APPENDIX 8-1

Peat Stability Risk Assessment-
Proposed Offsetting Lands

GDG
GAVIN & DOHERTY
GEOSOLUTIONS

Taurbeg WF Proposed Lifetime Extension Offsetting Measures– Peat Stability Risk Assessment (PSRA)

Client	**MKO**
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DISCLAIMER

REVISION SUMMARY

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01	13/03/2025	All	Revision to address client comments
02	07/05/2025	All	Revision to address final client comments
03	27/06/2025	Al	Revision to address project terminology

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EXECUTIVE SUMMARY

MKO commissioned Gavin and Doherty Geosolutions (GDG) to undertake a Peat Stability Risk Assessment (PSRA) for the Proposed Offsetting Measures, located in Coom, Co. Kerry, as part of the proposed extension of operational life of the Taurbeg Wind Farm in County Cork. The Proposed Offsetting Lands, which mainly comprise commercial forestry, are located near Mount Eagle Wind Farm in Co. Kerry, refer to Appendix A for the site location. The proposed works comprise deforestation of the commercial forestry to create areas of optimized hen harrier habitat.

The purpose of this report is to outline the potential for peat instability at the Proposed Offsetting Lands and to outline a quantitative peat stability risk assessment rating in line with the *Energy Consents Unit Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments* (ECUBPG, Scottish Government, 2017) for the proposed deforestation works.

The peat stability risk assessment findings showed that the Proposed Offsetting Lands have an acceptable margin of safety and low risk of peat failure and is suitable for the Proposed Offsetting Measures.

Consultation with published GSI maps and the observations from site investigations indicate that significant areas of the Proposed Offsetting Lands consist of commercially afforested blanket peat. Peat is mapped across the lands, with recorded peat thicknesses ranging from 0.2m to 3.2m across the lands, with an average peat depth of 1.6m recorded. In total 23% of recorded peat thicknesses were under 1m, and 72% were under 2m.

A desk study, site walkovers, ground investigation campaigns, stability analyses and a risk assessment were carried out to assess the potential for peat instability within the Proposed Offsetting Lands. 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 walkover inspections and peat probe campaign were carried out over a larger search area, to assess peat stability risk across the local area immediately adjacent to the Proposed Offsetting Lands, in particular those areas in the immediate vicinity of the existing peat landslides.

Two large peat landslides have been identified as having occurred within 500m of the Proposed Offsetting Lands. The site walkovers, stability analyses and risk assessment findings suggest that the Proposed Offsetting Measures will not increase the current risk profile in the area.

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 the Proposed Offsetting Lands' environment.

Three small areas, referred to as safety buffer (see Appendix L), has been highlighted and will have restricted habitat enhancement activities. A total of 18 areas across the Proposed Offsetting Measures have been identified as Felled Material Restriction areas and should not be used to place felled material.

1 INTRODUCTION

1.1 BACKGROUND

Gavin and Doherty Geosolutions (GDG) was commissioned in October 2024 by MKO to undertake a Peat Stability Risk Assessment (PSRA) for the Proposed Offsetting Lands, located in Coom, Co. Kerry, as part of the proposed extension of the operational life of the Taurbeg Wind Farm in County Cork, hereafter referred to as "the Proposed Offsetting Measures". Refer to Appendix A for the Proposed Offsetting Lands location. The proposed works comprise the deforestation of commercial forestry to create areas of optimized hen harrier habitat.

1.2 STATEMENT OF AUTHORITY

GDG has been involved in many Peat Stability Risk Assessment projects in both Ireland and the UK at various stages of development, i.e. preliminary feasibility, planning, 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.

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

- **Paul Quigley – Project Director**. Paul is a Chartered Engineer with over 28 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 gained extensive experience working in developments on peatlands, including the Corrib Gas Terminal, wind farm development and linear infrastructure such as roads, rail, gas pipeline, etc. 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.
- **Tim O'Shea.** Tim holds an honours degree in Civil and Environmental Engineering from University College Cork and is a Chartered member of Engineers Ireland. He has over 20 years post graduate experience in Civil Engineering. Tim is experienced in onshore wind right through the development and delivery cycle from consenting through to construction. He has worked on the EIA for a number of windfarms on upland peat sites. He has also managed the detailed design of a number of windfarms with significant peat risk.
- **Chris Engleman**. Chris is a Professional Geologist with a Master's degree in Geological Sciences from the University of Leeds. He is chartered with the Institute of Geologists Ireland (IGI) and European Federation of Geologists. He has five 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 (particularly Peat Stability Risk Assessments) 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 is the primary author of this report. Chris carried out peat probing, site walkovers, and supervised site investigation works at the Proposed Offsetting Lands in 2024.

- **Johan Van Niekerk**. Johan is a Senior Design Engineer who is part of GDG's Infrastructure team. He holds a Bachelor's degree in civil engineering and an Honours degree in Geotechnical engineering, both from the University of Pretoria. Johan has upward of seven years' experience in civil design and construction, and has been with GDG since 2023. Expertise includes 3D modelling, numerical analysis, ground investigations and earthworks design. Johan carried out peat probing at the Proposed Offsetting Lands in 2024.
- **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 Offsetting Lands in 2024.
- **Sowmya Reddy Gudipati**. Sowmya is a graduate engineer at GDG. She has two years of post-graduate experience working in the environmental, civil engineering, and renewables sectors. Sowmya has worked on multiple onshore wind and solar farm projects in the UK and Ireland. Sowmya carried out peat probing at the Proposed Offsetting Lands in 2024 and contributed sections to the desk study of this assessment.

1.3 PROPOSED PROJECT

The Proposed Project is described in detail in the EIAR Chapter 4: Description of the Proposed Project, and will consist of the lifetime extension of the existing Taurbeg Windfarm in North Cork and the Proposed Offsetting Lands.

This PSRA is restricted solely to the assessment of the Proposed Offsetting Measures. For the purposes of this PSRA, the Proposed Offsetting Lands has been divided into four areas, as shown in Figure 1-1, and in Figure A- 1 in Appendix A. Due to a lack of peat, Area 3 has screened out of this PSRA. As no works are proposed within the existing Taurbeg Wind Farm site, a PSRA has not been completed for the Proposed Lifetime Extension of the existing wind farm.

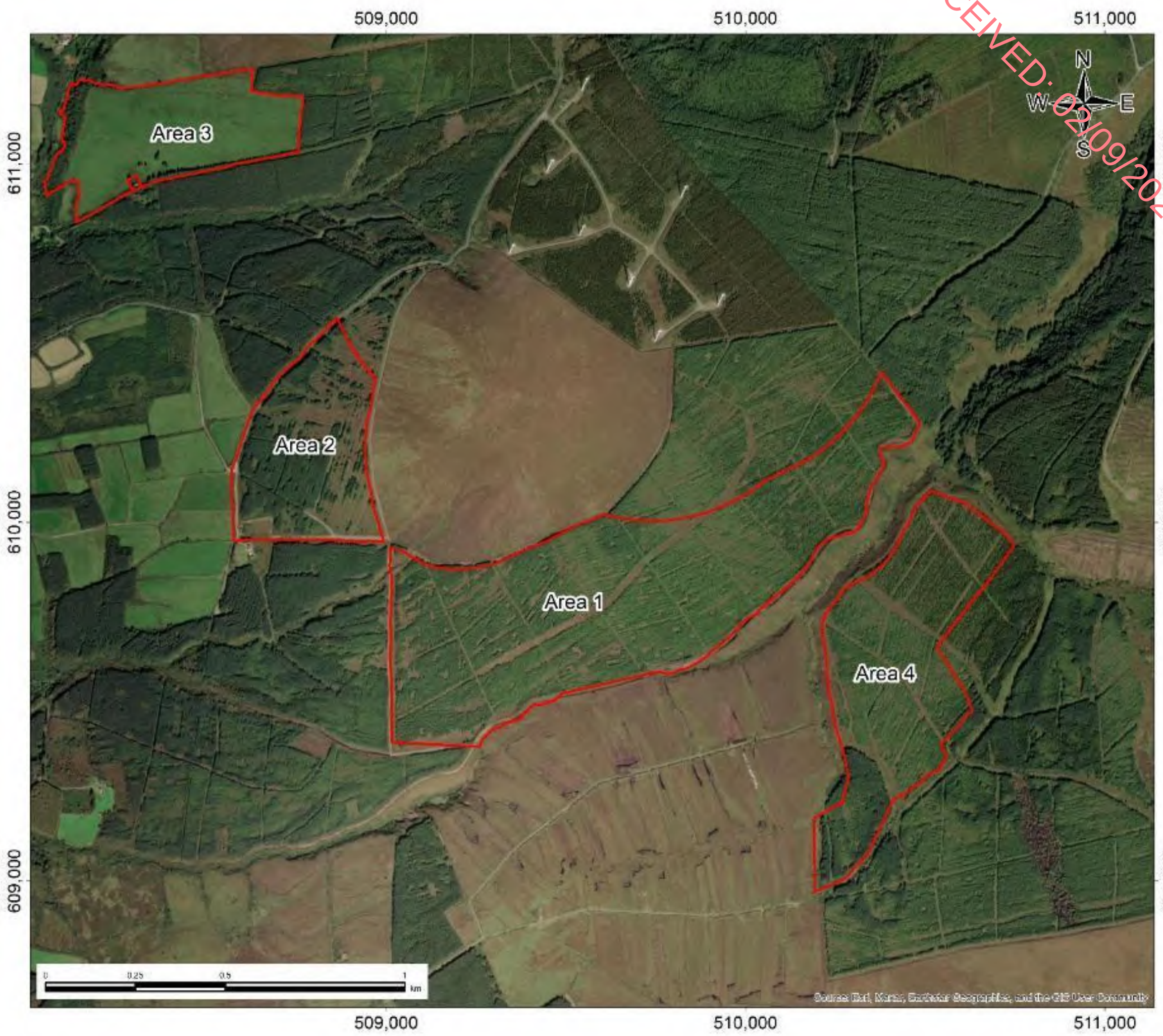

Figure 1-1: Proposed Offsetting Measures Location.

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. The term 'peat slide' is generally used to describe slab-like shallow translational failures (Hutchinson, 1988) with a shear failure mechanism operating within a discrete shear plane at the peat-substrate interface, below this interface, or more rarely within the peat body (Warburton et al., 2004). Peat landslides are commonly recorded in Ireland, Scotland, Wales and England. The term 'bog burst' has been used to describe particularly fluid failures involving rupture of the peat blanket surface or margin due to subsurface creep or swelling, with liquefied basal material expelled through surface tears followed by settlement of the overlying mass (Hemingway and Sledge, 1941-46; Bowes, 1960). Bog bursts are reported almost exclusively in the Republic of Ireland and Northern Ireland.

There is a significant degree of overlap in failure mechanisms and characteristics between these two broad groups. As a result of this, a formal, systematic classification scheme for peat landslides was developed by Dykes and Warburton (2007). This classification scheme is based on a comprehensive database of examples collated from the literature and field studies. The classes of peat landslide reflect:

- The type of peat deposit (raised bog, blanket bog, or fen bog);
- Location of the failure shear surface or zone (within the peat, at the peat-substrate interface, or below);
- Indicative failure volumes;
- Estimated velocity; and
- Residual morphology (or features) left after occurrence.

Descriptions of the failure mode, characteristic slope range and peat thickness of each type are provided in Table 1-1.

Table 1-1: Peat landslide types (after Dykes and Warburton, 2007).

Peat landslide type	Definition	Typical slope range	Typical peat thickness
Bog burst	Failure of a raised bog (i.e. bog peat) involving the break-out and evacuation of (semi-) liquid basal peat.	2 – 5˚	2 – 5m
Bog flow	Failure of a blanket bog involving the break-out and evacuation of semi-liquid highly humified basal peat from a clearly defined source area	2 – 5˚	2 – 5m
Bog slide	Failure of a blanket bog involving sliding of intact peat on a shearing surface within the basal peat.	5 – 8˚	1 – 3m
Peat slide	Failure of a blanket bog involving sliding of intact peat on a shearing surface at the interface between the peat and the mineral substrate material or immediately adjacent to the underlying substrate.	5 – 8˚ (inferred)	1 – 3m (inferred)
Peaty debris slide	Shallow translational failure of a hillslope with a mantle of blanket peat in which failure occurs by shearing wholly within the mineral substrate and at a depth below the interface with the base of the peat such that the peat is only a secondary influence on the failure.	4.5 – 32˚	< 1.5m

Peat landslide type	Definition	Typical slope range	Typical peat thickness
Peat flow	Failure of any other type of peat deposit (fen, transitional mire, basin bog) by any mechanism, including flow failure in any type of peat caused by head-loading.	Any of the above	Any of the above

1.4.2 Proposed Offsetting Measures

The slope angles at the Proposed Offsetting Lands vary from 0.3° to 41°, with an average of 7°. The lands are generally upland, with afforested blanket peat on hill slopes. The topography is discussed in further detail in Section 2.6. Evidence of large past landslides has been identified immediately adjacent to the proposed lands and the near surroundings on the available Google Earth imagery (available from 2010 onwards) and was confirmed during the fieldwork. Additional evidence for potential past relict instability has been identified in the southern portion of the lands and is discussed further in Section 4.3. There is an additional risk that historic landslides may not be identifiable, as 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 afforestation/deforestation) may hamper the identification of possible landslides.

1.4.3 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.

1.4.4 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 Offsetting Measures 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 works on peatlands.

Figure 1-2 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;
   - Artificial Drainage;
   - Land cover and land use; and

- Rainfall

2. Relevant academic literature and publications. Undertaking a walkover and fieldwork to:
   - Carry out geo-investigations including peat probing and hand shear vane testing;
   - 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 mitigation of any identified peat stability risks.

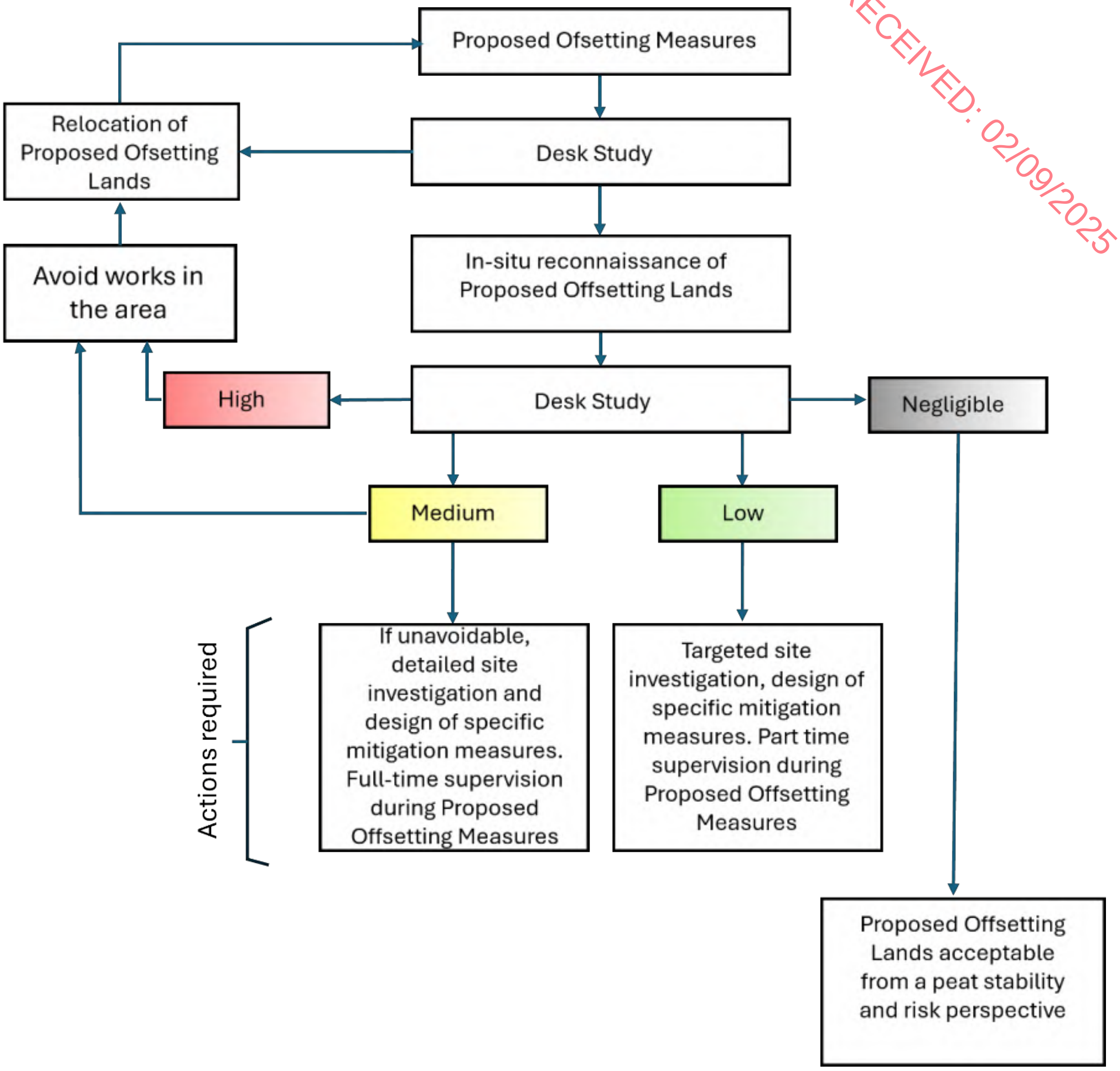

Figure 1-2: Workflow of the PSRA methodology for the acceptability of the Proposed Offsetting Measures (adapted from Scottish Executive, 2017).

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. Artificial Drainage;
10. Land cover and land use;
11. Rainfall;
12. Special areas of Conservation and Special Protection Areas; and
13. Relevant academic literature and publications.

2.1 GEOLOGY

2.1.1 BEDROCK GEOLOGY

Geological Survey Ireland (GSI) 1:100,000 scale bedrock mapping shows the Proposed Offsetting Lands and surrounding area to be underlain majorly by, Glenoween Shale Formation (GN) and Feale Sandstone Formation (FS), which is Upper Carboniferous in age (Namurian).

The lithology of the Glenoween Shale Formation is characterised by dark grey silty mudstone, sandy shales and fine-grained sandstone. The lithology of the Feale Sandstone formation comprises sandstone, siltstone and shale. The thickness of these Namurian shales ranges between 1m – 10m. The rock strata in the area are strongly folded with bedding dips between 20°-80° in both N/NE and S/SE directions. Site walkovers indicate that bedrock outcrops in topographic highs of the lands. The main bedrock unit and associated structural features within the Proposed Offsetting Measures boundary and surrounding area are shown in Figure B- 1.

2.1.2 QUATERNARY SEDIMENTS

The map of Quaternary sediments at 1:50,000 scale shown in Figure B- 2 in Appendix B (GSI, 2024) shows that the Proposed Offsetting Lands are underlain by afforested blanket peat, with Tills derived from Namurian sandstones and shales present along the far western margin of Area 2. Glacial till typically comprises a heterogeneous mix of sand, gravel, cobbles, and boulders, usually held in an overconsolidated clay matrix. This till classification indicates that the glacial tills are likely locally derived from the underlying Namurian age bedrock.

2.2 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 Offsetting Lands are mapped as containing soils classified as Blanket Peat (peaty). EPA/Teagasc mapping indicates that peaty soils dominate most of the lands with small parcels of Tills, derived from Namurian rocks located in the north and southwestern peripheries (Soil classification 1130a). GSI mapping indicates that in general, soils within the Proposed Offsetting Lands are poorly draining and display acidic mineralisation due to the prevalence of peat. The depth and extent of peat deposits may vary over short distances as a function of local underlying geology, past and ongoing geomorphological progression and management history.

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 2.12.

2.3 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 Offsetting Measures. 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 2.3-1 (Gao, 1996):

NDMI = (Band 5[2] – Band 6[3]) / (Band 5 + Band 6) **Equation 2.3-1**

Figure D- 1 in Appendix D illustrates the levels of estimated soil moisture across the Proposed Offsetting Lands 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 area as a whole displays a high moisture content.

