Templetuohy (Bord na Móna, 2022).
- Surface bunding. This consists of trenches being dug around the edges of the bog, with these being backfilled with peat material to reduce water flow from the margins of the bog. Surface bunds are constructed on the cutover areas surrounding the high raised bog, and serve to attenuate flow from the high bog to the surrounding areas. This has been successfully implemented in flat-lying bogs such as Killyconny Bog (Mackin et al., 2017)

5.2 PEAT STABILITY IN ENHANCED AREAS

In a 2023 study, Mills and Rushton examined 100 enhanced Scottish peatland areas, of which 41 were lowland raised bogs. In this study, three failures were recorded as having occurred after peat enhancement, with the following two of these occurring on raised bogs:

- Margin failure of a enhanced lowland raised bog at Moss Band (Lanarkshire).
- Margin failure of a enhanced lowland raised bog at Greenhead Moss (Lanarkshire).

In both previous instances, failure was associated with dome-shaped raised bogs, with gently dipping contacts between the peat and the mineral substrate of 1-2°. In both examples, while slopes were very gentle, drains were cut obliquely to the slope and were organised so as to concentrate flow at the lowest elevation areas of the bog. It is also generally considered that raising the water table across the peat mass will lead to an increase in pore water pressures, which is anticipated to slightly reduce stability across rewetted areas (Mills and Rushton, 2023). No known examples of peat failure triggered by peatland enhancement measures on lowland raised bogs have been identified in Ireland to date.

5.3 PEAT STABILITY AT THE PROPOSED PROJECT

In this instance, it is proposed that the peat will be rewetted by blocking the drains with peat dams being installed at the end of the drains, and at 20m intervals along the drains, in line with the best practice outlined by Mackin et al. (2017) and McDonagh (1996). This will reduce drainage from the area and allow the water table to rise, allowing for peat accumulation. It is considered that rewetting by this method is unlikely to trigger failure at this location, as the slope angle of the peat surface and of the basal contact between the peat and the mineral substrate is interpreted to be <0.5°, based on the data available. The parallel drains within the area are not convergent and are unlikely to concentrate flow in specific regions, leading to a significant weakening of the peat mass. It is considered that the process of rewetting is likely to lead to an increase in pore water pressure, which may slightly reduce peat stability at the rewetted area (Mills and Rushton, 2023). To account for this, an additional item has been added to the hazard assessment section of the PSRA calculation outlined in Section 6.3.

6 PEAT STABILITY RISK ASSESSMENT (PSRA)

A peat stability risk assessment (PSRA) has been carried out at each of the proposed structures, considering the landslide hazard probability and potential consequences at each location. The peat stability factor of safety is the most significant factor in generating a risk rating. The production of a PSRA risk rating for the site access tracks is not possible as they are linear structures that cover significant distances, but the same considerations were used in the design and assessment of the stability of the access road alignment.

6.1 RISK DEFINITION

Risk is the potential or probability of adverse consequences, including economic losses, environmental or social harm, or detriment. Risk is expressed as the product of a hazard (e.g. peat landslide) and its adverse consequences (Lee & Jones, 2004; Corominas et al., 2014) (Equation 6.1-1). Some use approximate synonyms and refer to risk as the product of the likelihood and the impact or the product of susceptibility and the exposure.

$$\text{Risk} = (\text{Hazard}) \times (\text{Adverse Consequences}) \qquad \text{Equation 6.1-1}$$

6.2 GENERAL METHODS FOR RISK ASSESSMENT

There are various levels of risk assessment, ranging between:

- Detailed quantitative risk assessments (QRA) where the objective is to generate more precise measures of the risks (e.g. expressing risk as a specific probability of loss). These require a large amount of quantitative input and time, and
- High-level qualitative assessments where the objective is to develop an approximate estimate of the risks, particularly in relative terms (e.g. low, medium, and high levels of risk).

Qualitative risk assessments are typically used for PSRA reports, given the availability of information and the time frame. To apply Equation 6.1-1, the quantitative information (e.g. FoS) and the qualitative information (e.g. geomorphic observations relevant to peat stability) that determine the hazard and the consequences need to be transformed into subjective ratings. The following sections address the calculation of the two risk components: hazard and consequence.

6.3 HAZARD ASSESSMENT

Landslide hazard is the likelihood or probability of landslide occurrence in each location and a given period. The likelihood or hazard of peat landslides has been determined according to the guidelines for geotechnical risk management given by Clayton (2001), taking into account the approach of MacCulloch (2005) and using the available data from the desk study, site reconnaissance, and site investigations.

The hazard is calculated from a variety of weighted factors, including the FoS and thirteen secondary factors related to geomorphic observations, topography, hydrology, vegetation, peat workings, existing loads, and slide history (Appendix M). These secondary factors are difficult to quantify in a stability calculation but may contribute to peat instability.

In accordance with the Scottish Guidance (2017), each hazard factor has been reclassified into one of four classes with rating values ranging from 0 to 3 (Appendix M). A rating of 0 indicates that the hazard factor is not relevant; ratings 1, 2, and 3 indicate low, moderate, and high correlation to peat slide hazard, respectively.

These factors have been assigned weighting values to reflect their relative importance in peat stability. Both the rating and the weighting values have been assigned according to the expert criteria of the project team and are presented in Appendix M. The hazard score of each factor is the multiplication of its rating value and weight value. These factors and their corresponding weightings are presented in Table 6-1.

The hazard values for a given wind farm element are the sum of the scores of all the hazard factors divided by the maximum hazard value possible to obtain a normalised hazard value ranging from 0 to 1 (see tables in Appendix M). Hazard is grouped into four categories: Negligible, low, medium, and high.

Table 6-1: Factors affecting peat stability and hazard.

Hazard factors			Role in peat stability	Weight
Factor of Safety			This is the most critical factor, including the slope angle, the peat depth, the peat density, the peat cohesion in the drained and undrained conditions, and the effective friction angle. This is the complete factor. See Section 4 for further details.	10
Secondary factors	Topography	Curvature Plan (across the slope)	This represents the curvature across the slope and the funnelling/dispersion of the runoff.	1
		Curvature Profile (downslope)	This represents the curvature down-slope and, therefore, the capacity of water retention and infiltration. Convex slopes are typically more prone to landslides.	
	Hydrology	Distance from watercourse (m)	This tends to affect the likelihood of landslides, especially in sectors where this distance is short.	
		Moisture index (NDMI)	This Landsat-derived factor indicates the water content or moisture of the vegetation, which can be considered as a proxy of the terrain moisture.	
		Evidence of piping	The presence of piping is clear evidence of potential peat instability.	
		The direction of existing drainage ditches	Drainage ditches that are aligned cross slope can affect the overall stability of a slope face.	
	Vegetation	Bush	This is an indicator of the type of peat at the site and the hydrological nature of the site.	
		Forestry	The vigour of forestry is another indicator of peat stability, with stunted trees more frequent in unstable sectors.	
	Peat workings	Peat cuts presence	This factor evaluates the effect of various peat workings on the stability of the peat.	
		Peat cuts vs contour lines	Where the peat cuts parallel the contour lines, the potential instability increases.	

Hazard factors			Role in peat stability	Weight
	Existing loads	Roads	Side-cast of solid roads and floating roads pose a load to the peat blanket.	
	Slide history	Distance to previous slides (km)	This suggests that landslides at the site are likely if a peat slide has occurred at the site or within a 10-kilometre radius. The weight assigned is doubled the weights for the other secondary factors	2
		Evidence of peat movement (e.g. tension cracks, compression features).	This factor evaluates the effect of any existing peat movement indicators on-site, such as tension cracks. The weight assigned is doubled the weights for the other secondary factors	

For the area highlighted for potential peatland enhancement, a further secondary category has been added:

Table 6-2: Additional factors affecting peat stability and hazard in areas proposed for peatland enhancement.

Hazard factors	Role in peat stability	Weight
Peat Rewetting	This factor evaluates the effects of different peat rewetting methodologies on-site, such as drain-blocking techniques and bunding. Rewetting causes water tables to rise, increasing pore pressures.	1

6.4 ADVERSE CONSEQUENCES ASSESSMENT

The impacts of peat landslides on the wind farm elements, surrounding environment, and existing assets may typically generate a variety of adverse consequences. This report qualitatively assessed these consequences following the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish-Executive, 2017).

Table 6-3 summarises the consequences considered for the PSRA of the development.

Table 6-3: Consequences considered for the PSRA.

Consequence factors	Description	Weight
The volume of potential peat flow (function of distance from the nearest watercourse and peat depth in the area)	This is the second most heavily weighted factor. It is estimated based on the distance from the nearest defined watercourse and the depth of peat in the area. The longer the distance and the deepest the peat depth, the larger the landslide.	3
Downslope features	This factor accounts for the type/shape of downslope features that may hamper or favour the propagation downhill of the peat flow.	1

Consequence factors	Description	Weight
Proximity from the defined valley (m)	This is the distance from the site to the nearest defined river valley. Rivers close to potential landslide sectors are more vulnerable to a landslide event.	
Downhill slope angle	This factor accounts for the runout distance as a matter of slope angle.	
Downstream aquatic environment	Reflects the severity of a peat slide event's impact on the receiving aquatic environment.	
Public roads in the potential peat flow path	Rates the impact of a peat slide striking a public road.	
Overhead lines in the potential peat flow path	Rates the impact of a peat slide striking a service line.	
Buildings in the potential peat flow path	Rates the impact of a peat slide striking a habitable structure.	
Capability to respond (access and resources)	Rates the capability of the site staff to respond to a peat instability event.	

The nine consequence factors considered have been reclassified in the same fashion the hazard factors were reclassified (Appendix M). A rating of 0 indicates that the consequence factor is not relevant and a rating of 3 indicates high consequences.

'Volume of potential landslide' has been assigned a weight of 3 to reflect its relative importance in the potential consequences. The rest of the factors have been assigned a weight of 1. Both the rating and the weighting values have been assigned according to the expert criteria of the project team. The score of each consequence factor is the multiplication of its rating value and its weight value (Appendix M).

The consequences value for a given wind farm element is the sum of the nine consequences scores. This total value is then divided by the maximum consequence value possible to obtain a normalised consequence value ranging from 0 to 1 (see tables in Appendix M). Consequences are grouped into four categories: Negligible, low, medium, and high.

6.5 RISK CALCULATION

Risk in each wind farm infrastructure element is calculated with Equation 6.1-1, i.e., multiplying the hazard scores and the consequences scores. The risk rating ranges between 0 and 1 and the following levels of risk rating have been distinguished (Table 6-1 and Table 6-3):

- High (0.6 to 1): Avoid project development at these locations. Mitigation is generally not feasible.
- Medium (0.4 to 0.6): The project should not proceed unless risk can be avoided or mitigated at these locations without significant environmental impact to reduce risk ranking to low or negligible.
- Low (0.2 to 0.4): Project may proceed pending further investigation to refine assessment and mitigate hazard through relocation or re-design at these locations.
- Negligible (0 to 0.2): The project should proceed with monitoring and mitigating peat landslide hazards at these locations as appropriate.

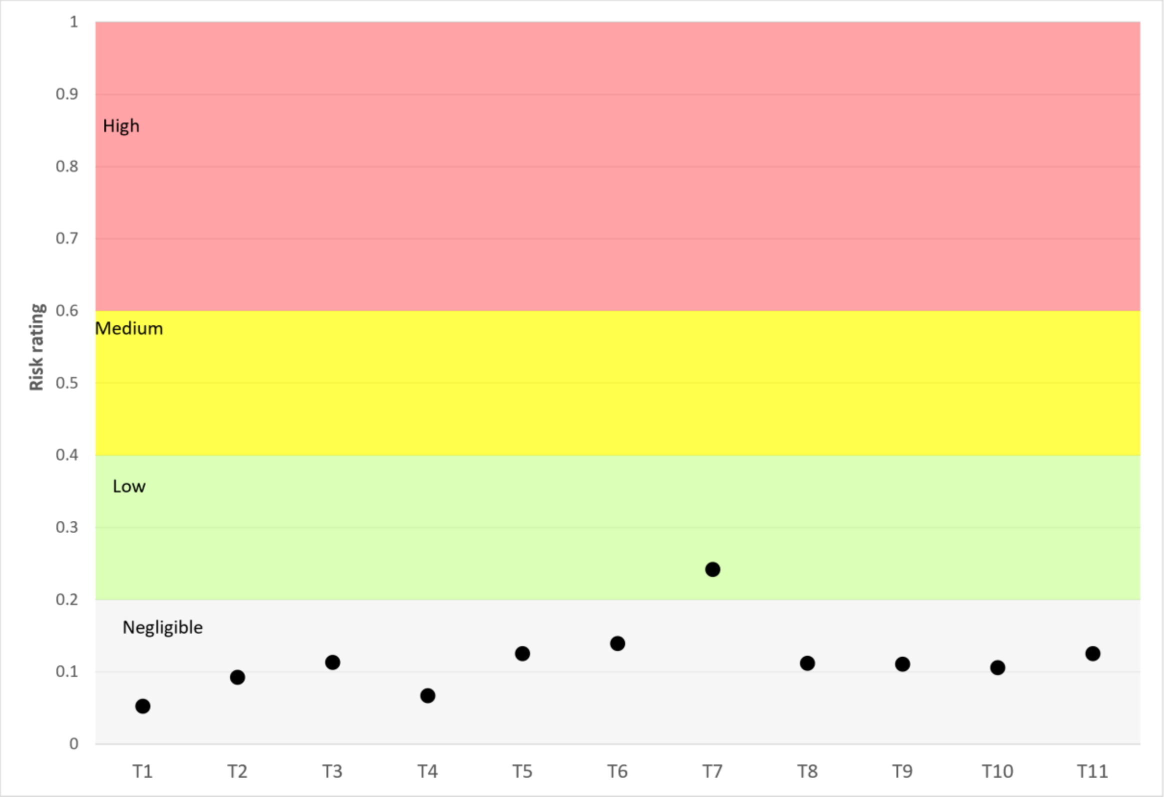


Figure 6-1: Risk ratings at the proposed turbine locations.

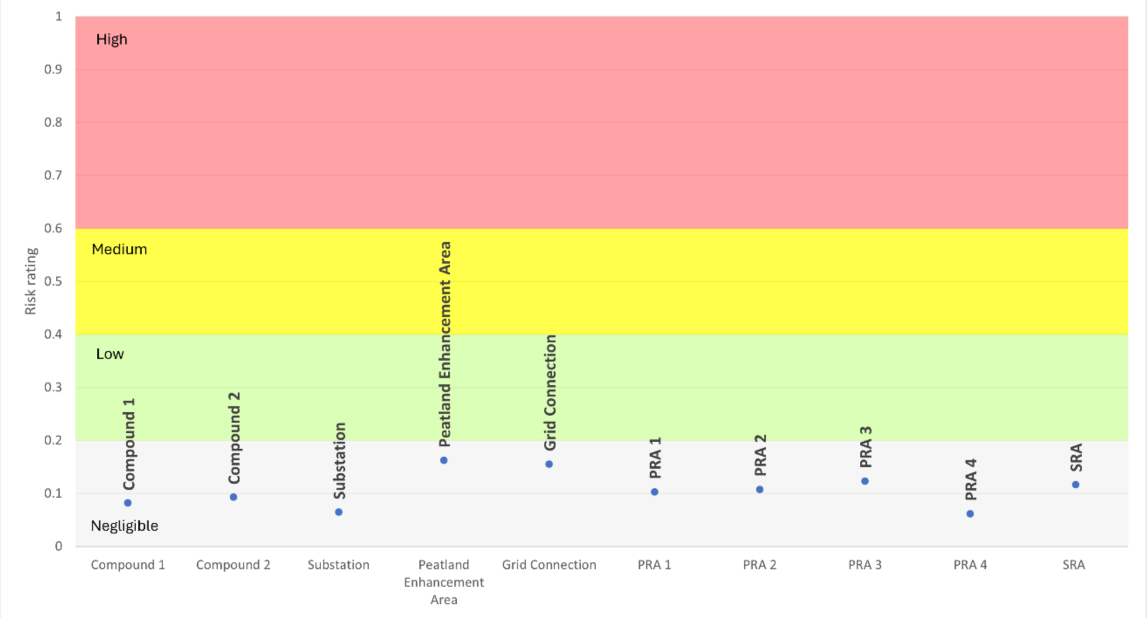


Figure 6-2: Risk ratings at the proposed infrastructure element sites.

Appendix M gathers the risk calculation process at each turbine considering the four scenarios of hazard: Undrained; undrained with a surcharge of 1 m; drained; and drained with a surcharge of 1 m (Table M- 1 to Table M- 21). Figure 6-1 and Figure 6-2 summarise the risk rating obtained at the turbines and compound locations. All the turbines and infrastructure elements are located in sectors of negligible to low risk.

It is stressed that the resulting risk rating does not indicate a probability of a landslide occurring; it simply expresses a rating of the potential risk.

7 GEOTECHNICAL RISK REGISTER

This register lists significant potential peat geotechnical hazards and associated risks concerning the construction and operation of the Proposed Project, and recommended mitigations.

Table 7-1: Geotechnical risk register

Ref.	Risk	Contributing factor	Mitigation
1	The collapse of the dried peat berm/ peat slippage	Overestimation of soil strength parameters	The soil parameters are based on the hand shear vane test carried out by GDG at each turbine location. Shear vane testing was carried out at 0.5m intervals through the peat to assess variation within the peat body. The interpreted undrained shear strength values take into account a conservative reduction factor for the influence of the fibres within the peat. Extensive sampling ground investigation at infrastructure location including trial pitting to assess the composition and strength of the peat and collect samples for testing. The derived values were compared with a literature review of the most common general drained and undrained parameters for each type of soil and on the descriptions. The GI completed to date is considered to be thorough and robust for the purposes of the EIAR, however, it is expected that further testing and assessment of the peat during further ground investigation campaigns will be required before construction. This will allow for a robust understanding of the ground conditions and the detailed design of access roads and structures. An extensive testing protocol shall be developed by the Construction stage contractor and the design team. These tests shall be observed by a suitably qualified engineer and reported to the owner's engineer. It would be expected that an observational approach will be required when constructing on peat due to the limitations associated with testing and verifying its strength and the contractor is required to frequently inspect the peat material and provide proof of inspection.
2	The collapse of	Underestimation of peat depth	Extensive ground investigation including trial pitting and peat probing has been carried out across the site. GI locations have been carried out at locations where

Ref.	Risk	Contributing factor	Mitigation
	berms/peat slippage		access was possible. Access was limited to some areas of the site with restrictions relating to forestry and terrain limiting coverage. Access in particular was limited to the area of raised bog proposed for peatland enhancement. Further GI will be required at these locations during the detail and construction stage to assess peat depths. This will be carried out by the detail designer and Contractors team. The design team shall develop their own testing criteria to satisfy and de-risk the possibility of larger peat depth occurring at these locations.
3	Failure of peat slope due to loading or agitation of existing instability	Failure to identify existing instability/ peat deformation at the site	Assessment of satellite imagery and topographical data for evidence of past landslide events was carried out as part of the desk study, finding no evidence of past instabilities or landslide events within the site area. The Geological Survey of Ireland (GSI) landslide database was examined, identifying two landslide events in the local region within 5km of the site, the closest approx. 3km from the site boundary. During the site walkovers, the site GDG engineers examined the landscape and the areas surrounding the proposed infrastructure for evidence of instability or past landslide events. No past landslide or instability events were identified. Although there is no evidence of landslides within the Proposed Project Site, this does not necessarily mean that landslides have never occurred at the proposed site location. It is noted that the geomorphological features associated with peat landslides (peat slides and bog bursts) are softened with time through erosion, drying, and re-vegetation, particularly given the forestry and peat harvesting activities that have taken place at this site. Access was limited to some areas of the site with restrictions relating to raised peat bogs traversed by large drainage ditches. Further inspection will be required during the detailed design and construction stage to inspect for peat instabilities. This will be carried out by the detail designer and Contractors team. The design team shall develop their own inspection and testing criteria to satisfy and de-risk the possibility of larger peat depth occurring at these locations.

Ref.	Risk	Contributing factor	Mitigation
4	The collapse of peat berm/peat slippage	Failure due to excessive loading of peat	The peat stability analysis factor of safety exercise examines the peat in the drained and undrained condition both without and with the addition of a surcharge equating to 1m of peat loading. Areas indicative of a low or moderate FoS result with the 1m peat surcharge within or adjacent to the proposed site infrastructure have been designated as safety buffer zones, as outlined in Section 4.6. Requirements for the safe and sustainable storage of peat and spoil material are outlined in the associated Peat and Spoil Management Plan (PSMP) document (GDG, 2023). The requirements and restrictions for peat and spoil management outlined in this document must be adhered to during the constriction stage.
5	Failure of peat slopes	Over/underestimation of exiting slope angles.	The peat stability analysis factor of safety exercise examines the peat slope angle using data drawn from a 2018 Bluesky LiDAR survey. It is noted that peat cutting has progressed significantly in specific areas across the site since this date, particularly in the vicinity of T7. It is assessed that the slope angle is likely to have decreased in this location, as the peat cut bank has migrated east, away from the turbine location. This will likely lead to a reduction in risk at this location, and an underestimation of the likely FoS, however uncertainty remains. An updated and more detailed topographic survey will be required prior to commencing the detailed design stage.
6	Instability of peat slippage	Variations in the groundwater conditions at the site	The groundwater conditions were examined during the walkovers and within the trial pit locations. Areas of saturated surface peat were identified during the walkovers as outlined in Section 3 and these have been considered in the risk assessment and findings of the report. Water strikes, peat water content, and groundwater conditions are noted in the trial pit locations (GDG, 2020). The groundwater conditions and peat moisture content way vary seasonally and/or more frequently with the immediate weather conditions. Long-term groundwater level monitoring across the site should be considered in further design stage ground investigations and further lab testing of the peat in its in-situ condition will need to be assessed for the construction design. Hydrology of the area

Ref.	Risk	Contributing factor	Mitigation
			shall be maintained as far as possible by implementing and maintaining an appropriate drainage system.
7	Instability due to unmapped subsurface karst features	Voids and subsidence due to karstic weathering of the underlying limestone bedrock.	The existing geological mapping and GI indicate the Proposed Project sits on limestone bedrock, which may be susceptible to karstic weathering. One karstic feature (an enclosed depression) is mapped 2km from the site boundary. Additional karstic features may occur within the site boundary but are obscured by overlying quaternary sediments. Confirmatory ground investigations to investigate the presence and extent of any karstic features in proximity to the infrastructure locations will be required to be undertaken at the design stage.
8	Instability due to rewetting of raised bog	Increases in pore water pressure due to blocking of drains with peat dams.	Limited access to the area proposed for peatland enhancement limits the available data to assess peat stability at the proposed area for peatland enhancement. Assessment of the available data and literature suggests that failure is unlikely to be triggered by the construction of peat dams, however further confirmatory ground investigation to confirm peat depths and characteristics across the area will be required to be undertaken at the design stage.

8 CONCLUSIONS AND RECOMMENDATIONS

Following the guidance of the Scottish Executive, a review of the published thematic geographic information (e.g. geology, soils, protected areas) and relevant background literature was undertaken for the Proposed Project. Site reconnaissance and site investigations were carried out to validate and enhance the desk study information. Based on the available data, the fieldwork, and GDG's professional judgement, it is concluded that significant peat slides are unlikely on the site with diligent peat management and careful consideration of the peat conditions at the site at the design and construction stage.

A deterministic Factor of Safety was calculated across the proposed element locations, and from this, a robust peat stability risk assessment (PSRA) was performed. The findings of the peat assessment showed that the site has an acceptable margin of safety and is suitable for the Proposed Project, provided appropriate mitigation measures, as outlined below, are implemented:

- All earthworks shall be designed by a competent geotechnical designer, informed by detailed ground investigation to confirm peat, mineral soil, and bedrock condition and properties.
- A detailed site investigation will be conducted by experienced geotechnical staff.
- The area's hydrology will be maintained as far as possible by implementing and maintaining an appropriate drainage system.
- Use of experienced contractors and trained operators to carry out the work.

The peat stability risk for the proposed infrastructure is negligible. However, the results of the factor of safety deterministic calculation and the site walkover allowed for the identification of safety buffer areas outlined in Section 4.6 and shown in Appendix L. These must be adhered to in future stages of the Proposed Project.

To minimise the risk of construction activity causing potential peat instability the Construction Method Statements (CMSs) for the project will implement in full, but not be limited to, the recommendations above.

Construction works shall follow the recommendations of the peat and spoil management plan: Peat and spoil management plan (GDG 20021-R02-PMP-00). During construction, it is strongly recommended to carry out frequent monitoring works, especially after heavy rainfall events or prolonged rainfall.

8.1 CONTINGENCY MEASURES

Due to the high factors of safety and negligible risk of peat landslides identified on site, it is not anticipated that peat failure will occur on site. However, in the event of peat failure (e.g. tension cracking, surface rippling, sliding), the following measures should be implemented:

1. All activities within the affected area shall cease immediately.
2. Where possible action shall be taken to prevent a potential peat slide from reaching any watercourse. In this instance, priority should be given to the one watercourse that crosses the site to the south of T06 and T07). This will usually take the form of the construction of check barrages on land if this is possible after considering the speed of the failure and accessibility of the terrain.
3. All relevant authorities should be notified if a peat slide event occurs on site.

4. Localised peat slides that do not present a risk to watercourses shall be stabilised where possible by rock infill and granular material. The area shall then be assessed by competent engineers, and further stabilisation measures will be implemented where necessary.
5. In the event of a peat slide that presents a risk to watercourses, a check barrage shall be installed within the watercourse, downstream of the likely point of entry. This shall consist of the placement of granular fill across the watercourse to prevent the passage of peat debris while allowing water flow.
6. The contractor will be responsible for providing suitable contingencies outlined within the construction stage CEMP. The contractor will additionally need to carry out a construction stage PSRA.

Further mitigations and contingency measures are outlined in the Peat and Spoil Management Plan (Appendix 4-2, GDG 20021-R-02-PMP-02).

REFERENCES

Bord na Móna (2022) Methodology Paper for the Enhanced Decommissioning, Rehabilitation and Restoration on Bord na Móna Peatlands – Preliminary Study

Bromhead, E. (1986). *The stability of slopes*. CRC Press.

Carling, P. A. (1986). Peat slides in Teesdale and Weardale, Northern Pennines, July 1983: description and failure mechanisms. *Earth Surface Processes and Landforms*, *11*(2), 193-206.

Clayton, C. R. I. (2001). Managing geotechnical risk: time for change? *Proceedings of the Institution of Civil Engineers-Geotechnical Engineering*, *149*(1), 3–11.

Corominas, J., van Westen, C., Frattini, P., Cascini, L., Malet, J.-P., Fotopoulou, S., … others. (2014). Recommendations for the quantitative analysis of landslide risk. *Bulletin of Engineering Geology and the Environment*, *73*(2), 209–263.

Dykes, A.P. and Kirk, K.J. (2006). Slope instability and mass movements in peat deposits. In Martini, I. P., Martinez Cortizas, A. and Chesworth, W. (Eds.) Peatlands: Evolution and Records of Environ mental and Climatic Changes. Elsevier, Amsterdam

European Environmental Agency (EEA), (2022). European Digital Elevation Model (EU-DEM), version 1.1. https://land.copernicus.eu/imagery-in-situ/eu-dem/eu-dem-v1.1?tab=metadata.

EPA, Teagasc, & Cranfield University (2018). Irish soil map 250k. Retrieved from http://gis.teagasc.ie/soils/downloads.php

Farrell, E. R., & Hebib, S. (1998). The determination of the geotechnical parameters of organic soils. In *Problematic soils* (pp. 33-36).

Feldmeyer-Christe, E., & Küchler, M. (2002). Onze ans de dynamique de la végétation dans une tourbière soumise à un glissement de terrain. *Bot. Helv*, *112*(2), 103–120.

Fernandez, F., Connolly, K., Crowley, W., Denyer, J., Duff, K. & Smith, G. (2014). Raised Bog Monitoring and Assessment Survey 2013. Irish Wildlife Manual No. 81. National Parks and Wildlife Service, Department of Arts, Heritage and Gaeltacht, Dublin, Ireland.

Gao, B.-C. (1996). NDWI—A normalized difference water index for remote sensing of vegetation liquid water from space. *Remote Sensing of Environment*, *58*(3), 257–266.

GDG (2023) Clonberne Wind Farm – Peat and Spoil management plan. Report: GDG 20021-R02-PMP-02

Google Earth (2010, 2015, 2020) Multitemporal Satellite Imagery. Retrieved from

GSI (2015) Karst.shp

GSI (2016). Landslide_Susceptibility.shp.

GSI (2018). Bedrock map of Ireland 100k.

GSI (2021). Quaternary geology of Ireland - Sediments map (shapefiles).

GSI (2022a). Landslide_Event_Perimeter.shp.

GSI (2022b). Landslides_DB_29052018.shp.

Hanrahan, E. T. (1967). Shear strength of peat. In *Proceedings of Geotechnical Conference* (Vol. 1, pp. 193-198).
Hungr, O. and Evans, S.G. (1985). An example of a peat flow near Prince Rupert, British Columbia. Canadian Geotechnical Journal, 22.
IS EN 1997 1.2005+AC.2009 - Eurocode 7. Geotechnical design. Part 1 General rules (including Irish National Annex 2007)

Kelly, L. & Schouten, M. (2002). Vegetation. In: M. Schouten, ed. Conservation and Restoration of Raised Bogs: Geological, Hydrological and Ecological Studies. Department of Environment and Local Government, Dublin, Ireland/ Staatabosbeheer, The Netherlands, pp. 110-169.

Komatsu, J., Oikawa, H., Ogino, T., Tsushima, M., & Igarashi, M. (2011, June). Ring shear test on peat. In *ISOPE International Ocean and Polar Engineering Conference* (pp. ISOPE-I). ISOPE.
Landva, A. O. (1980). Vane testing in peat. *Canadian Geotechnical Journal*, *17*(1), 1-19.
Landva, A. O., & Pheeney, P. E. (1980). Peat fabric and structure. *Canadian Geotechnical Journal*, *17*(3), 416-435.
Lee, E. M., & Jones, D. K. C. (2004). *Landslide risk assessment*. Thomas Telford London.

Lindsay, R. A., & Bragg, O. M. (2004). *Wind Farms and Blanket Peat: The Bog Slide of 16th October 2003 at Derrybrien, Co. Galway, Ireland*. Unpublished report to unspecified clients. London, University of East London.

MacCulloch, F. (2006*). Guidelines for the risk management of peat slips on the construction of low volume/low cost roads over peat*. *The ROADEX II Project*.

Mackin, F., Barr, A., Rath, P., Eakin, M., Ryan, J., Jeffrey, R. & Fernandez Valverde, F. (2017) Best practice in raised bog restoration in Ireland. Irish Wildlife Manuals, No. 99. National Parks and Wildlife Service, Department of Culture, Heritage and the Gaeltacht, Ireland.

McDonagh, E. (1996). Drain blocking by machines on Raised Bogs. Unpublished report for National Parks and Wildlife Service.

McGeever J. and Farrell E. (1988). The shear strength of an organic silt.
Proc. 2nd Baltic Conf., 1, Tallin USSR.
Met Éireann (2018) - 12 Average annual rainfall (mm) over Ireland for the period 1981-2010.

Mills, A. J. (2003). *Peat slides: morphology, mechanisms and recovery*. Durham University.

Mills, A.J. and Rushton, D. (2023). A risk-based approach to peatland restoration and peat instability. NatureScot Research Report 1259.

Minerex Environmental Ltd (2008). *Construction Phase Environmental Audit Report*. Doc. Ref.: 1914-176

Praeger, R. L (1897). Bog-Bursts, with Special Reference to the Recent Disaster in Co. Kerry. The Irish Naturalist, vol. 6, no. 6, 1897, pp. 141–62.

Rowe, R. K., MacLean, M. D., & Soderman, K. L. (1984). Analysis of a geotextile-reinforced embankment constructed on peat. *Canadian Geotechnical Journal*, *21*(3), 563-576.

Rowe, R. K., & Mylleville, B. L. (1996). A geogrid reinforced embarkment on peat over organic silt: A case history. *Canadian Geotechnical Journal*, *33*(1), 106-122.

Scottish-Executive. (2017). *Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments*. *Scottish Executive. 69p*.

Skempton, A. W., & DeLory, F. A. (1957). Stability of natural slopes in London Clay. In *Proc 4th Int. Conf. On Soil Mechanics and Foundation Engineering, vol. 2.* (pp. 72–78). Rotterdam.

Warburton, J., Higgett, D. and Mills, A. (2003). Anatomy of a Pennine Peat Slide. Earth Surface Processes and Landforms.

Warburton, J., Holden, J. and Mills, A. J. (2004). Hydrological controls of surficial mass movements in peat. Earth-Science Reviews 67 (2004), pp. 139-156.

Warburton, J. (2022*). Peat landslides*. In *Landslide Hazards, Risks, and Disasters* (pp. 165-198). Elsevier.

Wu, Y. (2003). Mechanism analysis of hazards caused by the interaction between groundwater and geo-environment. *Environmental Geology*, *44*(7), 811–819.

Xue, J., & Gavin, K. (2008). Effect of rainfall intensity on infiltration into partly saturated slopes. *Geotechnical and Geological Engineering*, *26*(2), 1

Zhang, L., & O'Kelly, B. C. (2014). The principle of effective stress and triaxial compression testing of peat. *Proceedings of the Institution of Civil Engineers-Geotechnical Engineering*, *167*(1), 40-50.

Appendix A LOCATION

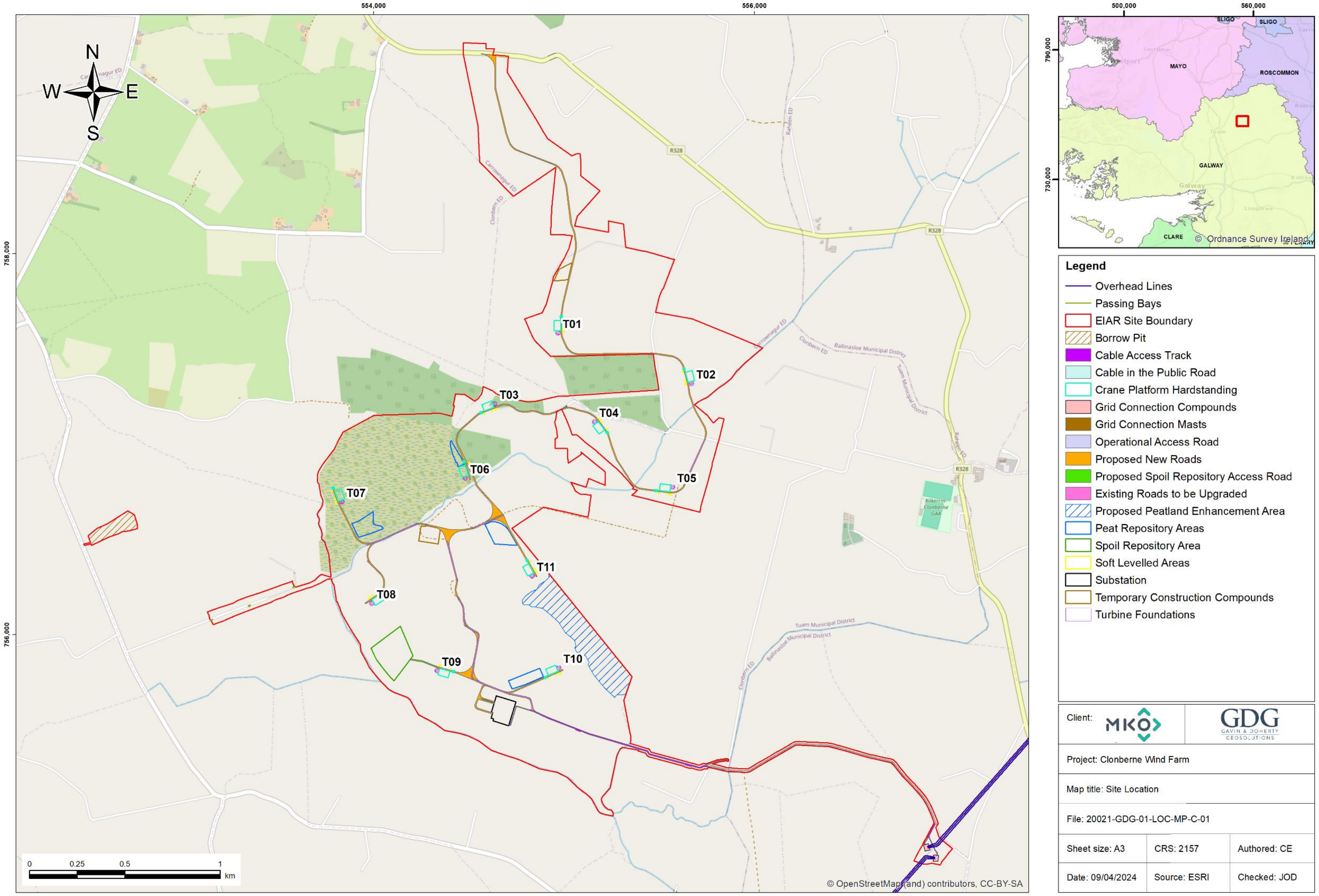


Figure A- 1: Proposed Project Location.

Appendix B GEOLOGY

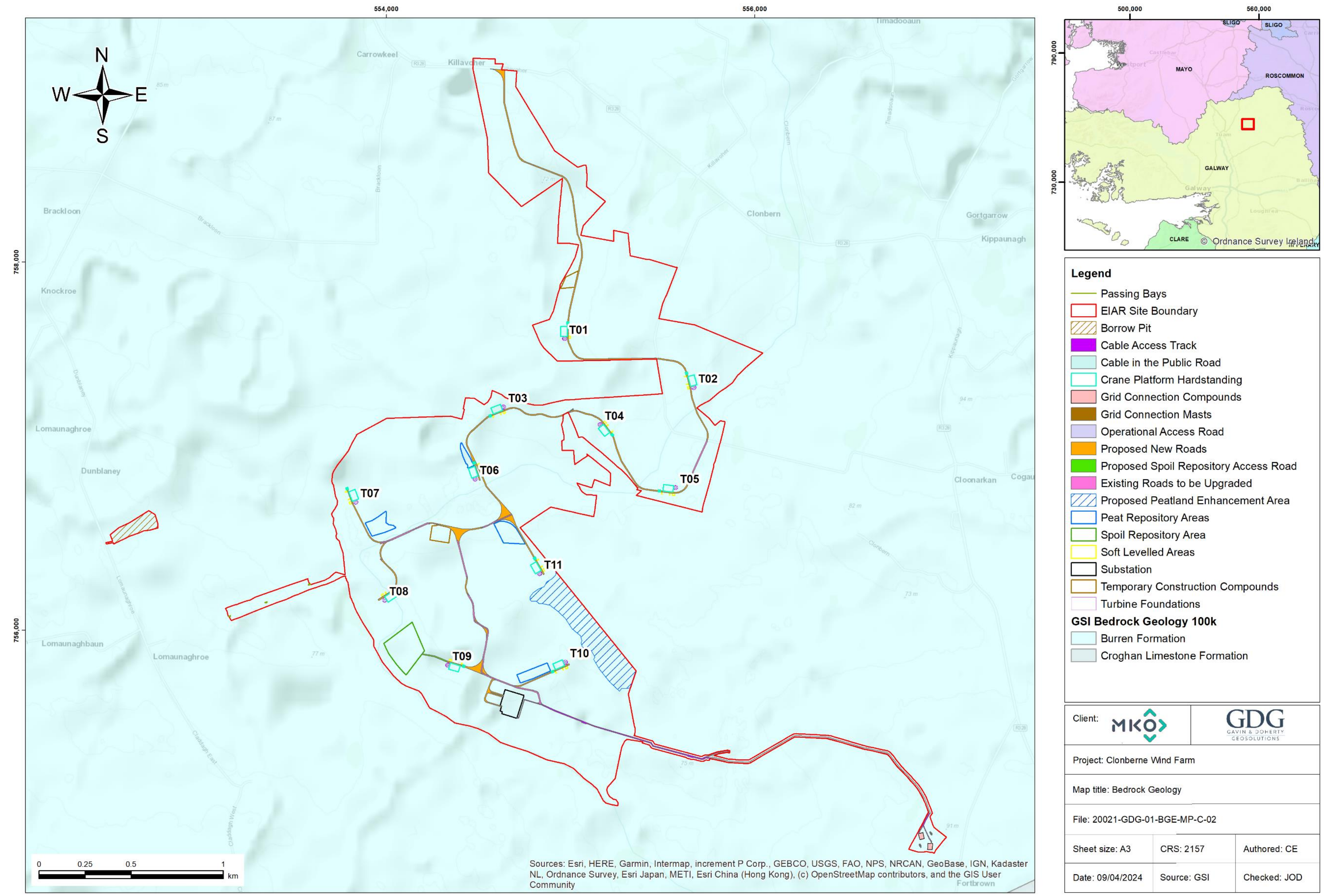


Figure B- 1: Bedrock Geology (GSI).

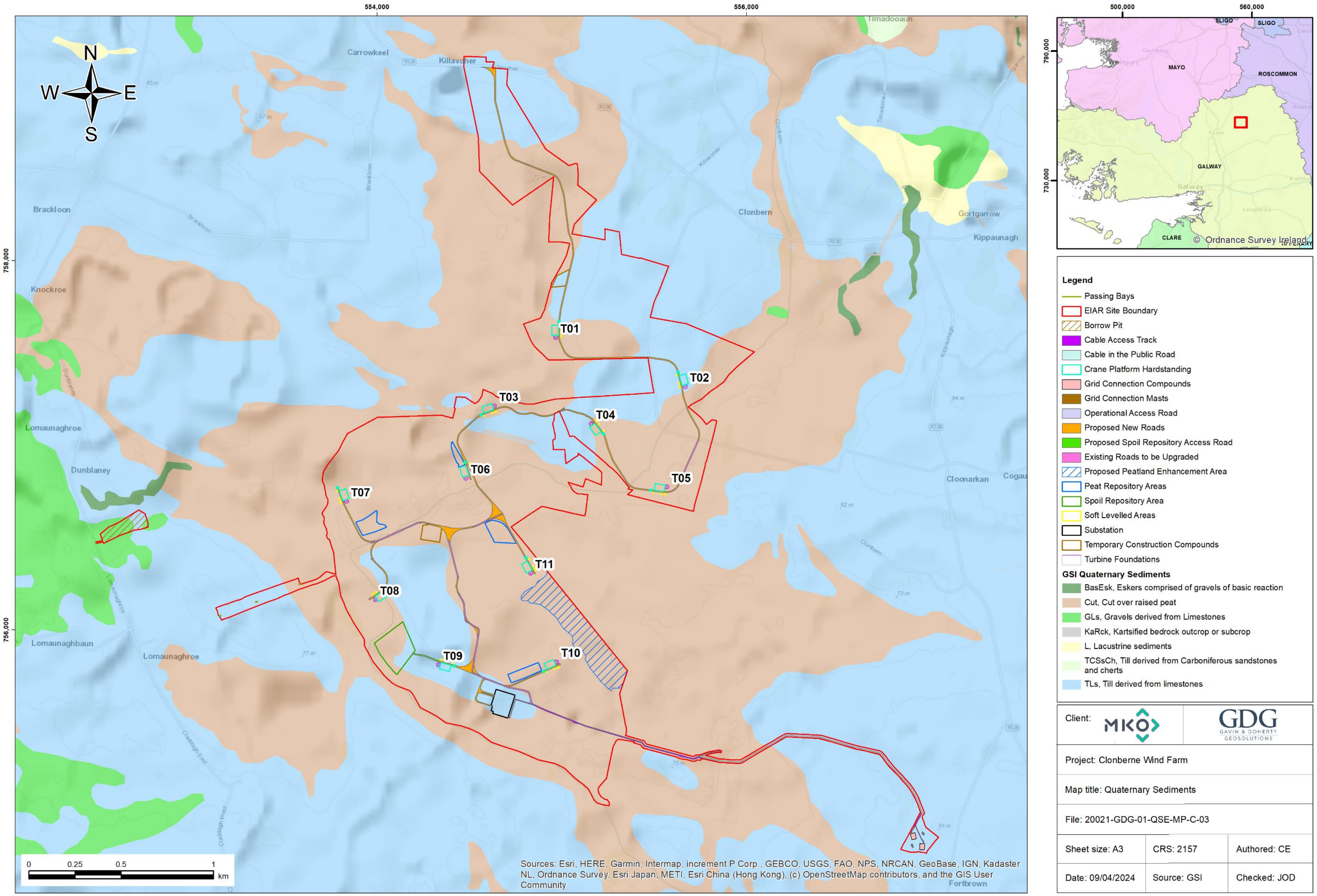


Figure B- 2: Quaternary Sediments (GSI).

Appendix C Soils

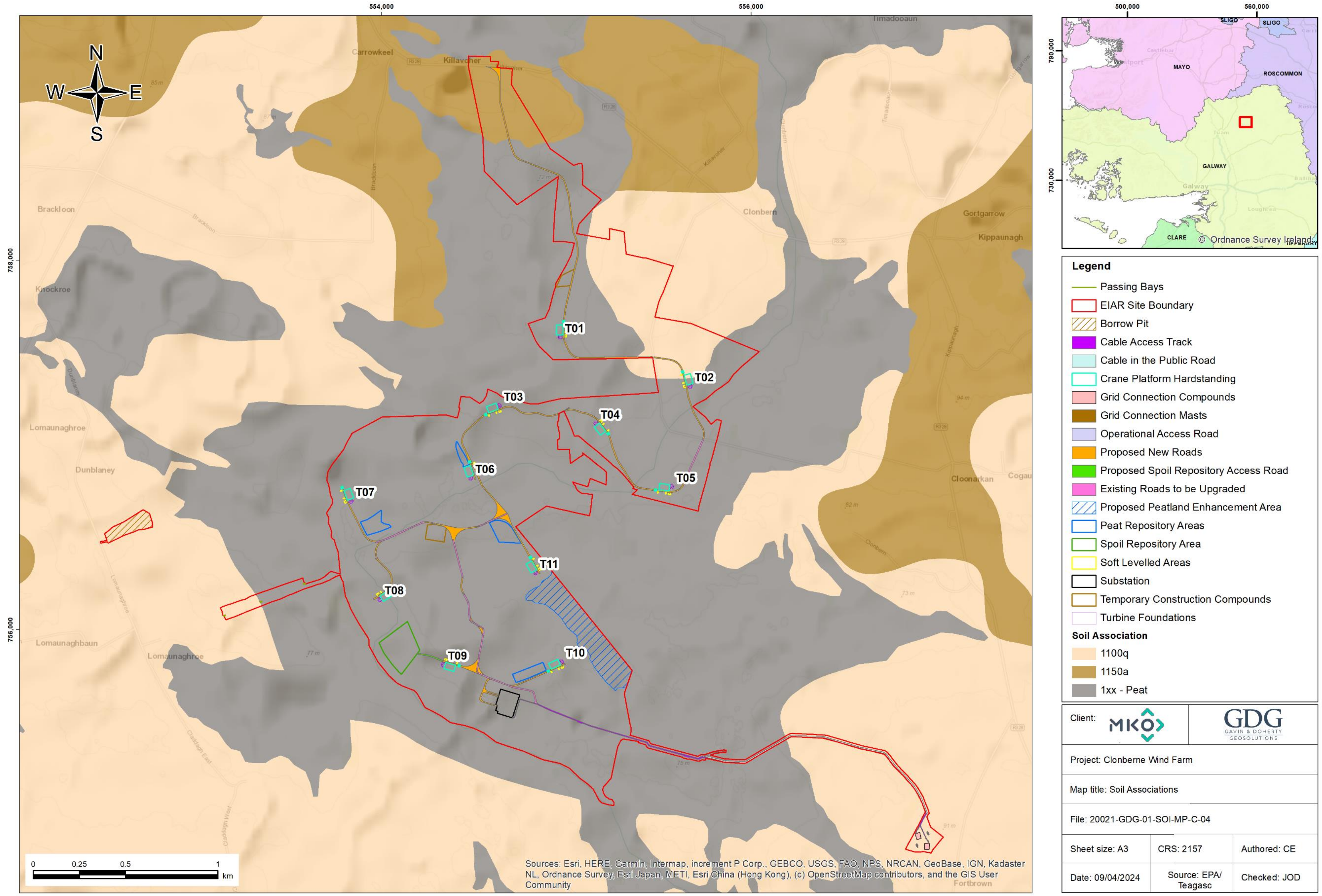


Figure C- 1: Soil Associations (EPA/Teagasc).

Appendix D MOISTURE

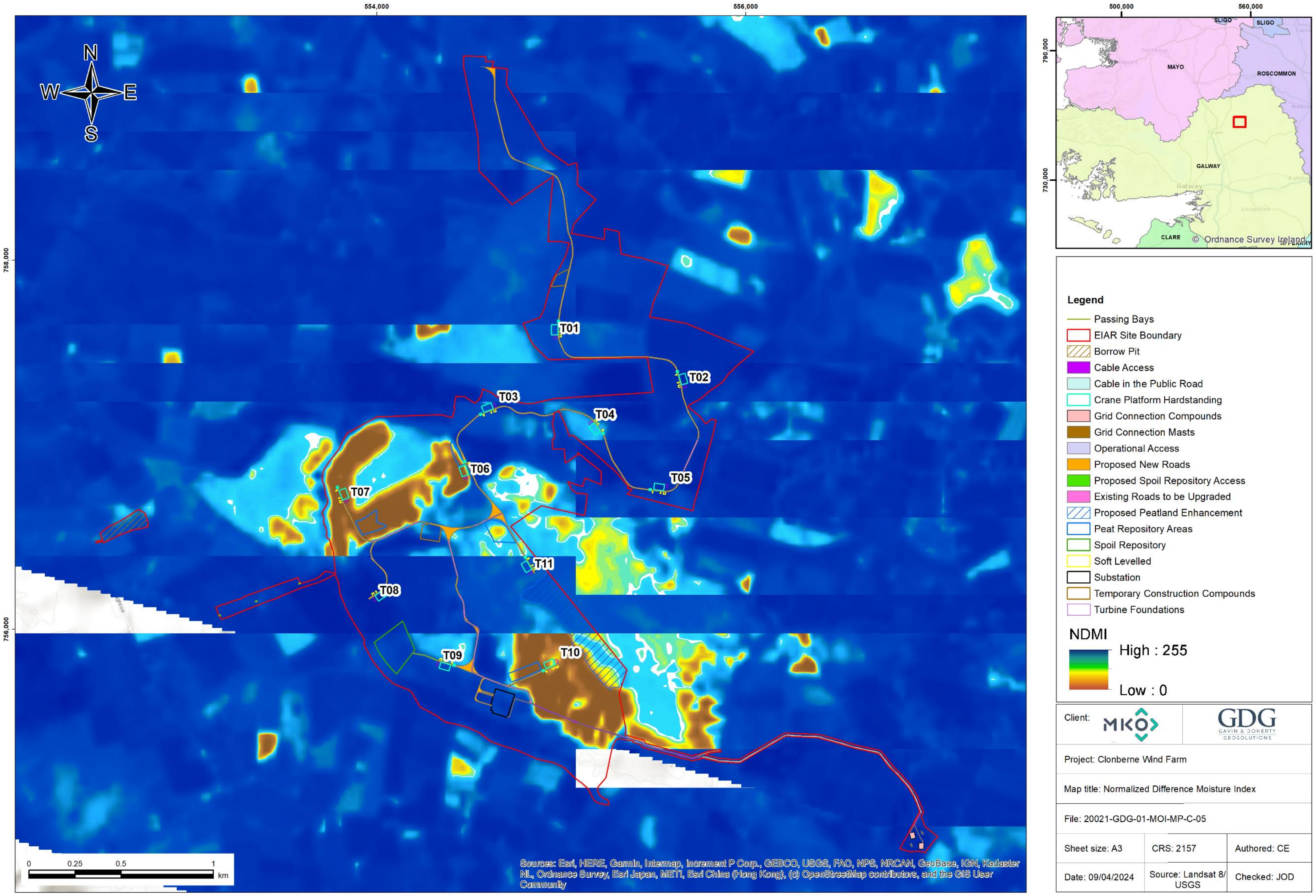


Figure D- 1: Normalised Difference Moisture Index (Landsat 8/USGS).

Appendix E HYDROGEOLOGY

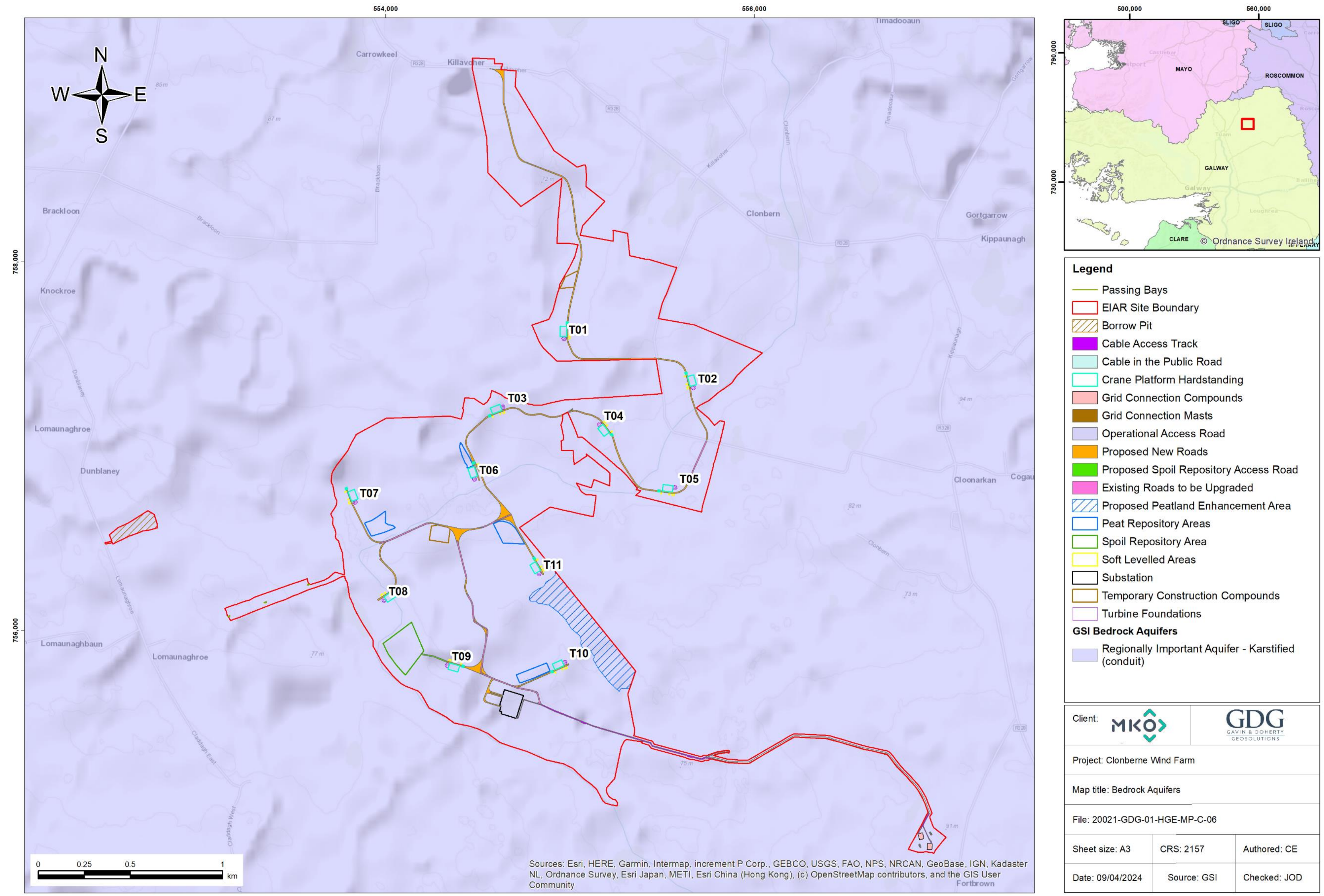


Figure E- 1: Bedrock Aquifers (GSI).

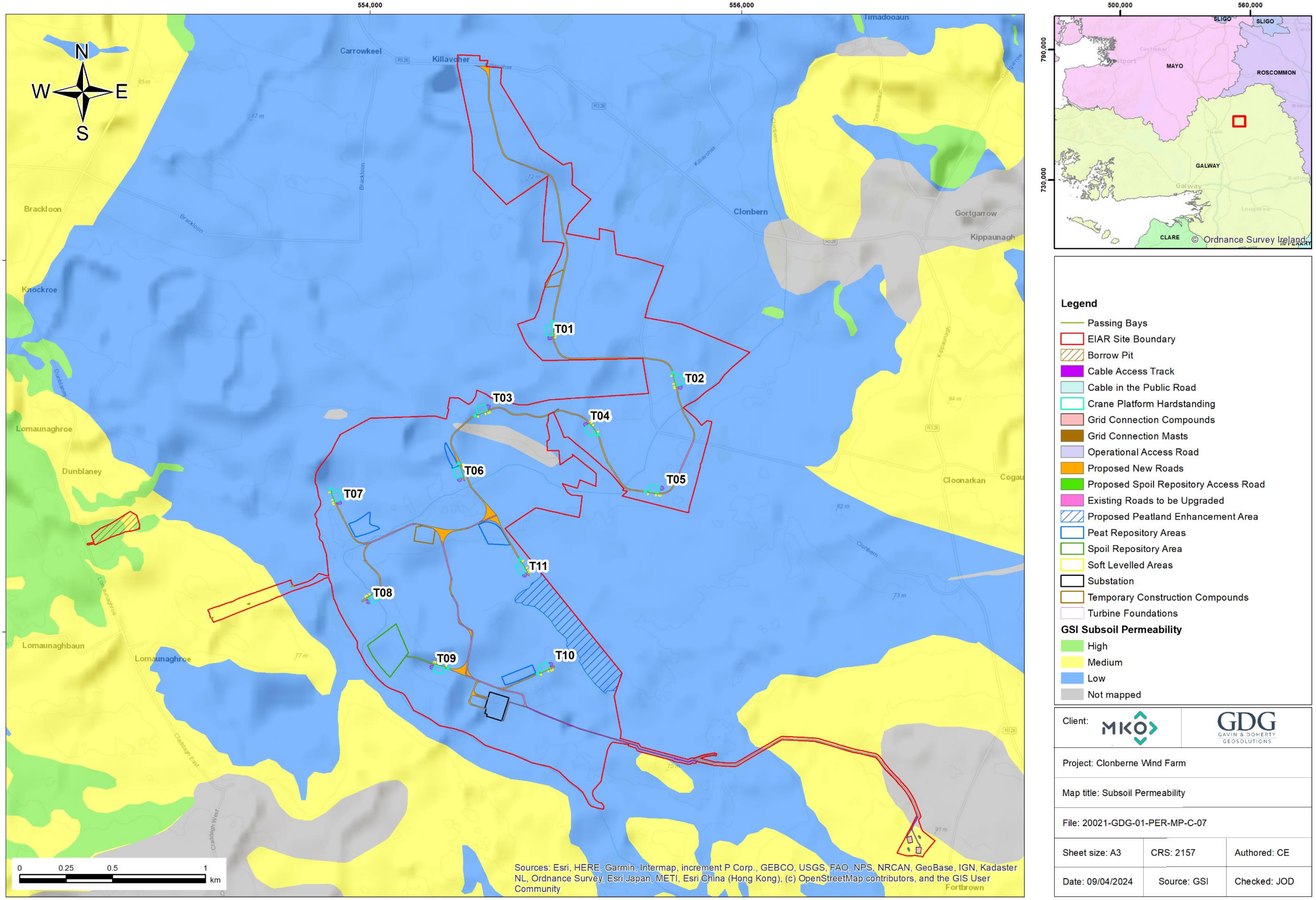


Figure E- 2: Subsoil Permeability (GSI).

Appendix F TOPOGRAPHY

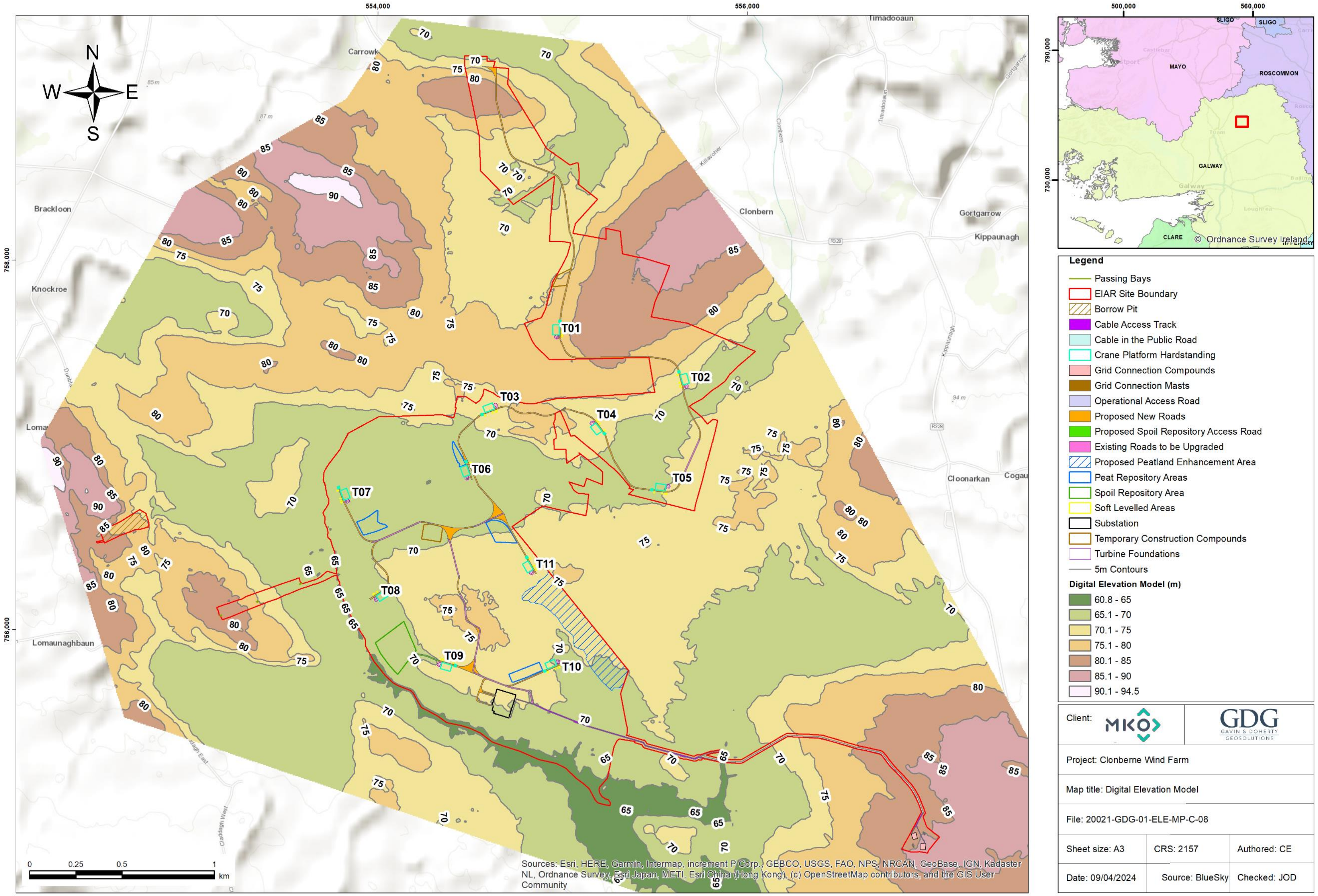


Figure F- 1: Digital Elevation Model (BlueSky, 2017).