2.4 Hydrogeology

2.4.1 Groundwater Bodies

According to GSI's groundwater map viewer, the Proposed Offsetting Lands are entirely underlain by the Scartaglin and Abbeyfeale groundwater bodies (GWB), (ID: IE_IE_SW_G_073) and (IE_SH_G_001). This GWB in relation to the Proposed Offsetting Measures boundary and surrounding area is shown in Figure E- 1.

The Scartaglin and Abbeyfeale GWB covers much of eastern Co. Kerry and comprises a total area of 472 km^2 and 935 km^2.

The Scartaglin and Abbeyfeale GWB are dominated by rock units from the Namurian undifferentiated group and large areas of Namurian sandstones, siltstones and shales. The GWB is described as low permeability with localised zones of enhanced permeability (GSI, 2003).

[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)

Aquifer units may be both confined and unconfined depending on local subsoil conditions. In general, groundwater flow will be concentrated in the upper part of the aquifers, approximately 10-15m below ground level (bgl). Static groundwater levels are often 1-7m bgl. The main discharges are to small streams crossing the aquifers. Local unconfined flow directions are oblique to the surface water channels and overall flow is westwards.

The Scartaglin and Abbeyfeale GWB is characterised as having a 'PP' – poorly productive flow regime (GSI, 2000a) and is not designated as a Groundwater-Dependent Terrestrial Ecosystems (GWDTE).

Groundwater body status for the 2015 – 2018 period is designated as 'Good' overall for both GWBs, passing both quantitative and chemical status requirements under the Water Framework Directive (WFD) 3rd cycle assessment. Groundwater body risk status for the same assessment period is currently designated as 'Not at risk'.

2.4.2 Aquifer Types

The bedrock aquifer type within the Proposed Offsetting Measures boundary and surrounding area is shown in Figure E- 2.

According to GSI's groundwater map viewer, bedrock directly underlying the lands is categorised as a Locally Important (LI) Aquifer Bedrock. This is defined as "Bedrock which is Moderately Productive only in Local Zones". This means groundwater flow occurs predominantly through fractures, fissures and joints, giving a low fissure permeability which tends to decrease with depth. Flow paths are thought to be between 30 – 300m in length and locally important aquifers are generally capable of yielding enough water to supply single domestic wells only (GSI, 2017). The bedrock aquifer has been categorised as a member of the 'Namurian Undifferentiated (NU)' Rock Unit Group (RUG).

The regional groundwater flow direction in the aquifer will be westwards towards the Atlantic Ocean (2000a).

Localised groundwater flow paths within the Proposed Offsetting Lands will follow the orientation of surface water sub-catchments from topographic highs to lower elevation discharge points. Shallow groundwater in the south of the lands will flow in the direction of the River Clydagh (Figure H- 1).

2.4.3 Subsoil Permeability

Subsoil permeability classifications within the Proposed Offsetting Measures boundary and surrounding area are presented in Figure E- 3.

Areas of 'Low' permeability, are mapped across the central and Northeast, South, and Southeast areas of the lands where Peat deposits are slightly thicker. Areas towards the Northwest and centre have been mapped as 'Medium' permeability.

There are no superficial aquifers located within or adjacent to the Proposed Offsetting Measures boundary, although it is possible that localised perched groundwater is present at the base of peat deposits and within granular layers/ lenses within the glacial till matrix.

2.4.4 Groundwater Vulnerability

Groundwater vulnerability in Ireland, as defined in the Water Framework Directive – Recharge and Groundwater Vulnerability, is a function of the thickness and permeability of the subsoil that overlies bedrock. These factors strongly influence the attenuation processes and the time it takes for contamination to be released into the subsurface.

Groundwater vulnerability classifications within the Proposed Offsetting Lands and surrounding area are presented in Figure E- 4.

The Proposed Offsetting Lands exhibit a mixture of ‘Extreme’ and High – Moderate groundwater vulnerability.

Due to the localised variability on-site, based on the site walkover, the ground vulnerability is expected to vary across the lands between ‘Extreme – Moderate’.

2.5 Multitemporal Aerial/Satellite Imagery

The aerial / satellite imagery used for this report is the OSI Geohive viewer (1995 onwards), and the Google Earth multitemporal imagery (2012 onwards - Figure 2-1 to Figure 2-5). This imagery has been used to:

- 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;

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

As discussed further in Section 2.7 and Section 4 below, two large existing peat landslides are identified in close proximity to the Proposed Offsetting Lands. Based on the available Google Earth imagery, the earlier slide (referred to as ME-A) occurred between 2012 and 2018. The second slide (ME-B) occurred in November 2020 (Fehiliy Timoney/GSI, 2024). A summary of the observations from the multitemporal imagery is given in Table 2-1.

Figure 2-1: Proposed Offsetting Lands Google Earth imagery (2011).

Figure 2-2: Proposed Offsetting Lands Google Earth imagery (2012).

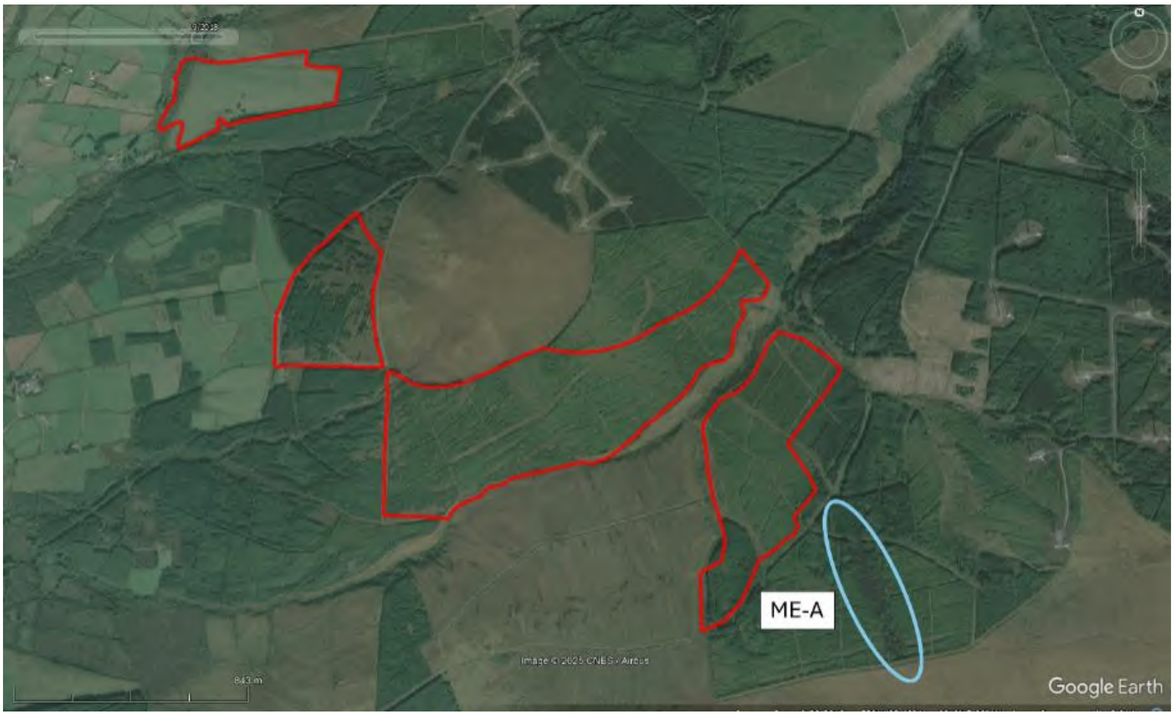

Figure 2-3: Proposed Offsetting Lands Google Earth imagery (2018). ME-A failure visible in the south of the image.

Figure 2-4: Proposed Offsetting Lands Google Earth imagery (2021). ME-A and ME-B failures visible in the south of the image.

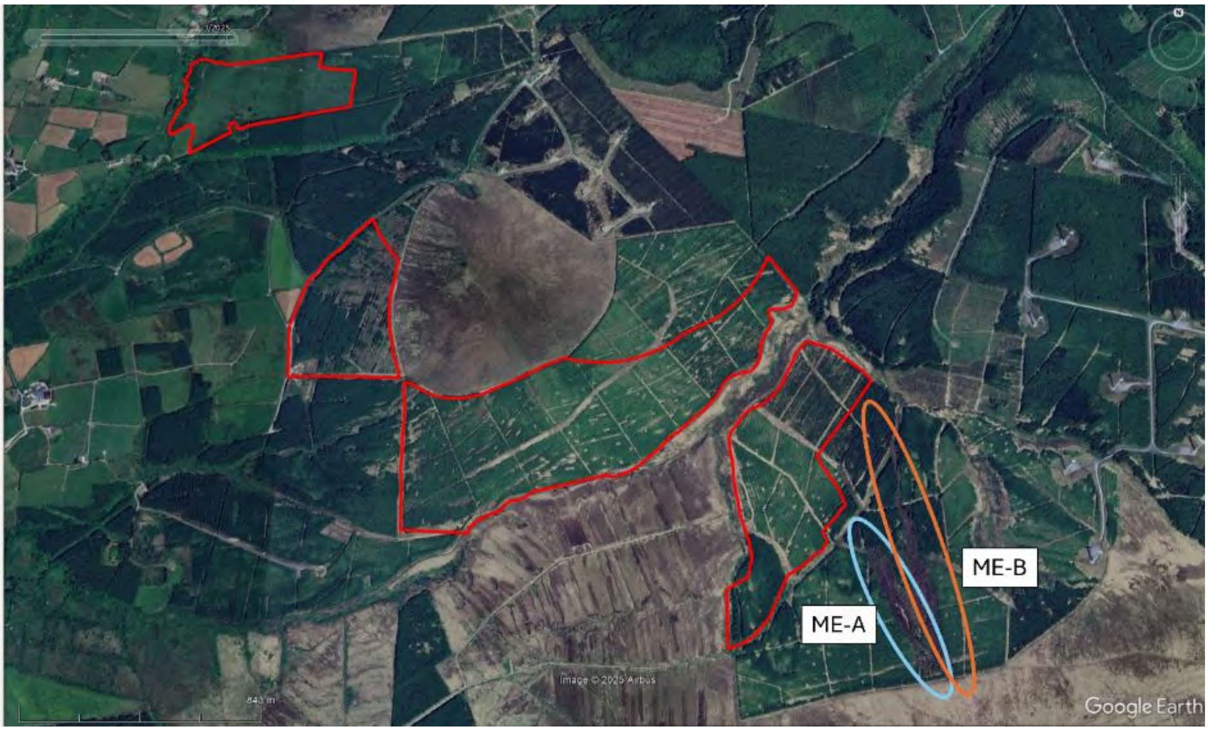

Figure 2-5: Proposed Offsetting Lands Google Earth imagery (2023). ME-A and ME-B failures visible in the south of the image.

Table 2-1: Review of historic land use from multitemporal aerial imagery.

Year	Source	Comment
1995	OSI	Rill drains and initial forestry planation in place in Area 4.
1996	OSI	Drainage network and initial forestry planation in place in Area 1 and Area 2
2001	OSI	Immature forestry visible in Areas 1, 2 and 4.
2006	OSI	Areas 1,2 and 4 covered in forestry plantation. No visible evidence of peat failure within the Proposed Offsetting Measures. Evidence of forestry works or potential die back in Area 2.
2011	Google Earth	Areas 1,2 and 4 covered in forestry plantation. No visible evidence of peat failure within the Proposed Offsetting Measures
2012	Google Earth	Areas 1,2 and 4 covered in forestry plantation. No visible evidence of peat failure within the Proposed Offsetting Measures
2018	Google Earth	Areas 1,2 and 4 covered in forestry plantation. ME-A peat failure visible.
2021	Google Earth	Areas 1,2 and 4 covered in forestry plantation. ME-A and ME-B peat failures visible.
2023	Google Earth	Areas 1,2 and 4 covered in forestry plantation. ME-A and ME-B peat failures visible.

2.6 TOPOGRAPHY

A Digital Elevation Model derived from a Bluesky LiDAR survey was used for the topographical analysis and is presented in Figure F- 1.

The Proposed Offsetting Lands topography is characterised by undulating hills. In the northwestern to southwestern portion, the ground elevation varies from approximately 421m AOD in the north to 321m AOD at Coom Hill in the south. Towards the northeast and southeast, the elevation ranges from 296m AOD, rising to 410m AOD near Mount Eagle Bogs. Across the central area of the lands, elevations range from 270m AOD in the west to 315m AOD in the east. Slope angles across the Proposed Offsetting Lands vary from 0.3° to 41°, with an average of 7° calculated (Figure F- 2).

2.7 SLOPE INSTABILITY MAPPING

Figure G- 1 illustrates the landslide susceptibility (GSI, 2016) across the Proposed Offsetting Measures boundary. This map was obtained by using an empiric probabilistic method at a regional scale and did provide input into site-specific scale engineering studies. The majority of the lands are mapped as a mixture of 'Moderately Low – High, with few areas mapped as 'low', especially along the river valley. Areas of 'High' susceptibility correspond to local topographic highs and locally steeper slopes.

The GSI landslide inventory records one landslide event roughly 200m to the southeast of the Proposed Offsetting Measures boundary on the 15th of November 2020 at 12:00 am. The event was named 'Knockfeha_2020' by the GSI and corresponds with landslide event ME-B outlined in Section 4 of this report. This existing landslide, along with an earlier event visible from aerial imagery (ME-A), located immediately to the west of the 2020 event, are described in more detail in Section 4, and are shown in Figure G- 2.

2.8 HYDROLOGY

According to the Ordnance Survey Ireland (OSi) shapefiles of rivers, lakes, and catchments/basins (Figure H- 1), the Proposed Offsetting Lands are located within the watershed of two catchments (Clydagh- Feale, and Shanowen). The central and southern points of the lands drain into the Clydagh River, which runs W-E through the centre of the lands, eventually draining to Feale and then to the Shannon. Western parts of Area 1 and Area 2 drain to the River Shanowen, which eventually drains to Dingle bay.

2.9 ARTIFICIAL DRAINAGE

Within the forestry plantations across the Proposed Offsetting Lands, there are numerous man-made drains, installed prior to planting to drain the peat. The locations of these drains are illustrated in Figure I- 1. The forestry plantations are generally drained by a network small (rill) drains, which vary from parallel to perpendicular to the contours, though are largely noted to be oblique to contours. The rill drains feed into collector, and eventually interceptor drains down slope of the forestry, with the majority of drains feeding into the Clydagh River.

Excavated firebreaks (approximately 5m in width) are visible on the upslope side of the forestry in the in the centre of the lands, and south of the Proposed Offsetting Measures boundary, and running downslope along the western boundary of the lands. These firebreaks would act as cut-off drains upslope of the forestry, likely connecting to the north-south trending drains within the forestry. It appears that the material excavated during construction of the firebreaks was deposited on the peat upslope of the firebreaks.

The rill drains appear to be spaced about 15m to 20m apart. Interceptor drains are generally located upgradient (cut-off drains) and down-gradient of forestry plantations. Interceptor drains are also located upgradient of existing forestry access roads.

2.10 LAND COVER AND LAND USE

Areas 1,2 and 4 of the Proposed Offsetting Lands currently consist of private coniferous plantation dating to 1995-1997, with forestry tracks traversing the lands. CORINE (2018) land use mapping (Figure J- 1) indicates that land use comprises almost entirely transitional woodland scrub, with Area 3 comprised of pastureland. Site walkovers conducted by GDG confirmed the presence of coniferous forestry and associated tracks.

2.11 Rainfall

Rainfall records from the Met Éireann rain gauge at Castleisland (Coom), roughly 1.3km SW of the Proposed Offsetting Lands (Figure K- 1), are available as far back as 1944, and have been examined as part of this assessment between 1945 and 2023 (the first and last complete years available), in Figure 2-6. The minimum recorded rainfall was 742mm, recorded in 1987, and the maximum recorded rainfall was 1865mm, recorded in 2008.

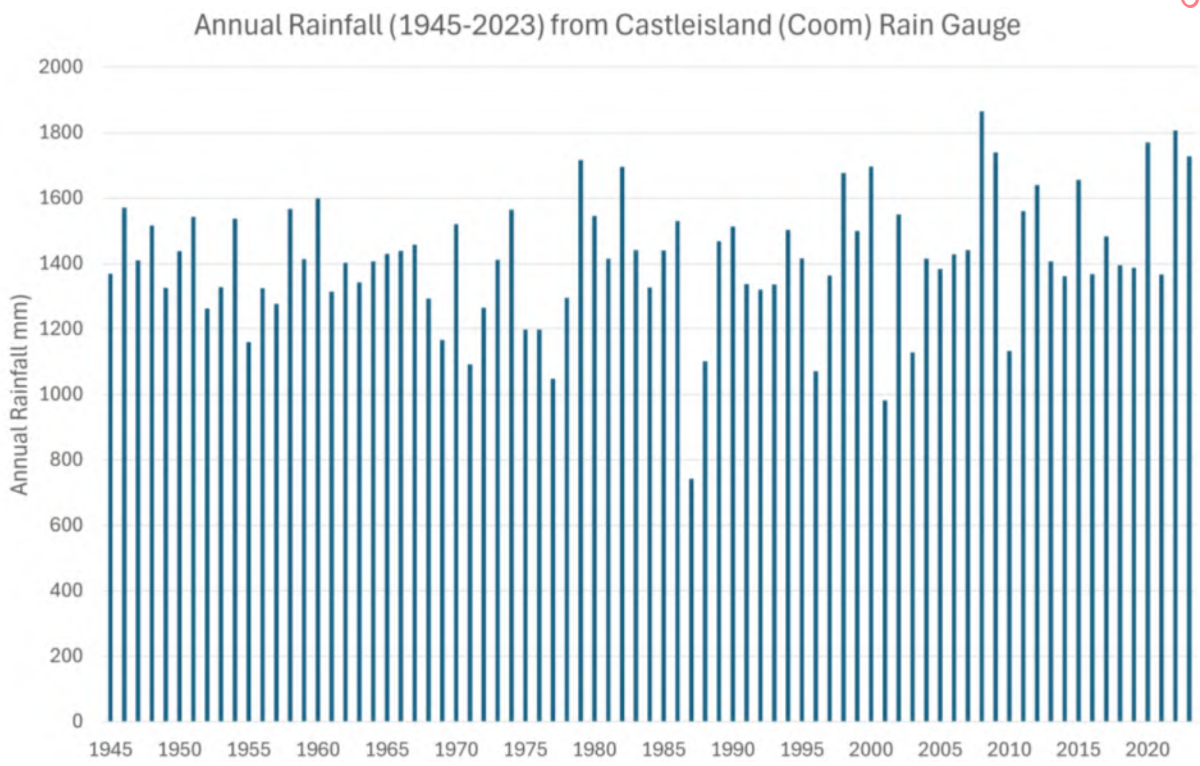

Figure 2-6: Annual rainfall records from Castleisland (Coom) rain gauge (1945-2023).

2.12 Special Areas of Conservation and Special Protection Areas

An overview of the Special Areas of Conservation (SAC) and Special Protection Areas (SPA) in the vicinity of the Proposed Offsetting Lands is illustrated in Figure K- 1.

2.12.1 Special Areas of Conservation

The Proposed Offsetting Lands are not located within an SAC. The areas of Proposed Offsetting Lands which drain to the river Clydagh (Figure H- 1) are located within the upper region of the River Shannon catchment that flows down to the Lower River Shannon SAC approximately 2km downstream of the Proposed Offsetting Lands. The Lower River Shannon SAC encompasses counties Clare, Cork, Kerry, Limerick, and Tipperary. This SAC supports several EU Habitats Directive listed habitats and species, including sandbanks, reefs, alluvial forest, otters, and river vegetation.

2.12.2 Special Protection Areas

The Proposed Offsetting Lands are located within Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA (004161), which is designated for Hen Harrier (Circus cyaneus). The open bog south of the conifer plantation in Area 4 is located within Mount Eagle Bogs NHA (002449) which is designated for protection of peatlands.