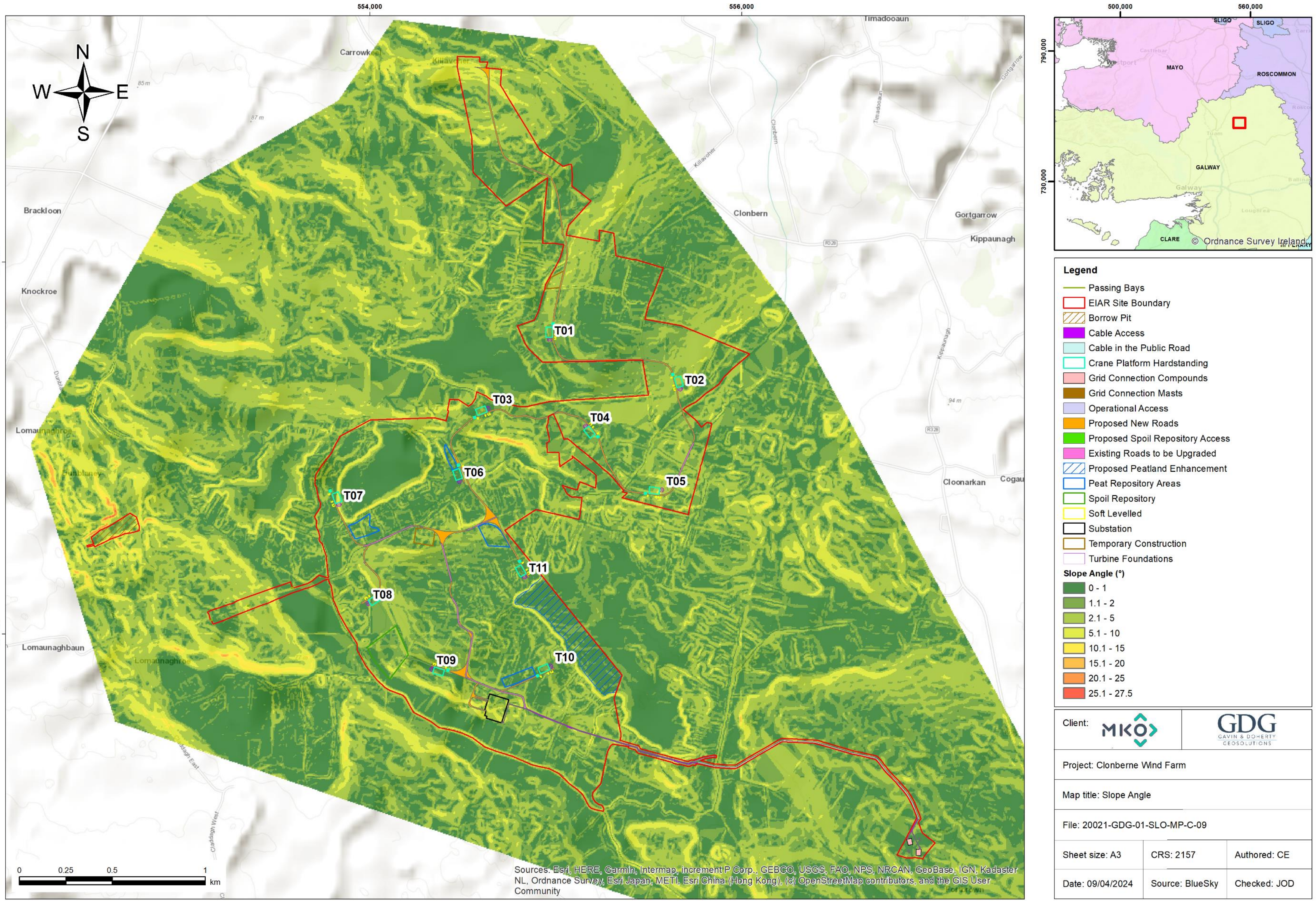


Figure F- 2: Slope Angles (Derived from BlueSky, 2017)

Appendix G Slope Instability Mapping

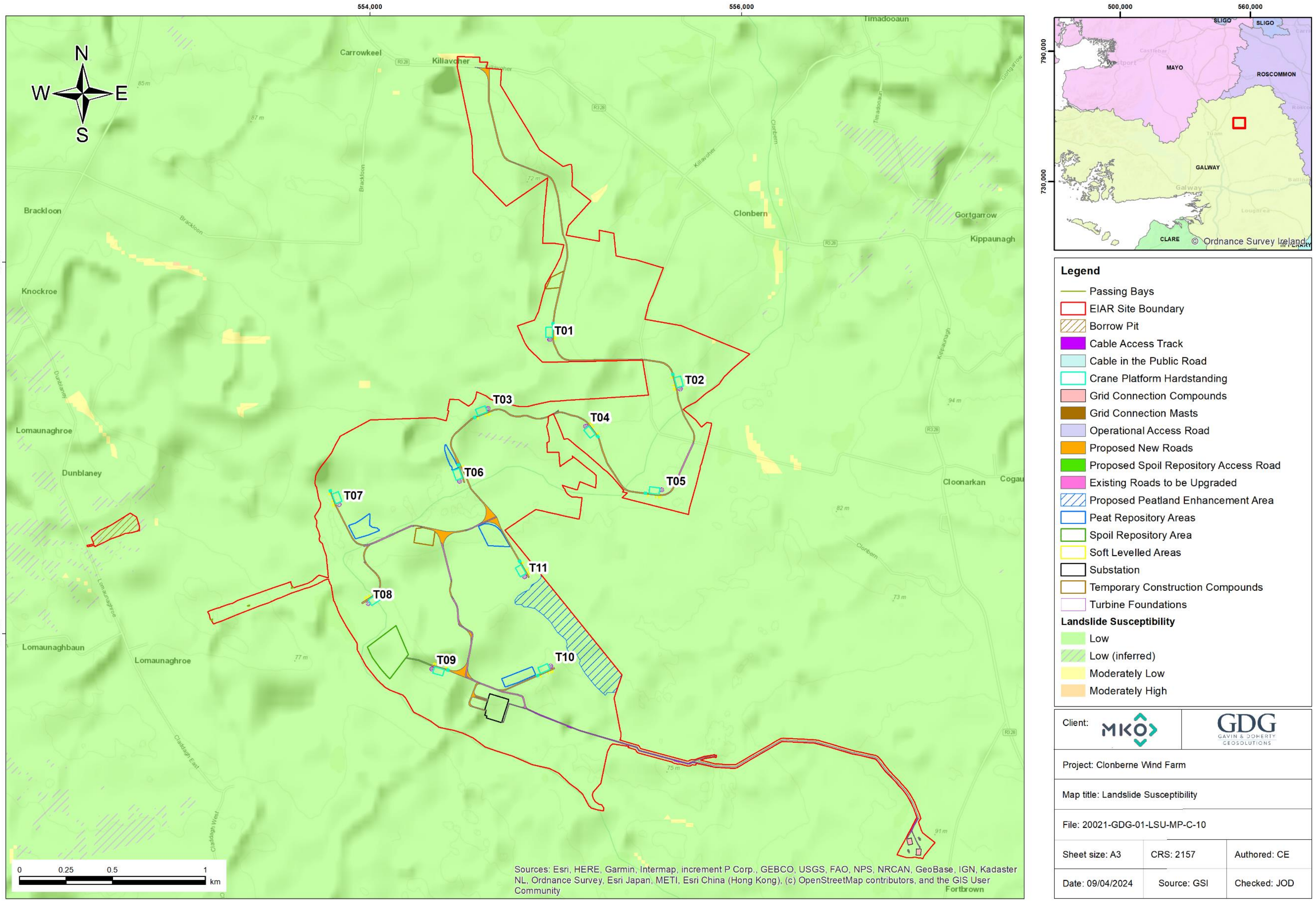
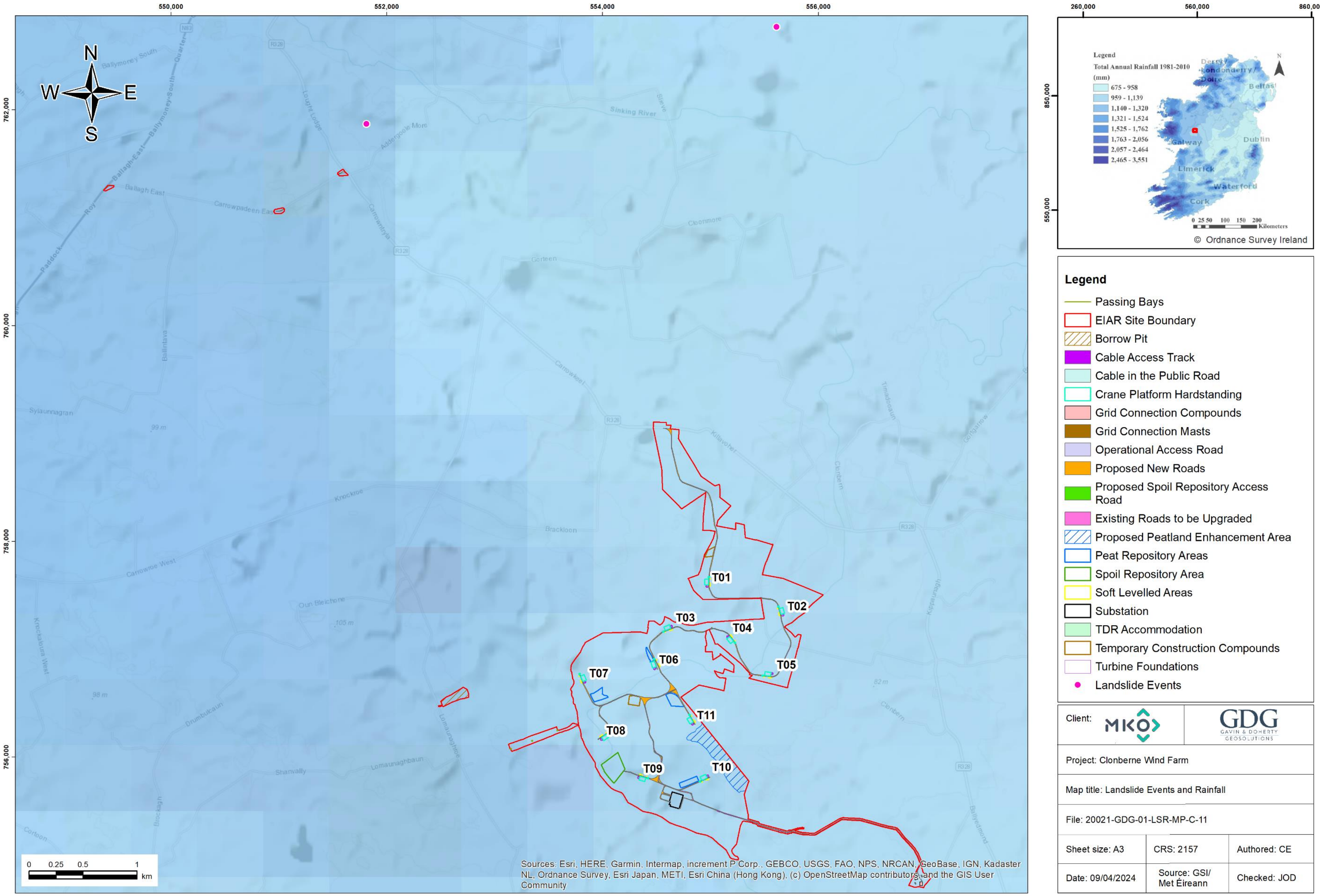


Figure G- 1: Landslide Susceptibility (GSI).



Project: Clonberne Wind Farm

Map title: Landslide Events and Rainfall

File: 20021-GDG-01-LSR-MP-C-11

Sheet size: A3	CRS: 2157	Authored: CE
Date: 09/04/2024	Source: GSI/ Met Éireann	Checked: JOD

Figure G- 2: Landslide Events and Rainfall (GSI/Met Eireann).

Appendix H HYDROLOGY

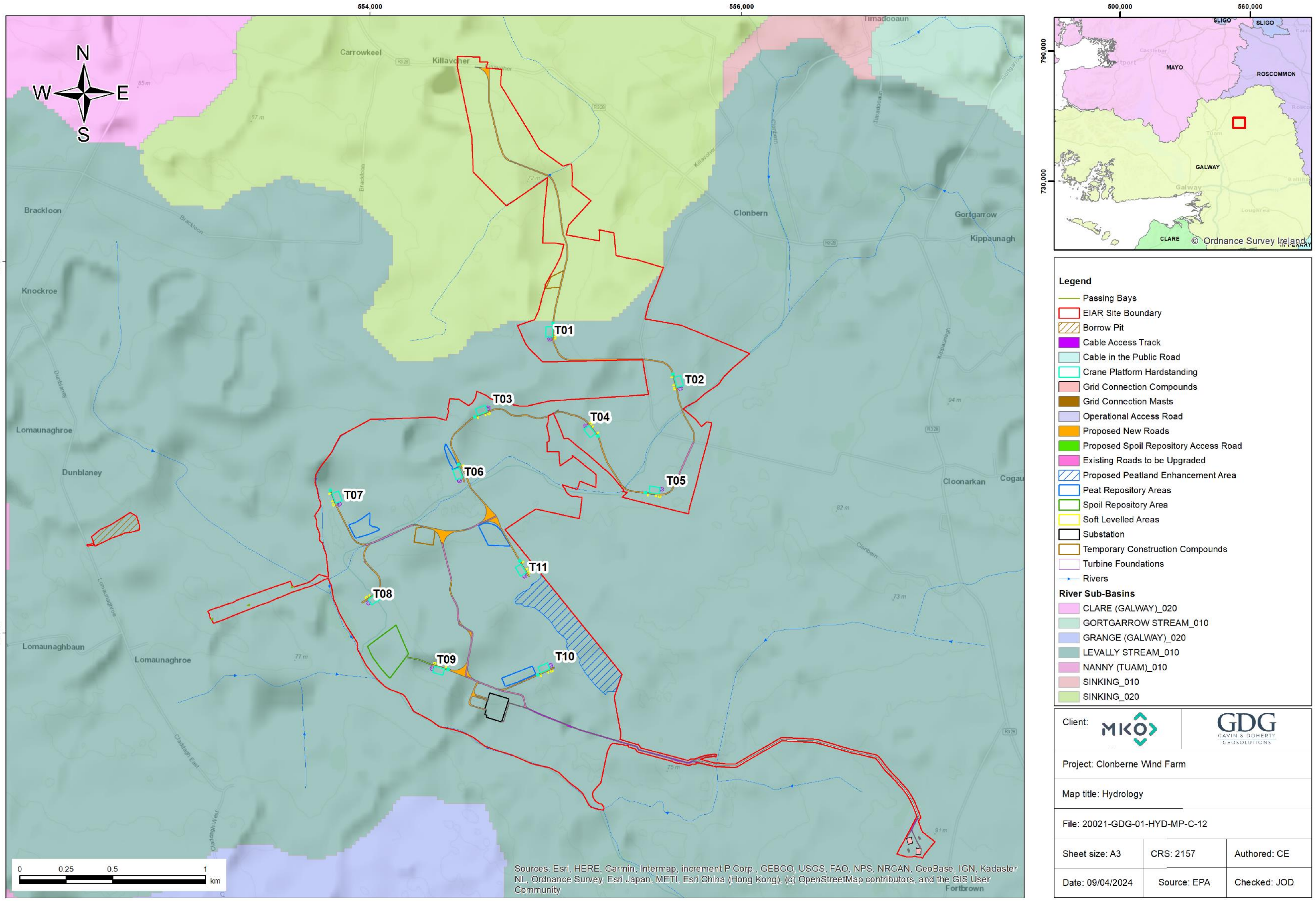


Figure H- 1: Hydrology (EPA).

Appendix I LANDCOVER

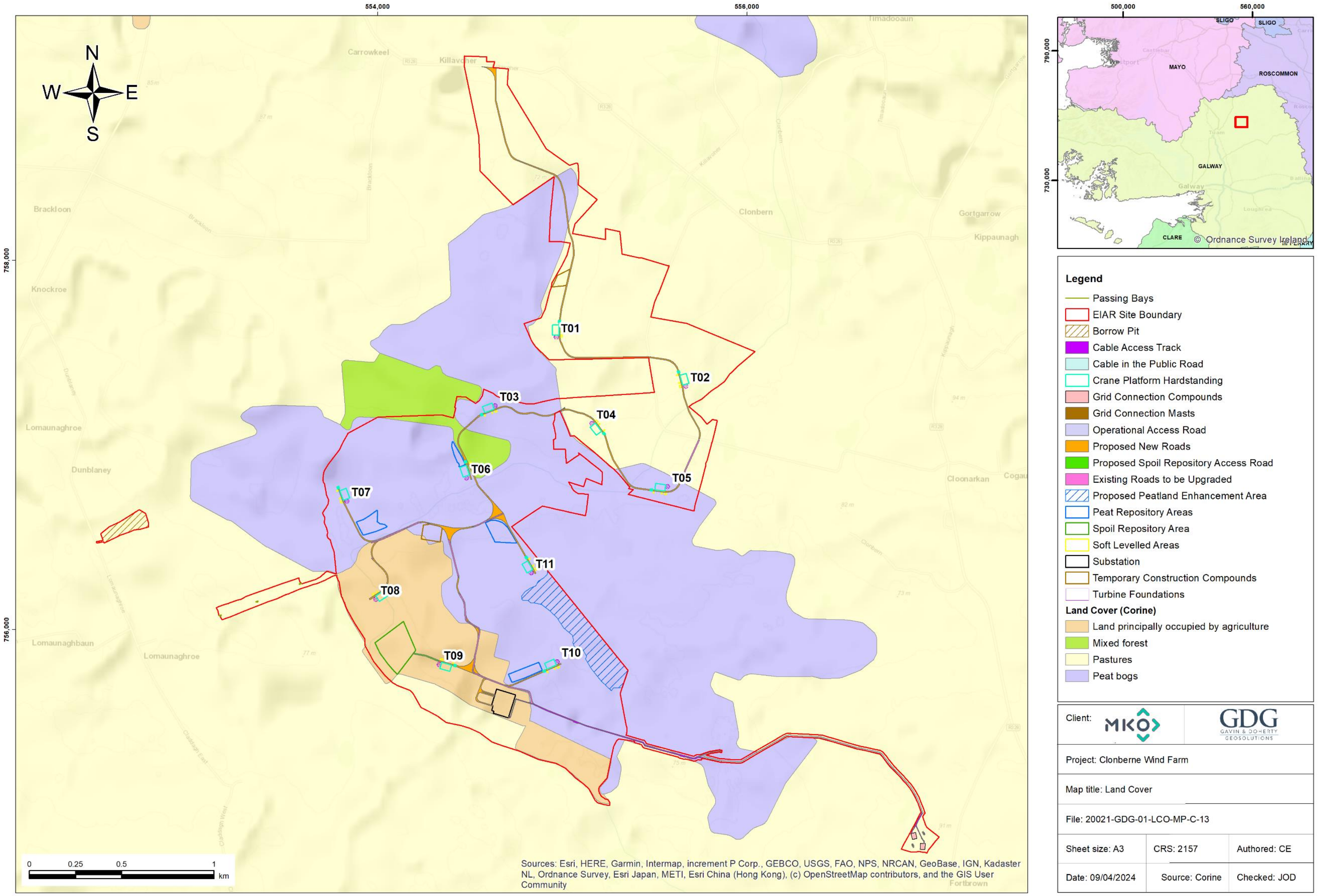
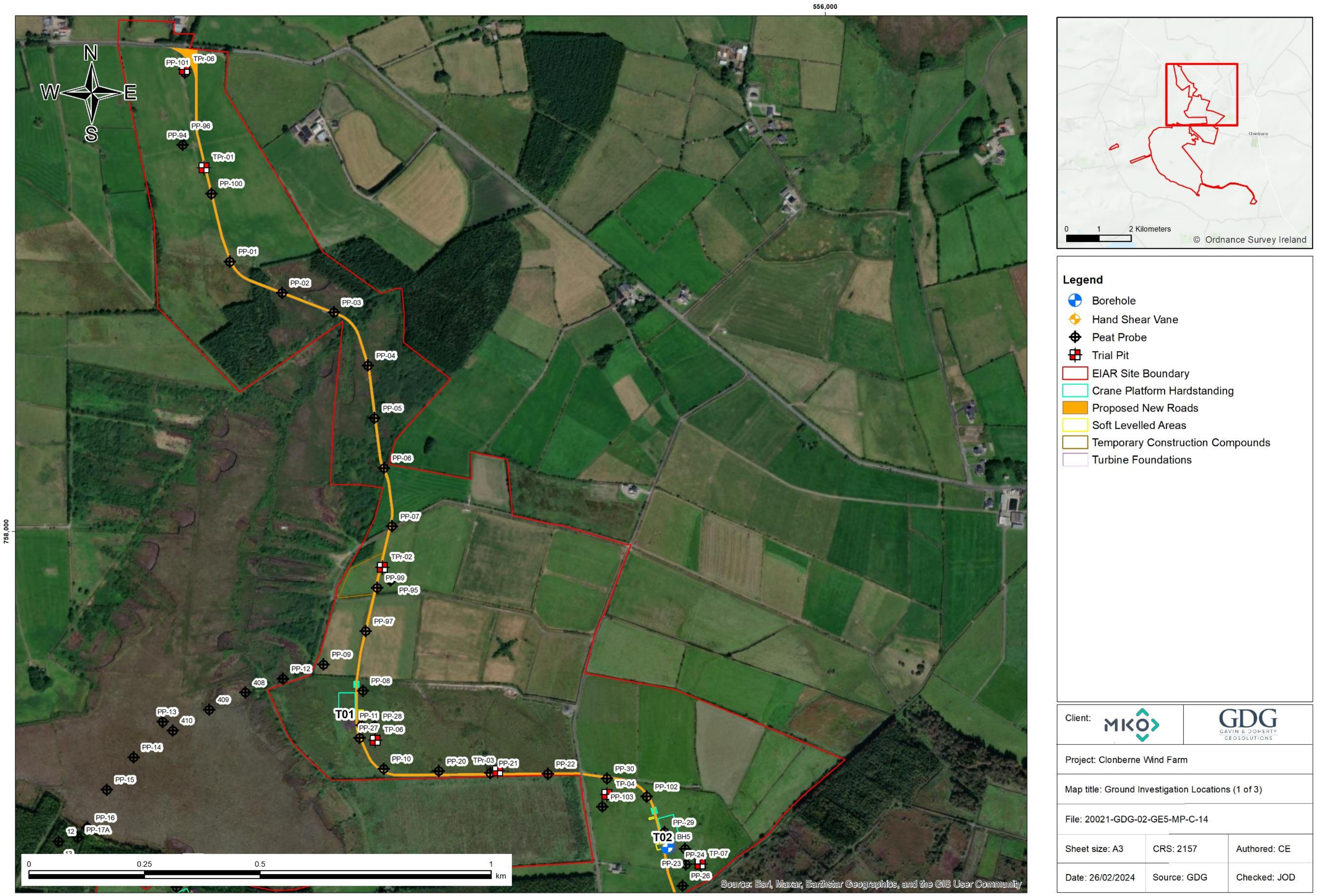


Figure I- 1: Landcover (Corine, 2018).



Legend

- Borehole
- Hand Shear Vane
- Peat Probe
- Trial Pit
- EIAR Site Boundary
- Crane Platform Hardstanding
- Proposed New Roads
- Soft Levelled Areas
- Temporary Construction Compounds
- Turbine Foundations

Client:

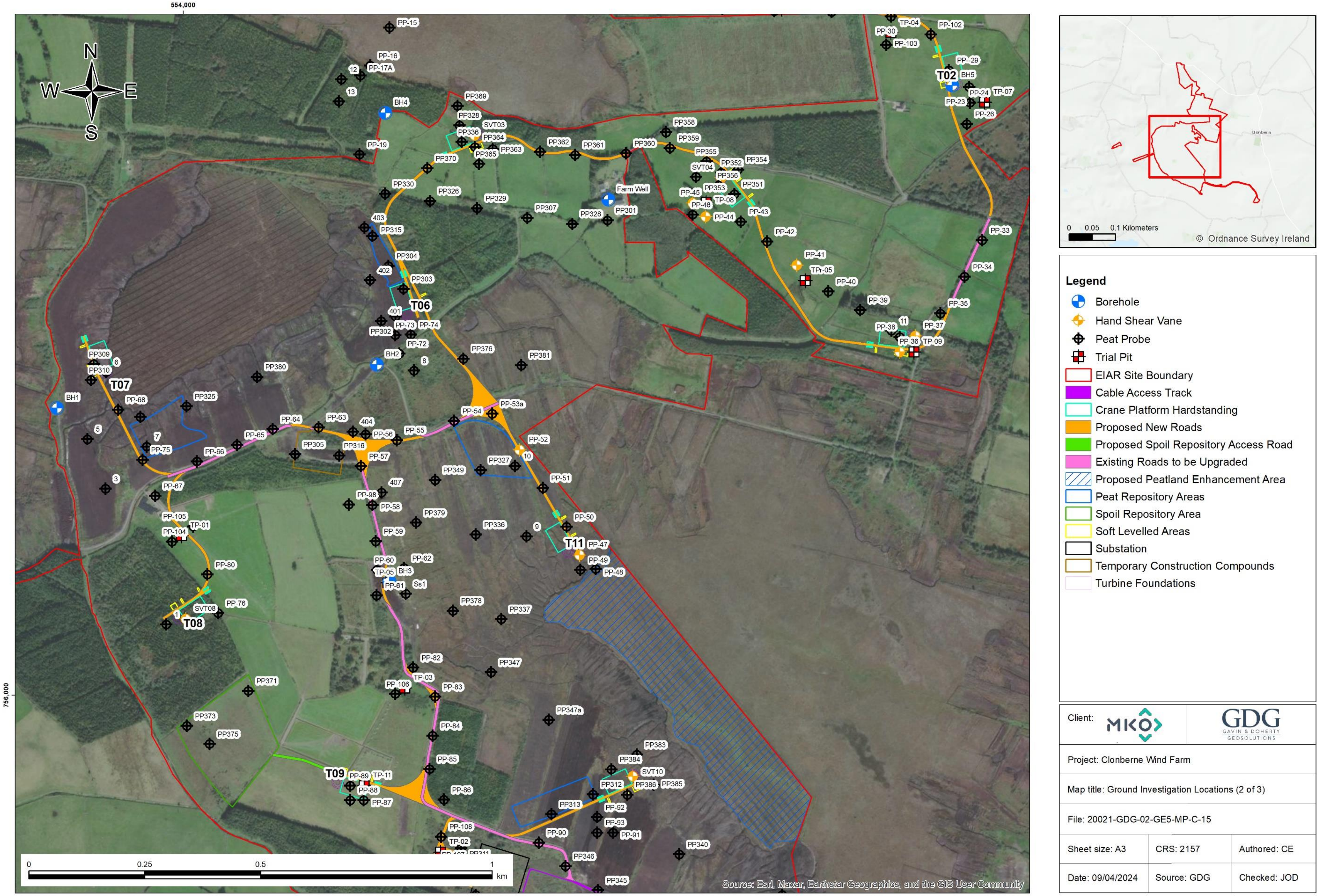
Project: Clonberne Wind Farm

Map title: Ground Investigation Locations (1 of 3)

File: 20021-GDG-02-GE5-MP-C-14

Sheet size: A3	CRS: 2157	Authored: CE
Date: 26/02/2024	Source: GDG	Checked: JOD

Figure J- 1: Ground Investigation Locations (1 of 3).



Client:

Project: Clonberne Wind Farm

Map title: Ground Investigation Locations (2 of 3)

File: 20021-GDG-02-GE5-MP-C-15

Sheet size: A3	CRS: 2157	Authored: CE
Date: 09/04/2024	Source: GDG	Checked: JOD

Figure J- 2: Ground Investigation Locations (2 of 3).

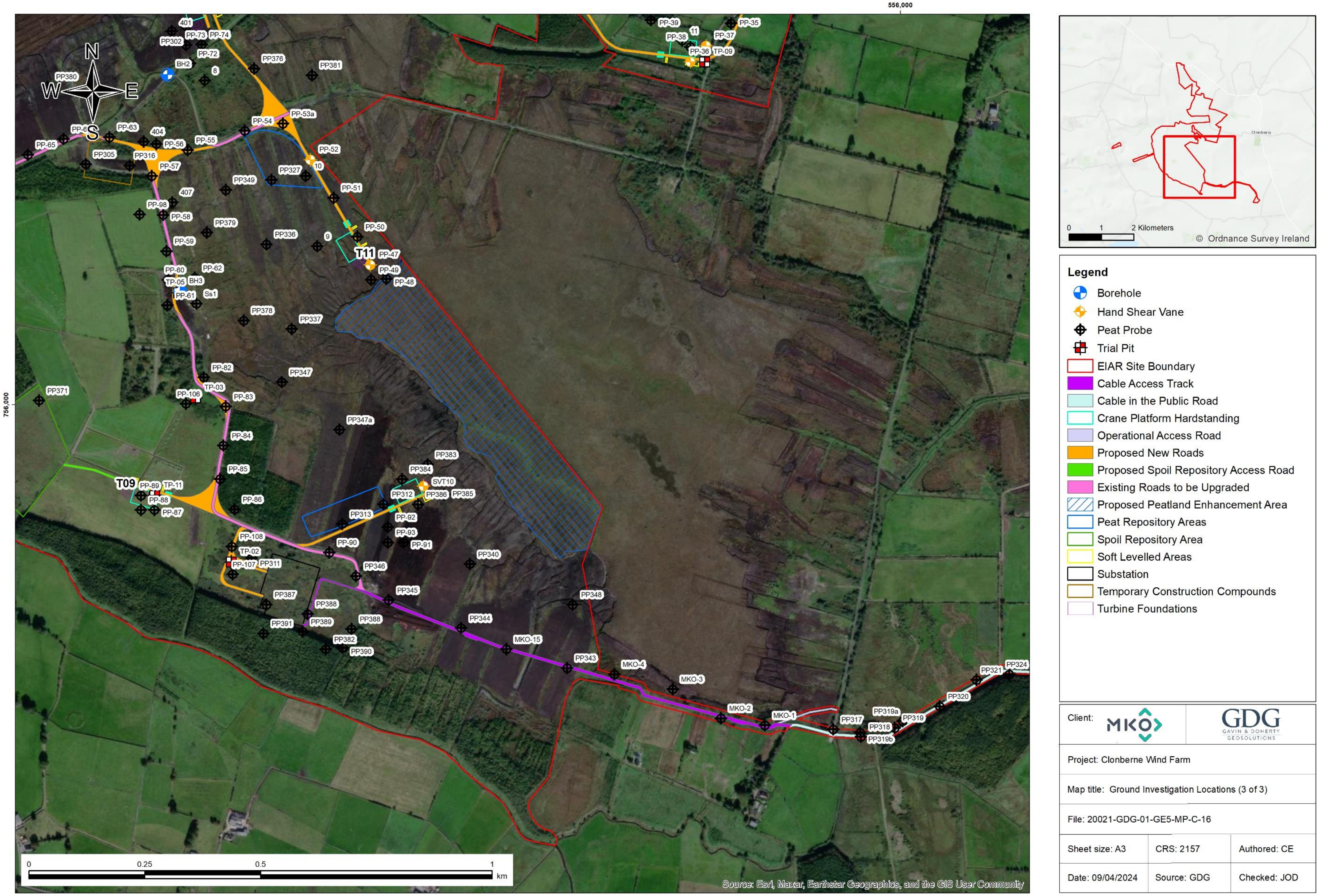
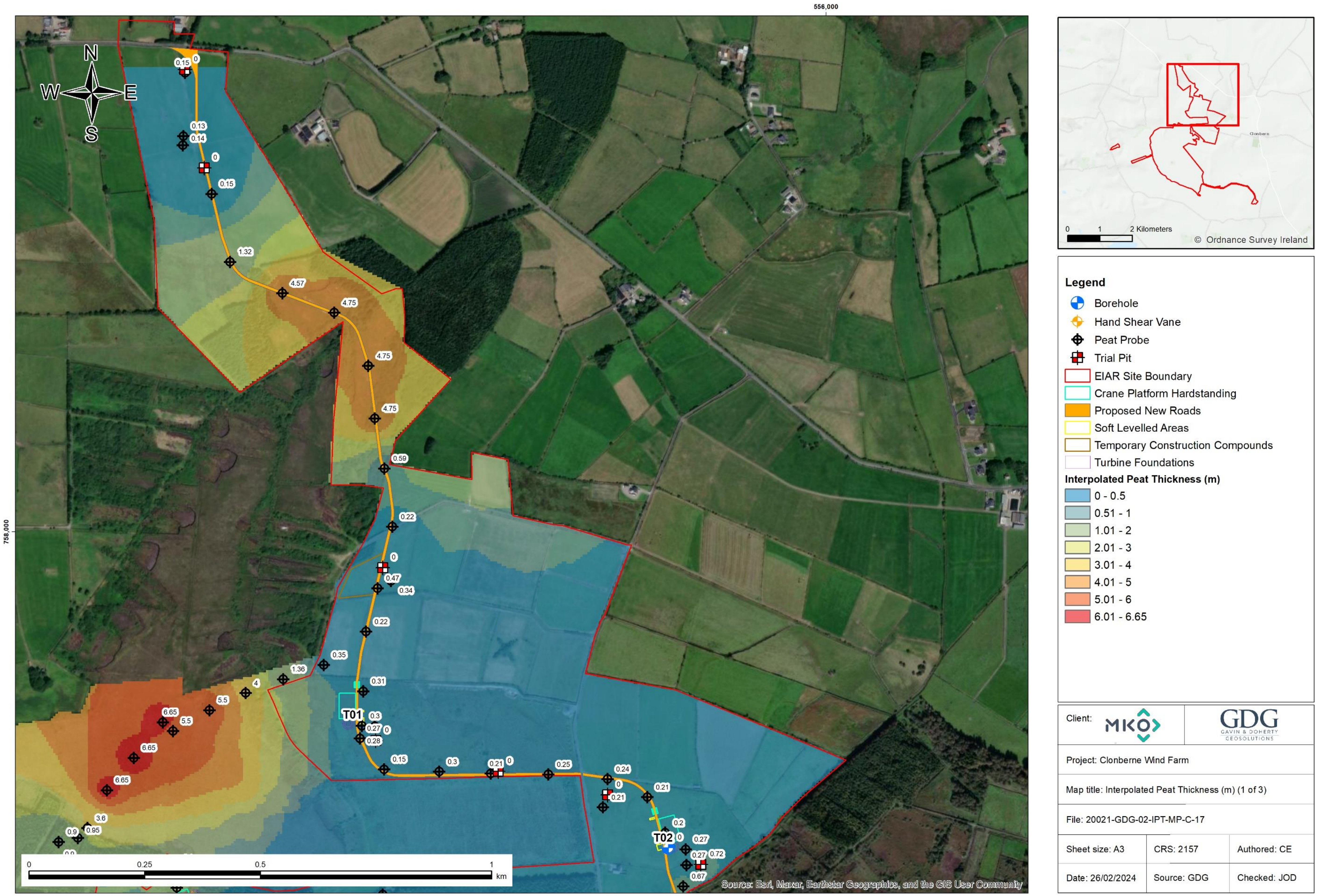


Figure J- 3: Ground Investigation Locations (3 of 3).



Project: Clonberne Wind Farm

Map title: Interpolated Peat Thickness (m) (1 of 3)

File: 20021-GDG-02-IPT-MP-C-17

Sheet size: A3	CRS: 2157	Authored: CE
Date: 26/02/2024	Source: GDG	Checked: JOD

Figure J- 4: Interpolated Peat Thickness (1 of 3).

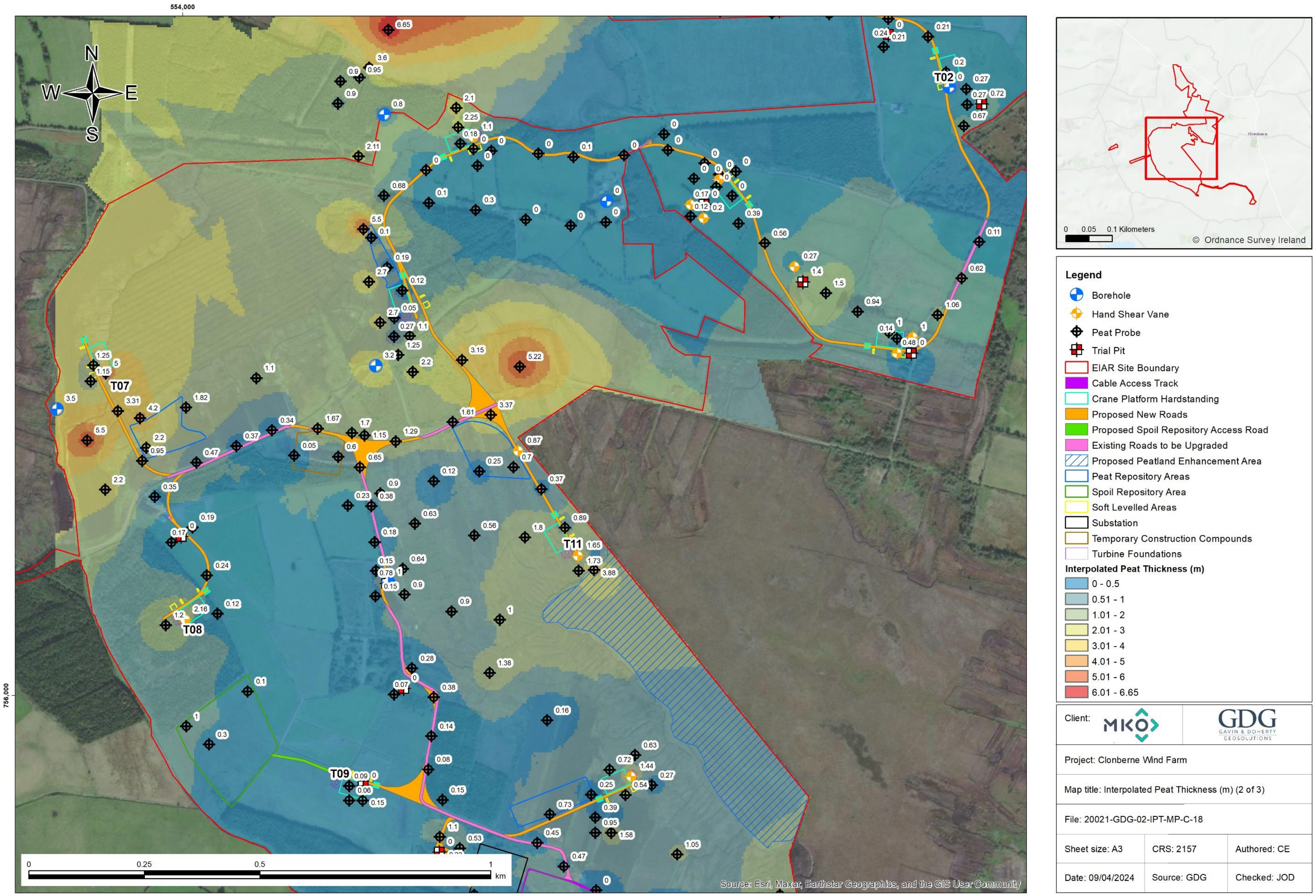


Figure J- 5: Interpolated Peat Thickness (2 of 3).

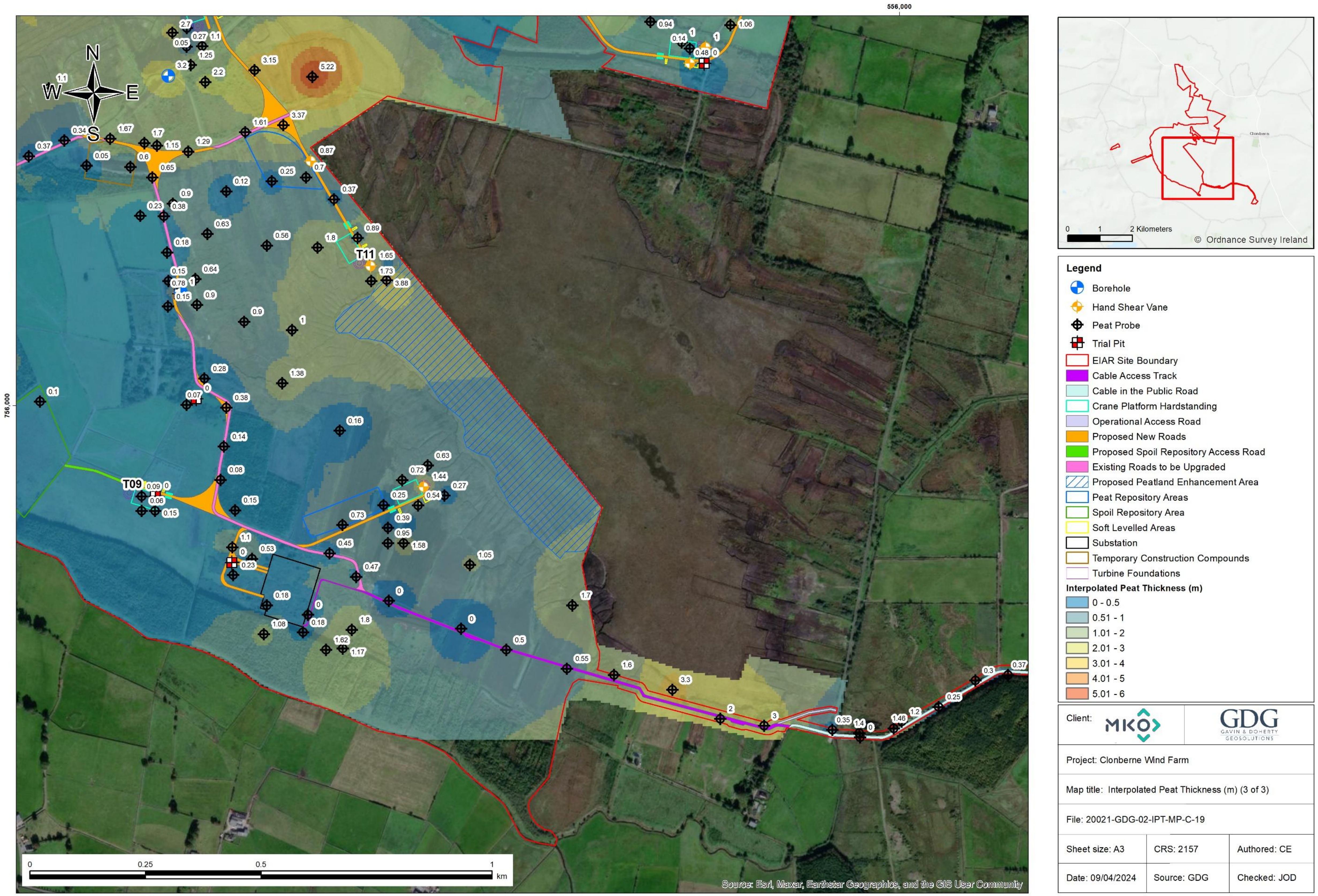
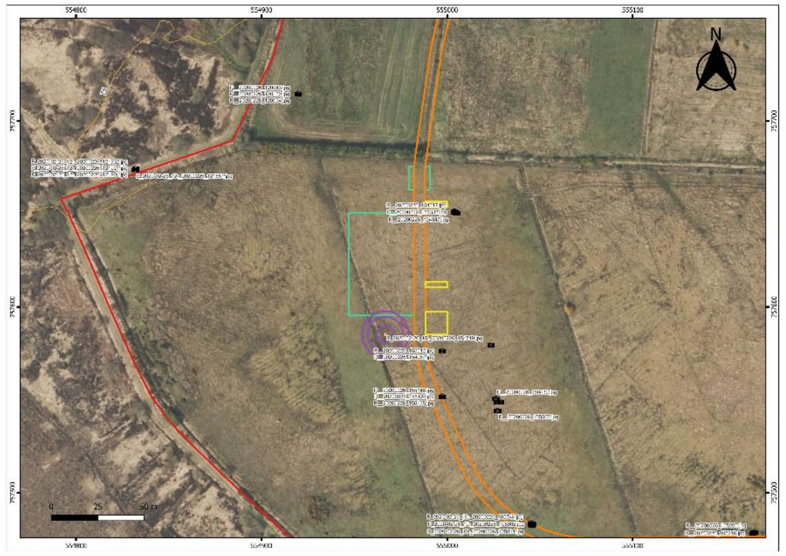
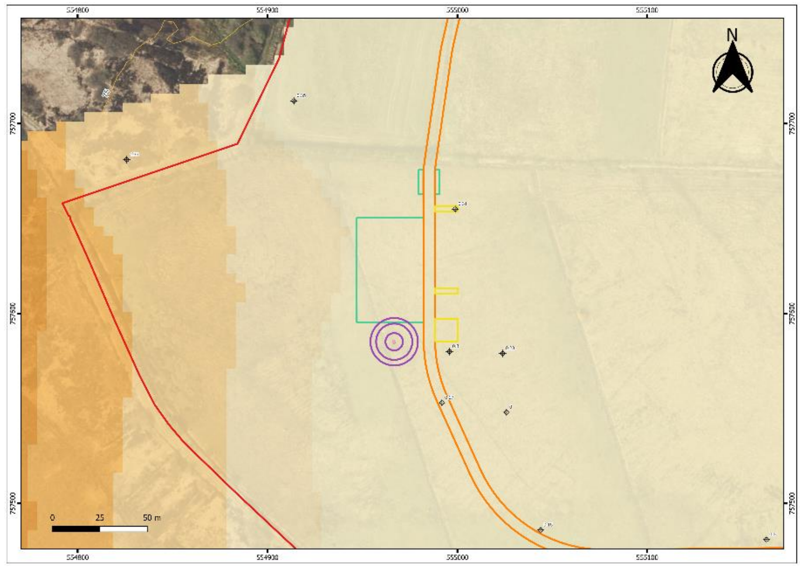
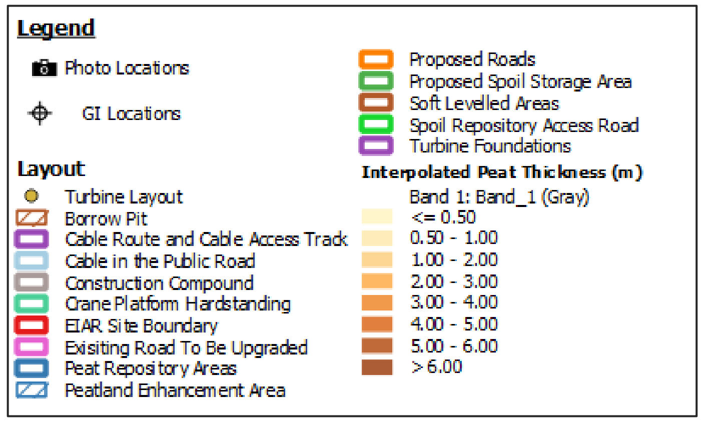


Figure J- 6: Interpolated Peat Thickness (3 of 3).

Table J- 1: Site reconnaissance of the Turbine 1 site.

<table>
<tr>
<td>Imagery
 </td>
<td>Peat geo-investigation
 </td>
<td colspan="2">20200226_154338.jpg
</td>
</tr>
<tr>
<td colspan="2">Shared legend
 </td>
<td colspan="2"></td>
</tr>
<tr>
<td>Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 25th of February 2020 and , 15th of September 2023 [GDG].

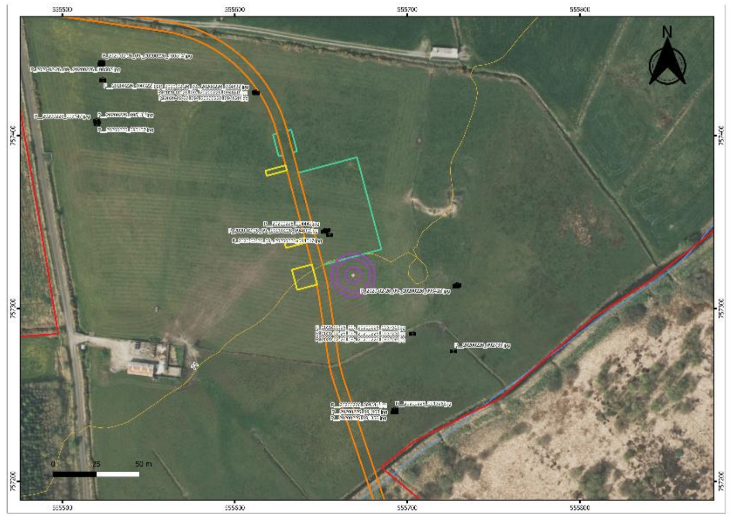
Geomorphology: T1 is located on a raised peat bog. Topography is flat.

Peat: The peat depth at T01 is 0.3 m and slope angle of 1.8 degrees.

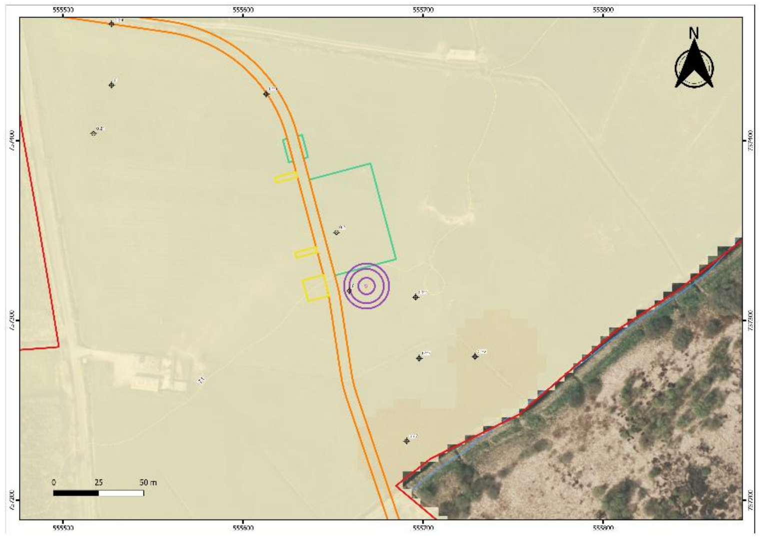
Instability evidence: No.</td>
<td>20200226_155012.jpg
</td>
<td>20200226_160430.jpg
</td>
<td>20200226_155508.jpg
</td>
</tr>
</table>

Table J- 2: Site reconnaissance of the Turbine 2 site.

Imagery

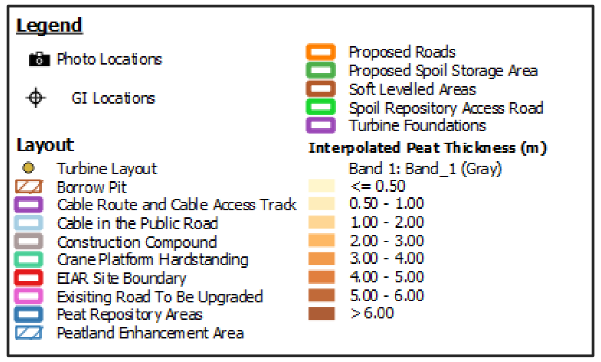


Peat geo-investigation



2020-02-26_20200226_094612.jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 25thth of February 2020 and , 15th of September 2023 [GDG].

Geomorphology: The topography is flat.

Peat: The peat depth at T02 is 0.9m with a slope angle of 2.1 degrees

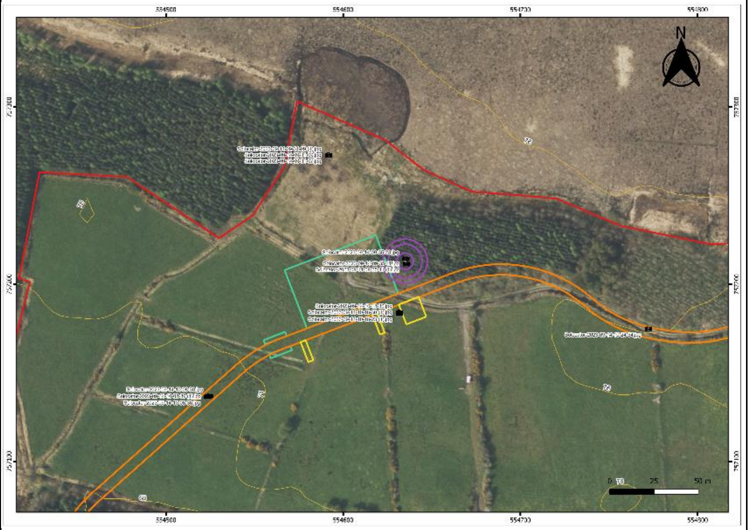
Instability evidence: No.

2020-02-26_20200226_093709.jpg

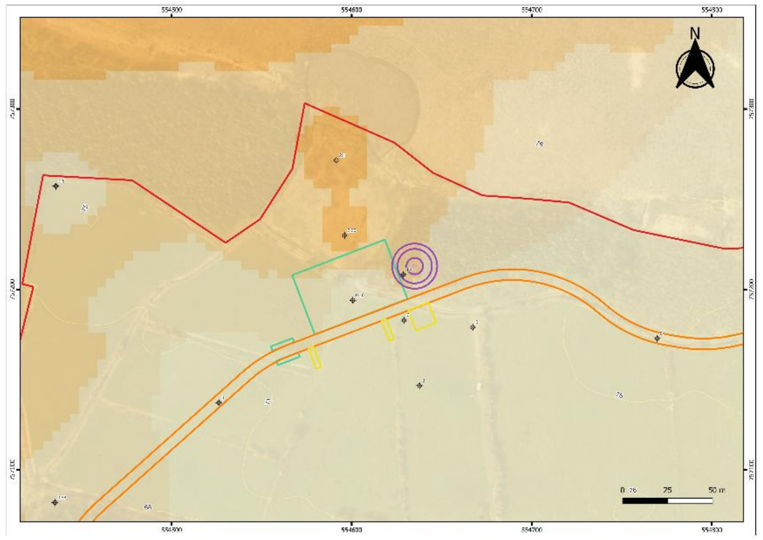
2020-02-26_20200226_092739.jpg

Table J- 3: Site reconnaissance of the Turbine 3 site.

Imagery

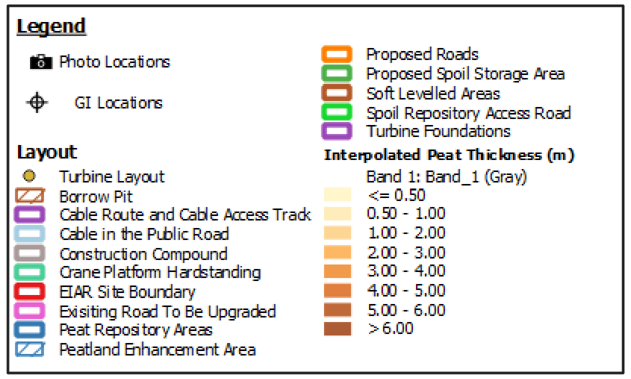


Peat geo-investigation



Solocator-2023-09-14-10-18-30.jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 14th September 2023 [GDG].

Geomorphology: T03 is located on a cut over peat bog. The topography is mostly flat.

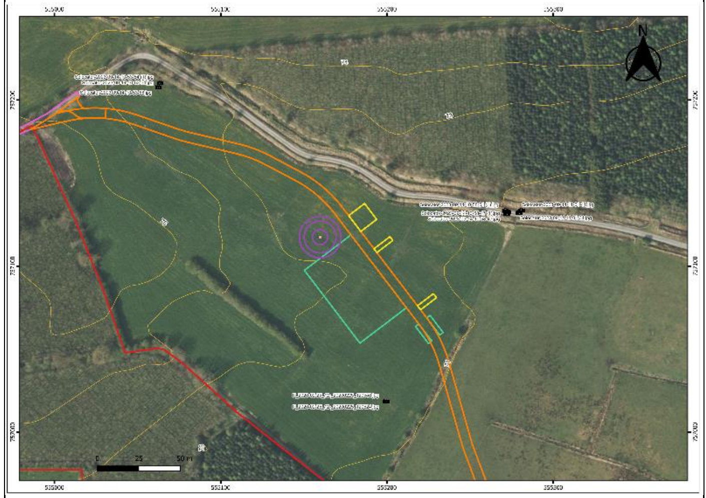
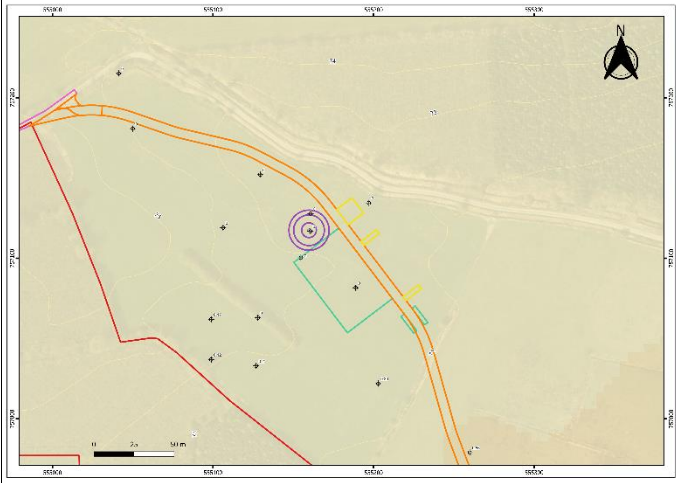
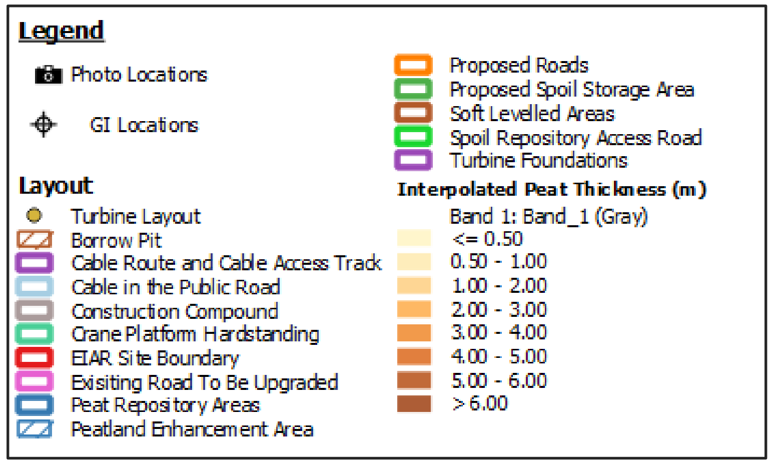
Peat: The peat depth is ~1.03m at the T03 location. The slope angle is 0.4 degrees.

Instability evidence: No.

Solocator-2023-09-14-09-31-09jpg

Solocator-2023-09-14-10-18-23.jpg

Table J- 4: Site reconnaissance of the Turbine 4 site.

<table>
<tr>
<td>Imagery
</td>
<td>Peat geo-investigation
</td>
<td colspan="2">Photo 25-02-2020, 12 27 32.jpg
</td>
</tr>
<tr>
<td colspan="2">Shared legend

Legend
📷 Photo Locations
⌖ GI Locations
Layout
● Turbine Layout
▨ Borrow Pit
🟪 Cable Route and Cable Access Track
🟦 Cable in the Public Road
⬜ Construction Compound
🟩 Crane Platform Hardstanding
🟥 EIAR Site Boundary
🟪 Exisiting Road To Be Upgraded
🟦 Peat Repository Areas
▨ Peatland Enhancement Area
🟧 Proposed Roads
🟩 Proposed Spoil Storage Area
🟫 Soft Levelled Areas
🟩 Spoil Repository Access Road
🟪 Turbine Foundations
Interpolated Peat Thickness (m)
Band 1: Band_1 (Gray)
🟨 <= 0.50
🟨 0.50 - 1.00
🟧 1.00 - 2.00
🟧 2.00 - 3.00
🟧 3.00 - 4.00
🟧 4.00 - 5.00
🟫 5.00 - 6.00
🟫 > 6.00</td>
<td colspan="2"></td>
</tr>
<tr>
<td>Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 28th of March 2020 and 15th of September 2023. [GDG].

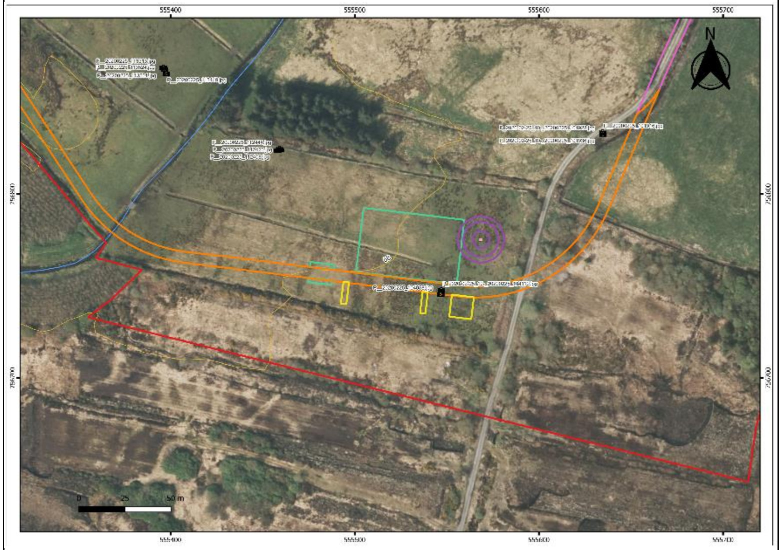
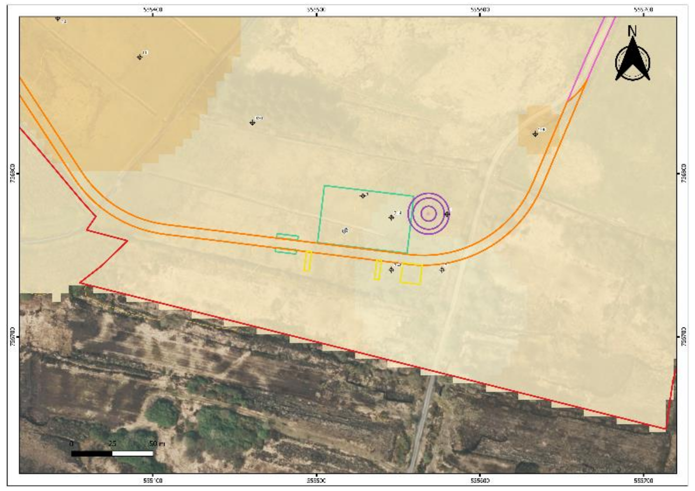
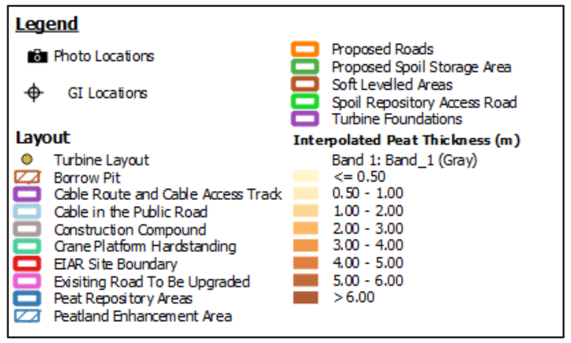
Geomorphology: The topography is generally flat glacial till.

Peat: The peat depth in this location is 0.0m. Slope angle is 2.2 degrees.

Instability evidence: No.</td>
<td>Solocator-2023-09-14-11-47(1)

 </td>
<td>Photo 25-02-2020, 12 11 35.jpg
</td>
<td>Photo 25-02-2020, 12 12 29.jpg
</td>
</tr>
</table>

Table J- 5: Site reconnaissance of the Turbine 5 site.

<table>
<tr>
<td>Imagery
</td>
<td>Peat geo-investigation
</td>
<td colspan="2">P_20200225_104058.jpg
</td>
</tr>
<tr>
<td colspan="2">Shared legend
 </td>
<td colspan="2"></td>
</tr>
<tr>
<td>Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 28th of March 2020 and 15th of September 2023. [GDG].

Geomorphology: Flat cut over peat bog.

Peat: Depths of 0.68 m at the turbine location. Slope angle is 4.6 degrees.

Instability evidence: No.</td>
<td>P_20200225_113449.jpg
</td>
<td>P_20200225_10916.jpg
</td>
<td>P_20200225_10916.jpg
</td>
</tr>
</table>

Table J- 6: Site reconnaissance of the Turbine 6 site.

Imagery

Peat geo-investigation

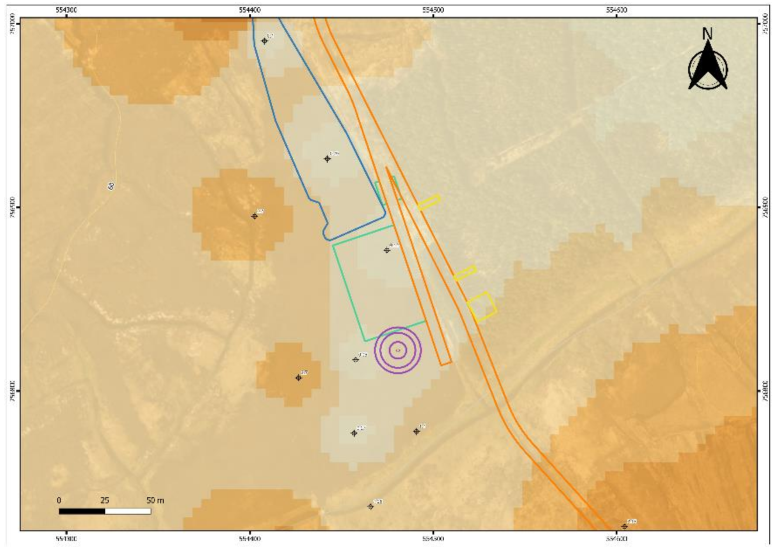
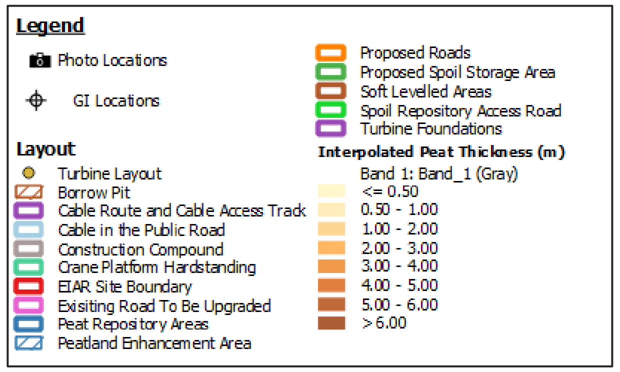


Photo 25-02-2020, 16 01 02.jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 25th of February 2020 and 15th of September 2023. [GDG].

Geomorphology: Topography is flat cut over peat. Peat is underlain by glacial till..

Peat: Peat depth at T06 is 0.64m, with a slope angle of 0.58 degrees.

Instability evidence: No.

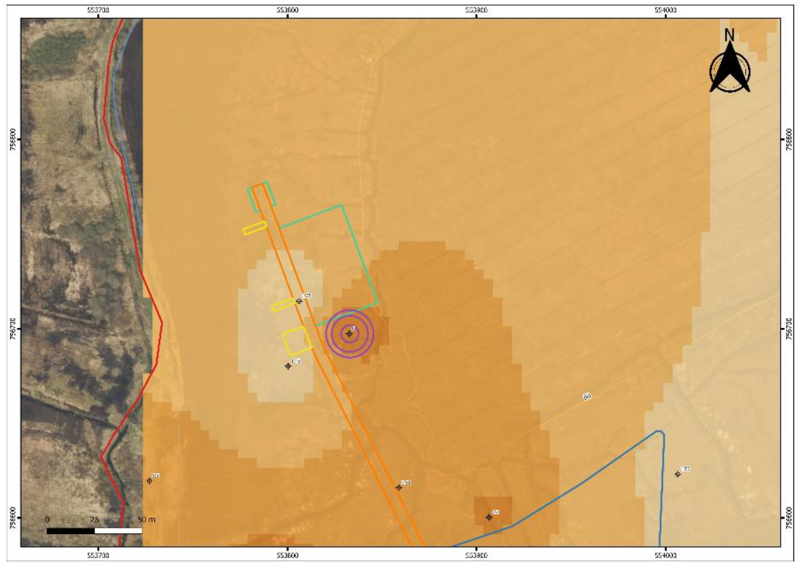
Solocator-2023-09-14-11-30-44(1).jpg

Photo 25-02-2020, 16 05 35.jpg

Table J- 7: Site reconnaissance of the Turbine 7 site.

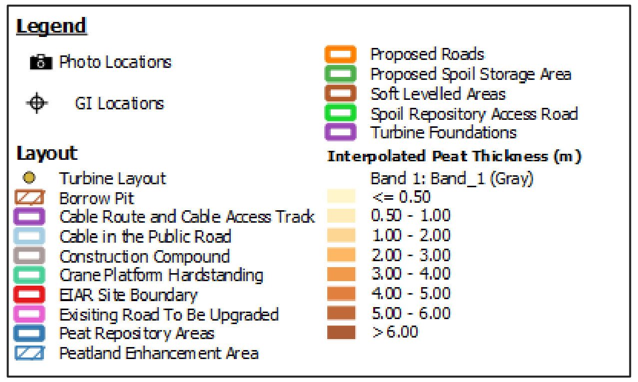
Imagery

Peat geo-investigation



Solocator-2013-09-14-11-47-41(1).jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 14th of September 2023

Geomorphology: Topography is mostly flat but there is a large drain <50m from the turbine site

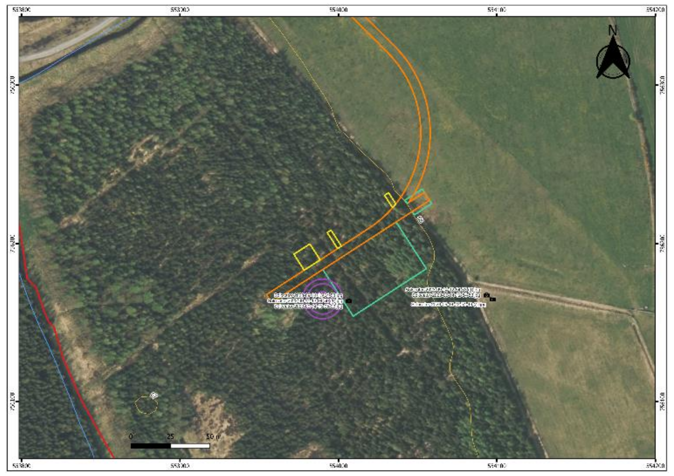
Peat: Peat depth at T7 is 4.4m, with a slope angle of 6.3 degrees.

Instability evidence: No.