3 SITE RECONNAISSANCE

GDG conducted a site reconnaissance as part of the assessment, comprising peat probing and site walk-over inspections (October 2024), including a site walkover by a chartered geologist, to record geomorphological features concerning the Proposed Offsetting Lands, peat depths, and peat strength. The walkover inspections and peat probe campaign were carried out over a larger search area, to assess peat stability risk across the local area immediately adjacent to the Proposed Offsetting Lands, in particular those areas in the immediate vicinity of the existing peat landslides. As such, the peat probe campaign includes assessment of areas upslope of, and outside of the Proposed Offsetting Measures boundary. An indication of the site conditions is shown in Figure 3-1 and Figure 3-2. Access was limited to some areas, limiting the number of peat probes taken in areas of extremely dense forestry. Site walkovers conducted by MKO in January 2025 confirmed that peat is not present in Area 3 (Figure 3-3). The original site walkover and peat probing campaign targeted a larger area of Proposed Offsetting Lands. Following the initial phases of this assessment, the area of the current Proposed Offsetting Measures was selected.

The October 2024 GDG Peat probing campaign comprised of:

1) 214 no. peat probes
2) 16 no. Hand Shear Vane Tests

Within the Proposed Offsetting Lands, the October 2024 GDG Peat probing campaign included:

1) 107 no. peat probes
2) 4 no. Hand Shear Vane Tests

In summary, intrusive ground investigations were carried out at a total of 230 locations, including 111 locations within the Proposed Offsetting Measures boundary. The site investigation locations are presented in Figure L- 1 and Figure L- 2 in Appendix L, and considered the following criteria, based on the 2017 Scottish Best Practice Guidance:

- Distance between probe points to avoid interpolation of peat depths across large distances – a minimum 100m grid was maintained where access allowed, across the search area;
- Areas immediately adjacent to the existing peat landslides were targeted at a greater density than the remaining part of the Proposed Offsetting Measures;
- 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.

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 L- 3 in Appendix L.

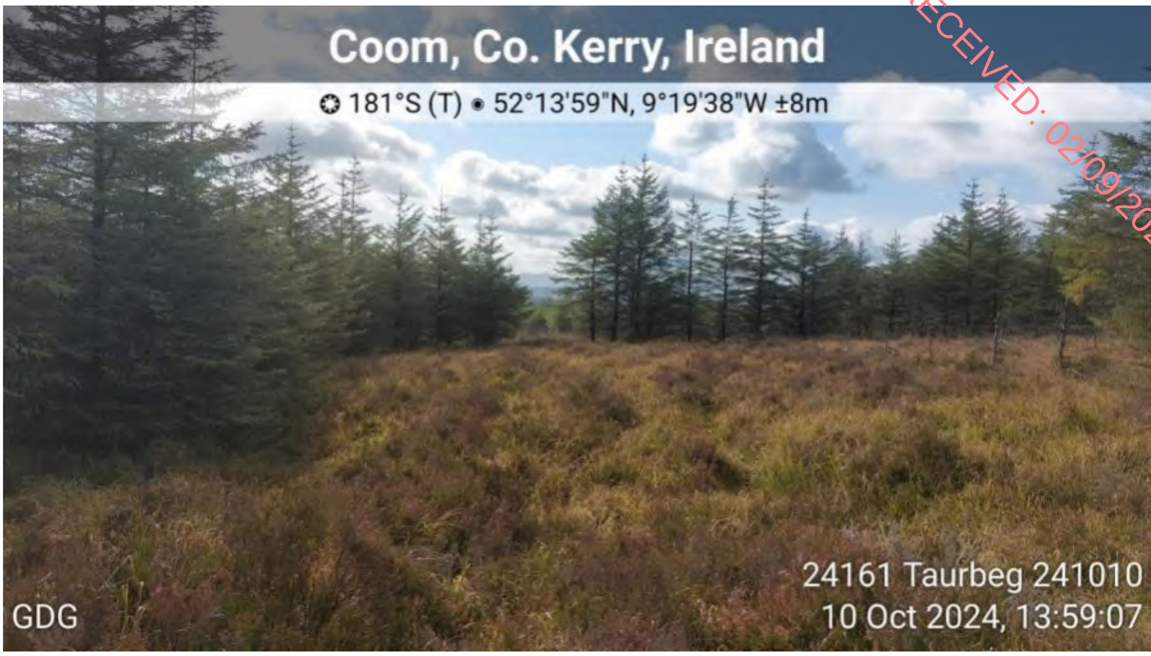

Figure 3-1: Afforested blanket peat from firebreak in Area 1 (refer to Appendix A for Site Location and key to Areas)

Figure 3-2: Afforested blanket peat from firebreak in Area 4

Figure 3-3: Mineral soils exposed at the edge of the forestry at the eastern edge of Area 3.

3.1 Ground Investigation Summary and Peat Conditions

3.1.1 Ground Investigation Summary

The ground conditions at the Proposed Offsetting Lands comprise a mixed upland environment, with extensive areas of upland blanket peat, afforested with coniferous forestry plantation over much of the lands. Site walkovers specifically targeted the areas adjacent to the existing peat landslides, in addition to covering the entire Proposed Offsetting Lands.

The peat thickness encountered by intrusive investigations varies up to a maximum of 3.8m, with a median of 1.7m recorded (Figure 3-4). Within the Proposed Offsetting Lands, the recorded peat thickness ranges from 0m to a maximum of 3.2m, with a median value of 1.6m recorded. In total, 23% of recorded peat thicknesses within the Proposed Offsetting Lands were under 1m, and 72% were under 2m.

Almost the entirety of the Proposed Offsetting Lands are covered in afforested blanket peat, with areas of open blanket peat observed to the north of the Proposed Offsetting Lands, approximately 350m south of the southern boundary. The frequency of different peat thicknesses is shown in Figure 3-4.

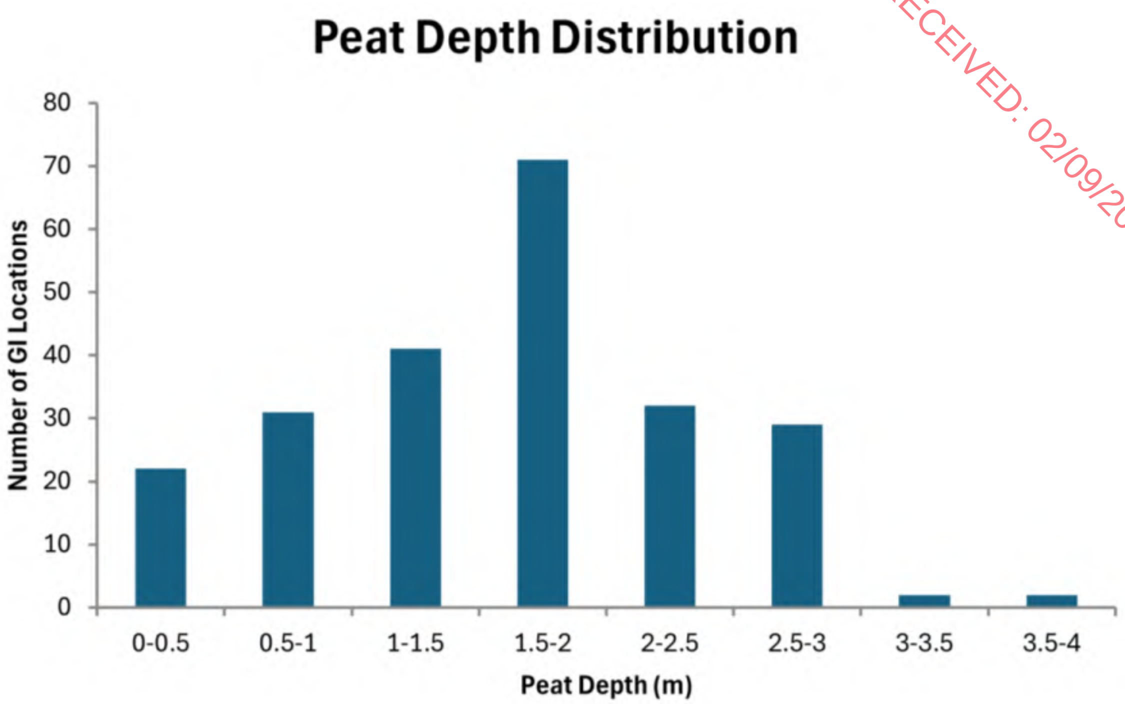

Figure 3-4: Histogram of peat depth frequency.

Hand shear vane tests (HSVs) were completed at 16 locations, of which four were located within the Proposed Offsetting Lands. A summary of the recorded values is provided in Table 3-1. The lowest undrained shear strength value recorded in the peat within the Proposed Offsetting Lands was 11kPa, recorded at 1.5m bgl in HSV5. In areas to the south of the Proposed Offsetting Lands, in proximity to the existing peat landslides (discussed in Section 4), a minimum value of 8kPa was recorded, along with a number of sites where the peat was too saturated for a reading to be taken (HSV14-HSV16, and HSV18.) Based on this available HSV data, a conservative value of 4kPa has been selected as the undrained shear strength value used in the peat stability calculations, as outlined in Section 6.3.

Table 3-1: Summary of hand shear vane test results

Location ID	Measured c_u (kPa)				Area	Notes
	0.5m BGL	**1m BGL**	**1.5m BGL**	**2m BGL**		
HSV3	20	12.5	15	-	Area 1	Lots of roots - roots could have influenced the strength at 0.5m depth
HSV5	16	16	11	-	Area 1	-
HSV6	35	21.5	22	-	Area 1	-
HSV7	14.5	12.5	16	-	Area 1	-
HSV9	21	13	22.5	-	15m S of Area 4	-
HSV10	10	16	14.5	-	300m S of Area 4	Dense grass, lot of roots - roots could have influenced the strength

HSV12	18	14	11.5	-	30m SE of Area 4	Peat was too saturated to make an accurate reading below 1.5m bgl
HSV13	32.5	27.5	-	-	140m SE of Area 4	Peat was too saturated to make an accurate reading below 1m
HSV14*	-	-	-	-	115m S of Area 4	**Peat was too saturated to make an accurate reading**
HSV15*	-	-	-	-	350m SE of Area 4	**Peat was too saturated to make an accurate reading**
HSV16*	-	-	-	-	580m SE of Area 4	**Peat was too saturated to make an accurate reading**
HSV17	14.5	12	17	22	385m SE of Area 4	Lots of roots - roots could have influenced the strength at 0.5m depth, but with depth increasing the peat was saturated
HSV18*	-	-	-	-	560m S of Area 4	**Peat was too saturated to make an accurate reading**
HSV 19	32.5	10	-	-	215m E of Area 2	Peat was too saturated to make an accurate reading below 1m
HSV 20	12	10.5	8	-	650m SE of Area 4	Lots of roots - roots could have influenced the strength at 0.5m depth
HSV 21	12	9.5	13	13.5	500m SE of Area 4	-

*Tests were carried out in saturated conditions, preventing an accurate reading from being taken.

3.1.2 Overview of Peat Conditions

The walkover indicated that the peat is heavily afforested with coniferous forestry plantation, with drains cut at varying angles, oblique to contours in places and perpendicular to contours in some locations. Despite the significant network of small drains located within the forestry, the peat was noted to be extremely wet, and saturated in numerous locations, particularly on the north-facing slope to the south of the Area 4 boundary. Sphagnum moss was observed growing across many of the fire breaks to the south of the Proposed Offsetting Measures boundary, indicating saturated conditions. Within the Proposed Offsetting Lands, evidence for saturated peat conditions was more limited, and the peat appeared to be more well-drained. This is supported by the HSV results outlined in Table 3-1, which indicate consistently higher undrained shear strength values within the Proposed Offsetting Lands, with no occurrences of locations being too saturated for a HSV test to be performed recorded within the boundary.

A large variation in the level of decomposition and humification was observed throughout the peat body. However, this generally appeared to increase with depth. The only locations where peat humification could be assessed were in those areas where peat was exposed in the vicinity of the existing peat landslides about 300m to the Southeast of the Proposed Offsetting Measures boundary. In these locations, peat appeared well humified and amorphous beneath the initial 30cm of more fibrous peat.

4 Assessment of Existing Peat Landslides

Two large peat landslides have been identified as having occurred immediately adjacent to the Proposed Offsetting Lands since 2012. These were first identified by Dykes (2021) and have been referred to in literature as the Mt Eagle Bog Landslides. The Mt Eagle Bog Landslides have also been assessed in detail by Fehiliy Timoney (FT)/Geological Survey Ireland (GSI, 2024). The exact dates of occurrence of these two landslides is unconfirmed, but the earlier event is known to have occurred between 27 March 2012 and 29 March 2019 (the dates of the Google Earth aerial images closest to it). The later event, identified by Dykes (2021) as KFM-20 (Knockanefune Mountain), and by FT/GSI as “the Mount Eagle Landslide” is better constrained by the Google Earth imagery, and is thought to have occurred in November 2020. To differentiate between the two failures for the purpose of this assessment, the pre-2019 event will be referred to as ME-A (Mt Eagle A), and the 2020 failure is referred to as ME-B (Mt Eagle B). The two failures occurred adjacent to each other, with ME-B occurring immediately to the east of ME-A, and slightly further upslope, with the runout zones overlapping. The source zone of ME-A is located a minimum distance of 150m to the east of the Proposed Offsetting Lands, while the source zone of ME-B is located a minimum of 280m to the southeast of the boundary. The runout from the ME-B event passes a minimum distance of 35m from the Proposed Offsetting Lands.

Dykes (2021) provided an assessment of the characteristics and potential failure mechanisms of ME-B based on publicly available Google Earth and drone aerial imagery, with brief reference to ME-A. GDG conducted an in-depth site walkover and peat probing campaign in the vicinity of both failures.

4.1 ME-A Landslide

4.1.1 Landslide Characteristics

The geometry of ME-A is generally, long and linear, with the source zone measured from Google Earth imagery at about 430m in length, with width varying ranging between 60-100m. The failure can be broken into three distinct sections (Figure 4-1). The head zone (the upper 90m) measures approximately 80m across and narrows to a ‘neck’ of approximately 60m for the next 70m. Below this, the source zone width increases to approximately 100m across the lower section, the main source zone (the remaining 270m). The slope angles across the failure vary from 3-7° in the upper 220m, to 7-11° in the lower 270m, with a convex break in slope approximately 220m below the head. The peat depths recorded around the margins of the ME-A failure indicate average peat depths of approximately 2.3m across the failure. The extents of the run-out zone from the ME-A landslide is uncertain, due to the long gap between aerial images, however assuming 2.3m of peat across the measures source area (approximately 32,600m^2), an approximate total peat failure volume of 75,000m^3 can be calculated.

The lower 270m of the failure (the main source zone), appears to have failed almost instantaneously, with almost complete evacuation of the peat across most of the area, with a large number of randomly distributed blocks floating on slurried catotelm peat throughout. In the October 2024 site walkovers, the mineral substrate was observed to be exposed within the central and downslope parts of the main source zone (Figure 4-2), although it appears from the earlier aerial imagery (Figure 4-10) that a thin layer of peat slurry initially covered much of the floor of the otherwise fully evacuated source zone. It is difficult to tell the condition of the basal peat from the aerial imagery, but these could reflect a basal sliding surface. The margins of the main source zone are fairly well defined, with some lateral fissures/tears extending into the forestry.

The area included within the narrow 'neck' (roughly 60m wide and 70m long, Figure 4-4), contains a large number of larger, more coherent peat rafts, with multiple trees. This area also shows less evidence of large scale sliding and lacks the large scale evacuation of peat slurry seen further downslope. This section of the failure coincides with a localised area of lower slope angle (3-5°), suggesting that this change in morphology can be attributed to greater basal sliding friction in this part of the slope. The area upslope of the 'neck' contains a large number of stranded peat rafts, arranged in a concentric, arcuate pattern at the head of the slide, but with a greater concentration of stranded rafts with significant peat evacuation around them. This area of reduced peat raft density coincides with an increase in slope angle, suggesting that this change in morphology can be attributed to reduced basal sliding friction in this part of the slope. The area at the head of the failure appears not to show evidence for significant evacuation of basal peat from above the arcuate peat rafts.

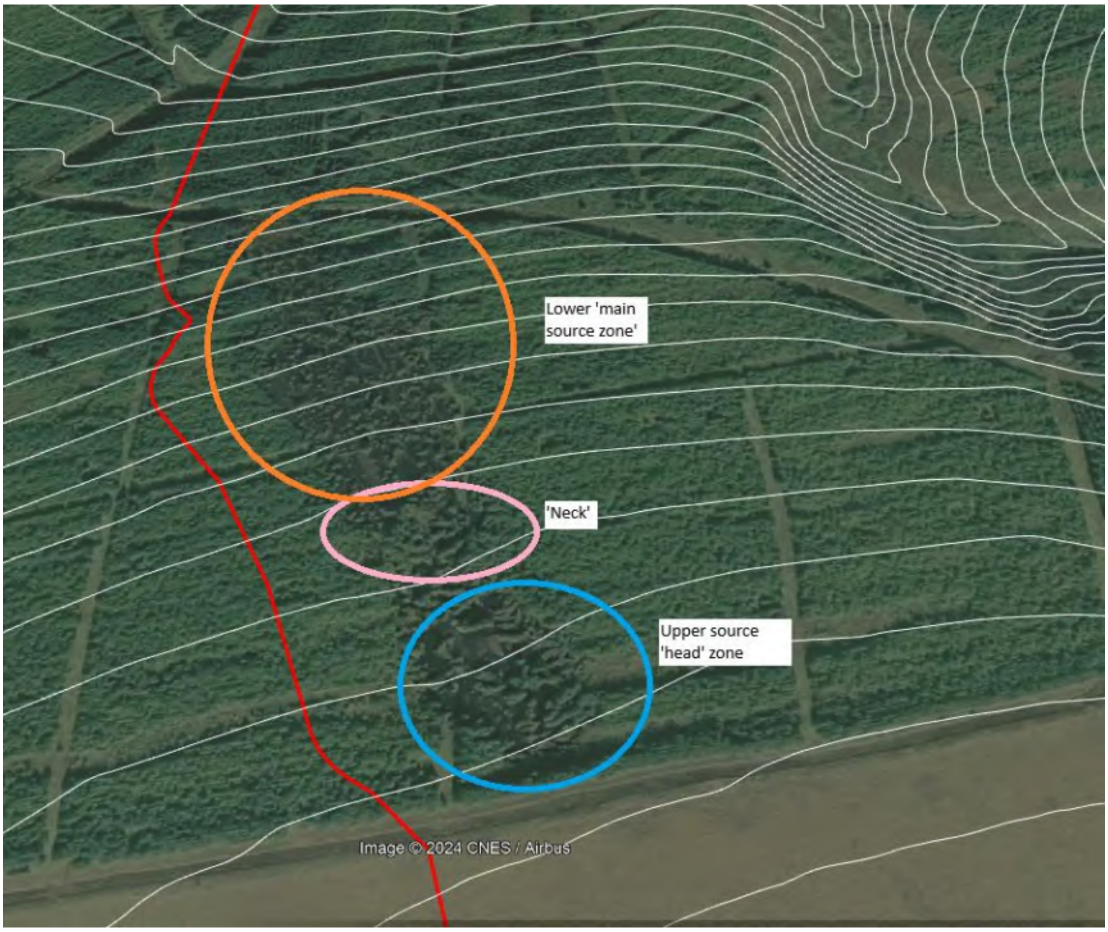

Figure 4-1: ME-A slide morphology (Google Earth, 2018).

Figure 4-2: View downslope of ME-A failure, with peat rafts and exposed substrate visible.

Figure 4-3: Peat raft at the western margin of ME-A.