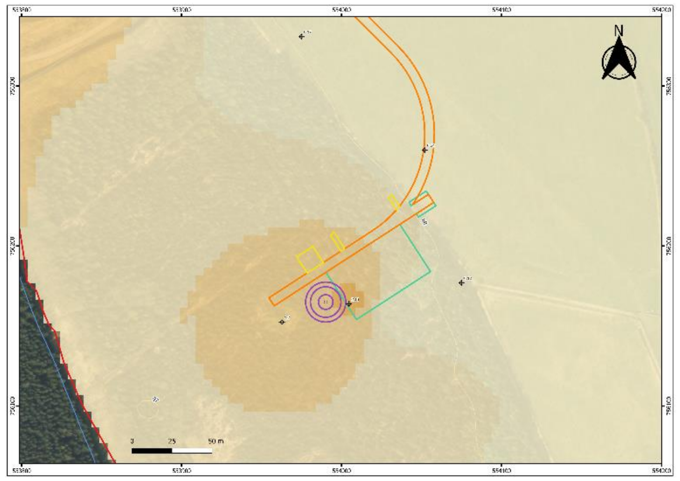
Solocator-2013-09-14-11-47-49(1).jpg

Table J- 8: Site reconnaissance of the Turbine 8 site.

Imagery



Peat geo-investigation



Solocator-2023-09-14-12-54-49(1).jpg

Shared legend

Legend

- Photo Locations
- ⌖ GI Locations

Layout

- ● Turbine Layout
- ▨ Borrow Pit
- ▭ Cable Route and Cable Access Track
- ▭ Cable in the Public Road
- ▭ Construction Compound
- ▭ Crane Platform Hardstanding
- ▭ EIAR Site Boundary
- ▭ Exisiting Road To Be Upgraded
- ▭ Peat Repository Areas
- ▨ Peatland Enhancement Area
- ▭ Proposed Roads
- ▭ Proposed Spoil Storage Area
- ▭ Soft Levelled Areas
- ▭ Spoil Repository Access Road
- ▭ Turbine Foundations

Interpolated Peat Thickness (m)

Band 1: Band_1 (Gray)

- ■ <= 0.50
- ■ 0.50 - 1.00
- ■ 1.00 - 2.00
- ■ 2.00 - 3.00
- ■ 3.00 - 4.00
- ■ 4.00 - 5.00
- ■ 5.00 - 6.00
- ■ > 6.00

Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 14th September 2023 [GDG]

Geomorphology: Topography is flat and forested.

Peat: Peat depth at T8 is 1.8m, with a slope angle of 2.3 degrees.

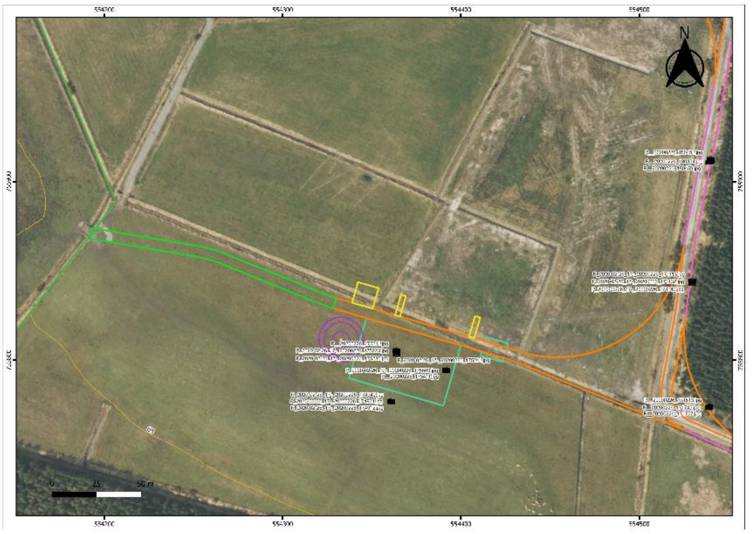
Instability evidence: No.

Solocator-2023-09-14-13-04-59(1).jpg

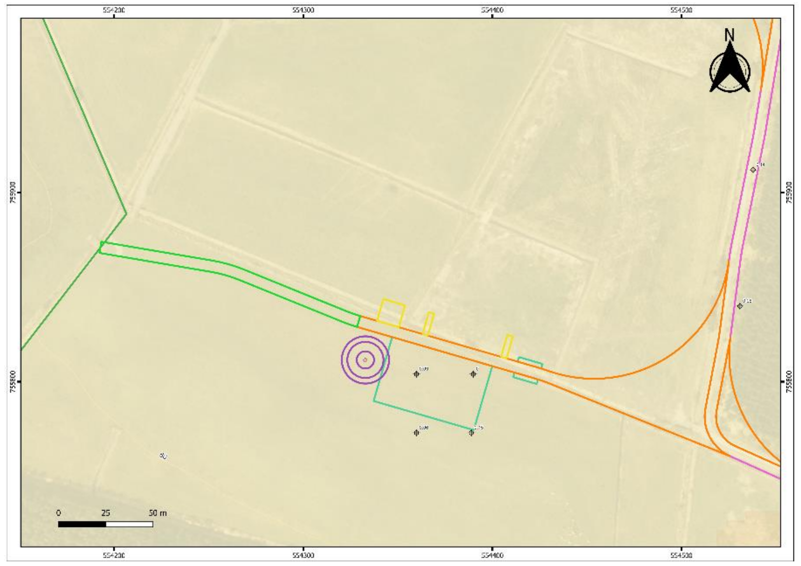
Solocator-2023-09-14-12-54-53(1).jpg

Table J- 9: Site reconnaissance of the Turbine 9 site.

Imagery

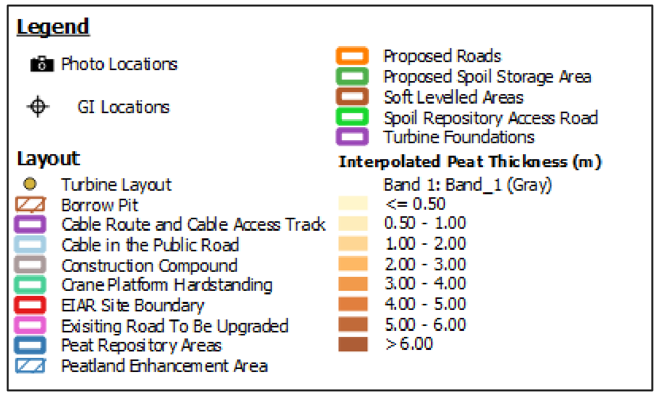


Peat geo-investigation



P_2020-02-26_17-_20200226_174921.jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 26th February 2020 [GDG]

Geomorphology: Topography is flat.

Peat: Peat depth at T9 is 0.09m, with a slope angle of 0.7 degrees.

Instability evidence: No.

P_2020-02-26_17-_20200226_175223.jgp

P_2020-02-26_17-_20200226_171132.jgp

Table J- 10: Site reconnaissance of the Turbine 10 site.

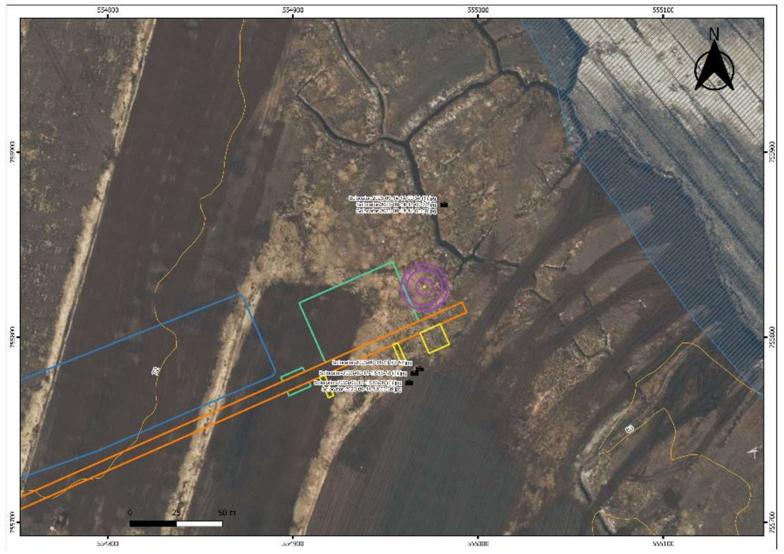
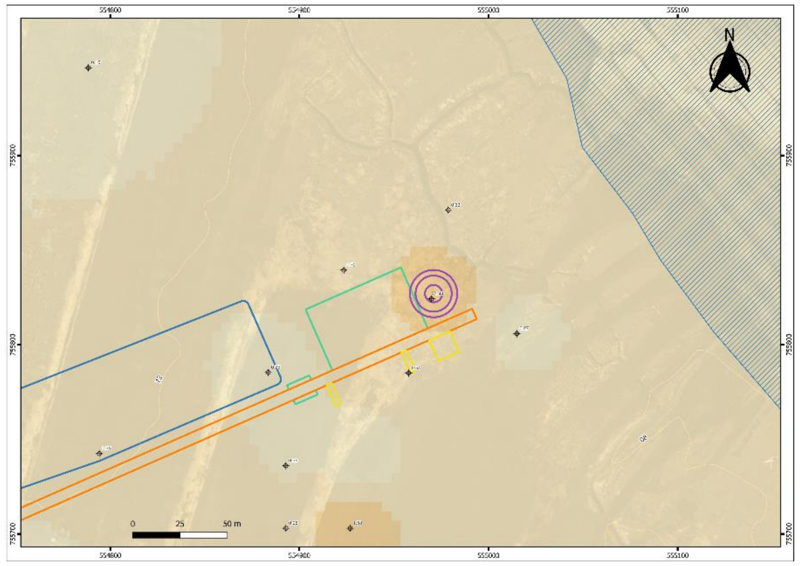
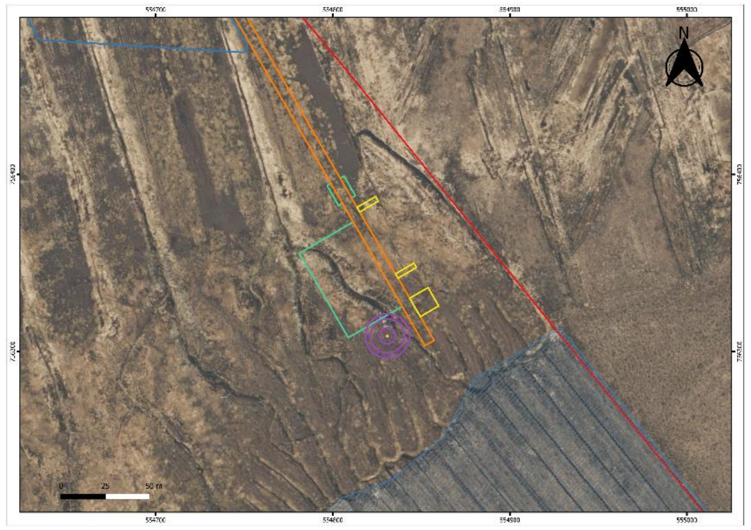
Imagery 	Peat geo-investigation 	Solocator-2023-09-14-14-00-38(1).jpg 
Shared legend **Legend** 📷 Photo Locations ⌖ GI Locations **Layout** ● Turbine Layout ▨ Borrow Pit ▭ Cable Route and Cable Access Track ▭ Cable in the Public Road ▭ Construction Compound ▭ Crane Platform Hardstanding ▭ EIAR Site Boundary ▭ Existing Road To Be Upgraded ▭ Peat Repository Areas ▨ Peatland Enhancement Area ▭ Proposed Roads ▭ Proposed Spoil Storage Area ▭ Soft Levelled Areas ▭ Spoil Repository Access Road ▭ Turbine Foundations **Interpolated Peat Thickness (m)** Band 1: Band_1 (Gray) ■ <= 0.50 ■ 0.50 - 1.00 ■ 1.00 - 2.00 ■ 2.00 - 3.00 ■ 3.00 - 4.00 ■ 4.00 - 5.00 ■ 5.00 - 6.00 ■ > 6.00		
Description **Date of the satellite images:** March 2022. [Maxar/Esri]. **Date of the ground-based pictures:** 14th of September 2023 [GDG] **Geomorphology**: Topography is flat and forested. Peat is underlain by soft lacustrine silts. **Peat**: Peat depth at T10 is 1.5m, with a slope angle of 0.98 degrees. **Instability evidence**: No.	Solocator-2023-09-14-13-53-39(1).jpg  	Solocator-2023-09-14-13-53-57(1).jpg 

Table J- 11: Site reconnaissance of the Turbine 11 site.

Imagery



Peat geo-investigation

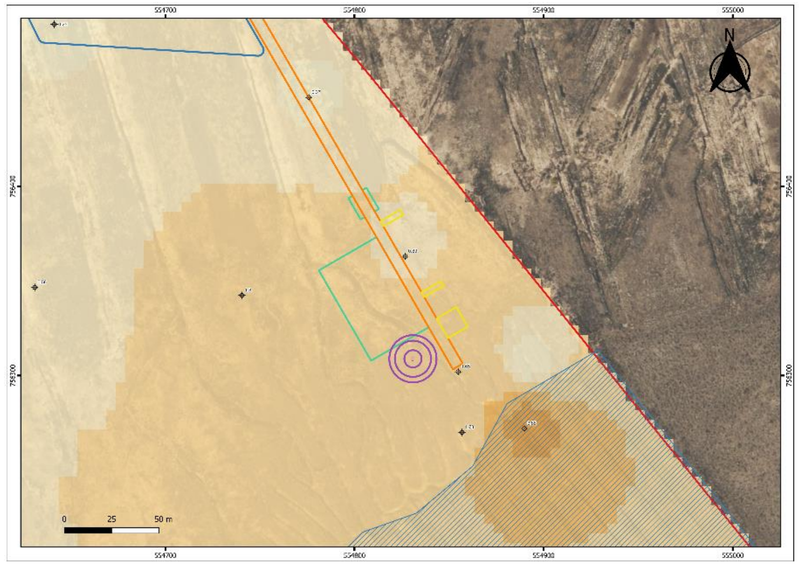
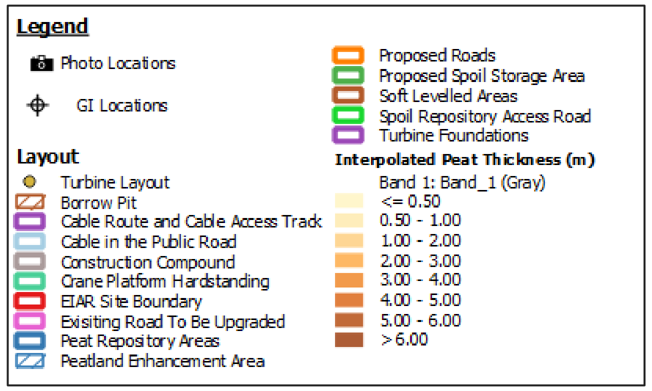


Photo 25-02-2020, 15 05 32.jpg

Shared legend



Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: 25th of February 2020 [GDG]

Geomorphology: Topography is flat with turbary cutting ~50m from turbine location.

Peat: Peat depth at T11 is 1.5m, with a slope angle of 1.4 degrees.

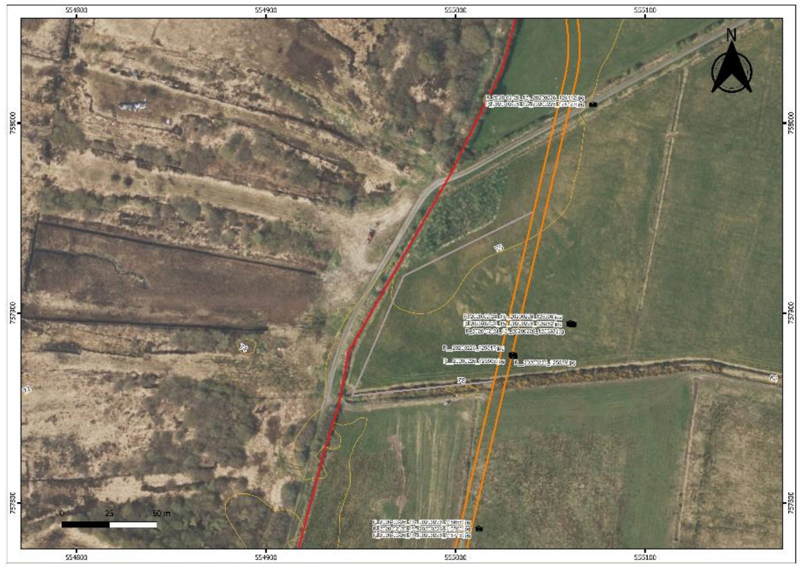
Instability evidence: No.

Photo 25-02-2020, 14 27 31.jpg

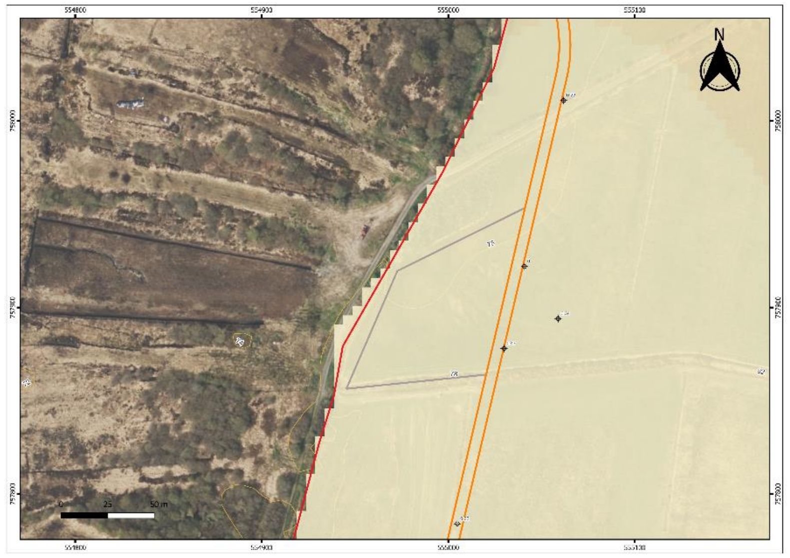
Photo 25-02-2020, 14 37 58.jpg

Table J- 12: Site reconnaissance of the north Construction Compound site.

Imagery

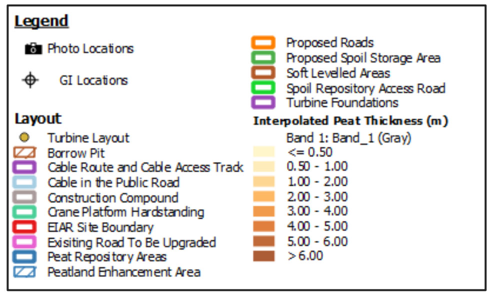


Peat geo-investigation



P_2020-02-24_15-_2020226_125308.jpg

Shared legend



Legend

📷 Photo Locations

⌖ GI Locations

Layout

● Turbine Layout
▨ Borrow Pit
▭ Cable Route and Cable Access Track
▭ Cable in the Public Road
▭ Construction Compound
▭ Crane Platform Hardstanding
▭ EIAR Site Boundary
▭ Existing Road To Be Upgraded
▭ Peat Repository Areas
▨ Peatland Enhancement Area

▭ Proposed Roads
▭ Proposed Spoil Storage Area
▭ Soft Levelled Areas
▭ Spoil Repository Access Road
▭ Turbine Foundations

Interpolated Peat Thickness (m)

Band 1: Band_1 (Gray)
<= 0.50
0.50 - 1.00
1.00 - 2.00
2.00 - 3.00
3.00 - 4.00
4.00 - 5.00
5.00 - 6.00
> 6.00

Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures 24th February 2020[GDG].

Geomorphology: Topography at site is mostly flat with existing founded roads adjacent to the location.

Peat: Peat depth is 0.3m, with a slope angle of 3.3 degrees.

Instability evidence: No.

P_2020226_125506.jpg

P_2020226_125539.jpg

Table J- 13: Site reconnaissance of the south Construction Compound site.

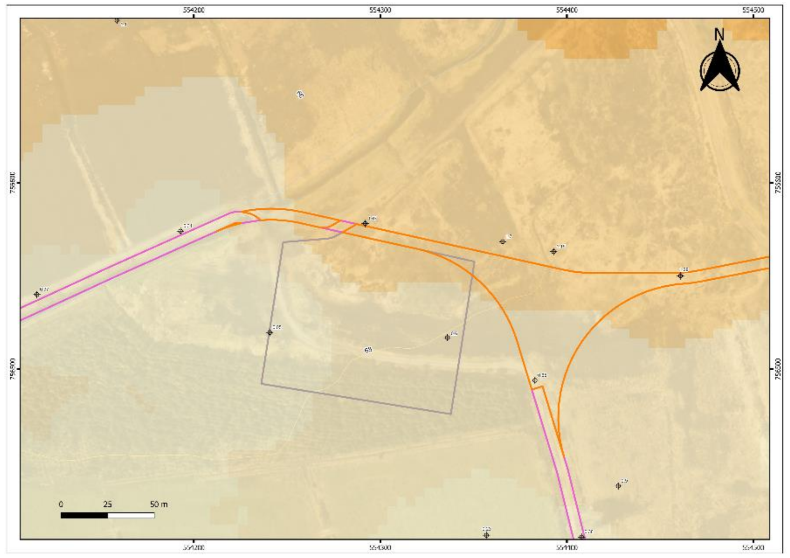
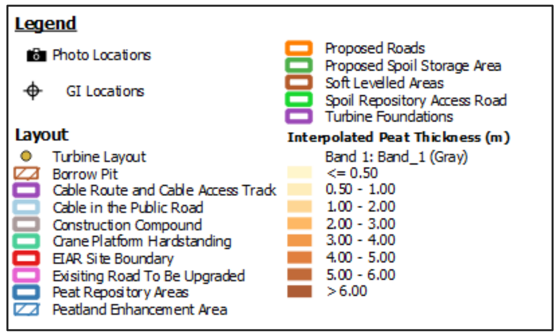
Imagery	Peat geo-investigation	P_2020-02-25_17-_20200215_172427.jpg
		
Shared legend 		
Description **Date of the satellite images:** March 2022. [Maxar/Esri]. **Date of the ground-based pictures** 25th of February 2020[GDG]. **Geomorphology**: Topography at site is mostly flat cut over peat bog. Peat cuts are set back from the site and there are drains perpendicular to contour lines. **Peat**: Peat depth is 0.70m, with a slope angle of 1.8 degrees. **Instability evidence**: No.		P_2020-02-25_17-_20200215_165403.jpg 

Table J- 14: Site reconnaissance of substation site.

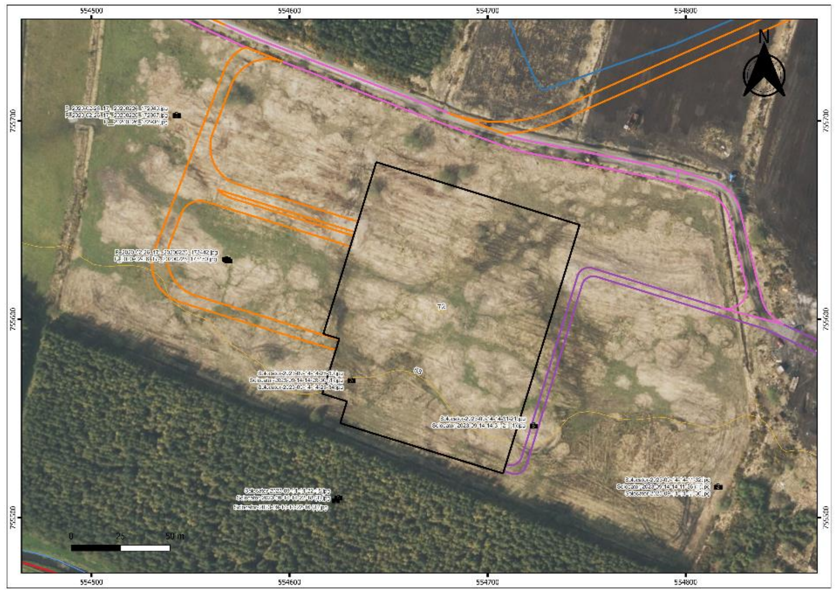
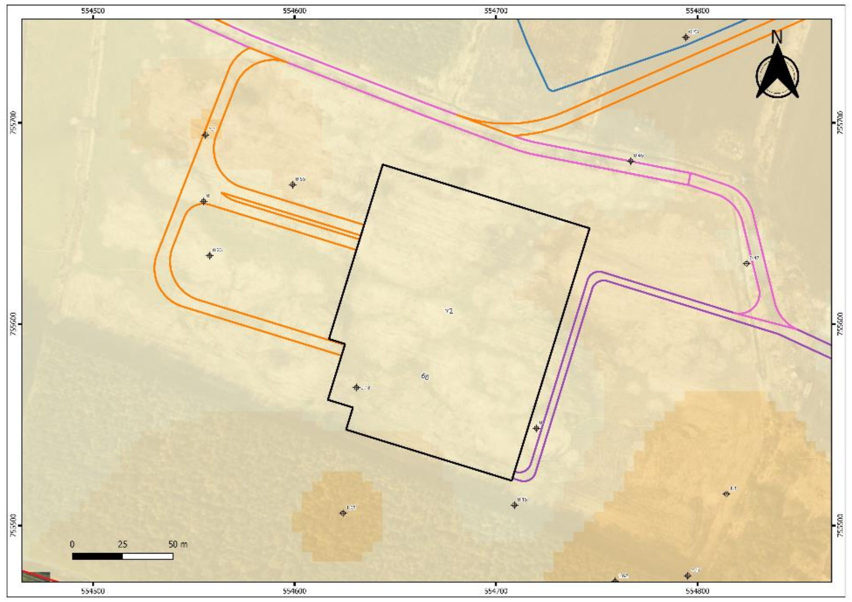
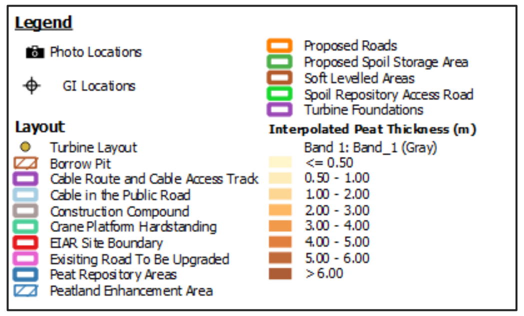
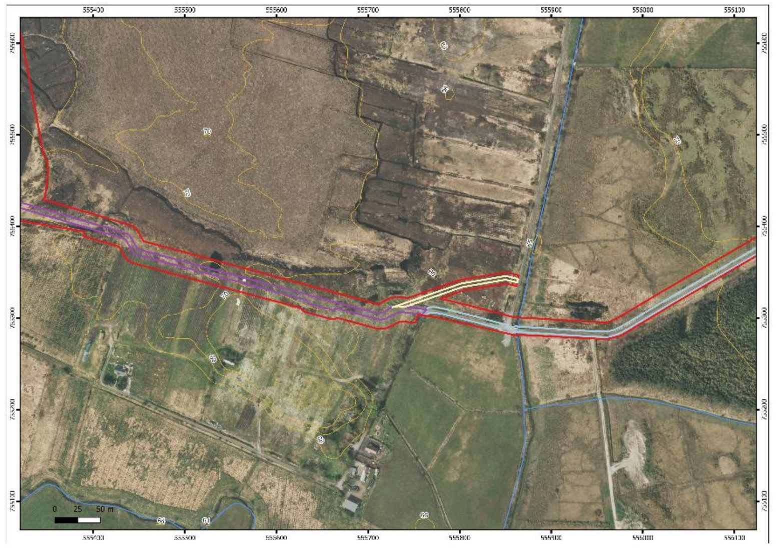
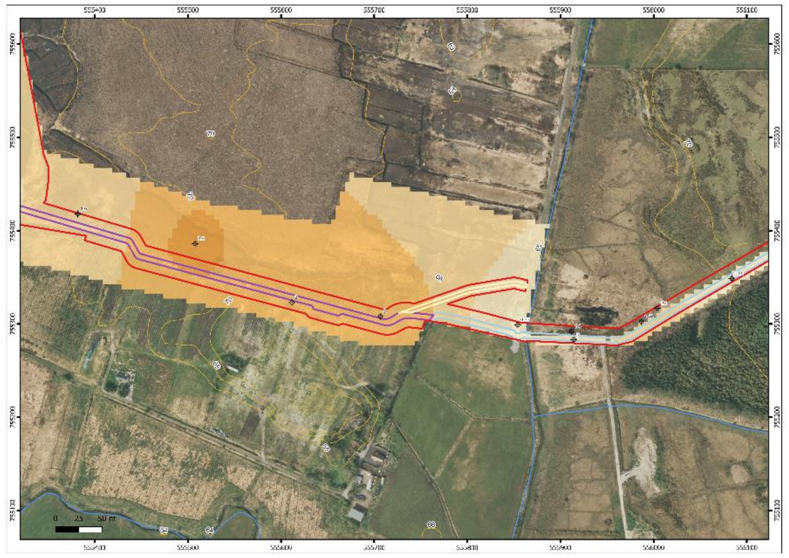
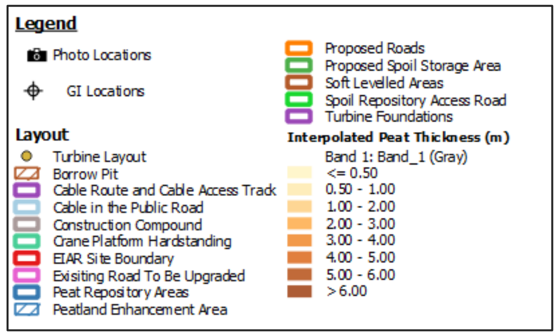
Imagery	Peat geo-investigation	Solocator-2023-09-14-14-31-21 (1)
		
Shared legend  		
Description **Date of the satellite images:** March 2022. [Maxar/Esri]. **Date of the ground-based pictures:** 26th of February 2020 and 14th of September 2023. [GDG]. **Geomorphology**: Flat forestry. **Peat**: Peat depth is 0.40m, with a slope angle of 4.4 degrees. **Instability evidence**: No.	Solocator-2023-09-14-14-28-34 (1)  	P_2020-02-26_17-_20200226_173450 

Table J- 15: Site reconnaissance of the Grid Connection.

<table>
<tr>
<td>Imagery
</td>
<td>Peat geo-investigation
</td>
<td></td>
</tr>
<tr>
<td colspan="2">Shared legend
 </td>
<td></td>
</tr>
<tr>
<td>Description

Date of the satellite images: March 2022. [Maxar/Esri].

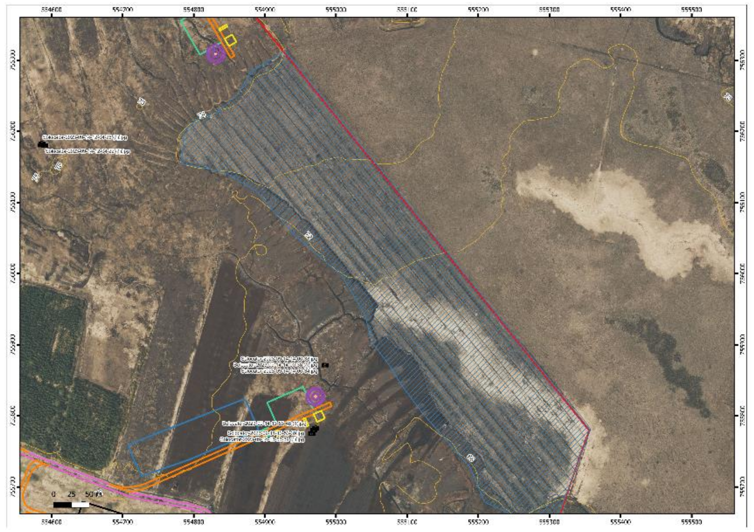
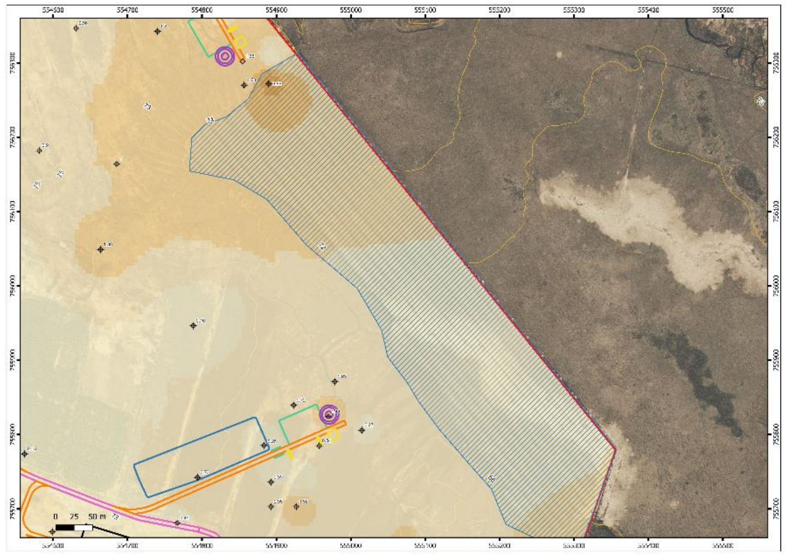
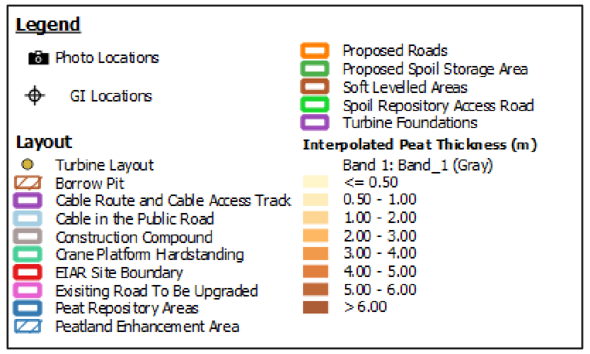
Date of the ground-based pictures: May 2023 [GDG].

Geomorphology: Flat topography.

Peat: Interpolated peat depth 2.3m, slope angle of 2 degrees.

Instability evidence: No.</td>
<td></td>
<td></td>
</tr>
</table>

Table J- 16: Site reconnaissance of the Proposed Peatland Enhancement Area.

<table>
<tr>
<td>Imagery
 </td>
<td>Peat geo-investigation
 </td>
<td></td>
</tr>
<tr>
<td colspan="2">Shared legend
 </td>
<td></td>
</tr>
<tr>
<td>Description

Date of the satellite images: March 2022. [Maxar/Esri].

Date of the ground-based pictures: May 2023 [GDG].

Geomorphology: Flat topography.

Peat: Interpolated peat depth 3.88m, slope angle of 0.80 degrees.

Instability evidence: No.</td>
<td></td>
<td></td>
</tr>
</table>

J.1 TRIAL PIT LOGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-01
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 553996.00 - 756344.00 Level:	Date 26/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 2.50	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20		▨	TOPSOIL (grassland)
				0.50		▤	Grey brown, stiff, high plasticity, sandy, gravelly CLAY.
▼				2.50		░	Light brown, loose to medium dense SAND with many cobbles and large boulders. Boulders and cobbles are rounded to subrounded.
							End of Pit at 2.50m

1
2
3
4
5

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-02
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 554555.00 - 755661.00		Date 26/02/2020
		Level:		
Location: Clonbern, Co. Galway		Dimensions (m):		Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)		Depth 3.55		Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.29		▨	Peaty TOPSOIL with rootlet.
				0.67		▤	Grey brown, stiff, sandy, gravelly CLAY with some cobbles.
				1.60		☒	Light brown, loose to medium dense slightly clayey, gravelly SAND with cobbles. Gravel and cobbles are rounded to subrounded.
				3.55		░	Grey, dense, gravelly, silty, fine to coarse SAND with large cobbles and boulders subrounded to subangular.
							End of Pit at 3.55m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-03
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 554478.00 - 756015.00 Level:	Date 26/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 3.00	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.13		▨	Brown TOPSOIL with rootlet.
				0.35		▤	Brown, soft, medium plasticity, gravelly, very sandy CLAY.
				0.71		▤	Grey, stiff, high plasticity, sandy, gravelly CLAY with boulders.
				3.00		▤	Grey/brown loose to medium clayey/silty coarse SAND with large cobbles and boulders subrounded to subangular.
							End of Pit at 3.00m

1
2
3
4
5

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

			TrialPit No TP-04 Sheet 1 of 1
Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 555527.00 - 757431.00 Level:	Date 26/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 1.20	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
						▨	Dark/brown TOPSOIL with rootlet.
				0.17		⁘	Dark grey , slightly silty, very sandy GRAVEL, with cobbles subrounded to rounded.
				0.84		⁘	Dark/grey very sandy GRAVEL with angular boulders and cobbles.
				1.20			End of Pit at 1.20m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-05
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 554441.00 - 756242.00 Level:		Date 27/02/2020
Location: Clonbern, Co. Galway		Dimensions (m):		Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)		Depth 2.10		Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.56			Black/brown fibrous PEAT.
				0.78			Brown pseudo fibrous slightly clayey PEAT.
				2.10			Grey, firm to stiff, high plasticity, sandy, very gravelly CLAY. Gravel is subrounded to subangular. At 1.2 mBGL many cobbles and boulders.
							End of Pit at 2.10m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-06
Sheet 1 of 1

Project Name: Clonbern Windfarm
Project No. 20021
Co-ords: 555026.00 - 757548.00
Level:
Date 26/02/2020

Location: Clonbern, Co. Galway
Dimensions (m):
Depth 2.30
Scale 1:25

Client: McCarthy Keville O'Sullivan Ltd. (MKO)
Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
						▨	Dark brown TOPSOIL with rootlet.
				0.25		▨	Grey, stiff, medium strength, sandy, very gravelly CLAY.
				0.72		▨	Dark grey soft, low strength, gravelly sandy, slightly clayey SILT with cobbles and boulders. Cobbles are gneiss angular, block with veins of quartz.
				2.30			End of Pit at 2.30m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-07
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 555729.00 - 757280.00 Level:	Date 26/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 2.80	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
	Depth	Type	Results					
						▨	TOPSOIL.	
				0.10		▨	Dark brown pseudo fibrous PEAT.	
▼				0.72		▨	Creamy grey, slightly organic, sandy, gravelly, silty CLAY with high cobble content. Cobbles are subrounded to subangular. Sandy lense at 1.6m.	1 2
				2.80			End of Pit at 2.80m	3 4 5

Remarks:

Stability:

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-08
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 555128.00 - 757063.00 Level:	Date 27/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 2.60	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.25		▨	TOPSOIL (grassland).
				0.52		▤	Grey, firm, sandy, gravelly CLAY.
▼				2.00		░	Light brown, medium dense to dense, silghtly silty, very gravelly, fine to coarse SAND, with many cobbles and boulders. Cobbles and boulders are rounded to subrounded.
				2.60		░	Grey, silghtly sandy GRAVEL with cobbles and boulders. Cobbles and boulders are angular to subangular (possible weathered bedrock).
							End of Pit at 2.60m

1
2
3
4
5

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TP-09
Sheet 1 of 1

Project Name: Clonbern Windfarm
Project No.: 20021
Co-ords: 555577.00 - 756741.00
Level:
Date: 27/02/2020
Location: Clonbern, Co. Galway
Dimensions (m):
Depth 2.80
Scale 1:25
Logged
Client: McCarthy Keville O'Sullivan Ltd. (MKO)

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
						▨	TOPSOIL (grassland)
				0.15		▨	Greyish brown, firm, slightly gravelly, sandy CLAY with some cobbles. Cobbles are subrounded to subangular.
▼				0.80		▨	Brownish grey high plasticity sandy gravelly silty CLAY.
				2.10		▨	Light grey, slightly clayey, slightly silty, sandy GRAVEL with cobbles and boulders (possible weathered bedrock).
				2.80			End of Pit at 2.80m

1
2
3
4
5

Remarks:

Stability:

AGS

Trial Pit Log

TrialPit No
TP-11
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 554390.00 - 755804.00 Level:	Date 26/02/2020
Location: Clonbern, Co. Galway		Dimensions (m):	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)		Depth 2.90	Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.38		▨	Brown peaty TOPSOIL with rootlets.
				1.12		░	Brown/grey firm sandy gravelly CLAY with cobbles and boulders. Cobbles and boulders are subangular to subrounded.
				2.90		░	Dark grey/blue, soft, high plasticity, slightly sandy, gravelly CLAY.
							End of Pit at 2.90m

Remarks:

Stability:

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 554655.00 - 758787.00 Level:	TrialPit No TPr-01 Sheet 1 of 1
			Date 27/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 2.80	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.15		▨	TOPSOIL (grassland)
				0.70		░	Brown, firm, sandy, gravelly CLAY with cobbles. Cobbles are subrounded to subangular.
▼				2.80		░	Light grey, medium dense to dense, silty, sandy GRAVEL with large cobbles and boulders. Boulders and cobbles are angular to subrounded.
							End of Pit at 2.80m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TPr-02
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 555041.00 - 757922.00 Level:	Date 27/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 2.25	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.20		▨	TOPSOIL (grassland)
				1.10		⁙	Brown firm to stiff sandy gravelly CLAY with some cobbles.
				2.25		⁘	Grey medium dense, sandy, silty GRAVEL with many cobbles. Cobbles are angular to subangular.
							End of Pit at 2.25m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TPr-03
Sheet 1 of 1

Project Name:	Clonbern Windfarm	Project No. 20021	Co-ords: 555291.00 - 757482.00 Level:	Date 26/02/2020
Location:	Clonbern, Co. Galway		Dimensions (m): Depth 2.10	Scale 1:25
Client:	McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.23		▨	Dark brown TOPSOIL with rootlets.
				0.90		▨	Dark grey medium dense sandy gravelly SILT with cobbles and boulders.
				2.10		▨	Grey brown, very soft, low strength, sandy, gravelly CLAY with cobbles and boulders.
							End of Pit at 2.10m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TPr-05
Sheet 1 of 1

Project Name: Clonbern Windfarm	Project No. 20021	Co-ords: 555342.00 - 756895.00 Level:	Date 27/02/2020
Location: Clonbern, Co. Galway		Dimensions (m): Depth 3.05	Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)			Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
▼				1.40		⁂	Dark brown fibrous PEAT with rootlets.
				3.05		▤	Grey stiff high strength CLAY.
							End of Pit at 3.05m

Remarks:

Stability:

AGS

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Trial Pit Log

TrialPit No
TPr-06
Sheet 1 of 1

Project Name: Clonbern Windfarm
Project No. 20021
Co-ords: 554613.00 - 759000.00
Level:
Date 27/02/2020
Location: Clonbern, Co. Galway
Dimensions (m):
Scale 1:25
Client: McCarthy Keville O'Sullivan Ltd. (MKO)
Depth 2.80
Logged

Water Strike	Samples & In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description
	Depth	Type	Results				
				0.30		▨	TOPSOIL (grassland)
				2.80		░	Brown to light brown sandy gravelly CLAY with cobbles and some boulders. Cobbles are subrounded to subangular.
							End of Pit at 2.80m

Remarks:

Stability:

AGS

Appendix K FACTOR OF SAFETY

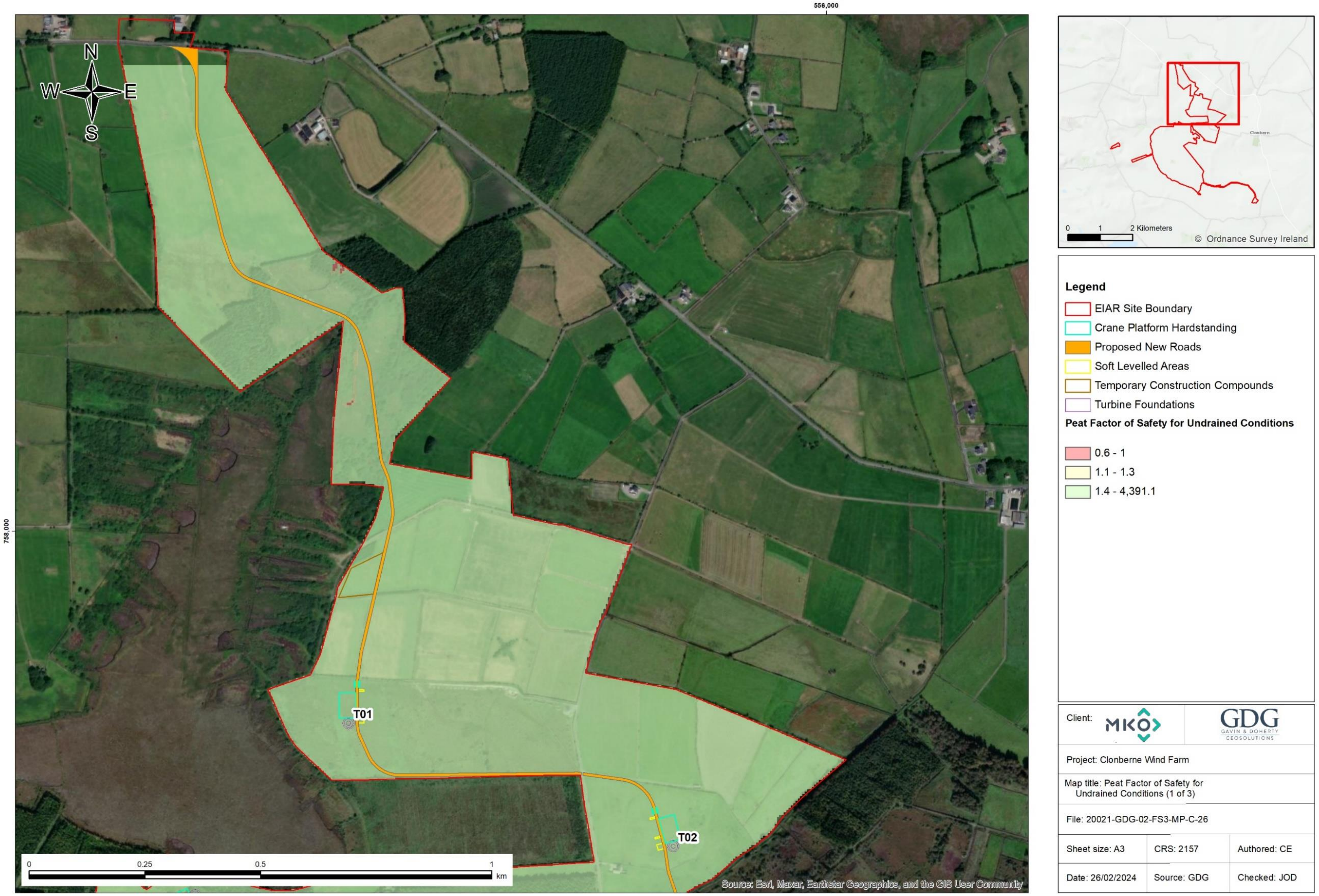


Figure K- 1: Peat Factor of Safety for Undrained Conditions (1 of 3).

***The area at the northern entrance boundary contains no peat and so has not been assigned a peat FoS value, as this area was not included in the peat thickness interpolation.**

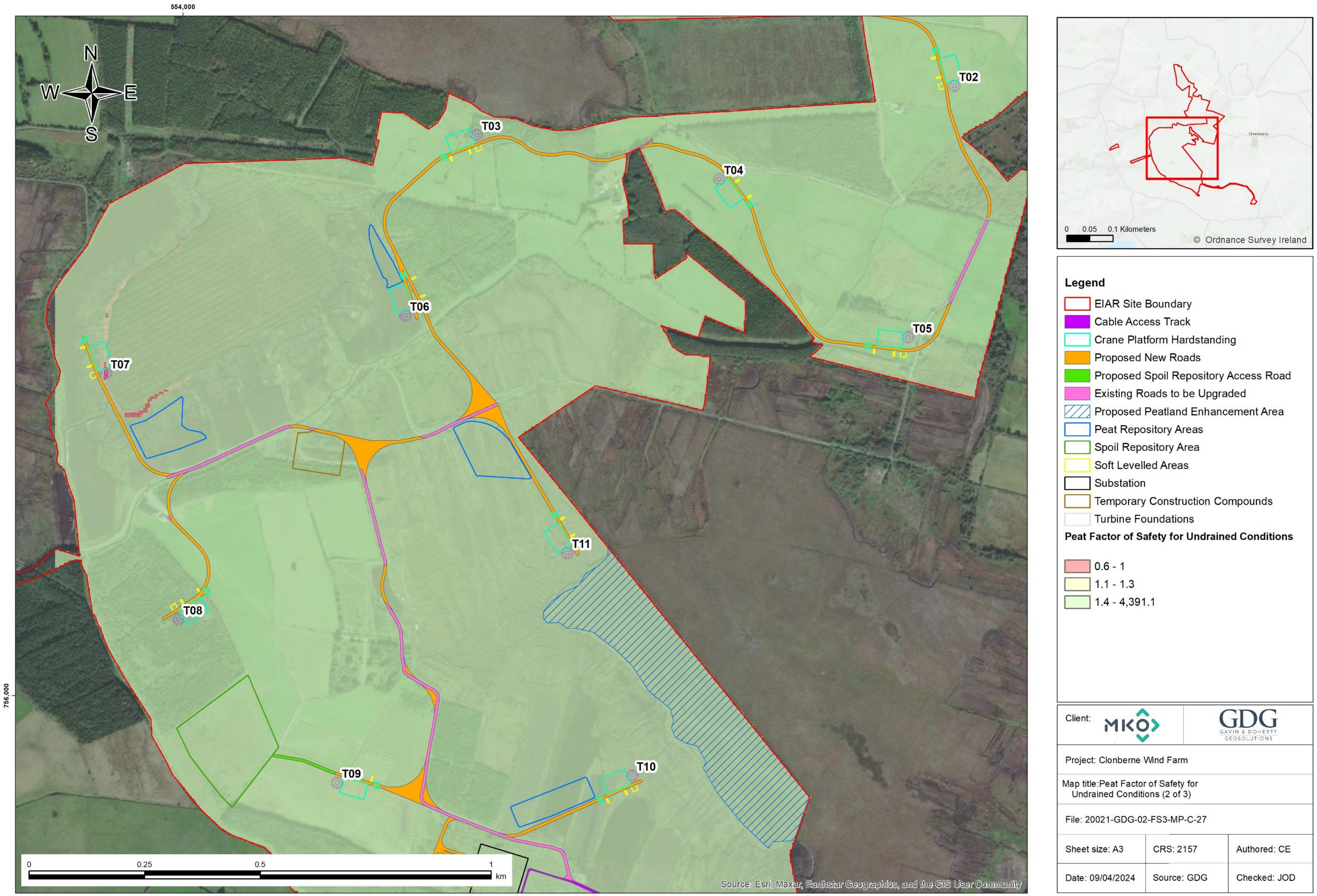
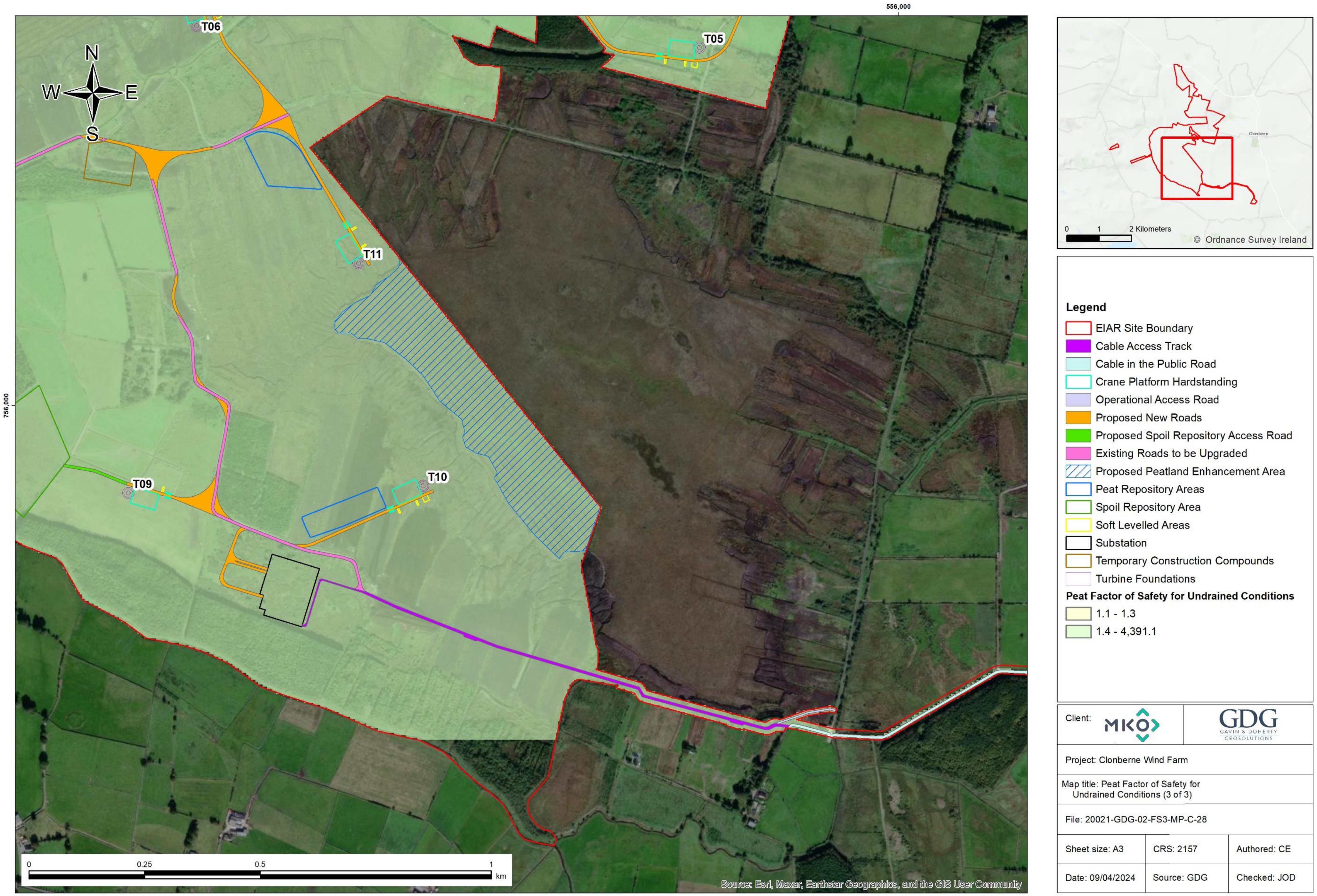


Figure K- 2: Peat Factor of Safety for Undrained Conditions (2 of 3).



Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

Figure K- 3: Peat Factor of Safety for Undrained Conditions (3 of 3).

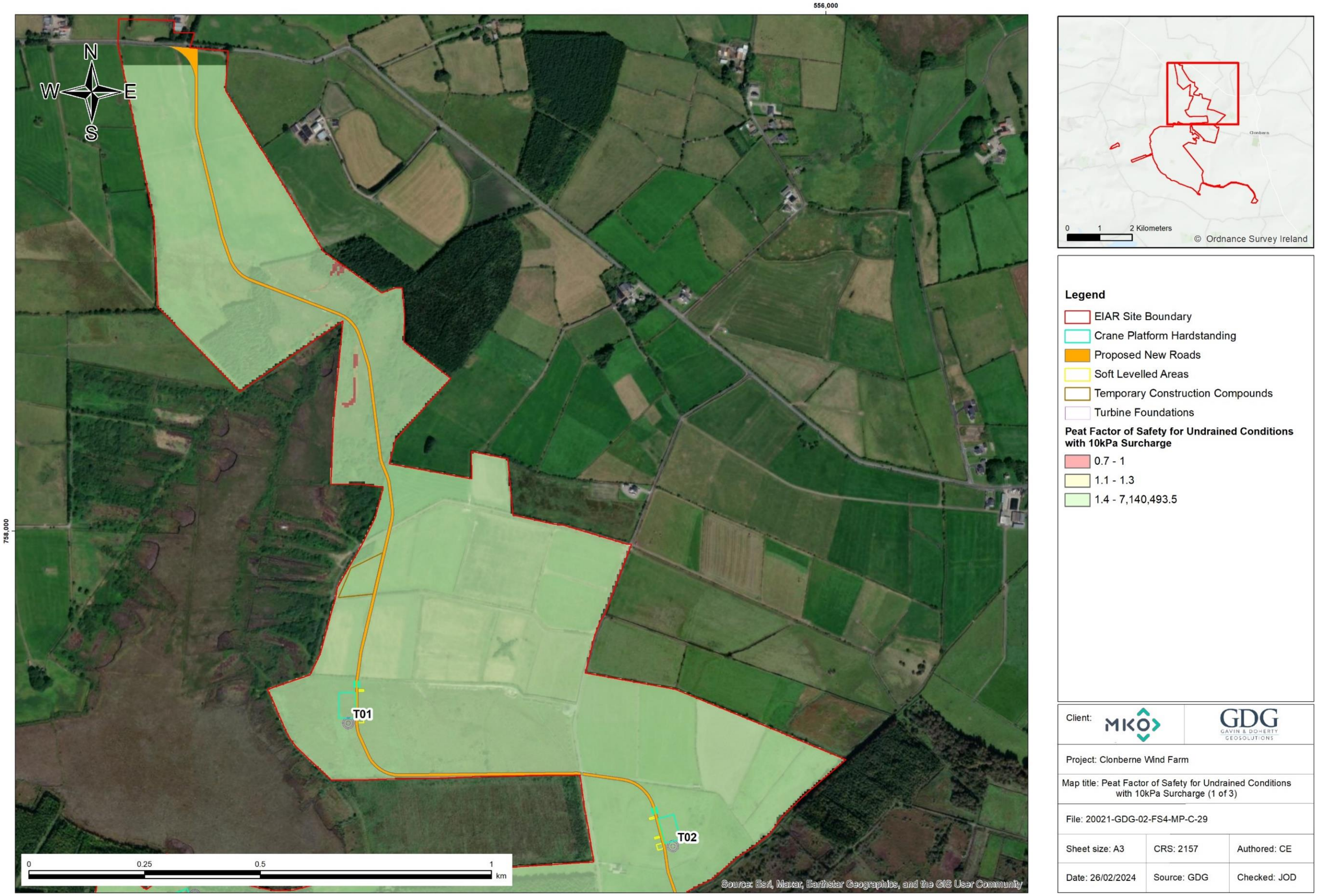
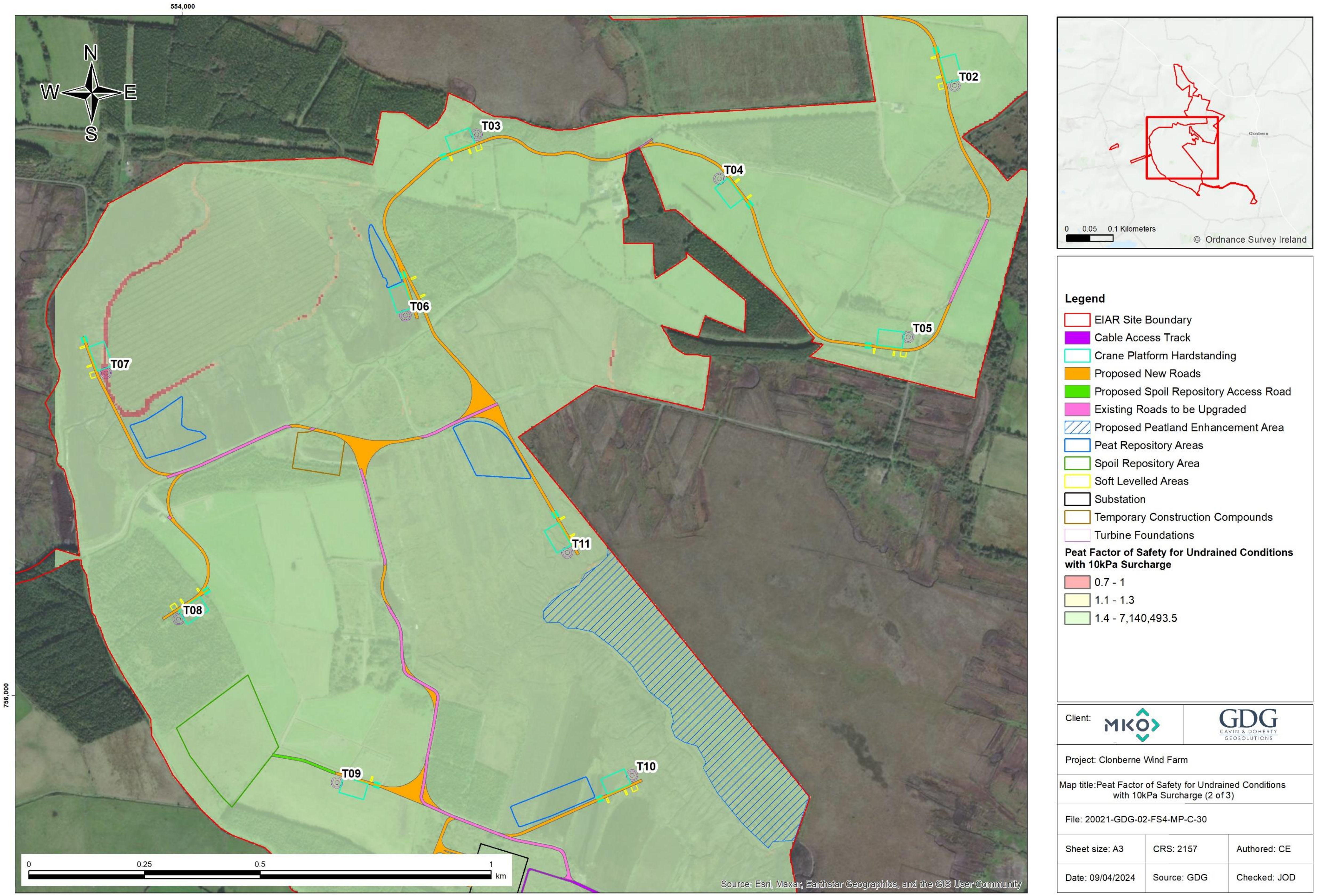


Figure K- 4: Peat Factor of Safety for Undrained Conditions with 10kPa Surcharge (1 of 3).

***The area at the northern entrance boundary contains no peat and so has not been assigned a peat FoS value, as this area was not included in the peat thickness interpolation.**



Client:

Project: Clonberne Wind Farm

Map title: Peat Factor of Safety for Undrained Conditions with 10kPa Surcharge (2 of 3)

File: 20021-GDG-02-FS4-MP-C-30

Sheet size: A3 | CRS: 2157 | Authored: CE

Date: 09/04/2024 | Source: GDG | Checked: JOD

Figure K- 5: Peat Factor of Safety for Undrained Conditions with 10kPa Surcharge (2 of 3).

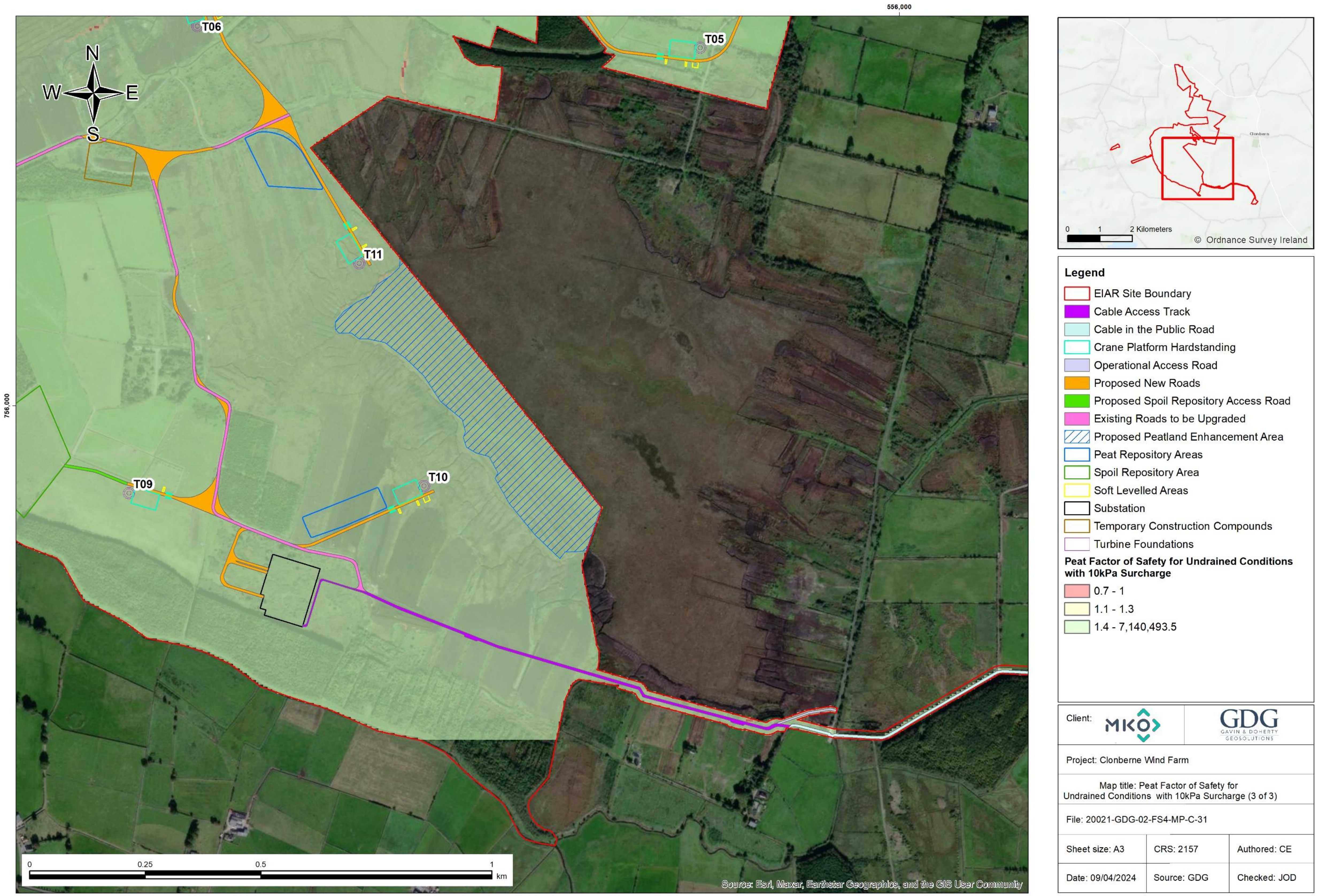


Figure K- 6: Peat Factor of Safety for Undrained Conditions with 10kPa Surcharge (3 of 3).