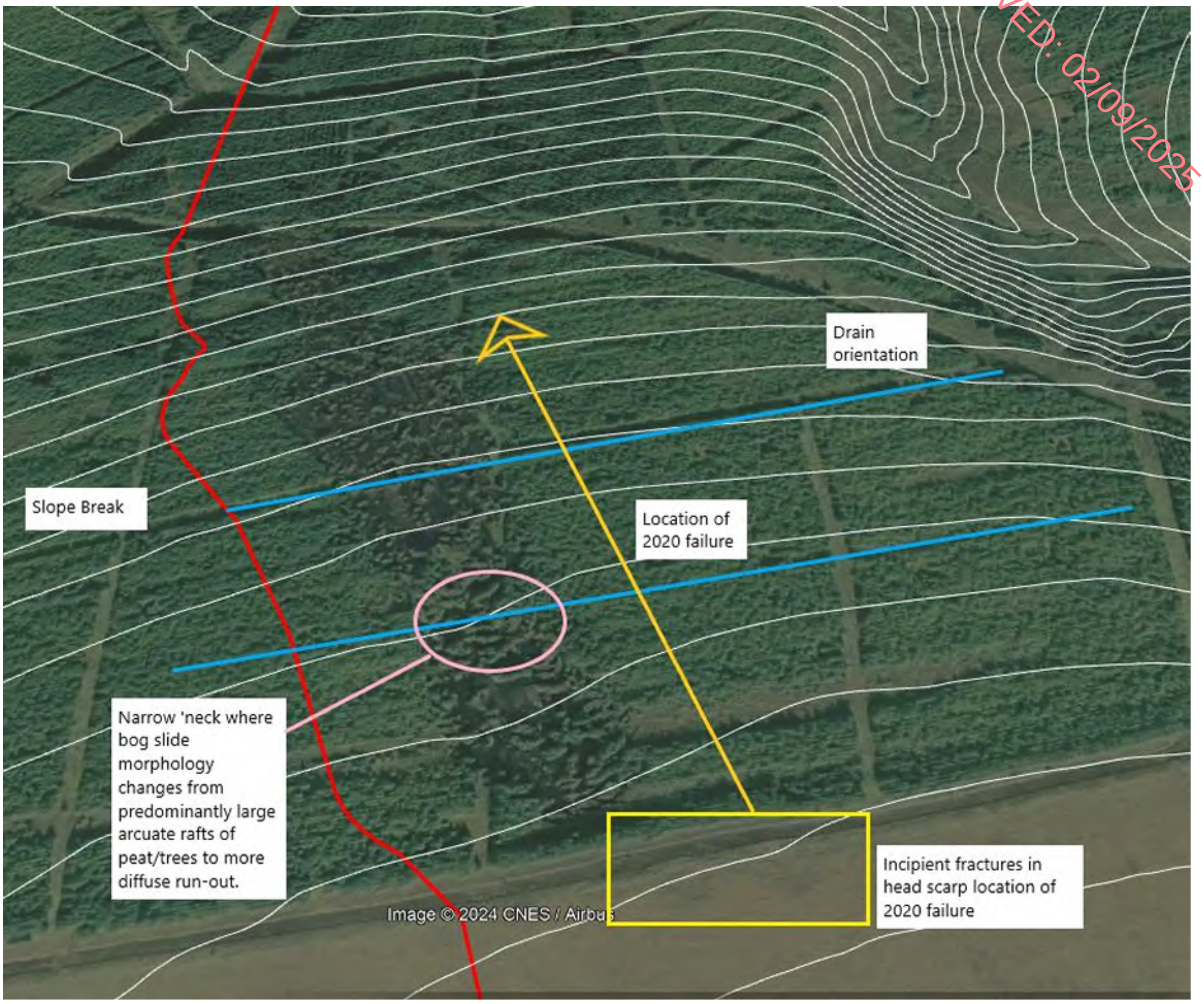

Figure 4-4: ME-A morphology, and incipient tension cracking at the future ME-B location (google Earth, 2018).

Based on the available evidence from aerial imagery and the site walkovers, it is determined that the ME-A failure should be classified as a bog slide (Table 1-1) defined by Dykes and Warburton (2007) as failure of a blanket bog (i.e. bog peat) involving sliding of intact peat on a shearing surface within the basal peat'. The failure appears to have occurred within the humified basal peat. The material is largely concentrated in rafts or blocks along the path, indicative of intact peat layers being displaced. The aerial imagery does not show evidence for extensive runout of liquefied peat in the ME-A event, and there is minimal lateral spreading visible, which suggests the movement is more confined. The failure margins are hard to identify clearly with the presence of the forestry, and with the eastern margin having been subsumed into ME-B. However, these margins appear to be fairly well-defined. The widening of slide footprint above the neck may also potentially indicate that this event proceeded as retrogressive translational failure extending uphill from the initial failure in the main source area, with larger, more coherent peat rafts upslope, suggesting an increase in basal friction at the 'neck'.

4.1.2 Conditioning Factors

The following contributing factors have been identified, which may have contributed to the initial failure of ME-A:

- Artificial drainage ditches have been cut parallel to contours, roughly perpendicular to the direction of failure across the source zone of the ME-A landslide (Figure 4-4). This may have the effect of focusing surface run-off water into a localised area of afforested blanket bog and leading to ponding of water in the vicinity of the source zone, leading to increased lubrication and increased buoyancy at the base of the peat profile. This is cited as a key factor by both Dykes (2020) and FT/GSI (2024).
- Areas of extremely wet, saturated peat were observed in the vicinity of the source zone. Hand shear vane readings taken during the 2024 GDG site walkovers recorded values as low as 8kPa, with some tests abandoned due the saturation of the peat. This indicates that areas in the vicinity of the failure experienced extremely low peat undrained shear strength.
- The presence of a slight convex break in slope at or close to the assumed failure initiation point has been identified from the available topographic data.
- The afforested and drained nature of the area is hypothesised to have contributed to disruption of the hydrological regime, and to have potentially exacerbated the impacts of the contour parallel drainage.

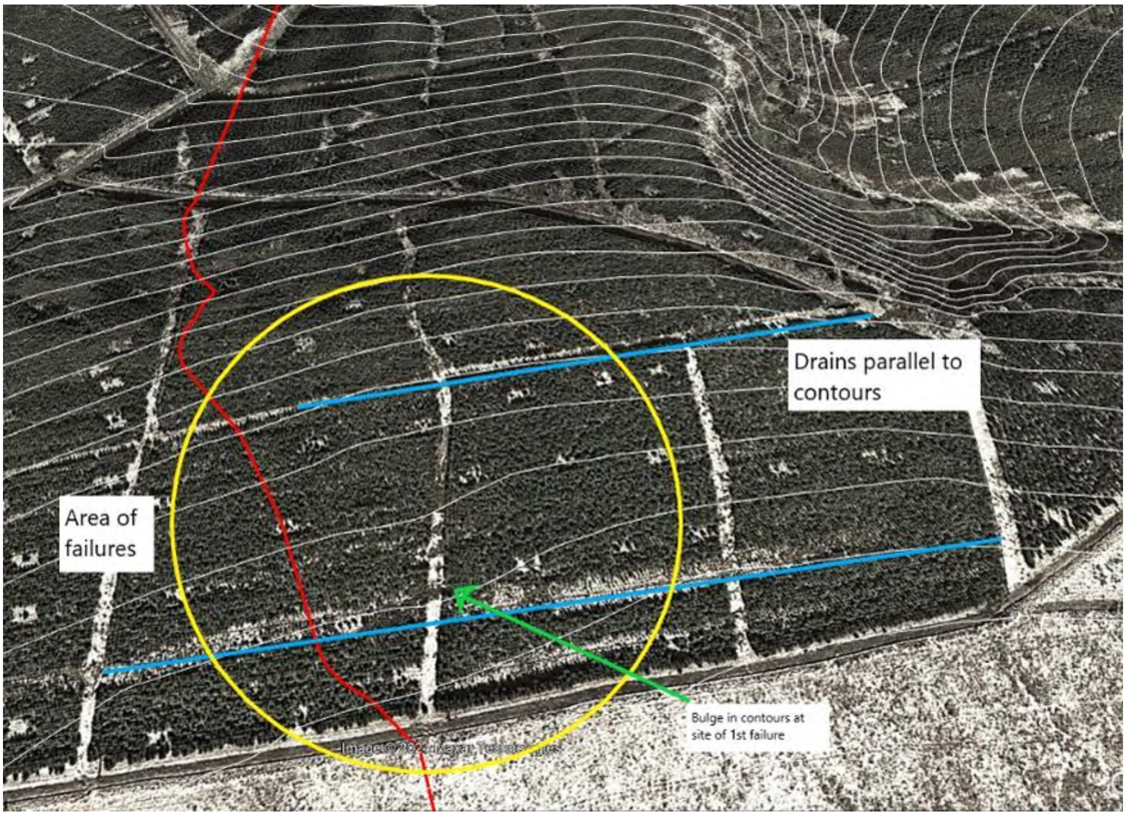

Figure 4-5: Drains cut parallel to contours in area of existing eat landslides (Google Earth, 2012).

4.1.3 Triggering Factors

No clear immediate trigger for the ME-A event has been identified. Due to the gap in available aerial imagery between 2013 and 2018, it is difficult to ascertain the precise timing of this failure.

4.2 ME-B Landslide

4.2.1 Landslide Characteristics

The Geometry of ME-B is broadly similar to ME-A, with this second failure having occurred directly adjacent to, and overlapping with the earlier event. The median peat depth recorded across the ME-B failure is 2.3m. The source zone was measured from Google Earth imagery at about 600m in length, with width varying ranging between 30-100m. The failure can be broken into three distinct sections (Figure 4-7). The head zone (the upper 150m) measures approximately 30-40m across and ends at the upslope margin in an arcuate, concentric set of tension cracks (Figure 4-6). Below this, the source zone width increases to approximately 60-100m across in the main source zone (the remaining 450m). Below this, the runout appears to have become more flow-like upon entering existing drainage channels, and to have split into two main runout zones of 750m and 500m in length, before entering a tributary of the River Clydagh. Existing drainage ditches are clearly visible in the aerial imagery, cutting across slope perpendicular to the failure long axis, and parallel to slope contours (Figure 4-10).

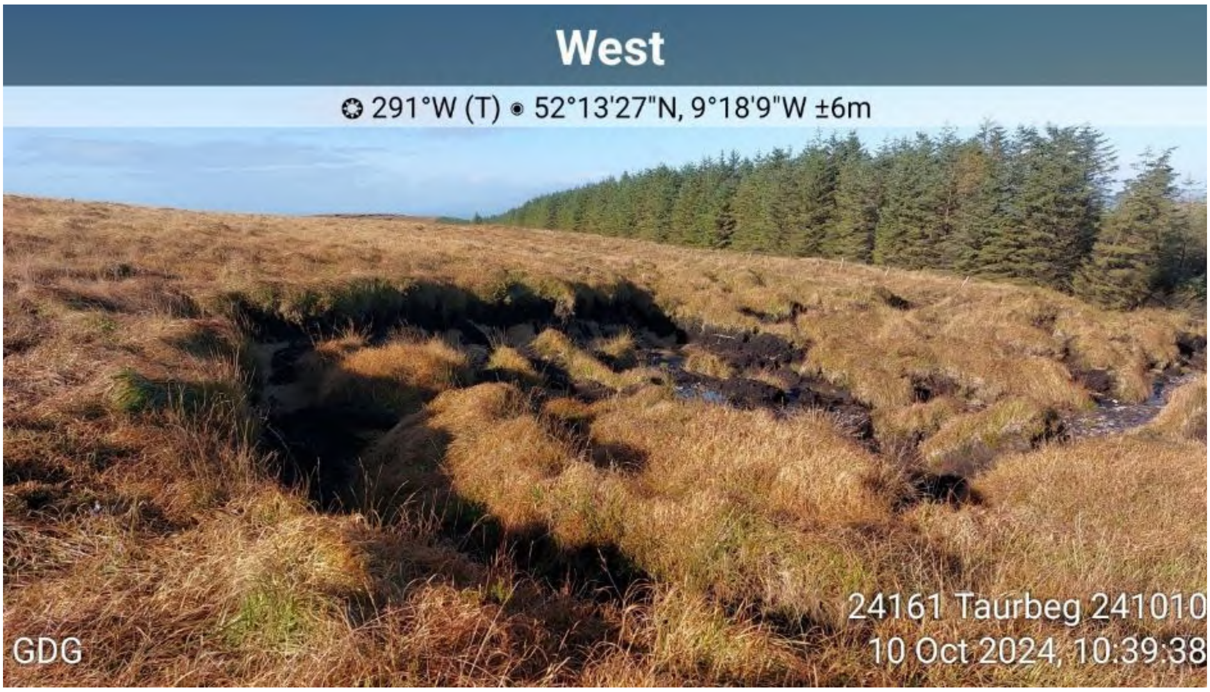

Figure 4-6: Arcuate, concentric tension cracks at the head scarp of ME-B.

In the October 2024 site walkovers, the mineral substrate was observed to be exposed within the central and downslope parts of the main source zone (Figure 4-9, Figure 4-11), although it appears from the earlier aerial imagery (Figure 4-10) that a thin layer of peat slurry initially covered much of the floor of the otherwise fully evacuated source zone. This peat shear surface was observed on site in a small number of locations (Figure 4-8). It is difficult to tell the condition of the basal peat from the aerial imagery, but these could reflect a basal sliding surface. The margins of the main source zone are fairly well defined, with some lateral fissures/tears extending into the forestry.

Analysis of aerial imagery and observations from the site walkover indicate that the failure mechanism was likely very similar to that of ME-A and should be classed as a bog slide. There are some notable differences, however. The most pronounced difference is that while the runout from ME-A appears to have been largely limited to the vicinity of the source area, while the runout from ME-B extends an additional 400-600mm downslope from the source area, and likely entered a tributary of the River Clydagh. This indicates a much greater degree of liquidity in the mobilised peat, with the run-out behaving in a more flow-like manner than in ME-A. Site observations in the run-out area support this conclusion, with peat clearly having been transported as liquid peat slurry.

Observations in the source and head areas indicate that there is not a significant degree of evidence for expulsion of material from the basal regions of the peat mass upslope of the arcuate peat rafts at the head of the failure, and that the failure margin is still well defined.

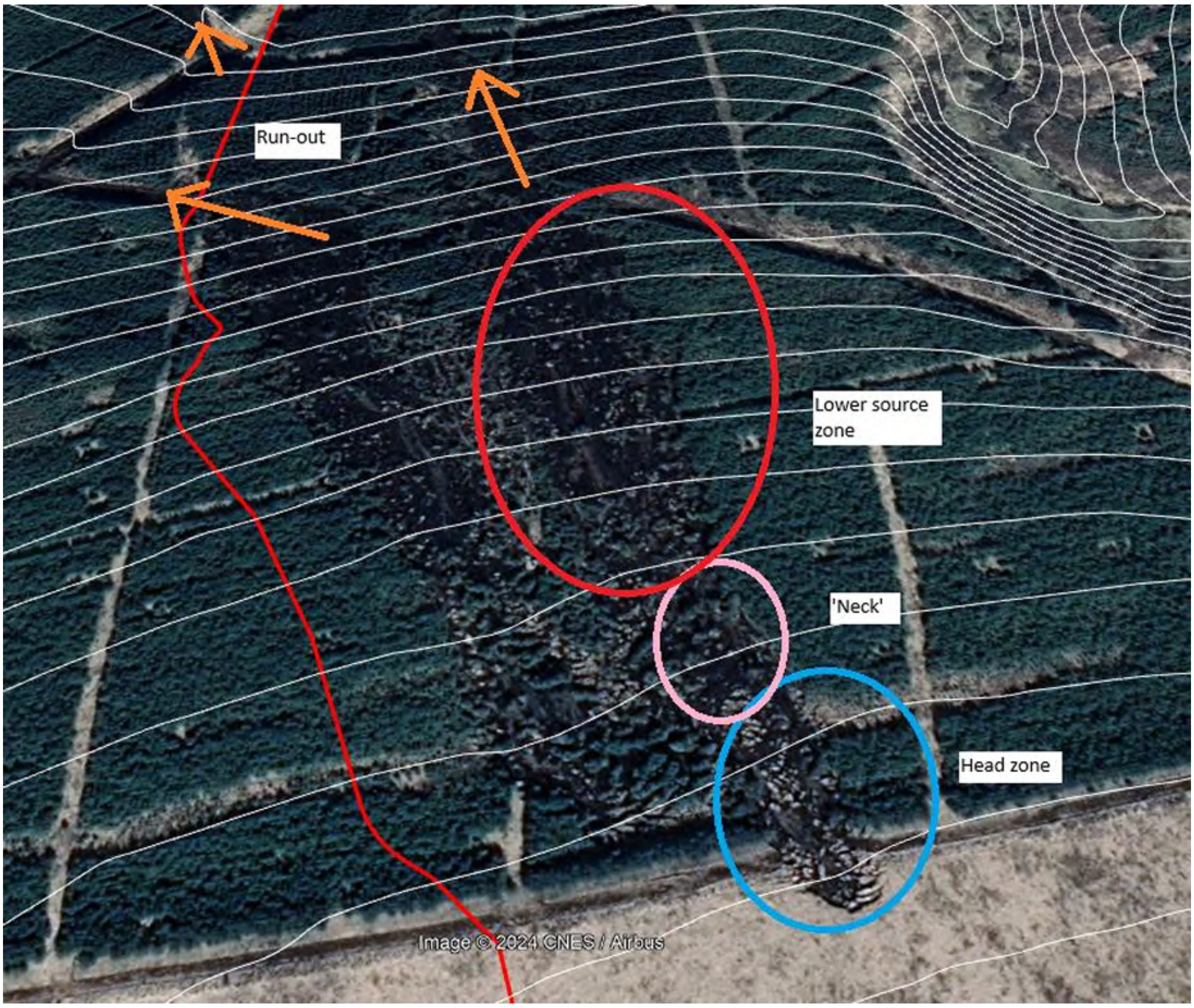

Figure 4-7: ME-B Slide morphology (Google Earth, 2021).

The main body of the failure contains a lower density of stranded peat rafts than observed in the aftermath of ME-A, with many of the rafts initially observed at ME-A having apparently been remobilised during the ME-B event. These morphological features suggest that, while ME-B should be classified as a bog slide, it seems likely that the failure transitioned into a bog flow like morphology downslope, after encountering existing drainage channels. Mineral soils are exposed and visible within the failure scar, suggesting that the failure may have occurred at the interface between the peat and the underlying mineral soil. However, following review of aerial imagery immediately following the failure (2021), and based on site observations, which suggest extensive failure planes within the basal peat, it is assumed that the mineral soils have been exposed by subaerial erosion of the failure scar in the four years following the failure.

Figure 4-8: Potential basal peat shear plane with flow paths, and contour parallel drain visible in foreground.

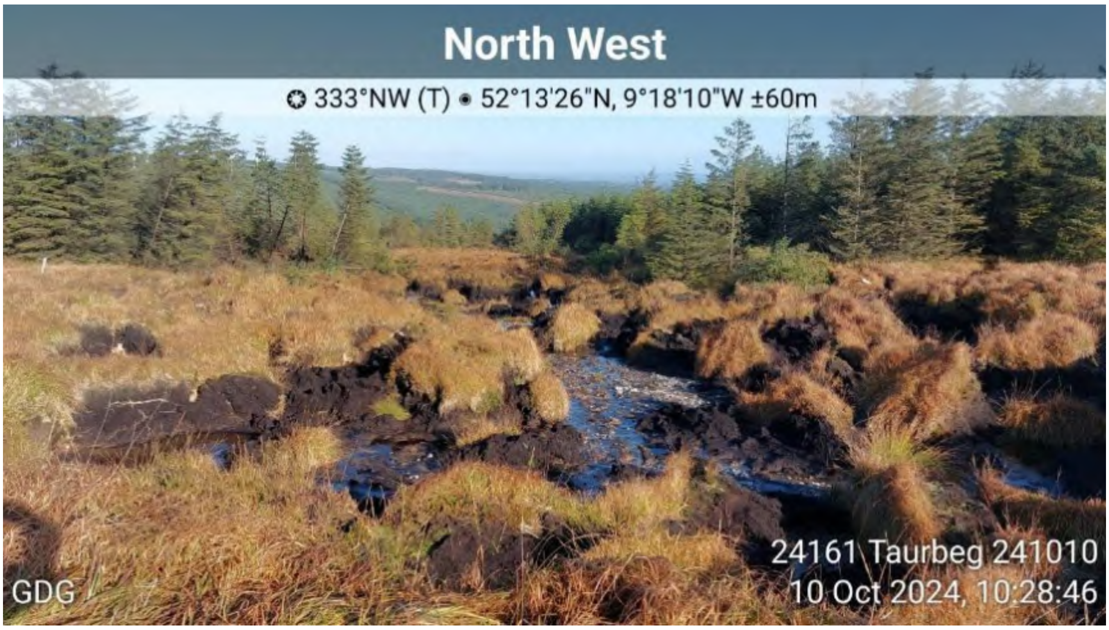

Figure 4-9: View downslope from the head scarp of ME-B. Mineral soil substrate exposed.

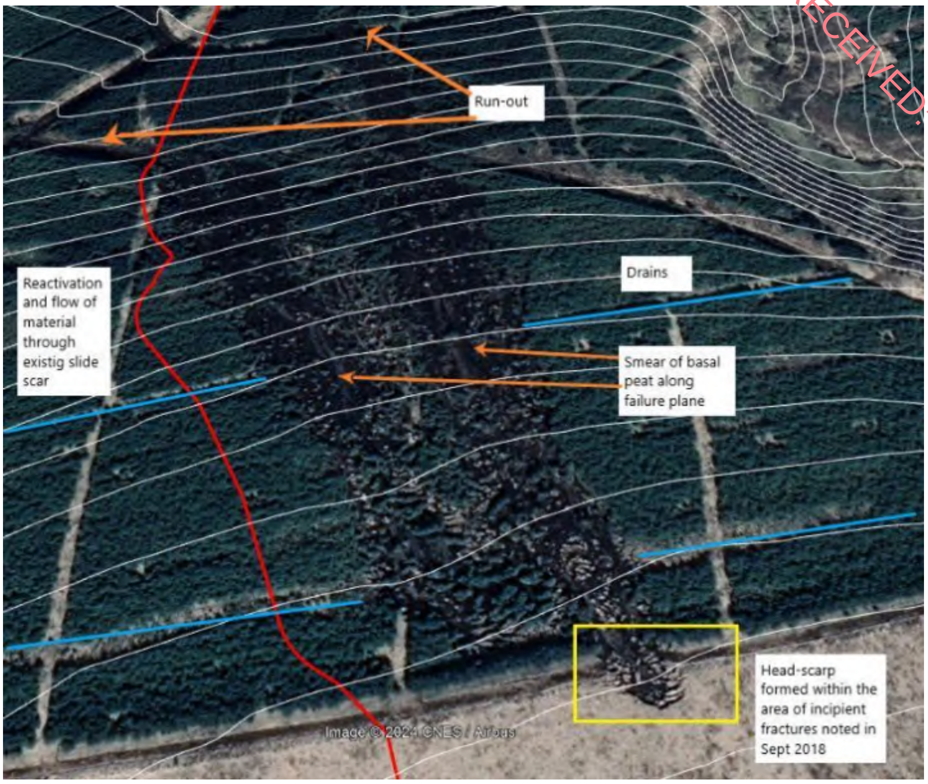

Figure 4-10: 2021 Google Earth imagery showing potential basal peat shear planes.

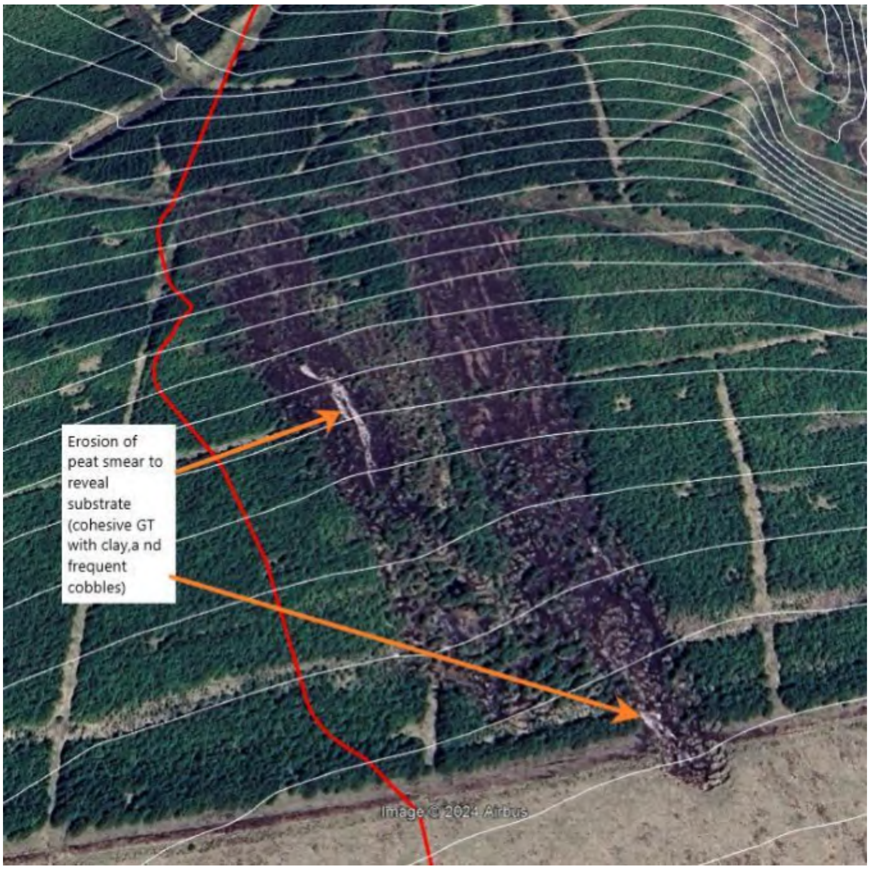

Figure 4-11: 2023 Google Earth imagery showing erosion of basal peat to mineral substrate.

Dykes (2021) and FT/GSI have conducted separate assessment of ME-B (referred to by FT/GSI at Mount Eagle Peat Slide) based on aerial imagery (both) and site observations (FT/GSI, 2024 only). Dykes supported the classification of ME-B as a bog slide, while FT/GSI suggested that this event should be classified as a peat slide and debris slide, based on the visible mineral soils within the failure scar, which they argue indicates a failure plane at the interface between the peat and the mineral soil.

4.2.2 Conditioning Factors

The following contributing factors have been identified, which may have contributed to the initial failure of ME-B. These are largely the same as for ME-A, with two additional factors added:

- Artificial drainage ditches have been cut parallel to contours (Figure 4-5 and Figure 4-8), roughly perpendicular to the direction of failure across the source zone of the ME-B landslide. This may have the effect of focusing surface run-off water into a localised area of afforested blanket bog and leading to ponding of water in the vicinity of the source zone, leading to increased lubrication and increased buoyancy at the base of the peat profile. This is cited as a key factor by both Dykes (2021) and FT/GSI (2024).
- Areas of extremely wet, saturated peat were observed in the vicinity of the source zone. Hand shear vane readings taken during the 2024 GDG site walkovers recorded values as low as 8kPa, with some tests abandoned due the saturation of the peat. These values could well be lower than 8kPa. This indicates that areas in the vicinity of the failure experienced extremely low peat undrained shear strength.
- The presence of a slight convex break in slope at or close to the assumed failure initiation point has been identified from the available topographic data.
- The afforested and drained nature of the area is hypothesised to have contributed to disruption of the hydrological regime, and to have potentially exacerbated the impacts of the contour parallel drainage.
- The impact of the ME-A failure is likely to have been instrumental in conditioning the slope to failure in the ME-B event. This failure will have removed lateral/downslope support from the source area of the ME-B landslide. It may be argued that the ME-B event was a direct trigger, and the aerial imagery in Figure 4-4 illustrates the appearance of tension cracks within the future head zone of the ME-B landslide having formed in the immediate aftermath of the ME-A event. The formation of these tension cracks will likely have accelerated the process of surface water infiltration into the basal peat within the source zone of the ME-B landslide, further weakening the peat.
- The ME-B source zone is intersected by the large, machine excavated firebreak which runs along the southern boundary of the coniferous forestry plantation. This will have allowed for additional surface water infiltration, and provided a concentration point for surface water ponding within the source zone, and removed downslope support form the head zone of the ME-B landslide.

4.2.3 Triggering Factors

No clear immediate trigger for the ME-B event has been identified. There was no clear significant rainfall event immediately prior to the failure in November 2020 (FT/GSI, 2024). However, the combination of a significant dry spell (April and May 2020) followed by relatively high daily rainfall amounts (from June 2020 onwards) may have been the triggering factor in the failure in association with the conditioning factors listed above (FT/GSI, 2024).

4.3 Potential Additional Areas of Instability

Two additional areas of potential relict/active instability have been identified during the 2024 GDG site walkovers. Both areas were identified on the north facing slope to the west of the ME-A and ME-B landslides, between 20m and 260m south of the Proposed Offsetting Lands. These areas have been considered as areas of peat instability in the qualitative assessment in Section 7.3.7.

Figure 4-12: Possible peat failure scarps. Possible evidence for relict instability.

Figure 4-13: Area of tension cracking observed in peat approximately 260m south of Proposed Offsetting Measures boundary.

4.3.1 Potential Relict Landslide

An area of significant peat scarps directly upslope of an area of extremely shallow peat was observed 20-200m to the south of the Proposed Offsetting Lands (Figure 4-12). The significant scarps (>1m), with visible tension cracking, are located in proximity to a significant convex break in slope and adjacent to a natural drainage line. It is hypothesised that this area could represent an area of relict instability pre-dating the plantation of the forestry. The area of potential relict instability is illustrated in Figure G- 2 in Appendix G.

4.3.2 Area of Tension Cracking

An area of visible tension cracking was observed to the south of the southern boundary of the forestry approximately 260m south of the Proposed Offsetting Measures (Area 4), directly to the south of the mechanically excavated firebreak. This tension cracking is visible at ground level (Figure 4-13) and may represent the early stages of peat failure in this location.

4.4 Comparison of Conditioning Factors

Following review of the two historical peat landslides observed to the south of Area 4 of the Proposed Offsetting Lands, the following observations can be made comparing the areas immediately adjacent to the historic failures and areas of potential instability, and the areas within the Proposed Offsetting Lands:

- Artificial drainage ditches have been cut parallel to roughly perpendicular to the direction of failure across the source zone of the ME-A and ME-B landslides. As outlined in Section 7.3.3, this drain orientation is commonly observed in the areas in close proximity to the ME-A and ME-B failures, but is not typically observed within the Proposed Offsetting Lands.
- Areas of extremely wet, saturated peat were observed in the vicinity of the source zone of the ME-A and ME-B landslides, along with both potential additional areas of instability. Hand shear vane readings taken during the 2024 GDG site walkovers recorded values as low as 8kPa, with multiple tests abandoned due the saturation of the peat. These values could well be lower than 8kPa. This indicates that areas in the vicinity of the failure experienced extremely low peat undrained shear strength. Hand shear vane results within the Proposed Offsetting Lands were consistently higher (Table 3-1), with a minimum undrained shear strength value of 11kPa recorded, and no tests abandoned due to the peat being too saturated.
- The presence of a slight convex break in slope at or close to the assumed failure initiation point has been identified from the available topographic data. Sharp convex slope breaks are not encountered within the Proposed Offsetting Lands (7.3.2).
- The afforested and drained nature of the area is hypothesised to have contributed to disruption of the hydrological regime, and to have potentially exacerbated the impacts of the contour parallel drainage. The areas within the Proposed Offsetting Lands are also afforested and drained, which may impact stability. This has taken into account in the analysis in Section 7.3.
- The impact of the ME-A failure is likely to have been instrumental in conditioning the slope to failure in the ME-B event. This failure will have removed lateral/downslope support from the source area of the ME-B landslide. It may be argued that the ME-B event was a direct trigger, and the aerial imagery in Figure 4-4 illustrates the appearance of tension cracks within the future head zone of the ME-B landslide having formed in the immediate aftermath of the ME-A event. The formation of these tension cracks will likely have

accelerated the process of surface water infiltration into the basal peat within the source zone of the ME-B landslide, further weakening the peat. This conditioning factor will not have an impact within the Proposed Offsetting Lands, as the historic landslides are located a minimum of 150m from the Proposed Offsetting Lands boundary.

- The ME-B source zone is intersected by the large, machine excavated firebreak which runs along the southern boundary of the coniferous forestry plantation. This will have allowed for additional surface water infiltration, and provided a concentration point for surface water ponding within the source zone and removed downslope support from the head zone of the ME-B landslide. A large, machine excavated firebreak runs along the northern boundary of Area 1 of the Proposed Offsetting Measures boundary. This is considered in Section 7.3.3, but due to the lower peat depths encountered in this location, is not considered to present the same level of risk as in the ME-B source area.
- The median peat depth recorded within the source areas of the two historic landslides (2.3m) was significantly higher than the median peat depth recorded across the Proposed Offsetting Lands (1.6m).

5 Proposed Offsetting Measures Methodology

The Proposed Offsetting Measures will be achieved by deforestation of approximately 105.5Ha of plantation forestry across the area to create new viable hen harrier habitat, and the works will consist of:

- Deforestation and removal of trees of approximately 10 HA;
- Deforestation to waste of approximately 95.5 HA;
- Windrowing of fell to waste material at 50m intervals where possible;

Replanting of forestry will not occur within the Proposed Offsetting Lands.

The forestry methodology has been designed by SWS Forestry. For the purposes of the forestry works, the Proposed Offsetting Lands have been divided into four areas (Area 1- Area 4), as shown in Figure A- 1. A detailed description of the proposed forestry works can be found in Chapter 4 (Project Description) of the EIAR, but is described in brief in Section 5.1 to Section 5.3. Area 3 contains no forestry, so forestry works are not proposed. This area has been excluded from the PSRA as no peat is present.

No further habitat restoration works such as drain blocking and re-wetting of peatland using peat dams or similar techniques are proposed. It is not proposed that forestry access tracks will be constructed.

5.1 Area 1

The forestry crop here is considered to be poor, and as such, the proposed methodology is to "cut to waste" by placing the entire crop in windrows about 50m apart, as illustrated in Figure 5-1. A Tracked Excavator Machine with Shears/Harvester Head would cut the trees, and following this, the harvesting operator will swing around and drop the entire tree as far as needed (typically up to 12m from where cut) where it would be within reach of and picked up by a second Tracked Excavator Machine with a dyke/rock bucket or grab that having picked the tree swings around again (c. 12m from where picked) resulting in a windrow being located c. 24 meters from where furthest away trees were cut. The process would then be replicated from the other side so that a windrow (c. 2-3 m wide) comprising approximately 50m of crop is created. The second machine will, using its attachment, compress the material so as to keep the windrows tight and as narrow as possible.

The key hazards to peat stability here is the application of surcharge to the peat by plant tracking, and by placement of the windrows. Windrows will not be placed in areas calculated as being of elevated risk for peat instability.

5.2 Area 2

The proposed method would be to cut the crop within the heavier (more productive) area comprising c. 10 HA within Area 2 using a shears/harvesting head on a tracked excavator and then using a forwarder to draw all material (whole trees) to a storage area near the entrance. The forwarder would use brash/trees to support the ground upon which it is travelling, bringing approximately 5 ton loads of entire trees to the storage area at a time. Brash would be replenished as required should ground conditions disimprove in order to minimise the impact of machinery causing rutting. Material (estimated total volume c. 2,000 ton) would be left on site adjacent to the entrance for 4-6 months to dry out, after which time a chipping machine would be brought on site, chipping the material and blowing it into lorries for onward deliver to biomass plants.

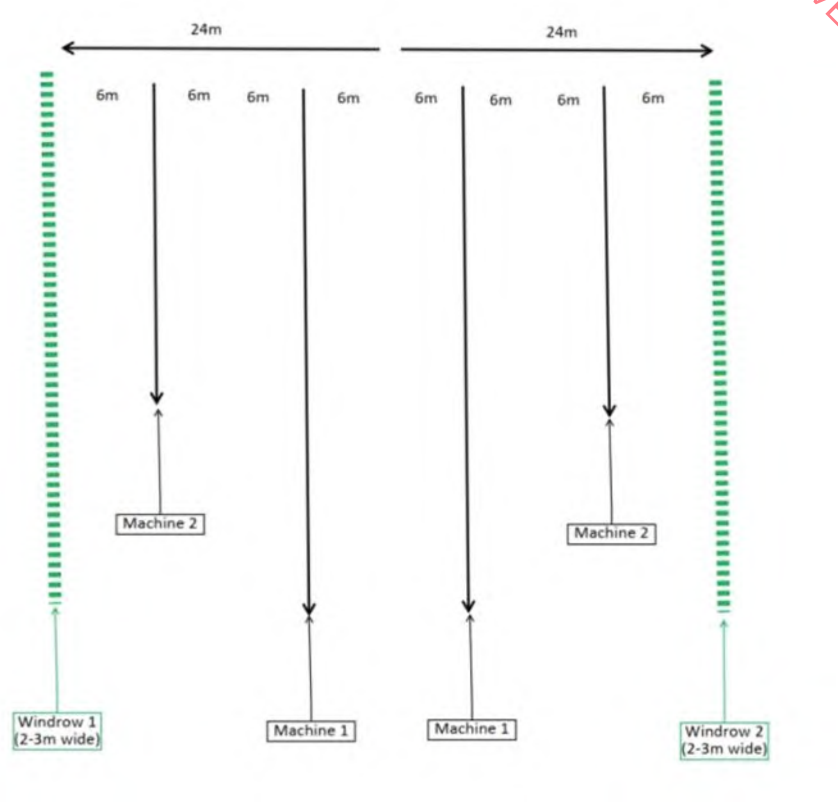

Figure 5-1: Indicative sketch of windrow orientation.

The key hazards to peat stability here is the application of surcharge to the peat by plant tracking. Felled trees will not be placed in areas calculated as being of elevated risk for peat instability (as outlined in Section 8.2).

5.3 AREA 4

As in Area 1, the forestry crop is considered to be poor, and as such, the proposed methodology is to "cut to waste" by placing the entire crop in windrows approximately 50m apart., as illustrated in Figure 5-1. A Tracked Excavator Machine with Shears/Harvester Head would cut the trees, and following this, the harvesting operator will swing around and drop the entire tree as far as needed (approximately 12m from where cut) where it would be within reach of and picked up by a second Tracked Excavator Machine with a dyke/rock bucket or grab that having picked the tree swings around again (approximately 12m from where picked) resulting in a windrow being located approximately 24 meters from where furthest away trees were cut. The process would then be replicated from the other side so that a windrow (about 2-3 m wide) comprising approximately 50m of crop is created. The second machine will, using its attachment, compress the material to keep the windrows tight and as narrow as possible.

The key hazard to peat stability is the application of surcharge to the peat by plant tracking, and by placement of the windrows. Windrows will not be placed in areas calculated as being of elevated risk for peat instability.

6 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.

6.1 MAIN APPROACHES TO ASSESS PEAT STABILITY

The main approaches for assessing peat stability for renewable energy 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 2i 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 2ii does. In this report, the peat stability assessment is carried out by using Approach 2b: deterministic (FoS) approach (Bromhead, 1986).

6.2 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 6-1.

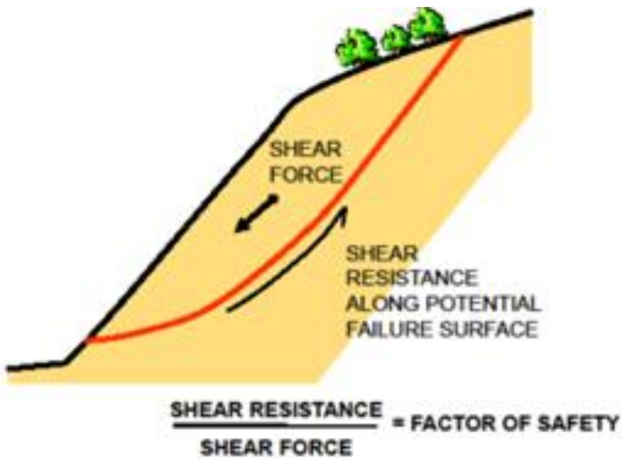

Figure 6-1: Balance of forces in a slope (Scottish Executive, 2017).

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 6-1.

Table 6-1: Factor of Safety limits assumed in this report.

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

Eurocode 7 (EC7) (I.S. EN 1997 1.2005+AC.2009) 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 Proposed Offsetting Lands, the previous FoS method has been used for this assessment rather than EC7 partial factors.

6.3 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) and drained (long-term stability) analyses have been carried out.

6.3.1 Undrained Conditions

The undrained loading condition applies in the short term during the Proposed Offsetting Measures works and until works-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 (Lindsay and Bragg, 2004), 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 Offsetting Lands, several tests could not be completed due to saturated peat conditions, registering values of 0kPa (Table 3-1). The lowest registered value for a completed test was 8 kPa.