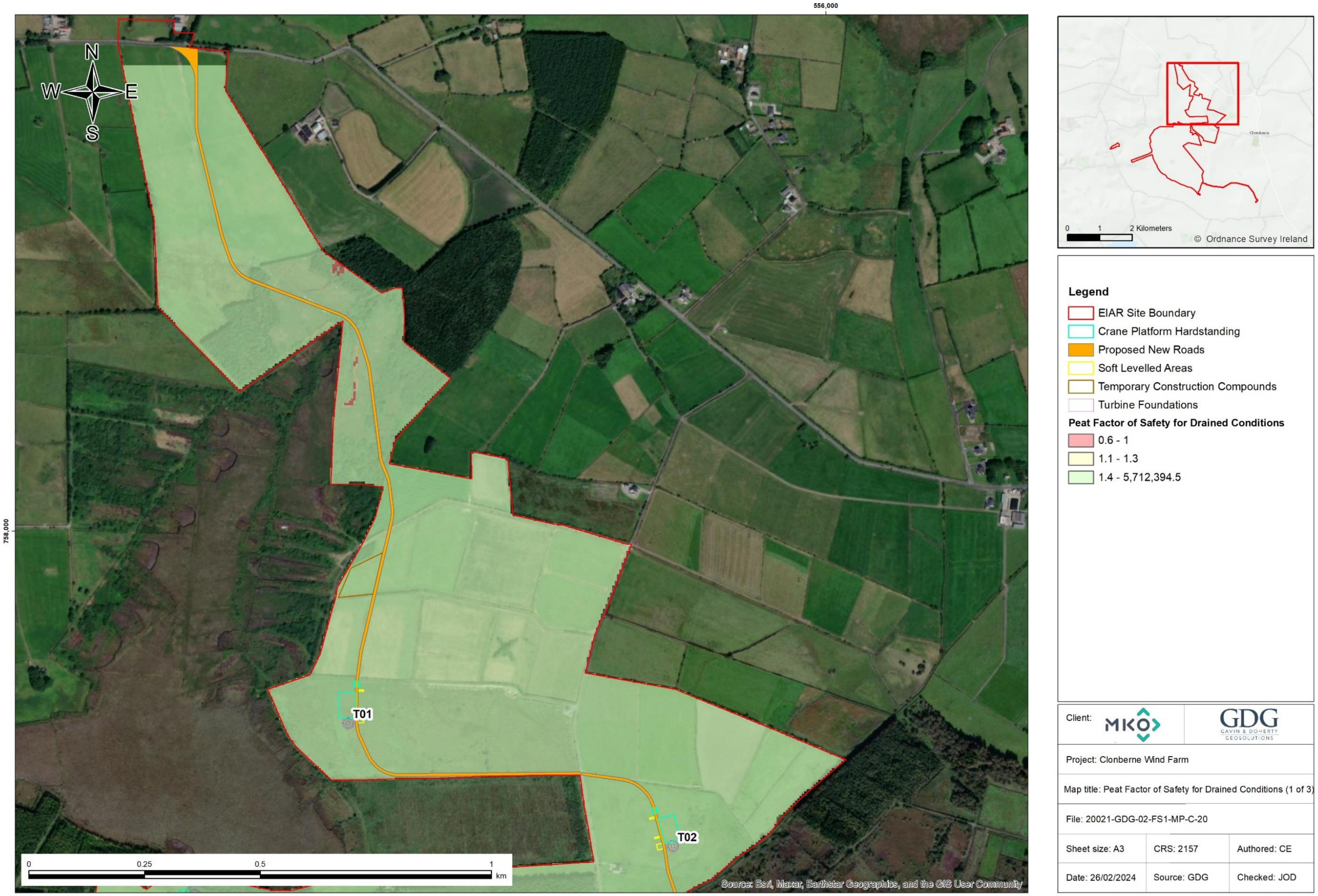


Figure K- 7: Peat Factor of Safety for Drained Conditions (1 of 3).

***The area at the northern entrance boundary contains no peat and so has not been assigned a peat FoS value, as this area was not included in the peat thickness interpolation.**

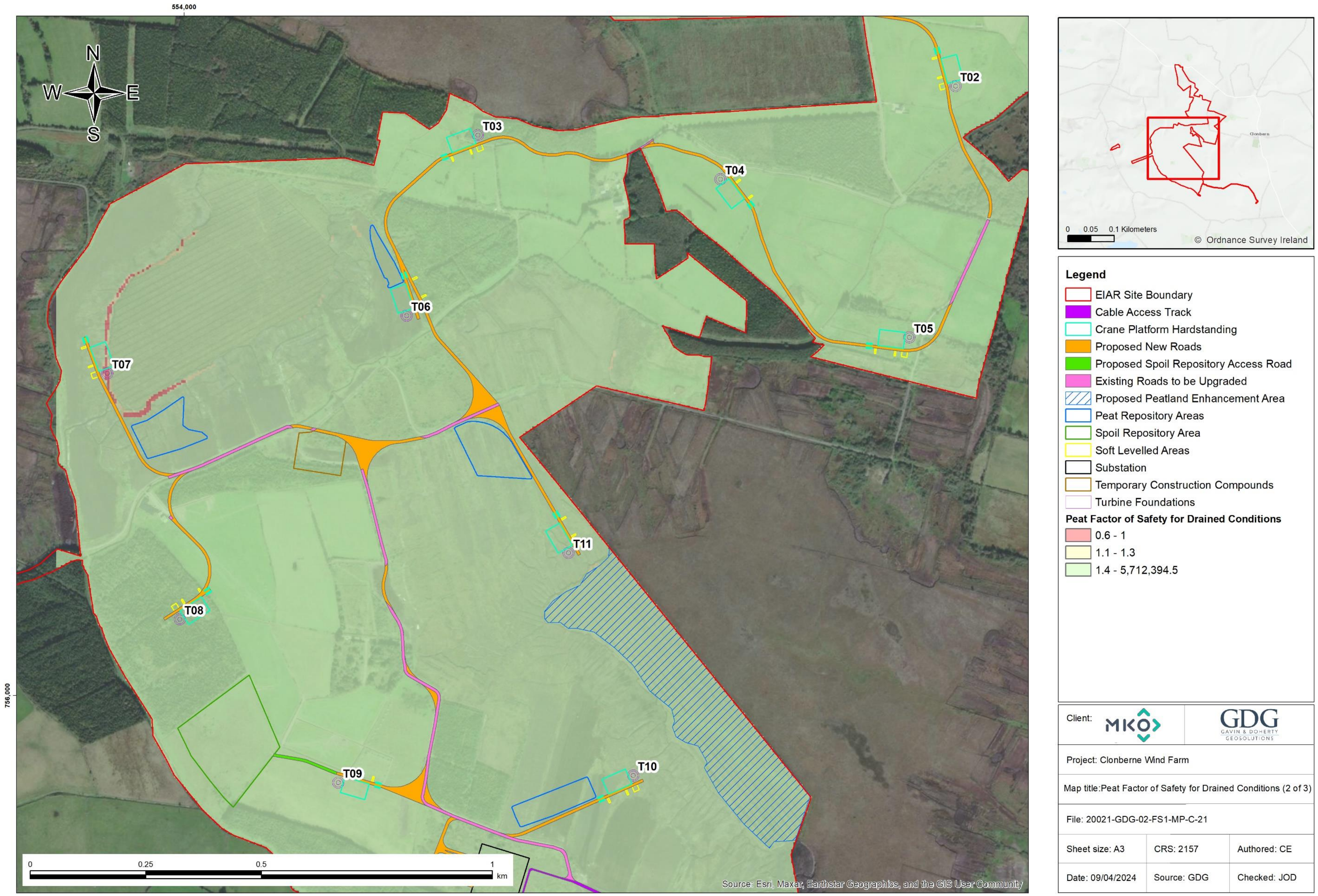
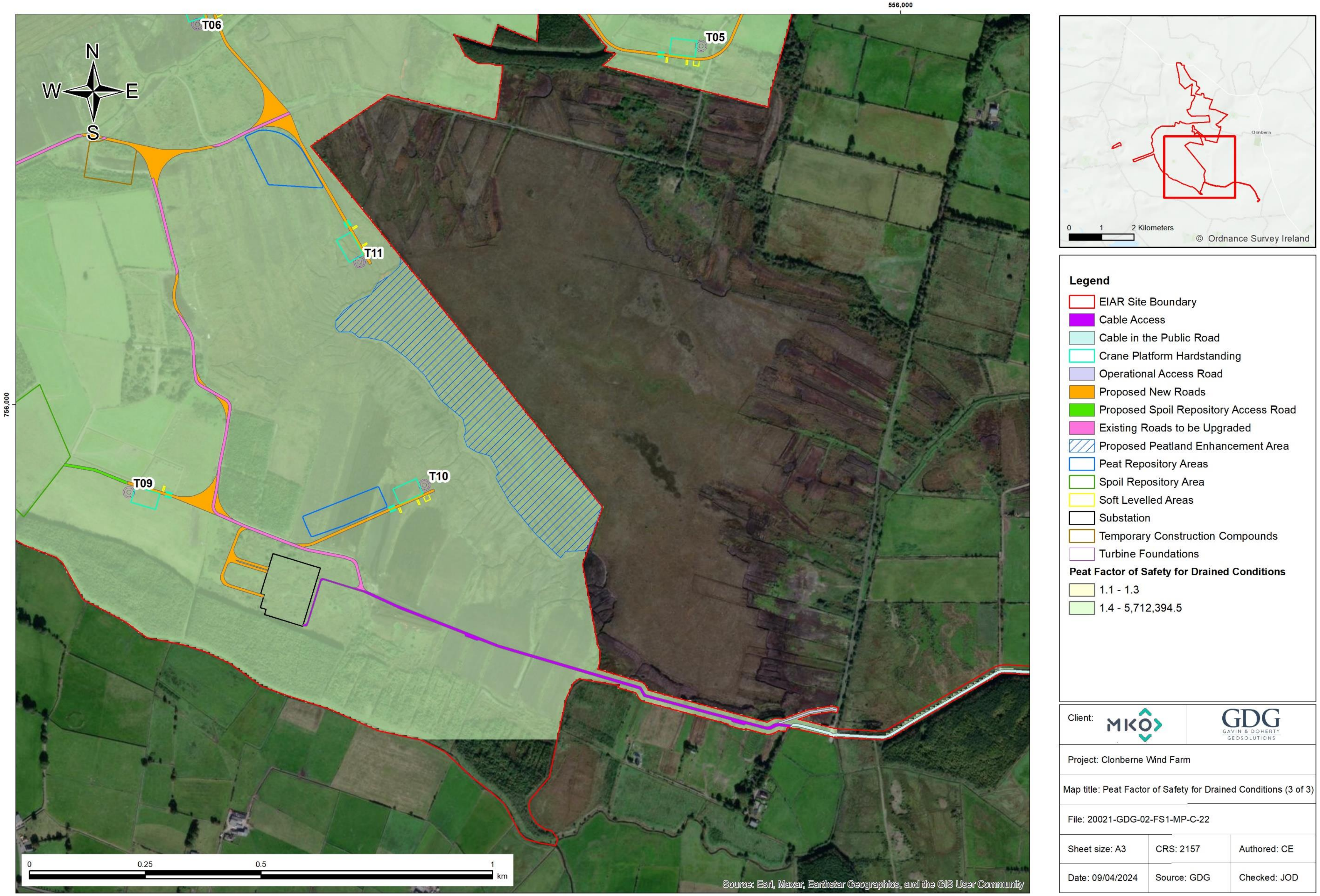


Figure K- 8: Peat Factor of Safety for Drained Conditions (2 of 3).



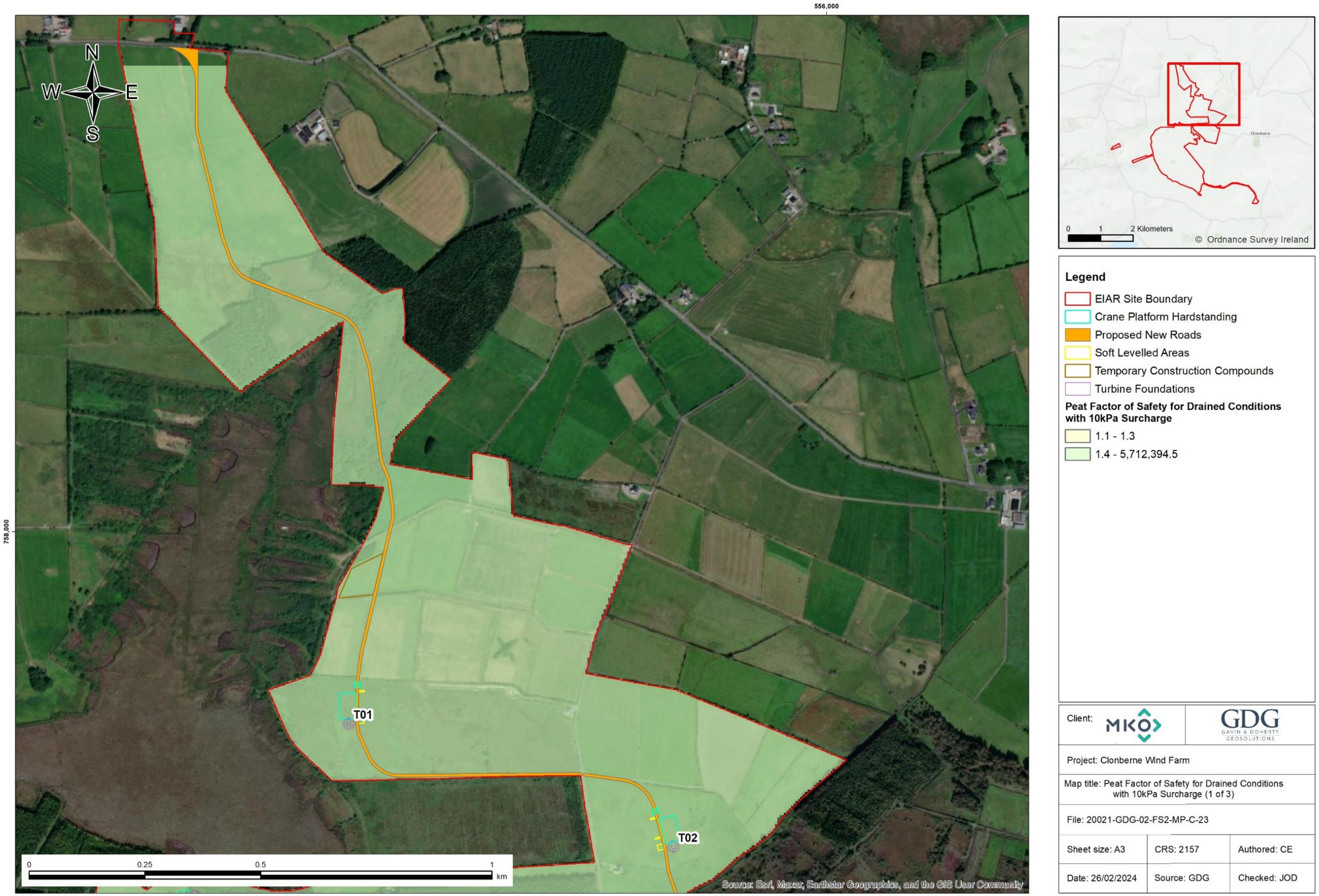
Project: Clonberne Wind Farm

Map title: Peat Factor of Safety for Drained Conditions (3 of 3)

File: 20021-GDG-02-FS1-MP-C-22

Sheet size: A3	CRS: 2157	Authored: CE
Date: 09/04/2024	Source: GDG	Checked: JOD

Figure K- 9: Peat Factor of Safety for Drained Conditions (3 of 3).



Project: Clonberne Wind Farm

Map title: Peat Factor of Safety for Drained Conditions with 10kPa Surcharge (1 of 3)

File: 20021-GDG-02-FS2-MP-C-23

Sheet size: A3
CRS: 2157
Authored: CE

Date: 26/02/2024
Source: GDG
Checked: JOD

Figure K- 10: Peat Factor of Safety for Drained Conditions with 10kPa Surcharge (1 of 3).

***The area at the northern entrance boundary contains no peat and so has not been assigned a peat FoS value, as this area was not included in the peat thickness interpolation.**

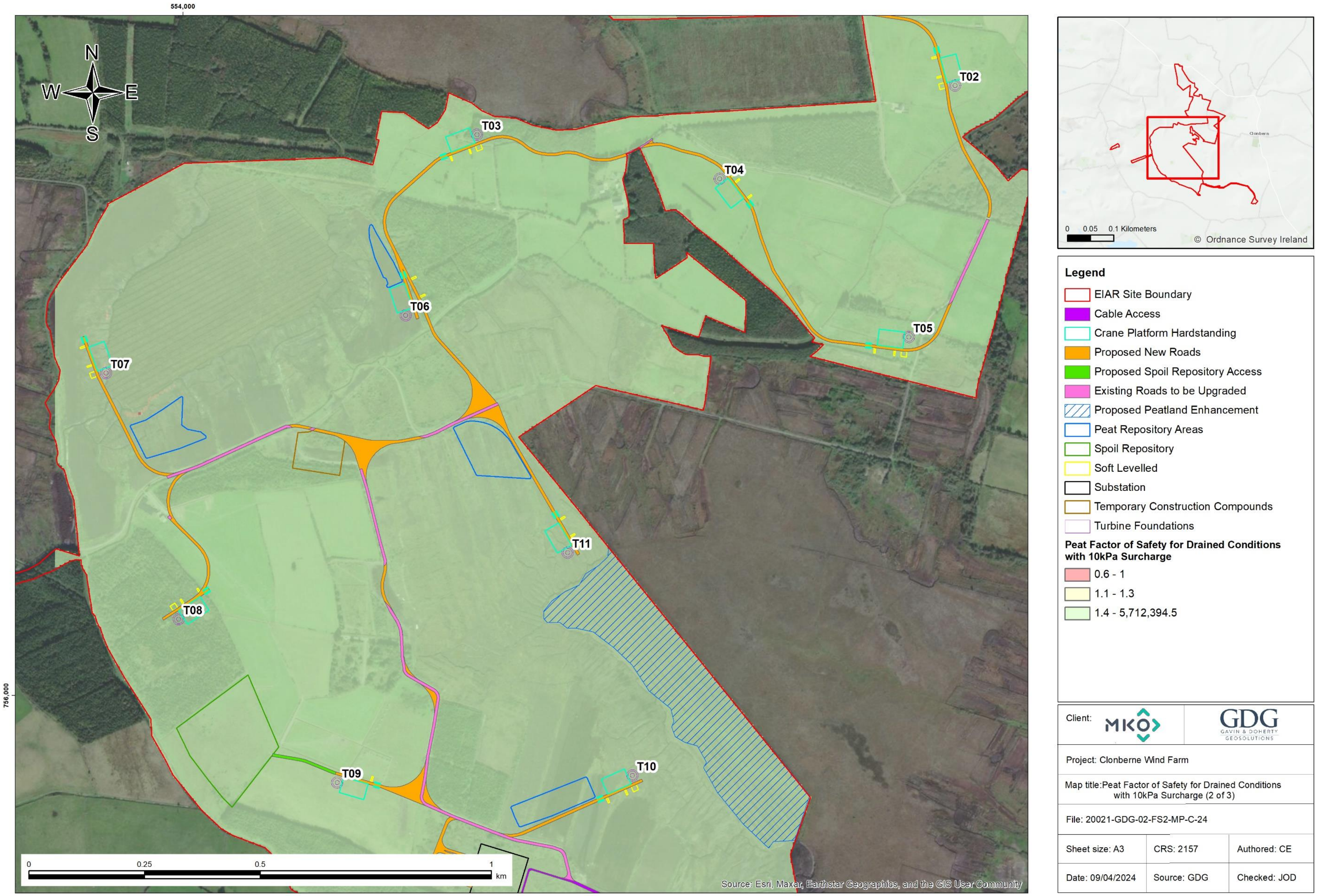


Figure K- 11: Peat Factor of Safety for Drained Conditions with 10kPa Surcharge (2 of 3).

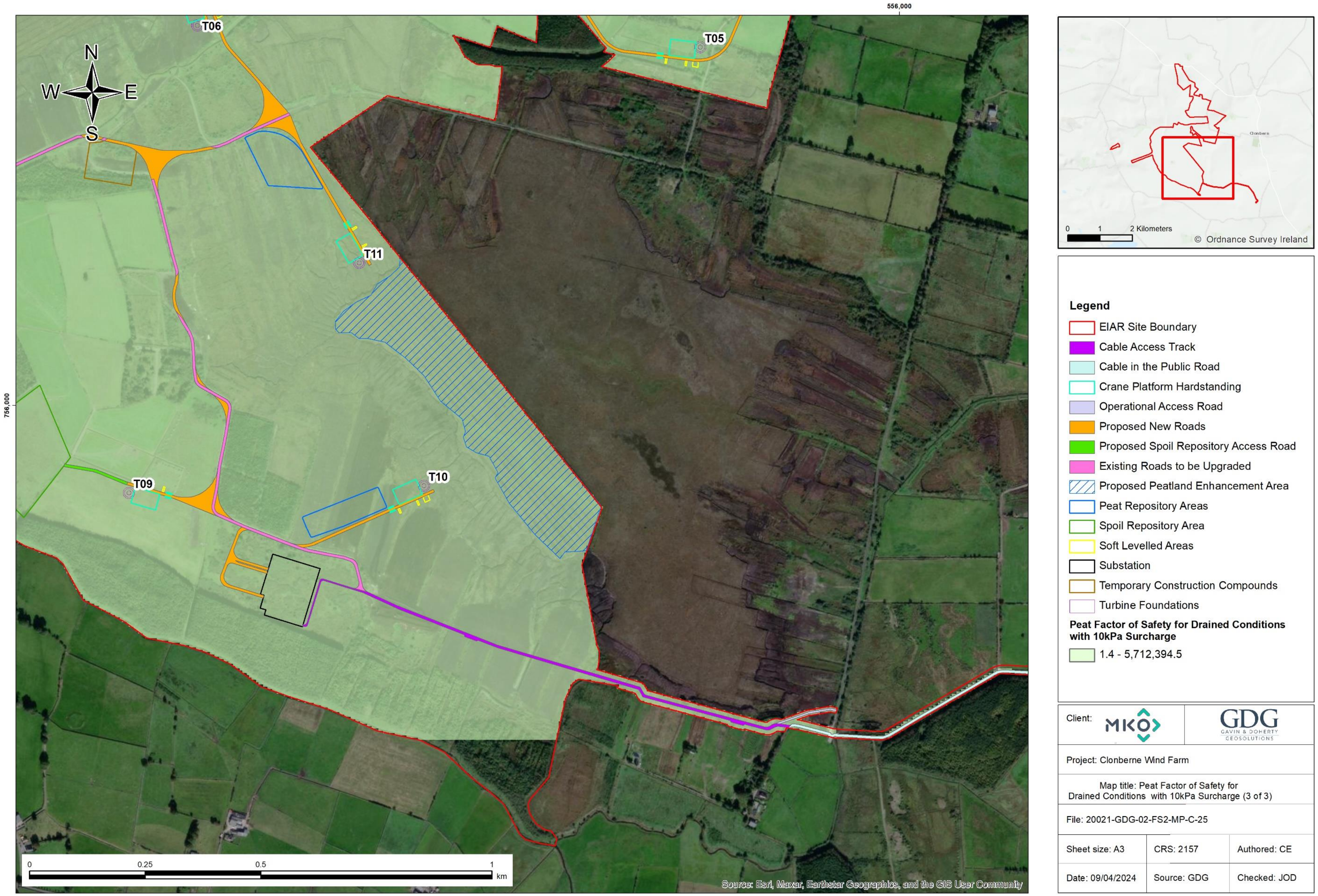


Figure K- 12: Peat Factor of Safety for Drained Conditions with 10kPa Surcharge (3 of 3).

Table K- 1: Factor of Safety Calculation for Undrained Conditions.

Proposed infrastructure	Slope	Cos Slope	Sin Slope	Undrained shear strength	Bulk unit weight of Peat	Peat depth	Factor of Safety	Surcharge	Factor of Safety with Surcharge	Slope
	(º)			Cu (kPa)	Y (kN/m^3)	(m)		(m)		Rad
T1	1.8	1.000	0.032	5	10	0.3	**49.42**	1	**12.02**	0.031508
T2	2.1	0.999	0.037	5	10	0.1	**151.31**	1	**12.32**	0.037298
T3	0.4	1.000	0.008	5	10	1.0	**62.12**	1	**31.61**	0.007766
T4	2.2	0.999	0.039	5	10	0.0	**3968.94**	1	**12.80**	0.038984
T5	4.6	0.997	0.080	5	10	0.7	**9.22**	1	**3.72**	0.080515
T6	0.6	1.000	0.010	5	10	0.6	**76.83**	1	**30.10**	0.010102
T7	6.3	0.994	0.111	5	10	4.4	**1.03**	1	**0.84**	0.110732
T8	2.3	0.999	0.040	5	10	1.8	**7.06**	1	**4.53**	0.03953
T9	0.7	1.000	0.013	5	10	0.1	**453.41**	1	**35.59**	0.012946
T10	1.0	1.000	0.017	5	10	1.5	**20.17**	1	**11.94**	0.017089
T11	1.4	1.000	0.025	5	10	1.5	**12.91**	1	**7.82**	0.025173
CC N	3.3	0.998	0.058	5	10	0.3	**29.00**	1	**6.69**	0.057596
CC S	1.8	1.000	0.031	5	10	0.7	**22.75**	1	**9.37**	0.031416
Substation	3.5	0.998	0.061	5	10	0.4	**20.51**	1	**5.86**	0.061087
Peatland Enhancement Area	0.8	1.000	0.014	5	10	3.9	**9.23**	1	**7.34**	0.013963
Grid Connection	3.0	0.999	0.052	5	10	2.4	**3.99**	1	**2.81**	0.05236
PRA 1	1.2	1.000	0.021	5	10	0.7	**34.11**	1	**14.05**	0.020944
PRA 2	1.8	1.000	0.031	5	10	1.1	**14.48**	1	**7.58**	0.031416
PRA 3	1.4	1.000	0.024	5	10	2.2	**9.30**	1	**6.40**	0.024435
PRA 4	0.4	1.000	0.007	5	10	0.4	**179.06**	1	**51.16**	0.006981
PRA 5	1.0	1.000	0.017	5	10	0.7	**40.93**	1	**16.86**	0.017453
SRA	1.7	1.000	0.030	5	10	0.4	**42.15**	1	**12.04**	0.029671

Undrained conditions

$$F = \frac{c_u}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c_u = Undrained strength
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
α = Slope angle

Table K- 2: Factor of Safety Calculation for Drained Conditions.

Proposed infrastructure	Drained shear strength	Bulk unit weight of Peat	Peat depth	Bulk unit weight of water	Height of water table above failure surface	Slope	Cos Slope	Cos^2 Slope	Sin Slope	ϕ'	Tan ϕ'	**FoS**	Surcharge (m)	**FoS Surcharge**
	Cu (kPa)	Y (kN/m^3)	(m)	Y (kN/m^3)	(m)	(º)								
T1	4	10	0.32	9.8	0.32	1.8	1.000	0.999	0.032	25	0.466	**39.83**	1	**20.88**
T2	4	10	0.09	9.8	0.09	2.1	0.999	0.999	0.037	25	0.466	**121.30**	1	**21.36**
T3	4	10	1.04	9.8	1.04	0.4	1.000	1.000	0.008	25	0.466	**50.89**	1	**55.39**
T4	4	10	0.00	9.8	0.00	2.2	0.999	0.998	0.039	25	0.466	**3175.39**	1	**22.16**
T5	4	10	0.68	9.8	0.68	4.6	0.997	0.994	0.080	25	0.466	**7.49**	1	**6.47**
T6	4	10	0.64	9.8	0.64	0.6	1.000	1.000	0.010	25	0.466	**62.39**	1	**52.52**
T7	4	10	4.44	9.8	4.44	6.3	0.994	0.988	0.111	25	0.466	**0.90**	1	**1.51**
T8	4	10	1.79	9.8	1.79	2.3	0.999	0.998	0.040	25	0.466	**5.88**	1	**8.00**
T9	4	10	0.09	9.8	0.09	0.7	1.000	1.000	0.013	25	0.466	**363.45**	1	**61.72**
T10	4	10	1.45	9.8	1.45	1.0	1.000	1.000	0.017	25	0.466	**16.69**	1	**21.01**
T11	4	10	1.54	9.8	1.54	1.4	1.000	0.999	0.025	25	0.466	**10.70**	1	**13.78**
CC N	4	10	0.30	9.8	0.30	3.3	0.998	0.997	0.058	25	0.466	**23.36**	1	**11.61**
CC S	4	10	0.70	9.8	0.70	1.8	1.000	0.999	0.031	25	0.466	**18.50**	1	**16.35**
Substation	4	10	0.40	9.8	0.40	4.4	0.997	0.994	0.077	25	0.466	**13.07**	1	**8.02**
Peatland Enhancement Area	4	10	3.88	9.8	3.88	0.8	1.000	1.000	0.014	25	0.466	**8.05**	1	**13.25**
Grid Connection	4	10	2.30	9.8	2.30	3.0	0.999	0.997	0.052	25	0.466	**3.51**	1	**5.14**
PRA 1	4	10	0.70	9.8	0.70	1.2	1.000	1.000	0.021	25	0.466	**27.74**	1	**24.52**
PRA 2	4	10	1.10	9.8	1.10	1.8	1.000	0.999	0.031	25	0.466	**11.88**	1	**13.29**
PRA 3	4	10	2.20	9.8	2.20	1.4	1.000	0.999	0.024	25	0.466	**7.83**	1	**11.34**
PRA 4	4	10	0.40	9.8	0.40	0.4	1.000	1.000	0.007	25	0.466	**144.58**	1	**89.02**
PRA 5	4	10	0.70	9.8	0.70	1.0	1.000	1.000	0.017	25	0.466	**33.28**	1	**29.42**
SRA	4	10	0.40	9.8	0.40	1.7	1.000	0.999	0.030	25	0.466	**34.04**	1	**20.95**

Drained conditions

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2 \alpha \tan\phi'}{\gamma z \sin\alpha \cos\alpha}$$

Where,

F = Factor of Safety
c' = Effective cohesion
γ = Bulk unit weight of material
z = Depth to failure plane assumed as depth of peat
γ_w = Unit weight of water
h_w = Height of water table above failure plane
α = Slope angle
ϕ' = Effective friction angle

Appendix L SAFETY BUFFER AREAS AND PEAT STOCKPILE RESTRICTION AREAS

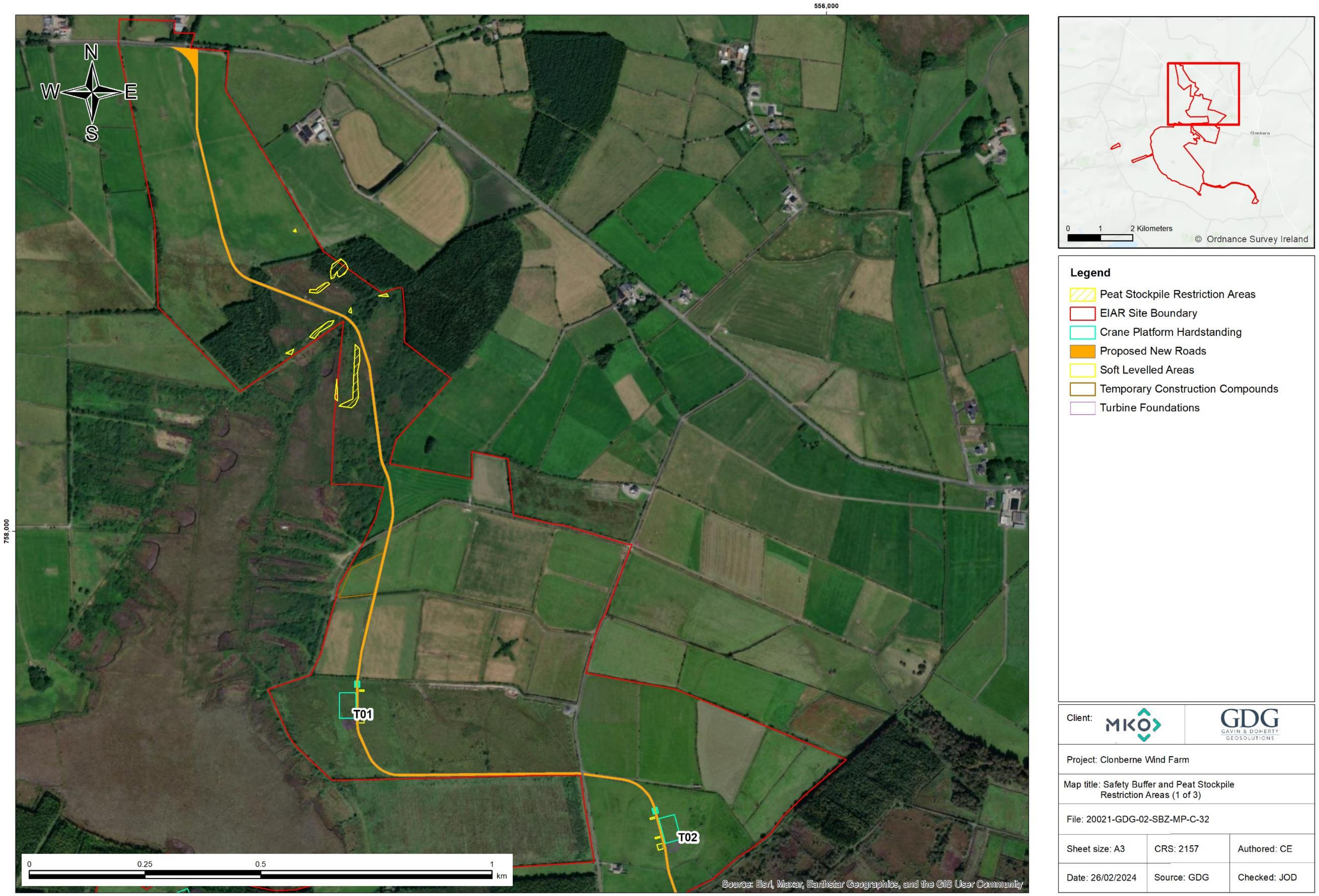
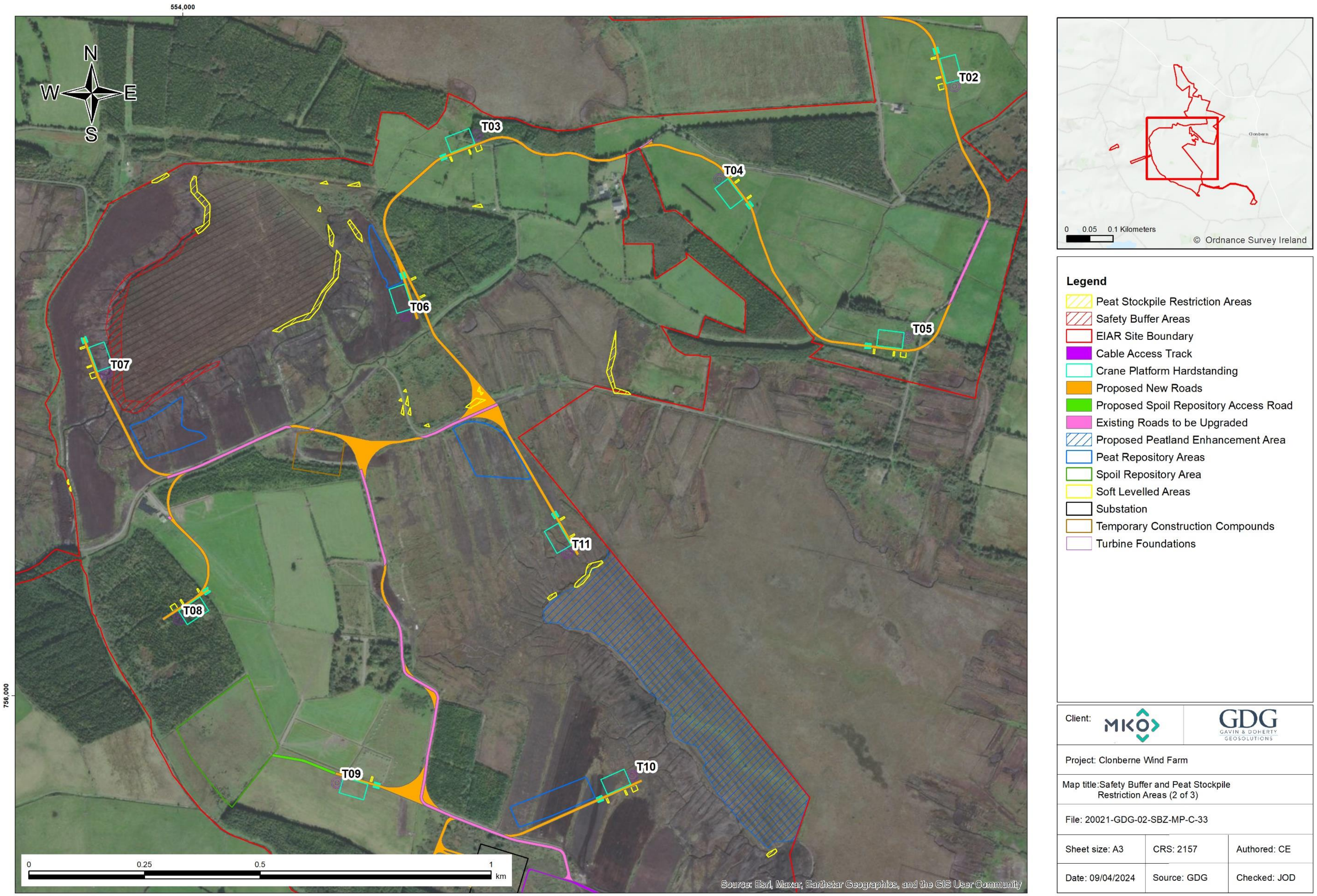


Figure L- 1: Safety Buffer and Peat Stockpile Restriction Areas (1 of 3).