A back analysis exercise was conducted on the existing peat failures to the south of the Proposed Offsetting Lands, with this exercise indicating that a c_u of 4kPa was sufficient to bring the sections of slope that failed to the point of equilibrium. Based on this exercise, and on GDG's experience in the assessment of similar blanket peats and values reviewed in the literature, a conservative value of 4 kPa has been adopted for the undrained shear strength (c_u) across the entire Proposed Offsetting Lands. 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:

$$F = \frac{c_u}{\gamma z sin\alpha cos\alpha}$$ Equation 6.3-1

Where,

F = Factor of Safety;

c_u = Undrained strength (4 kPa in the Proposed Offsetting Lands);

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 5 m. This is obtained from the 5m DEM provided by MKO).

6.3.2 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 6-2 shows a summary of the drained parameters used in published literature. Based on GDG's experience in the assessment of similar blanket 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°.

Table 6-2: 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 Farrell (1988)	6	38

Reference	Cohesion, c' (kPa)	Friction Angle, ø'
McGreever and Farrell (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

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

$$F = \frac{c' + (\gamma z - \gamma_w h_w)\cos^2\alpha \tan\phi'}{\gamma z \sin\alpha \cos\alpha}$$ Equation 6.3-2

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 5m DEM provided by MKO);

ø' = Effective friction angle (25°).

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, 2024), as outlined in Section 2.6, accurately represent slope angles within the Proposed Offsetting Lands.
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.

6.4 FoS Results

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

Table M- 1 and Table M- 2 in Appendix M show the FoS calculation process at each GI location within the Proposed Offsetting Measures boundary for undrained and drained conditions, respectively. The FoS calculation for the rest of the Proposed Offsetting Lands, i.e. the areas between the GI points, has been carried out semi-automatically in GIS by implementing Equation 6.3-1 and Equation 6.3-2 in the GIS raster calculator.

6.4.1 FoS for Undrained Conditions

The spatial distribution of the FoS values calculated for undrained conditions (no surcharge) is shown in Figure M- 1 in Appendix M. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas along the south eastern and south western boundaries of Area 1 and Area 4 that are shown with a factor of safety of <1.

These risk areas are caused by locally steeper slope close to the edge of the forestry, where the topography dips towards the river valley, and towards machine excavated firebreaks. Where required, additional mitigation, including Safety Buffer zones and Felled Material Restriction areas, have been scheduled in Section 8 which the contractor must adhere to during the Proposed Offsetting Measures works.

6.4.2 FoS for Undrained Condition and Surcharge of 10 kPa

Figure M- 2 in Appendix M depicts 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. The vast majority of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas in the north of Area 2, and along the south and eastern boundaries of Area 1 and Area 4 which show a FoS value of 1-1.3, or <1.

The area of low factor of safety in Area 2 is generated by the simulation of the placement of 1m of peat surcharge on a locally steep slope where little to no peat currently exists. As no peat will be placed during the forestry works, this is not considered to represent a true peat landslide risk. The risk areas in Area 1 and Area 4 are caused by locally steeper slope close to the edge of the forestry, where the topography dips towards the river valley, and towards machine excavated firebreaks. Where required, additional mitigation, including Safety Buffer zones and Felled Material Restriction areas, have been scheduled in Section 8 which the contractor must adhere to during the Proposed Offsetting Measures works.

6.4.3 FoS for Drained conditions

The spatial distribution of the FoS values calculated for undrained conditions (no surcharge) is shown in Figure M- 2 in Appendix M. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas along the eastern and southwestern extremities of Area 1 and Area 4 where pixels are calculated as having factor of safety values of <1.

These risk areas are caused by locally steeper slope close to the edge of the forestry, where the topography dips towards the river valley, and towards machine excavated firebreaks. Where required, additional mitigation, including Safety Buffer zones and Felled Material Restriction areas, have been scheduled in Section 8 which the contractor must adhere to during the Proposed Offsetting Measures works.

6.4.4 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 M- 4 in Appendix M. Almost all of the pixels are shown to be stable and safe (FoS > 1.3, green), but there are some small areas along the eastern and southwestern boundaries of Area 1 and Area 4 where pixels are calculated as having factor of safety values of <1.

These risk areas are caused by locally steeper slope close to the edge of the forestry, where the topography dips towards the river valley, and towards machine excavated firebreaks. Where required, additional mitigation, including Safety Buffer zones and Felled Material Restriction areas, have been scheduled in Section 8 which the contractor must adhere to during the Proposed Offsetting Measures works.

6.5 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.

7 PEAT STABILITY RISK ASSESSMENT (PSRA)

A peat stability risk assessment (PSRA) has been carried out across the Proposed Offsetting Lands, 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.

7.1 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 7.1-1). 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.

$$\text{Risk} = (\text{Hazard}) \times (\text{Adverse Consequences}) \qquad \text{Equation 7.1-1}$$

7.2 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 7.1-1, 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.

7.3 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 Mills (2023), 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 six secondary factors related to geomorphic observations, including previous slide history, forestry, land use, artificial drainage, substrate and slope convexity. These secondary factors are difficult to quantify in a stability calculation but may contribute to peat instability. The hazard scores have been assigned to rasters generated in ArcGIS and calculated for each pixel within the Proposed Offsetting Lands.

In accordance with the Scottish Guidance (2017), each hazard factor has been reclassified into one of four classes using the ArcGIS raster calculator, with rating values ranging from 0 to 3, with a fifth class (4) added for existing slide history. 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.

The rating of 4 in the existing slide history category indicates areas within the extent of existing landslides.

These factors have been assigned weighting values to reflect their relative importance in peat stability. The rating values have been assigned according to the expert criteria of the project team and are presented in Appendix M. These factors and their corresponding weightings are presented in Table 7-1.

Table 7-1: Factors affecting peat stability and hazard.

<table>
<tr><th colspan="3">Hazard factors</th><th>Role in peat stability</th><th>Weight</th></tr>
<tr><td colspan="3">Factor of Safety</td><td>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 6 for further details.</td><td>10</td></tr>
<tr><td rowspan="6">Secondary factors</td><td>Topography</td><td>Slope Form</td><td>This represents the curvature across down-slope. Peat failures are commonly associated with convex slope breaks.</td><td rowspan="5">1</td></tr>
<tr><td>Hydrology</td><td>Artificial drainage</td><td>Drainage ditches that are aligned cross slope can affect the overall stability of a slope face.</td></tr>
<tr><td>Vegetation</td><td>Forestry</td><td>The vigour of forestry is another indicator of peat stability, with stunted trees more frequent in unstable sectors.</td></tr>
<tr><td>Land Use</td><td>Evidence for Peat Cutting</td><td>The presence of peat cuts at a site can negatively impact peat stability.</td></tr>
<tr><td>Substrate Geology</td><td>Substrate Type</td><td>Peat failures are frequently cited in association with soft clays and cohesive glacial tills.</td></tr>
<tr><td>Slide history</td><td>Distance to previous slides (m)</td><td>This suggests that landslides at the site are likely if a peat slide has occurred at the site or within a close radius. The weight assigned is doubled the weights for the other secondary factors</td><td>2</td></tr>
</table>

The hazard value for a given pixel is the sum of the scores of all the hazard factors (multiplied by their weighting) divided by the maximum hazard value possible to obtain a normalised hazard value ranging from 0 to 1 (see Table 7-2). Hazard is grouped into four categories: Negligible, low, medium, and high. The hazard (likelihood) class scores are shown in Figure N- 8.

Table 7-2: Normalised Hazard Scoring

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

A detailed description of the scoring methodology for each contributing factor is given in Section 7.3.1 to Section 7.3.7

7.3.1 Factor of Safety

This is the most critical hazard factor, taking into account the slope angle, the peat depth, the peat density, and shear strength in the undrained condition respectively. Please see Section 6 for further details. For the purposes of this assessment, the undrained scenario with 10kPa peat surcharge has been selected, as this is considered the critical stability scenario. The hazard score for the factor of safety has been calculated by reclassifying the factor of safety values as illustrated in Table 7-3. The reclassified factor of safety scores are shown in Figure N- 1.

Table 7-3: Factor of safety classes (undrained with 10kPa surcharge), influence on stability and score.

Factor of Safety	Significance	Likelihood Score
1.30 or greater	Stable/safe	0
1.10-1.29	Stable but not safe	1
1.01-1.10	Slope close to equilibrium	2
≤1.0	Unstable	3

The factor of safety scores across the Proposed Offsetting Lands are discussed in further detail in Section 6.4.

7.3.2 Slope Form

Table 7-4 shows slope form classes, influence on stability and related scores. Slope form has been interpreted from the available topographic data. Convex and concave slopes (i.e. positions in a slope profile where slope gradient changes by a few degrees) have been associated with the initiation point of peat landslides by a number of authors e.g. Dykes and Warburton, 2007a; Boylan et al., 2011). Convexities are often associated with thinning of peat, such that thicker peat upslope applies stresses to thinner 'retaining' peat downslope. Conversely, buckling and tearing of peat may trigger failure at concavities. The slope form scores are shown in Figure N- 2.

Table 7-4: Slope form classes, influence on stability and score.

Slope Form	Significance	Likelihood Score
Flat Slope	Peat slides are rarely reported on flat ground	0
Concave Slope	Peat slides are occasionally reported on concave slopes	1
Planar Slope	Peat slides are often reported on planar slopes	2

Slope Form	Significance	Likelihood Score
Convex Slope	Peat slides are most frequently reported on convex slopes	3

Slopes within the Proposed Offsetting Lands boundary are typically classed as planar, with localised convex slope breaks identified 250-500m upslope of the southern boundary of Area 4. An area of concave slope is identified between 50 and 250m to the north, upslope of Area 1.

7.3.3 Artificial Drainage

Table 7-5 shows the artificial drainage classes, influence on stability and related scores. Drain orientation has been interpreted from the available OSI and Google Earth aerial imagery, and from site observations. Transverse / oblique drainage lines, both natural and artificial, may reduce peat stability by creating lines of weakness in the peat slope and encouraging the formation of peat pipes. A number of peat failures have been identified which have failed over moorland grips (Warburton et al., 2004).

Roughly 40% of peat slides and 30% of bog bursts occur in drained areas (Mills, 2023), though usually in association with drains that are oblique to slope rather than along contour (noting that contour aligned drains are less common. Mills (2023) asserts that despite this, contour aligned drains hypothetically have the greatest negative impact on instability. It is also noted that contour aligned drains have been identified in association with the ME-A and ME-B failures described in Section 4.

Table 7-5: Artificial drainage classes, influence on stability and score.

Drainage Orientation	Significance	Likelihood Score
No/minimal artificial drainage	No effect on stability	0
Drains are generally aligned downslope (<30° to slope)	Failures are rarely associated with artificial drains parallel to slope or adjacent to natural drainage lines	1
Drains are generally aligned oblique (15°-60°) to contour	Peat slides are often reported in association with drains aligned oblique to slope	2
Drains are generally aligned along contours (<15°)	Peat slides have been observed in association with contour aligned drains (including the ME-A and ME-B landslides). Hypothetically, contour aligned drains have greatest effect on instability	3

The majority of the rill drains within the Proposed Offsetting Lands are aligned oblique to slope, with interceptor drains typically aligned downslope. Some areas towards the eastern boundary of the area, and some areas upslope of the southern boundary have rill drains aligned along contours. The artificial drainage class scores are shown in Figure N- 3.

7.3.4 Forestry

Table 7-6 shows the forestry classes, influence on stability and related scores. Lindsay and Bragg (2005) suggested that row alignments, desiccation cracking and loading (by trees) could all influence peat stability.

Table 7-6: Forestry classes, influence on stability and score.

Forestry Class	Significance	Likelihood Score
Not afforested	No influence on stability	0
N/A	N/A	3
Afforested area	Peat underlying forestry has inter ridge cracks which are conducive to slope instability	2
N/A	N/A	3

As the majority of the Proposed Offsetting Lands are afforested, the whole area has been assigned a score of '2'. The forestry class scores are shown in Figure N- 4.

7.3.5 Land Use

Table 7-7 shows the land use classes, influence on stability and related scores. Mills (2023) carried out a review of landslide triggering factors and found that strong evidence for a causal link between peat cutting and peat landslides is somewhat lacking, though peat failures have been reported in association with peat cutting. Therefore, the classes outlined in Table 7-7 are based on fundamental stability principles rather than evidence, e.g. the effects of cuttings on adjacent, upslope peat (which might act to reduce its stability) or the effects of machine cutting in fragmenting the peat mass (not dissimilar to the effects of cutting of drains).

Table 7-7: Land Use classes, influence on stability and score.

Land Use	Significance	Likelihood Score
Other Land Use (e.g. forestry – covered in Section 7.3.4)	No influence on stability	0
N/A	N/A	1
Turbary/Hand Cutting	Hand cutting may remove slope support from adjacent upslope materials	2
Machine Cutting	Machine cutting of peat has significant impacts on slope compartmentalisation and has been reported in association with peat slides	3

As the majority of the Proposed Offsetting Lands are afforested, and no peat cutting was observed within the boundary, the whole area has been assigned a score of '0'. The land use class scores are shown in Figure N- 5.

7.3.6 SUBSTRATE GEOLOGY

Table 7-8 shows the substrate geology classes, influence on stability and related scores. Substrate geology has been interpreted from site observation and peat probe date (sound of probes at the point of refusal) where possible but is largely unknown for the Proposed Offsetting Lands. In instances where substrate in uncertain, an intermediate score (2) has been applied).

Peat failures are frequently cited in association with glacial till deposits in which an iron pan is observed in the upper few centimetres (Dykes and Warburton, 2007a). They have also been observed over glacial till without an obvious iron pan, or over impermeable bedrock. They are rarely cited over permeable bedrock, probably due to the reduced likelihood of peat formation

Table 7-8: Substrate geology classes, influence on stability and score.

Substrate Geology	Significance	Likelihood Score
N/A	N/A	0
Granular or bedrock	Failures are less frequently associated with bedrock or granular (silt / sand / gravel) substrates	1
Gritty/granular till with clay OR substrate unknown	Failures are occasionally associated till substrates with a minor clay component. Lack of understanding of substrate condition is a significant uncertainty (an intermediate score is therefore applied)	2
Cohesive (clay) or iron pan	Failures are often associated with soft clay substrates and/or iron pans	3

Granular substrate, with bedrock/weathered bedrock outcropping at/or near the surface was identified in the northwest portions of the Proposed Offsetting Lands. These areas were assigned a score of '1'. Within the existing peat landslides upslope of the Proposed Offsetting Lands, cohesive glacial tills with frequent cobbles and gravel were exposed. These areas were therefore scored a '2'. Data acquired from the sound of peat probe termination depths was inconclusive, and substrate was largely not visible elsewhere. The remaining portions of the lands were therefore assigned a score of '2'. The substrate class scores are shown in Figure N- 6.

7.3.7 Existing Landslide History

Table 7-9 shows the existing landslide history classes, influence on stability and related scores. While there is no observable direct relationship between distance to existing landslides and future failures, it is hypothesised that the likelihood of peat landslides will increase with proximity to existing failures or evidence for instability (e.g. tension cracks).

Table 7-9: Existing landslide history classes, influence on stability and score.

Existing Landslide History	Significance	Likelihood Score
No pre-existing peat landslide within 1km	No influence on stability	0
Pre-existing peat landslide within 1km	Failures still may be more likely within a larger radius of pre-existing peat landslides	1
Pre-existing peat landslide within 500m	Failures may be more likely within a close radius of pre-existing peat landslides	2
Pre-existing peat landslide within 250m	Failures often recur on hillslopes with pre-existing peat landslides	3
Pre-existing peat landslide extent, or visible evidence of peat instability (e.g. tension cracks)	Large peat failures are likely to remain unstable, and may reactivate, or trigger adjacent failures. Visible features of peat instability may indicate that failure is in progress, or may be initiated in the near future.	4

The existing landslide footprints (including the areas of potential relict instability and tension cracking) have been assigned a score of '4', and all other areas scored based on distance buffers as outlined above. Parts of Area 4 closest to the existing landslides received a score of '3', while the remainder of Area 4 received a score of '2'. The eastern parts of Area 1 received a score of '1', while the wester parts of Area 1, and the entirety of Area 2 received a score of '0'. The existing landslide distance class scores are shown in Figure N- 7.

7.4 Adverse Consequences Assessment

The impacts of peat landslides on the surrounding environment may typically generate a variety of adverse consequences. This report qualitatively assessed these consequences following the Scottish-Executive ECUBP Guidance (2017).

Table 7-10 summarises the consequences considered for the PSRA of the Proposed Offsetting Measures.

Table 7-10: Consequences considered for the PSRA.

Consequence factors		Description	Weight
Potential Failure Volume	The volume of potential peat flow (function peat depth in the area)	This is the second most heavily weighted factor. It is estimated based on the depth of peat in the area. The deeper the peat depth, the larger the landslide.	3
Watercourse Proximity	Proximity to watercourses (m)	This is the distance from the pixel to the nearest defined river valley. Rivers close to potential landslide sectors are more vulnerable to a landslide event.	1
Topography	Downhill slope angle	This factor accounts for the runout distance as a matter of slope angle.	1
Environmental Sensitivity	Downstream aquatic environment	Reflects the severity of a peat slide event's impact on the receiving aquatic environment.	1
Infrastructure	Public roads in the potential peat flow path	Rates the impact of a peat slide striking a public road.	1
Infrastructure	Overhead lines in the potential peat flow path	Rates the impact of a peat slide striking a service line.	1
Infrastructure	Buildings in the potential peat flow path	Rates the impact of a peat slide striking a habitable structure.	1
Response	Capability to respond (access and resources)	Rates the capability of the site staff to respond to a peat instability event.	1

The eight 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. The consequence scores have been assigned to rasters generated in ArcGIS and calculated for each pixel within the Proposed Offsetting Measures boundary.

'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 consequences value for a given pixel is the sum of the eight consequences scores (each multiplied by their weighting). This total value is then divided by the maximum consequence value possible to obtain a normalised consequence value ranging from 0 to 1 (see Table 7-11). Consequences are grouped into four categories: Negligible, low, medium, and high. The total adverse consequence class scores are shown in Figure N- 17.

A detailed description of the scoring methodology for each consequence factor is given in Section 7.3.1 to Section 7.3.7.

Table 7-11: Normalised Adverse Consequences Scoring

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

7.4.1 Potential Peat Flow Volume (Peat Depth)

Table 7-12 shows potential peat flow volume (peat depth) classes, influence on adverse consequences and related scores. Peat depths are assessed from the available peat ground investigations (Section 3). Greater thicknesses of peat are capable of producing greater failure volumes. The peat depths have been assessed using the interpolated peat depth raster outlined in Section 3. The potential peat volume class scores are shown in Figure N- 9.

Table 7-12: Peat depth classes, influence on consequences and score.

Peat Depth Class	Significance	Adverse Consequence Score
0-0.5m	Peat depths of under 0.5m are considered peaty soils and will not generate significant pea landslides volumes.	0
0.5-1m	Increasing peat depth creates the possibility for more significant landslide volume.	1
1-2m	Increasing peat depth creates the possibility for more significant landslide volume.	2
>2m	Increasing peat depth creates the possibility for more significant landslide volume.	3

Large parts of Area 4 are given scores of '3' and '2', due to the generally deeper peat encountered in these areas. Area 1 is given scores ranging from '0' to '3', as the peat depths vary significantly across the area. The areas given a score of '3' are generally quite localised, and the majority of the Area is given a score of '2'. The majority of Area 2 is given a score of '0', due to the shallow peat depths encountered, though this increases slightly to a score of '1' on the eastern half of Area 2, with some portions of the eastern margins of the area receiving a score of "2".

7.4.2 Proximity to Watercourses

Table 7-13 shows watercourse proximity classes, influence on adverse consequences and related scores. Proximity to watercourses has been defined using OSI/EPA watercourse shapefiles, with distance buffers produced in ArcGIS.

Distance between a given pixel and watercourses influences the ability of peat material to enter a watercourse following failure. The watercourse proximity class scores are shown in Figure N- 10.

Table 7-13: Watercourse proximity classes, influence on consequences and score.

Distance to Defined Watercourse	Significance	Adverse Consequence Score
>1km	Peat unlikely to enter watercourse.	0

Distance to Defined Watercourse	Significance	Adverse Consequence Score
500m-1km	Peat less likely to enter watercourse. Only highly liquefied material mar reach watercourse.	1
200-500m	Peat material must travel a significant distance before entering watercourses. Volume of peat entering watercourse may be reduced.	2
0-200m	Peat landslide material can easily enter watercourses.	3

Much of Area 1 and Area 4 are scored "3", as large portions of these areas are located within 200m of the River Clydagh, with small tributaries running through the centre of Area 1. The remaining portions of Area 1 and Area 4 are scored "2". The majority of Area 2 is scored "2", "1" or "0", as this area is located further from the mapped watercourses.

7.4.3 Slope Angle

Table 7-14 shows slope angle classes, influence on adverse consequences and related scores. The downhill slope angle will act as a control on the potential run-out distance of peat material in the event of a failure. The greater the slope angle, the further the run-out is likely to travel. The slope angle has been calculated from the topographic BlueSky LiDAR data (DTM) provided by MKO (2024). The slope angle class scores are shown in Figure N- 11.

The vast majority of Areas 1 and 4 are scored "1" or "2", as the slope angles within these areas typically range between 2-10°. Almost the entirety of Area 2 is scored "3", as slope angles within this area are typically >10° (average of 12°).

Table 7-14: Slope angle classes, influence on consequences and score.

Slope Angle (°)	Significance	Adverse Consequence Score
<2	Peat run-out distance is likely to increase as a function of slope angle	0
2-5	Peat run-out distance is likely to increase as a function of slope angle	1
5-10	Peat run-out distance is likely to increase as	2

Slope Angle (°)	Significance	Adverse Consequence Score
	a function of slope angle	
>10	Peat run-out distance is likely to increase as a function of slope angle	3

7.4.4 Downslope/Downstream Environment Sensitivity

Table 7-15 shows downstream aquatic environment classes, influence on adverse consequences and related scores. The presence of sensitive aquatic environments or drinking supplies downstream of potential peat failures will increase the potential for adverse environmental and human consequences.

Table 7-15: Downstream aquatic environment classes, influence on consequences and score.

Downstream Aquatic Environment	Significance	Adverse Consequence Score
No watercourses present	No impact	0
Non-sensitive	Non-sensitive environments will not be as severely impacted by peat failure.	1
Sensitive	Peat failure within or upstream of sensitive aquatic environments will likely have a significant environmental impact	2
Drinking water supply	Peat failure within or upstream of drinking water supplies will have a significant impact on water supply	3

As discussed in Section 2.12, much of the Proposed Offsetting Lands are located in the upper region of the River Shannon catchment that flows down to the Lower River Shannon SAC, and the entirety of the Proposed Offsetting Lands are located within the Stack's to Mullaghareirk Mountains, West Limerick Hills and Mount Eagle SPA. Any peat landslide occurring within the boundary has the potential to enter one of the watercourses which drain the area (particularly the River Clydagh), potentially impacting the SAC. Any peat landslide would also have the potential to impact the SPA. The whole Proposed Offsetting Lands has therefore been classified as sensitive and given a score of '2'. The environmental sensitivity class scores are shown in Figure N- 12.

7.4.5 Public Roads in Potential Peat Flow Path

Table 7-16 shows public road classes, influence on adverse consequences and related scores. The presence of public roads within potential flow pathways has been assessed using Google Earth aerial imagery, and the flow pathways map shown in Figure F- 3. The increased size/importance of the infrastructure leads to increased consequences in the event of a peat failure. The public road consequences class score is shown in Figure N- 13.

Table 7-16: Public roads in potential peat flow paths, influence on consequences and score.

Public roads in potential peat flow paths	Significance	Adverse Consequence Score
No roads in potential flow path	No impact	0
Minor roads	Risk to members of the public, cost of repair and replacement of minor road infrastructure	1
Local roads	Increased risk to members of the public, increased cost of repair and replacement of local road infrastructure	2
Regional/National Roads	Significant risk to members of the public, increased cost of repair and replacement of regional/national road infrastructure	3

Areas 1 and 4 are scored “0”, as there are no public roads downslope of these areas, and there fore none within potential flow paths. Area 2 is scored “1”, as there is a minor road immediately downslope of this area.

7.4.6 OVERHEAD LINES IN POTENTIAL PEAT FLOW PATH

Table 7-17 shows overhead line classes, influence on adverse consequences and related scores. The presence of public roads within potential flow pathways has been assessed using Google Earth aerial imagery, and the flow pathways map shown in Figure F- 3. The increased importance of the infrastructure leads to increased consequences in the event of a peat failure. The overhead lines consequence class is shown in Figure N- 14.

Table 7-17: Overhead lines in potential peat flow paths, influence on consequences and score.

Overhead Lines in Potential Peat Flow Paths	Significance	Adverse Consequence Score
No OHLs in potential flow path	No impact	0
Phone lines	Disruption to the public, cost of repair and replacement phone-line infrastructure	1
Electricity (LV)	Increased disruption to the public, increased cost of repair and replacement of LV infrastructure	2
Electricity (MV, HV)	Significant disruption the public, increased cost of repair and replacement of MV/HV infrastructure	3

The entirety of the Proposed Offsetting Lands is scored a "0" as there are no overhead lines within potential flow paths.

7.4.7 Buildings in Potential Peat Flow Path

Table 7-18 shows building classes, influence on adverse consequences and related scores. The presence of public roads within potential flow pathways has been assessed using Google Earth aerial imagery, and the flow pathways map shown in Figure F- 3. The increased importance of the infrastructure leads to increased consequences in the event of a peat failure. The building consequences class score is shown in Figure N- 15.

Table 7-18: Buildings in potential peat flow paths, influence on consequences and score.

Buildings in Potential Peat Flow Paths	Significance	Adverse Consequence Score
No buildings in potential flow path	No impact	0
Farm outhouses	Risk to members of the public, cost of repair and replacement of outbuildings	1
Wind Farm Infrastructure/Substations	Increased risk to members of the public, increased cost of repair and replacement of wind farm infrastructure	2
Residential Properties	Significant risk to life for members of the public, increased cost of repair and	3

Buildings in Potential Peat Flow Paths	Significance	Adverse Consequence Score
	replacement of residential buildings	

The entirety of Area 1 and Area 4, and the majority of Area 2 are scored "0", as there are no buildings in potential flow paths downslope of these areas. A portion of the southwest corner of Area 2 is scored "3" as there is a potential residential building downslope of this area.

7.4.8 Capability to Respond to Future Peat Landslides

Table 7-19 shows response capability classes, influence on adverse consequences and related scores. In assessing the potential adverse consequences of a future peat landslide, the capability of the relevant authorities to respond to mitigate and limit potential adverse impacts will factor into the potential magnitude of any adverse effects. The greater the capability of the relevant authorities to respond, the higher chance that adverse effects can be mitigated.

Table 7-19: Capability to respond to future peat landslides, influence on consequences and score.

Capability to Respond	Significance	Adverse Consequence Score
N/A	N/a	0
Good	Well connected sites with easy access to regional and national road infrastructure, close (within 30 minute drive) to large population centres. Easily accessed, with rapid response possible.	1
Fair	Moderately well connected sites, with access to local roads, within 1 hour of to large population centres. Medium potential response times.	2
Poor	Remote sites, accessed only be minor roads or forestry tracks. Long potential response times.	3

Due to the remote location of the Proposed Offsetting Lands, a score of '3' has been assigned across the entire site. The capability to respond class score is shown in Figure N- 16.

7.5 Risk Calculation

Risk at each 5m x 5m pixel is calculated with Equation 7.5-1, i.e., multiplying the hazard scores and the consequences scores:

$$\text{Risk Score} = (\text{Hazard Score}) \times (\text{Adverse Consequences Score}) \qquad \text{Equation 7.5-1}$$

The risk rating ranges between 0 and 1 and the following levels of risk rating have been distinguished (Table 7-2 and Table 7-11, based on the Scottish Government Best Practice Guidelines (2017):

- <u>High (0.6 to 1)</u>: 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.

It should be noted that these guidelines were developed for large energy developments (e.g. wind farm developments) on peatlands. It is considered that if risk is carefully mitigated, that the Proposed Offsetting Measures can proceed in areas scored as medium, due to the low impact of forestry measures.

Appendix N gathers the risk calculation process across the Proposed Offsetting Lands, with the risk scores illustrated in Figure N- 18. Almost the entirety of the Proposed Offsetting Measures is located in areas of negligible or low risk, with a few small, localised areas of medium risk identified. These areas are contained within the Safety Buffer zones and Felled Material Restriction areas outlined in Section 8.2.

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

8 Mitigation Measures

8.1 Mitigation by Avoidance

The Proposed Offsetting Lands has been selected using an iterative process, carried out alongside this assessment, to remove areas of high risk for peat instability from the area where possible. Safety buffer zones which are to be avoided during deforestation have been identified and are outlined in Section 8.2.1. Felled Material Restriction areas (FMRs) have also been identified and are outlined in Section 8.2.2. Stockpiling or placement of forestry materials will not be carried out in these areas.

8.2 Safety Buffer Zones and Felled Material Restriction areas

From the site reconnaissance and the calculations of the FoS for the peat slopes, a series of safety buffer zones (SBZ) and Felled Material Restriction (FMR) areas are proposed and presented in Appendix O, Figure O- 1.

8.2.1 Safety Buffer Zones

Safety Buffer zones are areas identified during the initial phases of the PSRA and 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 < 1in the undrained scenario. Five Safety Buffer zones have been identified within the Proposed Offsetting Measures Boundary. It is considered that the low factor of safety calculated in these areas is caused by localised factors, and do not represent a global stability risk. Each safety buffer zone is located at the edge of the forestry, close to machine excavated firebreaks or small streams, with the locally higher slopes generating the low factor of safety score. It is considered that these areas do not present a significant peat landslide risk, provided the below mitigations are adhered to.

These areas are to be marked out on site with warning tape, and the following mitigation measures adhered to:

- No large plant is to enter the Safety Buffer zones.
- No logs, windrows, stone or other materials will be temporarily or permanently placed in the areas within the FMR areas.

Safety buffer areas are outlined in Figure O- 1 in Appendix O and will be included in the Safety File for the Proposed Offsetting Measures.

8.2.2 Felled Material Restriction areas

Although the peat stability results and safety buffers have been considered in the siting of the Proposed Offsetting Measures, there are some locations where forestry work is required within a safety buffer zone. The stability assessment results at these locations suggest FoS values <1 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 felled logs or other materials.

Felled Material Restriction (FMR) areas are identified at 18 locations within the Proposed Offsetting Lands.

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

FMR areas are outlined in Appendix O, Figure O- 1. Certain mitigations must be adhered to within the FMR areas in future stages of the Proposed Offsetting Measures:

- No logs, windrows, stone or other materials will be temporarily or permanently placed in the areas within the FMR areas,
- Any trees permanently felled in the area will be immediately removed and placed/ stored in an appropriate storage location,
- Plant used within these areas will be low ground bearing and only the necessary plant will be used here. No excessive quantity or size of plant will be stored in these areas,
- During, and for seven days following significant rainfall events, all works in the FMR areas will be halted, to prevent disturbance of potentially saturated peat.

Safety buffer zones are outlined in Appendix O, Figure O- 1.

8.3 Engineering Mitigation Measures

Many of the site specific (e.g. peat depth, slope angle) and site independent variables (e.g. weather) that contribute to the incidence of natural peat landslides are beyond engineering control without significant damage to the peat itself. However, a number of engineering measures exist to minimise the risks associated with potential triggers (such as short term peaks in hydrogeological activity).

8.3.1 Proposed Offsetting Measures works Management

Inappropriate storage of excavated/felled material, as well as uncontrolled loading of peat material is considered one of the main causes of peat instability and landslide event triggers. The management and control of these activities is key to de-risking peat stability at the Proposed Offsetting Lands. It is required that the construction method statements for the project also take into account, but not be limited, to the guidance documents listed in Section 1 and the recommendations and requirements outlined throughout this document.

The general requirements for the management of peat and the mitigation of peat instability at the Proposed Offsetting Measures are as follows:

- Appointment of experienced and competent contractors;
- The forestry works on site should be supervised by experienced and qualified personnel;
- Allocate sufficient time for the project to proceed safely with all peat stability mitigation measures included in the programme;
- Set up, maintain and report findings from monitoring systems, including sightline monitoring;
- Maintain vigilance and awareness through Tool-Box-Talks (TBTs) on peat stability;
- Prevent undercutting of slopes and unsupported excavations;
- Prevent placement of loads/overburden on marginal ground;
- Manage and maintain a robust drainage system. This will be the responsibility of the appointed contractor;

- Storage of felled material including windrows be carried out in the permitted areas only;
- All works will be halted during significant rainfall events, and for a minimum of one day afterwards; and
- A method statement and risk assessment (RAMS) which considers the potential causes and mitigations of peat instabilities and landslide is required and must be regularly communicated to all site staff. An observational approach by all site staff to the ground conditions and the risks should be promoted and any changes in the ground or site conditions should be reported and the risk dynamically assessed.

8.3.2 Drainage Measures

Installation of targeted drainage measures would aim to isolate areas of susceptible peat from upslope water supply, re-routing surface (flushes/gullies) and subsurface (pipes) drainage around critical areas. Surface water drainage plans should be implemented to account for modified flows created by Proposed Offsetting Measures works, which in turn may affect peat stability, pollution and wildlife interests. Drainage measures need to be carefully planned to minimise any negative impacts.

8.4 Monitoring

The installation of movement monitoring posts is recommended for areas where works are taking place on or adjacent to identified peat depths greater than 2m.

Movement monitoring posts will be installed upslope and downslope of the works areas and will be as outlined:

- Posts will be 1m to 1.5m in length, installed at 5m intervals with no less than seven posts in each line of sight (~30m).
- A string line will in attached to the first and last post with all intermediate posts in contact with one side of the string line,
- A numbering system will be designs for the monitoring posts and a record will be kept of this numbering system.

Movement monitoring posts will be observed at least once a day with more frequent inspections which adjacent works are ongoing. Should movements be recorded the frequency of these inspections will be increased. Record will be kept of all monitor post inspections with reference to date, time and any relative movement between posts, if any. Any movement identified in the posts will be recorded with reference to the post numbering system. The contactor will also develop a routine inspection of all areas surrounding work in peat, not just exclusively on the monitoring posts. These inspections will include an assessment of ground stability and drainage conditions. These inspections should identify any cracking or deformation on the peat surface, excessive settlement on structures, drain blockages or springs etc.

8.5 Engineering Mitigation Measures to Control Landslide Impacts

Although the stability of the peat is considered to be safe for the activities proposed, and should the peat be managed in line with the details of this document, the risk of a peat failure or landslide is negligible to very low. However, it is important to consider the actions which will be carried out if signs of instability are identified during the outlined monitoring or should a failure occur at the Proposed Offsetting Lands.

The full methodologies for these activities will be outlined in the Contractor's RAMS and include the methodologies for immediate and long-term response.

8.5.1 Movement or Instability Observed in Monitoring Areas

Where excessive movement has been observed in the installed monitoring outlined in Section 8.4 the following measures will be taken:

- All works will be suspended in the area,
- A competent Geotechnical Engineer will carry out an assessment of the peat instability including drainage. The competent Geotechnical Engineer will compile a report outlining the surveys undertaken, the potential cause of the instability, assessment of any increased risk caused by the instability, and the further measures required to manage this risk,
- An increased monitoring regime will be specified including increase in number of monitoring post lines, decrease on monitoring post spacing and an increase in the frequency of monitoring post observations,
- Should no further movement be detected, activities will be recommenced while maintaining the increased monitoring regime,
- Should further excessive movement be detected, the geotechnical engineer will need to be informed and the design of further reinstatement works will be required such as excavation of the disturbed material, installation of a granular berms or similar.

8.5.2 Emergency Response to a Landslide Event

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 will be implemented by the contractor:

- All members of the project team will be alerted immediately or as it is safe to do so;
- All habitat restoration works will be ceased with immediate effect, and all available resources will be used for the management and mitigation of the risks posed by the event;
- Localised peat slides that do not present a risk to watercourses will be assessed by competent engineers, and will be stabilised by rock infill and granular material where necessary;
- The key initial activity will be to prevent displaced materials from reaching any watercourses or sensitive environments. Given the terrain of the Proposed Offsetting Lands, the key risk is the development of a propagation landslide or slip within topographic valleys and watercourses. Where possible, catch ditches will be constructed to aid prevent further run out of the disturbed peat material. These catch ditches may slow or halt runout, although it is preferable that they are cut in non-peat material. Simple earthwork ditches can form a useful low-cost defence. Paired ditches and barrages have been observed (Tobin, 2003) to slow peat landslide runout at failure sites.

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.

9 GEOTECHNICAL RISK REGISTER

The register included in Table 9-1 lists significant potential peat geotechnical hazards and associated risks concerning the Proposed Offsetting Measures, and recommended mitigations.

Table 9-1: Geotechnical risk register

Ref.	Risk	Contributing factor	Mitigation
1	Peat Instability	Overestimation of soil strength parameters	The soil parameters are based on the hand shear vane test carried out by GDG across the Proposed Offsetting Lands. 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. 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. It would be expected that an observational approach will be required when carrying out forestry works 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	Peat Instability	Underestimation of peat depth	Extensive peat ground investigation including peat probing and hand shear vane testing has been carried out across the Proposed Offsetting Lands. GI locations have been carried out at locations where access was possible. Access was limited to some areas of the Proposed Offsetting Lands with restrictions. It would be expected that an observational approach will be required when carrying out forestry works 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.
3	Failure of peat slope due to loading or	Failure to identify existing instability/ peat deformation at	Assessment of satellite imagery and topographical data for evidence of past landslide events was carried out as part of the desk study, in addition to four site walkovers. Desk study review focused on the two

Ref.	Risk	Contributing factor	Mitigation
	agitation of existing instability	the Proposed Offsetting Lands	recorded existing peat landslides within close proximity to the Proposed Offsetting Lands. Additional areas of potential instability have been identified and discussed further in Section 2.7 and 7.3.7. During the site walkovers, the site GDG engineers examined the landscape and the areas surrounding the existing peat landslides, and in other areas identified as areas of potential current instability, including areas upslope of the Proposed Offsetting Lands. No direct evidence of peat instability was identified within the Proposed Offsetting Lands. Although there is no evidence of landslides within the Proposed Offsetting Lands boundary, this does not necessarily mean that landslides have never occurred at the Proposed Offsetting Lands. 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. Access was limited to some areas of the Proposed Offsetting Lands with restrictions relating to raised peat bogs traversed by large drainage ditches. Further inspection will be required during the forestry stage to inspect for peat instabilities. This will be carried out by the Contractors team. The design team will develop their own inspection and testing criteria to satisfy and de-risk the possibility of larger peat depth occurring at these locations.
4	Peat Instability	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 have been designated as safety buffer zones, as outlined in Section 8.2. The 1m peat loading scenario is used here to assess the impact of peat loading with permanently felled immature forestry and placing materials into "wind rows". The forestry contractor will have to adhere to defined safety buffer and Felled Material Restriction areas.
5	Failure of peat slopes	Over/underestimation of existing slope angles.	The peat stability analysis factor of safety exercise examines the peat slope angle using data drawn from a 2024 Bluesky LiDAR survey. This survey was

Ref.	Risk	Contributing factor	Mitigation
			provided in the form of a 5x5m DEM raster. It is possible that slope angles generated using this raster may slightly over/under estimate the slope angle at any given pixel. It is considered that this level of detail is acceptable for carrying out the factor of safety analysis, and that this gives a more representative view of slope wide slope angles. Conservative peat strength values have been assumed.
6	Instability of peat/ slippage	Variations in the groundwater conditions at the Proposed Offsetting Lands	The groundwater conditions were examined during the walkovers. Areas of saturated surface peat were identified during the walkovers as outlined in Section 2.12 and these have been considered in the risk assessment and findings of the report. The groundwater conditions and peat moisture content way vary seasonally and/or more frequently with the immediate weather conditions. Hydrology of the area will be maintained as far as possible by implementing and maintaining an appropriate drainage system.