Project: Clonberne Wind Farm

Map title: Safety Buffer and Peat Stockpile Restriction Areas (2 of 3)

File: 20021-GDG-02-SBZ-MP-C-33

Sheet size: A3	CRS: 2157	Authored: CE
Date: 09/04/2024	Source: GDG	Checked: JOD

Figure L- 2: Safety Buffer and Peat Stockpile Restriction Areas (2 of 3).

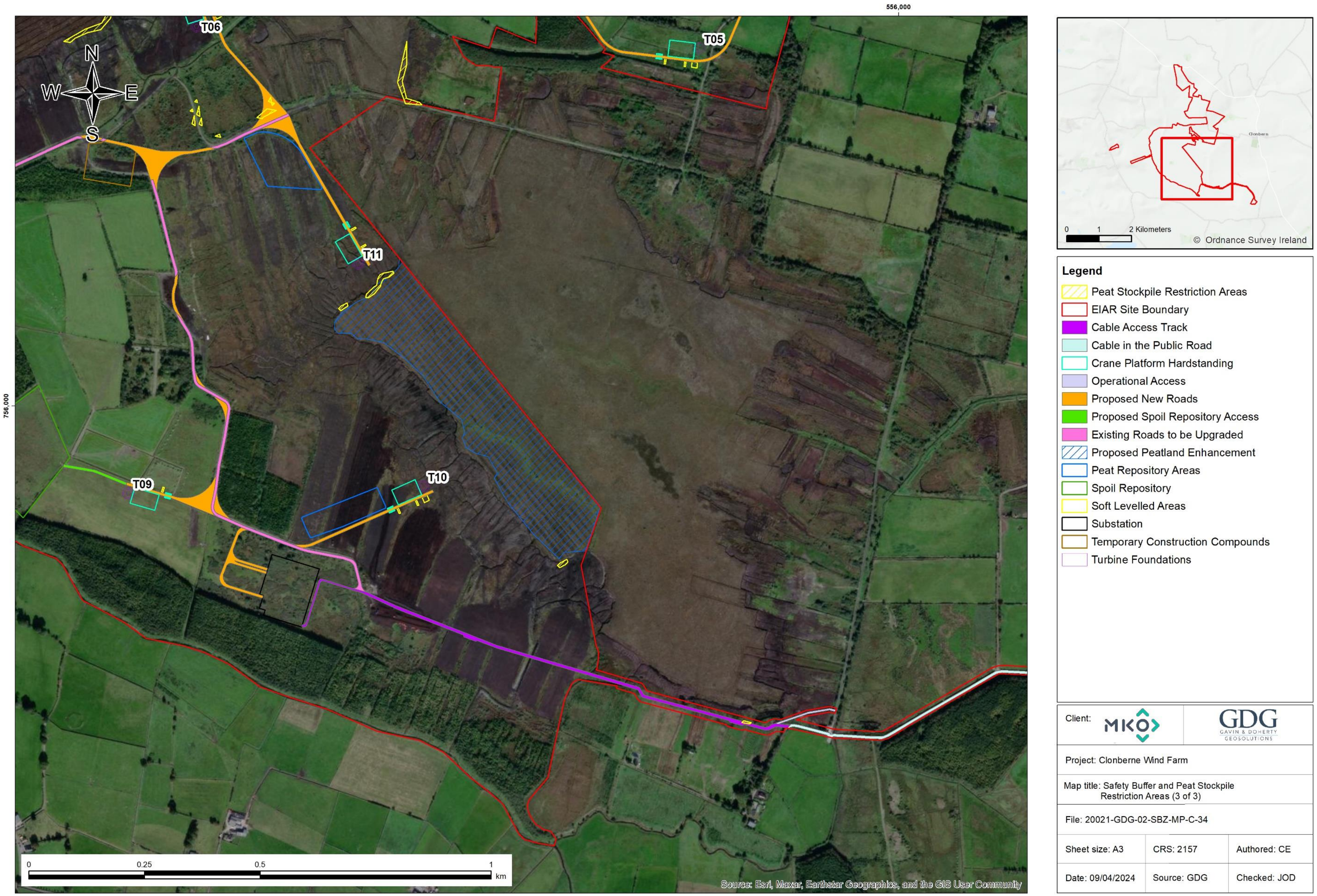


Figure L- 3: Safety Buffer and Peat Stockpile Restriction Areas (3 of 3).

Appendix M PEAT STABILITY RISK ASSESSMENT

Table M- 1: Peat Stability Risk Assessment at Turbine 1.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 1**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				**Rating value**	**Weighting**	**Score**	**Comment**
			U	US	D	DS	0	1	2	3				
Factor of Safety			49.4	12.0	39.8	20.9	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.3m. Slope angle: 1.8º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP (TP06) : Grey, stiff, medium strength, sandy, very gravelly CLAY.
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No peat
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No peat
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat topography.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	Nearest watercourse ~500m away
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	No peat
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	No evidence
		Existing drainage ditches	NA				NA	Down slope	Varied / Oblique	Across slope	0	1	0	Flat topography, but drains perpendicular to contours.
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Grassland				NA	Dry heather	Grassland	Wetlands	2	1	2	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	No peat
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	No peat
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	Solid roads
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{total}$ 25

Max. possible 102

Hazard $_{0-1}$ **0.25**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	NA	NA	Small	Medium	Large	0	3	0	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	NA	NA	> 500	200 - 500	< 200	0	1	0	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$ 7

Max. possible 33

Consequences $_{0-1}$ **0.21**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.25 0.21 = **0.05**

Table M- 2: Peat Stability Risk Assessment at Turbine 2.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 2**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			151	12.3	121.0	21.4	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.09m. Slope angle: 2.1º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	TP 4 notes: Dark grey , slightly silty, very sandy GRAVEL, with cobbles subrounded to rounded
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No Peat
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No peat
	Topography	General curvature downslope	Planar				NA	-	Planar	Convex	2	1	2	
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	SE
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	~110m
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	No peat
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	No peat
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Wetlands				NA	Dry heather	Grassland	Wetlands	3	1	3	
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	-				NA	-	Cutaway / Turbary	Machine cut	1	1	1	No peat
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	No peat
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	34.5
Max. possible	102
Hazard $_{0-1}$	**0.34**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	NA	NA	Small	Medium	Large	0	3	0	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Intermediate	NA	Horizontal	Intermediate	Steep	2	1	2	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	9
Max. possible	33
Consequences $_{0-1}$	**0.27**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.34 0.27 = **0.09**

Table M- 3: Peat Stability Risk Assessment at Turbine 3.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 3**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			62.1	31.60	50.9	55.4	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~1.03 m. Slope angle: 0.4º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No TP
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	2	2	4	No TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	SW
	Hydrology	Distance from watercourse (m)	200 - 300				NA	> 300	200 - 300	< 200	2	1	2	~280m
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Varied / Oblique				NA	Down slope	Varied / Oblique	Across slope	2	1	2	Varied
		Annual rainfall	> 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	3	1	3	
	Vegetation	Bush	Grassland				NA	Dry heather	Grassland	Wetlands	2	1	2	
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$ 34.5

Max. possible 102

Hazard $_{0\text{-}1}$ **0.34**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$ 11

Max. possible 33

Consequences $_{0\text{-}1}$ **0.33**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.34 0.33 = **0.11**

Table M- 4: Peat Stability Risk Assessment at Turbine 4.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 4**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			3968.00	12.80	3175.00	22.16	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0 m. Slope angle: 2.2º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	No Peat
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP (TP08) records: Light brown, medium dense to dense, silghtly silty, very gravelly, fine to coarse SAND, with many cobbles and boulders. Cobbles and boulders are rounded to subrounded
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No Peat
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No Peat
	Topography	General curvature downslope	Planar				NA	-	Planar	Convex	2	1	2	
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	SE
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	~300m
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	No Peat
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	No Peat
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Grassland				NA	Dry heather	Grassland	Wetlands	2	1	2	Agricultural tillage land
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	No forestry. Agricultural land.
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	No Peat
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	No Peat
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	28
Max. possible	102
Hazard $_{0-1}$	**0.27**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	NA	NA	Small	Medium	Large	0	3	0	No peat.
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	8
Max. possible	33
Consequences $_{0-1}$	**0.24**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.27	0.24	=	**0.07**

Table M- 5: Peat Stability Risk Assessment at Turbine 5.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 5**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				**Rating value**	**Weighting**	**Score**	**Comment**
			U	US	D	DS	0	1	2	3				
Factor of Safety			9.2	3.7	7.5	6.5	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~ 0.68m. Slope angle: 4.6º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP is TP09: LGreyish brown, firm, slightly gravelly, sandy CLAY with some cobbles. Cobbles are subrounded to subangular.
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	TP records no peat SE of turbine
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	2	2	4	TP records no peat SE of turbine
	Topography	General curvature downslope	Planar				NA	-	Planar	Convex	2	1	2	
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	~100m
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Wetlands				NA	Dry heather	Grassland	Wetlands	3	1	3	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	-				NA	-	Cutaway / Turbary	Machine cut	1	1	1	No peat cutting
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	No peat cutting
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	No peat cutting
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	No peat cutting

Hazard $_{total}$ 36

Max. possible 96

Hazard $_{0-1}$ **0.38**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	Rating criteria				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	NA	NA	Horizontal	Intermediate	Steep	0	1	0	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$ 11

Max. possible 33

Consequences $_{0-1}$ **0.33**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.38 0.33 = **0.13**

Table M- 6: Peat Stability Risk Assessment at Turbine 6.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 6**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				**Rating value**	**Weighting**	**Score**	**Comment**
			U	US	D	DS	0	1	2	3				
Factor of Safety			76.8	30.10	62.63	52.52	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.64 m. Slope angle: 0.58º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	No				NA	Yes	Partially	No	3	1	3	No TP
		Peat wetness	No				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	No TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	SE
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	~50m
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Dry heather				NA	Dry heather	Grassland	Wetlands	1	1	1	No bush - forestry area.
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	No peat cuts.
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{total}$ 35.5

Max. possible 93

Hazard $_{0-1}$ **0.38**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$ 12

Max. possible 33

Consequences $_{0-1}$ **0.36**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.38 0.36 = **0.14**

Table M- 7: Peat Stability Risk Assessment at Turbine 7.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 7**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			1.0	0.84	0.90	1.51	-	≥ 1.3	1.3 - 1.0	≤ 1.0	3	10	30	Peat depth: ~4.4 m. Slope angle: 6.3º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No TP
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	No TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	~80m
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	Very low slope angle, but large drain fairly near to turbine site (<50m).
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Dry heather				NA	Dry heather	Grassland	Wetlands	1	1	1	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	No peat cuts.
		Peat cuts vs contour lines	Parallel				NA	Perpendicular	Oblique	Parallel	3	1	3	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	54
Max. possible	93
Hazard $_{0-1}$	**0.58**

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Medium	NA	Small	Medium	Large	2	3	6	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	14
Max. possible	33
Consequences $_{0-1}$	**0.42**

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.58 0.42 = **0.25**

Table M- 8: Peat Stability Risk Assessment at Turbine 8.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 8**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			7.1	4.53	5.88	8.00	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~1.8 m. Slope angle: 2.3º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP (TP01) records: Grey brown, stiff, high plasticity, sandy, gravelly CLAY.
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	NA				NA	Down slope	Varied / Oblique	Across slope	0	1	0	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	No bush - forestry area.
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	No peat cuts.
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard total	29.5
Max. possible	96
Hazard 0-1	**0.31**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences total	12
Max. possible	33
Consequences 0-1	**0.36**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.31 0.36 = **0.11**

Table M- 9: Peat Stability Risk Assessment at Turbine 9.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 9**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				**Rating value**	**Weighting**	**Score**	**Comment**
			U	US	D	DS	0	1	2	3				
Factor of Safety			453.4	35.59	363.45	61.72	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.09 m. Slope angle: 0.7º.
Secondary factors	Slide history	Distance to previous slides (km)	NA				NA	5 - 10	< 5	On site	0	2	0	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP (TP11) records: Brown/grey firm sandy gravelly CLAY with cobbles and boulders. Cobbles and boulders are subangular to subrounded.
		Peat fibres across transition to subsoil	Yes				NA	Yes	Partially	No	1	1	1	
		Peat wetness	Dry / Stands well				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	200 - 300				NA	> 300	200 - 300	< 200	2	1	2	
		Surface moisture index (NDMI)	135 - 174				NA	0 - 96	96 -135	135 - 174	3	1	3	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	NA				NA	Down slope	Varied / Oblique	Across slope	0	1	0	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	Grassland				NA	Dry heather	Grassland	Wetlands	2	1	2	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	No peat cuts.
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	No peat cuts.
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	31
Max. possible	102
Hazard $_{0-1}$	**0.30**

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	12
Max. possible	33
Consequences $_{0-1}$	**0.36**

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.30 | 0.36 = **0.11**

Table M- 10: Peat Stability Risk Assessment at Turbine 10.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Turbine 10**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			20.2	11.94	16.69	21.01	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~1.5 m. Slope angle: 0.98º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No TP
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	No TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Varied / Oblique				NA	Down slope	Varied / Oblique	Across slope	2	1	2	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	27
Max. possible	93
Hazard $_{0-1}$	**0.29**

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	12
Max. possible	33
Consequences $_{0-1}$	**0.36**

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.29 0.36 = **0.11**

Table M- 11: Peat Stability Risk Assessment at Turbine 11.

Clonberne Wind Farm

Inspected on: Sep-23
Inspected by: BMC
Completed by: CE
Date: Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			12.9	7.82	10.70	13.78	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~1.5 m. Slope angle: 1.4º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No TP
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	3	2	6	No TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat area.
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	1000 - 1400 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	2	1	2	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	Turbary cutting ~50m from turbine
		Peat cuts vs contour lines	Parallel				NA	Perpendicular	Oblique	Parallel	3	1	3	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$ 32

Max. possible 93

Hazard $_{0-1}$ **0.34**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	Farm out-houses	NA	Farm out-houses	-	Dwelling	1	1	1	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$ 12

Max. possible 33

Consequences $_{0-1}$ **0.36**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.34 0.36 = **0.13**

Table M- 12: Peat Stability Risk Assessment at northern construction compound.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Temporary compound site 1 (Northern)**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			29	6.7	23	11.6	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: 0.3, Slope angle: 3.3
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	1	2	2	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	Dry heather				NA	Dry heather	Grassland	Wetlands	1	1	1	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	Founded roads
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{total}$ 25

Max. possible 93

Hazard $_{0-1}$ **0.27**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	NA	NA	Horizontal	Intermediate	Steep	0	1	0	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$ 10

Max. possible 33

Consequences $_{0-1}$ **0.30**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.27 0.30 = **0.08**

Table M- 13: Peat Stability Risk Assessment at southern construction compound.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Temporary compound site 2 (Southern)**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			22.8	9.4	19	16.3	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: 0.7, Slope angle: 1.8
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness	Dry / Stands well				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	1	2	2	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water (water table level indicator)	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	Very low slope angle, but drains perpendicular to contour lines.
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	Peat cuts set back from site.
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	-				NA	Solid	-	Floating	2	1	2	Unsure if founded or floated.
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{\text{total}}$ 28.5

Max. possible 93

Hazard $_{\text{0-1}}$ **0.31**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	NA	NA	Horizontal	Intermediate	Steep	0	1	0	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{\text{total}}$ 10

Max. possible 33

Consequences $_{\text{0-1}}$ **0.30**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.31	0.30	=	**0.09**

Table M- 14: Peat Stability Risk Assessment at the Substation.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Substation**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	Sep-23
Inspected by:	BMC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			20.5	5.9	13	∞	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.4 m. Slope angle: 4.4º.
Secondary factors	Slide history	Distance to previous slides (km)	NA				NA	5 - 10	< 5	On site	0	2	0	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	Nearest TP (TP02, 30m away from substation) records: sand.
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	
	Topography	General curvature downslope	-				NA	-	Planar	Convex	1	1	1	
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	135 - 174				NA	0 - 96	96 -135	135 - 174	3	1	3	
		Surface water (water table level indicator)	NA				NA	Localised	Ponded in drains	Springs	0	1	0	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	NA				NA	Down slope	Varied / Oblique	Across slope	0	1	0	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry (if applicable)	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	-				NA	-	Cutaway / Turbary	Machine cut	1	1	1	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate
												Hazard $_{total}$	25.5	
												Max. possible	96	
												Hazard $_{0-1}$	**0.27**	

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	NA	NA	Small	Medium	Large	0	3	0	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	
							Consequences $_{total}$	8	
							Max. possible	33	
							Consequences $_{0-1}$	**0.24**	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.27	0.24	=	**0.06**

Table M- 15: Peat Stability Risk Assessment at the Proposed Peatland Enhancement Area.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Peatland Enhancement Area**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	EFC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			9.23	7.34	8	13	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~3.88 m. Slope angle: 0.8º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	Yes				NA	-	-	Yes	3	2	6	
	Subsoil conditions (visible in trial pits)	Subsoil type	Gravel / Firm glacial till				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	1	1	1	
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	135 - 174				NA	0 - 96	96 -135	135 - 174	3	1	3	
		Surface water (water table level indicator)	Ponded in drains				NA	Localised	Ponded in drains	Springs	2	1	2	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	Dry heather				NA	Dry heather	Grassland	Wetlands	1	1	1	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	
		Peat cuts vs contour lines	Perpendicular				NA	Perpendicular	Oblique	Parallel	1	1	1	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate
	Rewetting		Blocked Drains				NA	Blocked Drains	Bunds	Blocked Drains + Bunds	1	1	1	

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	36
Max. possible	94
Hazard $_{0-1}$	**0.38**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Medium	NA	Small	Medium	Large	2	3	6	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$	14
Max. possible	33
Consequences $_{0-1}$	**0.42**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.38	0.42	=	**0.16**

Table M- 16: Peat Stability Risk Assessment at grid connection route.

Peat Stability Risk Assessment (PSRA)

Clonberne Wind Farm

Location:	**Grid Connection**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	EFC
Completed by:	CE
Date:	Nov-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			4	2.8	4	5.1	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~2.3 m. Slope angle:6.9º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension cracks, step features, compression features).	Yes				NA	-	-	Yes	3	2	6	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP nearby
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No TP nearby
		Peat wetness	NA				NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No TP nearby
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	SW, S, SE				NA	SW, S, SE	W, E	NW, N, NE	1	1	1	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	135 - 174				NA	0 - 96	96 -135	135 - 174	3	1	3	
		Surface water (water table level indicator)	Ponded in drains				NA	Localised	Ponded in drains	Springs	2	1	2	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	Dry heather				NA	Dry heather	Grassland	Wetlands	1	1	1	
		Forestry (if applicable)	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	
		Peat cuts vs contour lines	Perpendicular				NA	Perpendicular	Oblique	Parallel	1	1	1	
	Existing loads	Roads	NA				NA	Solid	-	Floating	0	1	0	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
🟩 0.3 - 0.5	Low
🟨 0.5 - 0.7	Medium
🟥 0.7 - 1.0	High

Hazard $_{total}$	34
Max. possible	93
Hazard $_{0\text{-}1}$	**0.37**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow (function of distance from nearest watercourse and peat depth in the area)	Medium	NA	Small	Medium	Large	2	3	6	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$	14
Max. possible	33
Consequences $_{0\text{-}1}$	**0.42**

Consequences	
0.0 - 0.3	Negligible
🟩 0.3 - 0.5	Low
🟨 0.5 - 0.7	Medium
🟥 0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
🟩 0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
🟨 0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision during construction.
🟥 0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.37	0.42	=	**0.16**

Table M- 17: Peat Stability Risk Assessment at PRA 1.

Peat Stability Risk Assessment (PSRA)

Carrig Wind Farm

Location:	**PRA 1**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	BMC
Completed by:	CE
Date:	Dec-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			34.1	14.1	27.7	24.5	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.7m. Slope angle: 1.2º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g.	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No TP
		Peat fibres across transition to	NA				NA	Yes	Partially	No	0	1	0	
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Varied / Oblique				NA	Down slope	Varied / Oblique	Across slope	2	1	2	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	
		Peat cuts vs contour lines	Parallel				NA	Perpendicular	Oblique	Parallel	3	1	3	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$ 31.5

Max. possible 93

Hazard $_{0-1}$ **0.34**

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	NA	NA	Horizontal	Intermediate	Steep	0	1	0	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$ 10

Max. possible 33

Consequences $_{0-1}$ **0.30**

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time
0.60 - 1.00	High	Avoid construction in this area.

Risk rating = Hazard * Consequences

Risk rating = 0.34 0.30 = **0.10**

Table M- 18: Peat Stability Risk Assessment at PRA 2.

Peat Stability Risk Assessment (PSRA)

Carrig Wind Farm

Location:	**PRA 2**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	BMC
Completed by:	CE
Date:	Dec-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			14.5	7.6	11.9	13.3	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~1.1 m. Slope angle: 1.8º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No neaby trial pit
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No neaby trial pit
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No neaby trial pit
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	200 - 300				NA	> 300	200 - 300	< 200	2	1	2	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	Wetlands				NA	Dry heather	Grassland	Wetlands	3	1	3	
		Forestry	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	
		Peat cuts vs contour lines	Oblique				NA	Perpendicular	Oblique	Parallel	2	1	2	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	30
Max. possible	93
Hazard $_{0-1}$	**0.32**

Consequence factors	Value	Rating criteria				Rating value	Weighting	Score	Comment
		0	1	2	3				
Volume of potential peat flow	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	11
Max. possible	33
Consequences $_{0-1}$	**0.33**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.32	0.33	=	**0.11**

Table M- 19: Peat Stability Risk Assessment at PRA 3.

Peat Stability Risk Assessment (PSRA)

Carrig Wind Farm

Location:	**PRA 3**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	BMC
Completed by:	CE
Date:	Dec-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			9.3	6.4	7.8	11.3	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: 2.2m. Slope angle: 1.4º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g.	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No nearby TP
		Peat fibres across transition to	NA				NA	Yes	Partially	No	0	1	0	No nearby TP
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No nearby TP
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	Cutaway / Turbary				NA	-	Cutaway / Turbary	Machine cut	2	1	2	
		Peat cuts vs contour lines	Perpendicular				NA	Perpendicular	Oblique	Parallel	1	1	1	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Hazard $_{total}$	27
Max. possible	93
Hazard $_{0-1}$	**0.29**

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	1	2	3				
Volume of potential peat flow	Medium	NA	Small	Medium	Large	2	3	6	
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequences $_{total}$	14
Max. possible	33
Consequences $_{0-1}$	**0.42**

Risk rating

Risk		Action required
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.29	0.42	=	**0.12**

Table M- 20: Peat Stability Risk Assessment at PRA 4.

Peat Stability Risk Assessment (PSRA)

Carrig Wind Farm

Location:	**PRA 4**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	BMC
Completed by:	CE
Date:	Dec-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			179.0	51.2	144.6	89.0	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~0.4 m. Slope angle: 0.4º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g. tension	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No nearby TPs
		Peat fibres across transition to subsoil	NA				NA	Yes	Partially	No	0	1	0	No nearby TPs
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No nearby TPs
	Topography	General curvature downslope	NA				NA	-	Planar	Convex	0	1	0	Flat
		Distance to the convexity break (only if previous factor is Convex)	NA				NA	> 100 m	50 - 100 m	< 50 m	0	1	0	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	> 300				NA	> 300	200 - 300	< 200	1	1	1	
		Surface moisture index (NDMI)	0 - 96				NA	0 - 96	96 -135	135 - 174	1	1	1	
		Surface water	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry	NA				NA	Good growth	Fair	Stunted growth	0	1.5	0	
	Peat workings	Peat cuts presence	NA				NA	-	Cutaway / Turbary	Machine cut	0	1	0	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{total}$	21
Max. possible	93
Hazard $_{0-1}$	**0.23**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow	Small	NA	Small	Medium	Large	1	3	3	
Downslope hydrology features	NA	NA	Bowl / contained	Minor undefined watercourse	Valley	0	1	0	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$	9
Max. possible	33
Consequences $_{0-1}$	**0.27**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time supervision
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.23	0.27	=	**0.06**

Table M- 21: Peat Stability Risk Assessment at the SRA.

Peat Stability Risk Assessment (PSRA)

Carrig Wind Farm

Location:	**SRA**
Conditions:	**Undrained (U), undrained surcharge (US), drained (D), drained surcharge (DS)**
Inspected on:	May-23
Inspected by:	BMC
Completed by:	CE
Date:	Dec-23

Hazard factors			Value				Rating criteria				Rating value	Weighting	Score	Comment
			U	US	D	DS	0	1	2	3				
Factor of Safety			42.2	12.0	34.0	21.0	-	≥ 1.3	1.3 - 1.0	≤ 1.0	1	10	10	Peat depth: ~01m. Slope angle: 2º.
Secondary factors	Slide history	Distance to previous slides (km)	5 - 10				NA	5 - 10	< 5	On site	1	2	2	
		Evidence of peat movement (e.g.	NA				NA	-	-	Yes	0	2	0	
	Subsoil conditions (visible in trial pits)	Subsoil type	NA				NA	Gravel / Firm glacial till	Smooth rock	Soft sensitive clay	0	1	0	No nearby TPs
		Peat fibres across transition to	NA				NA	Yes	Partially	No	0	1	0	No nearby TPs
		Peat wetness					NA	Dry / Stands well	Slowly squeezing	Extremely wet / Undiggable	0	2	0	No nearby TPs
	Topography	General curvature downslope	Convex				NA	-	Planar	Convex	3	1	3	
		Distance to the convexity break (only if previous factor is Convex)	< 50 m				NA	> 100 m	50 - 100 m	< 50 m	3	1	3	
		Slope aspect (for high latitudes in northern hemisphere)	NA				NA	SW, S, SE	W, E	NW, N, NE	0	1	0	
	Hydrology	Distance from watercourse (m)	< 200				NA	> 300	200 - 300	< 200	3	1	3	
		Surface moisture index (NDMI)	96 -135				NA	0 - 96	96 -135	135 - 174	2	1	2	
		Surface water	Localised				NA	Localised	Ponded in drains	Springs	1	1	1	
		Evidence of piping (subsurface flow)	NA				NA	-	-	Yes	0	1	0	
		Significant surface desiccation (previous summer was dry?)	NA				NA	-	-	Yes	0	1.5	0	
		Existing drainage ditches	Down slope				NA	Down slope	Varied / Oblique	Across slope	1	1	1	
		Annual rainfall	< 1000 mm/yr				NA	< 1000 mm/yr	1000 - 1400 mm/yr	> 1400 mm/yr	1	1	1	
	Vegetation	Bush	NA				NA	Dry heather	Grassland	Wetlands	0	1	0	
		Forestry	Good growth				NA	Good growth	Fair	Stunted growth	1	1.5	1.5	
	Peat workings	Peat cuts presence	-				NA	-	Cutaway / Turbary	Machine cut	1	1	1	
		Peat cuts vs contour lines	NA				NA	Perpendicular	Oblique	Parallel	0	1	0	
	Existing loads	Roads	Solid				NA	Solid	-	Floating	1	1	1	
	Time of year for construction		Late Summer, Autumn				NA	Spring	Winter, Early Summer	Late Summer, Autumn	3	1	3	Wost case estimate

Hazard $_{total}$	32.5
Max. possible	93
Hazard $_{0-1}$	**0.35**

Hazard	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Consequence factors	**Value**	**Rating criteria**				**Rating value**	**Weighting**	**Score**	**Comment**
		0	**1**	**2**	**3**				
Volume of potential peat flow	Small	NA	Small	Medium	Large	1	3	3	No peat.
Downslope hydrology features	Minor undefined watercourse	NA	Bowl / contained	Minor undefined watercourse	Valley	2	1	2	
Proximity from defined valley (m)	> 500	NA	> 500	200 - 500	< 200	1	1	1	
Downhill slope angle	Horizontal	NA	Horizontal	Intermediate	Steep	1	1	1	
Downstream aquatic environment	Sensitive	NA	Non-sensitive	Sensitive	Drinking water supply	2	1	2	
Public roads in potential peat flow path	NA	NA	Minor road	Local road	Regional road	0	1	0	
Overhead lines in potential peat flow path	NA	NA	Phone lines	Electricity (LV)	Electricity (MV, HV)	0	1	0	
Buildings in potential peat flow path	NA	NA	Farm out-houses	-	Dwelling	0	1	0	
Capability to respond (access and resources)	Fair	NA	Good	Fair	Poor	2	1	2	

Consequences $_{total}$	11
Max. possible	33
Consequences $_{0-1}$	**0.33**

Consequences	
0.0 - 0.3	Negligible
0.3 - 0.5	Low
0.5 - 0.7	Medium
0.7 - 1.0	High

Risk rating

Risk		**Action required**
0.00 - 0.20	Negligible	Normal site investigation
0.20 - 0.40	Low	Targeted site investigation, design of specific mitigation measures. Part time supervision during construction.
0.40 - 0.60	Medium	Avoid construction in the area if possible. If unavoidable, detailed site investigation and design of specific mitigation measures. Full time
0.60 - 1.00	High	Avoid construction in this area.

Risk rating =	Hazard *	Consequences		
Risk rating =	0.35	0.33	=	**0.12**

GLOBAL PROJECT REACH

Offices

Dublin (Head Office)
Gavin & Doherty Geosolutions
Unit A2, Nutgrove Office Park
Rathfarnham
Dublin 14, D14 X627
Phone: +353 1 207 1000

Belfast
Gavin & Doherty Geosolutions (UK) Limited
Scottish Provident Building
7 Donegall Square West
Belfast, BT1 6JH

Edinburgh
Gavin & Doherty Geosolutions (UK) Limited
21 Young Street
Edinburgh
Scotland, EH2 4HU

Rhode Island
Gavin & Doherty Geosolutions Inc.
225 Dyer St, 2nd Floor
Providence, RI 02903
USA

Bath
Gavin & Doherty Geosolutions (UK) Limited
The Guild High Street, Bath
Somerset
BA1 5EB

Cork
Gavin & Doherty Geosolutions
Unit 4E, Northpoint House,
North Point Business Park
Cork, T23 AT2P

London
Gavin & Doherty Geosolutions (UK) Limited
85 Great Portland Street, First Floor
London
W1W 7LT

Utrecht
Gavin & Doherty Geosolutions
WTC Utrecht, Stadsplateau 7
3521 AZ Utrecht
The Netherlands

Website: www.gdgeo.com
Email: info@gdgeo.com