10 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 Offsetting Lands. 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 Proposed Offsetting Lands with diligent peat management and careful consideration of the peat conditions at the Proposed Offsetting Lands during the Proposed Offsetting Measures works .

A deterministic Factor of Safety was calculated across the Proposed Offsetting Lands, and from this, a robust peat stability risk assessment (PSRA) was performed. The findings of the peat assessment showed that the Proposed Offsetting Lands have an acceptable margin of safety and is suitable for the Proposed Offsetting Measures, provided appropriate mitigation measures, as outlined in Section 8, are implemented. These must be adhered to in future stages of the Proposed Offsetting Measures.

The peat stability risk for the Proposed Offsetting Lands are almost entirely scored as negligible to low, aside from a few small, localised areas classed as medium. It is considered that these areas do not present a significant peat slide risk if the mitigation measures outlined in Section 8 are implemented, and that the residual risk is manageable.

To minimise the risk of forestry 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.

During deforestation works, it is strongly recommended to carry out frequent monitoring works, especially after heavy rainfall events or prolonged rainfall.

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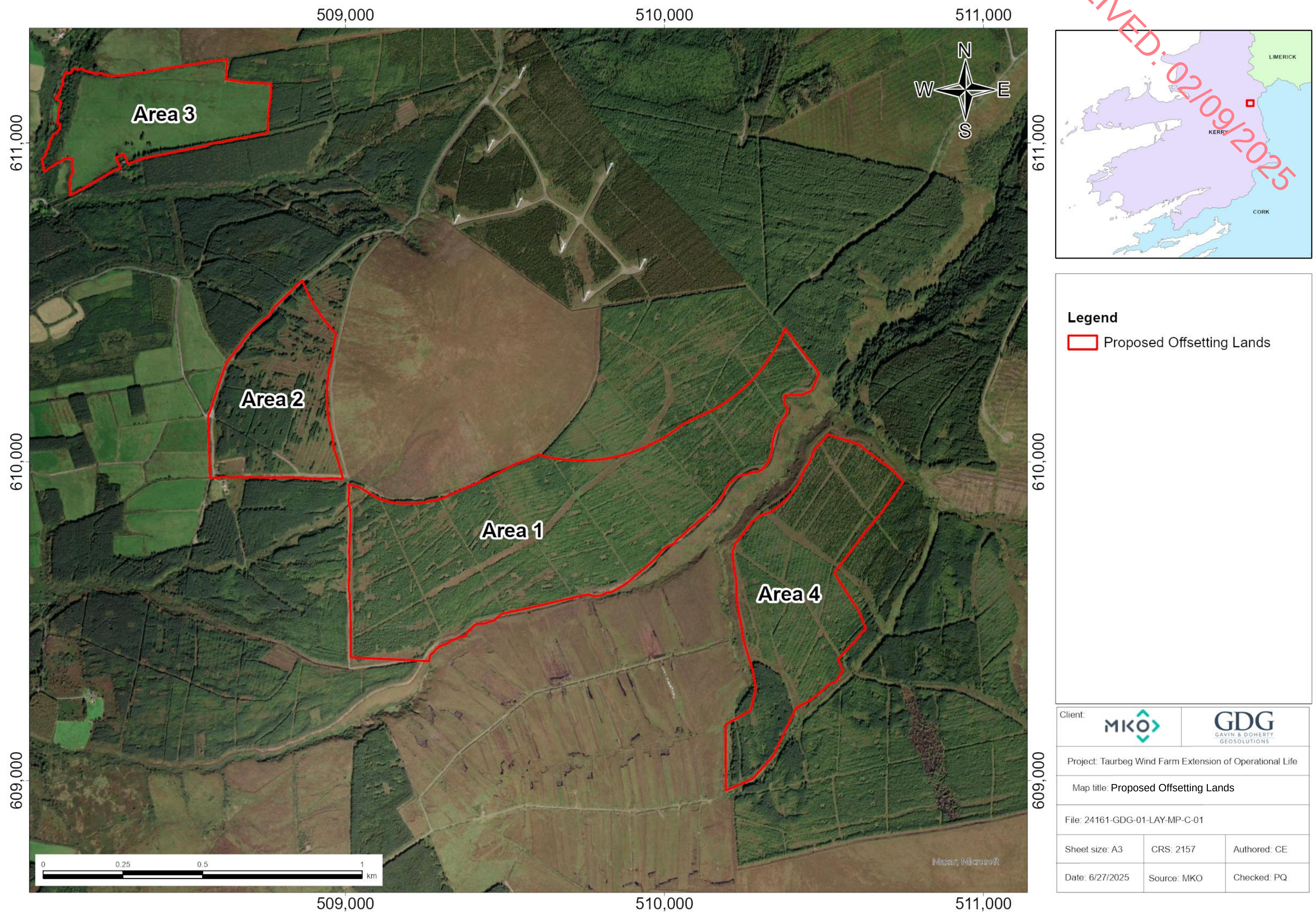

Figure A- 1: Proposed Offsetting Measures Location.

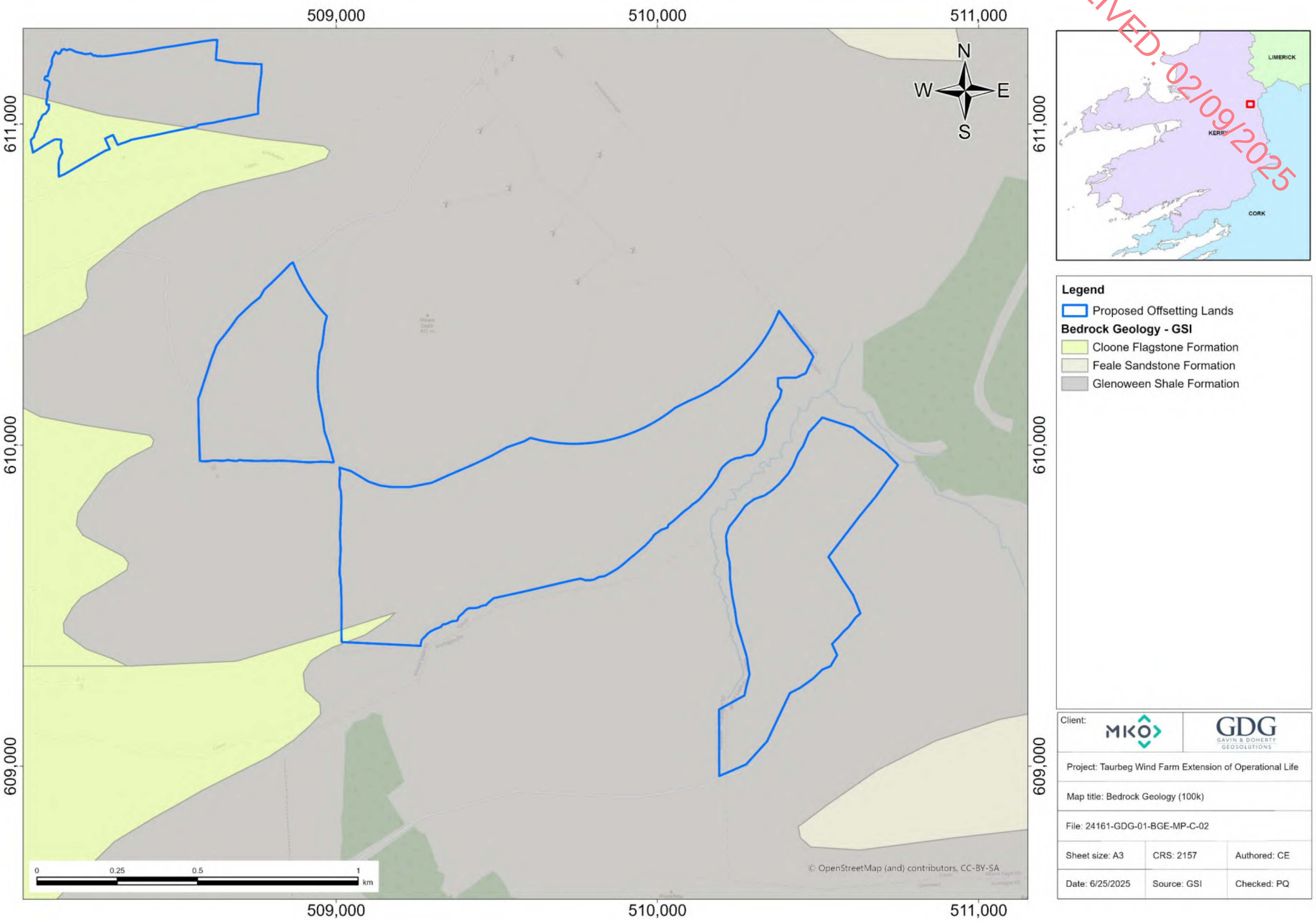

Figure B- 1: Bedrock Geology (GSI).

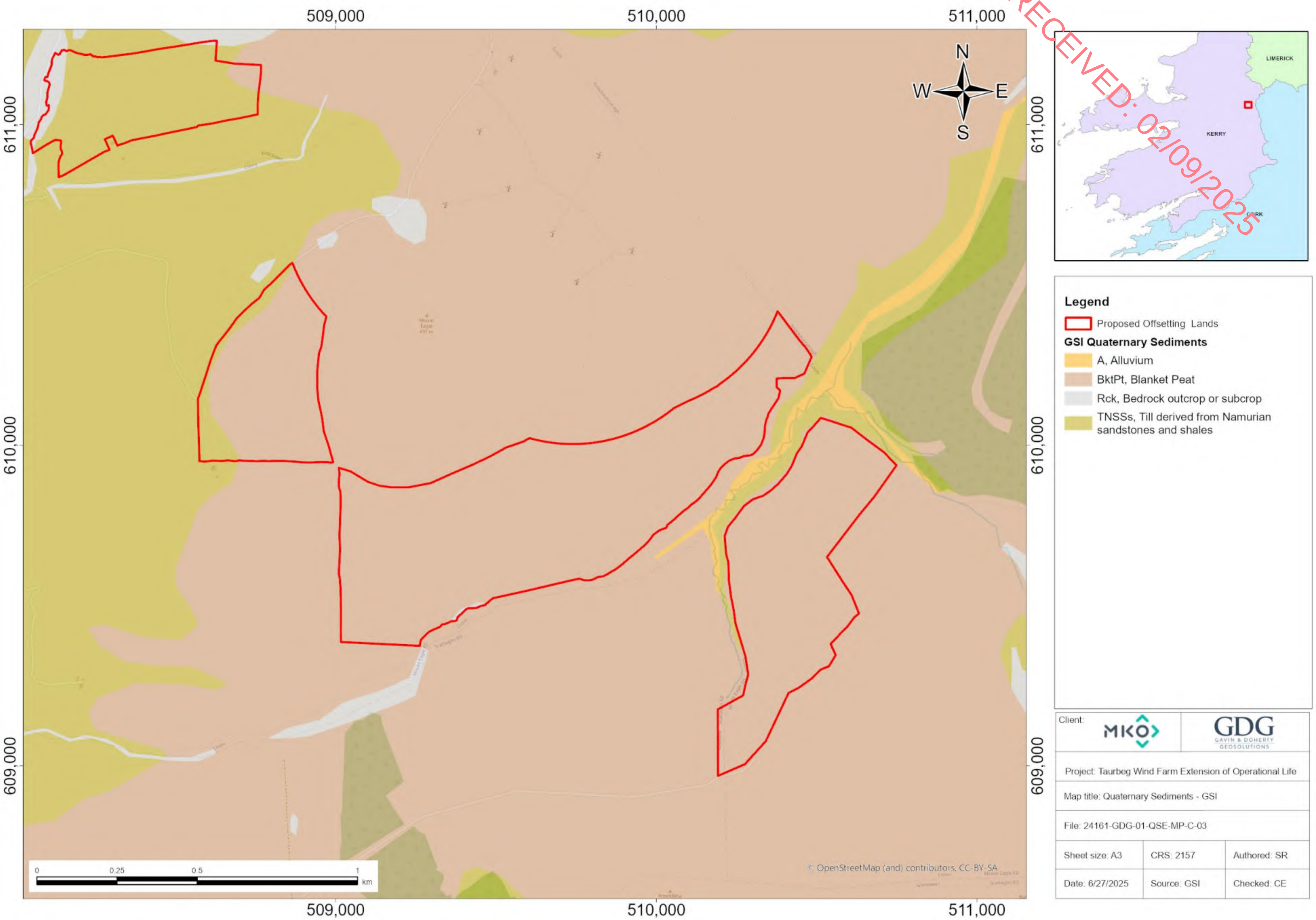

Figure B- 2: Quaternary Sediments (GSI).

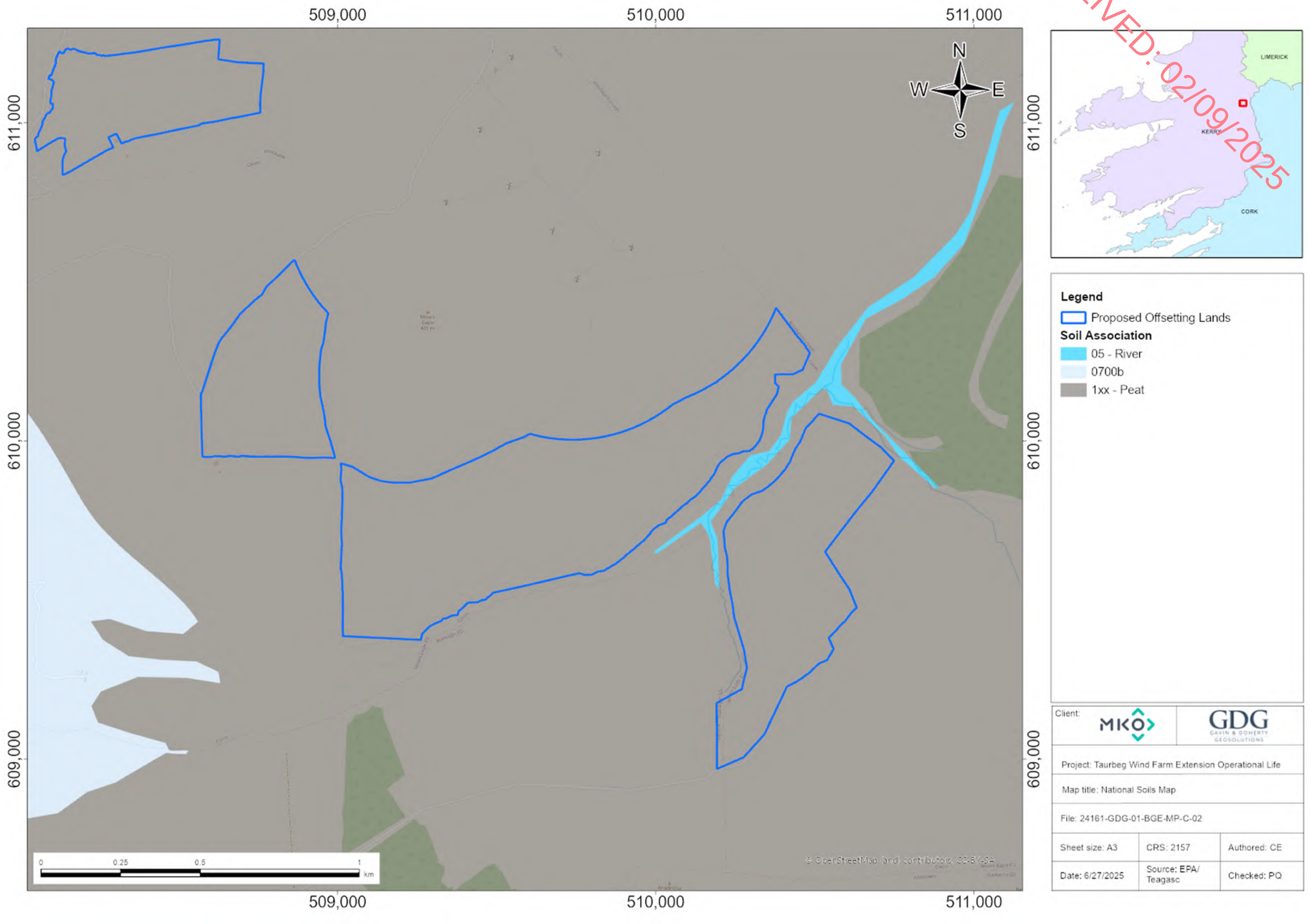

Figure C- 1: Soil Associations (EPA/Teagasc).

Appendix D MOISTURE

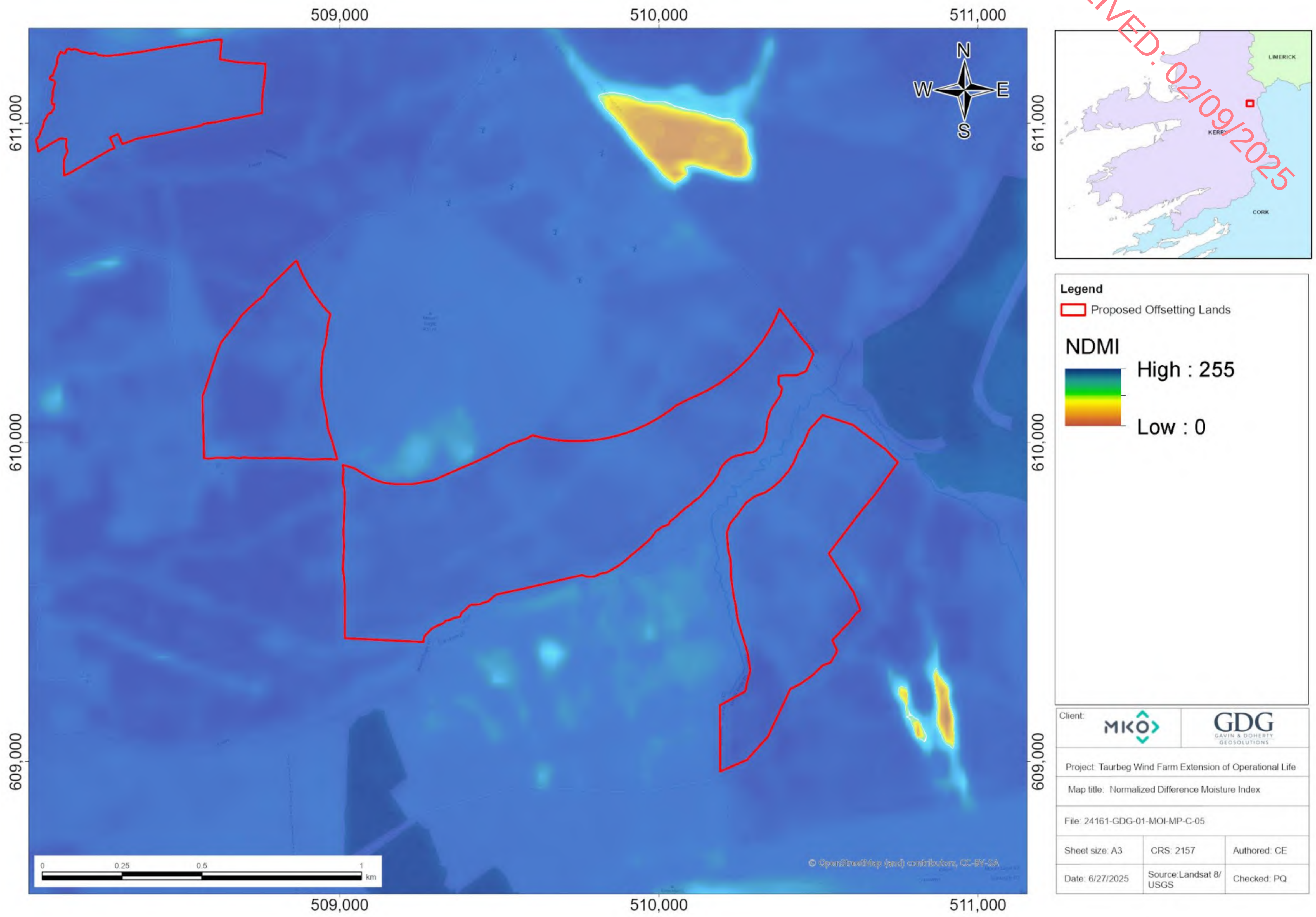

Figure D- 1: Normalised Difference Moisture Index (Landsat 8/USGS).

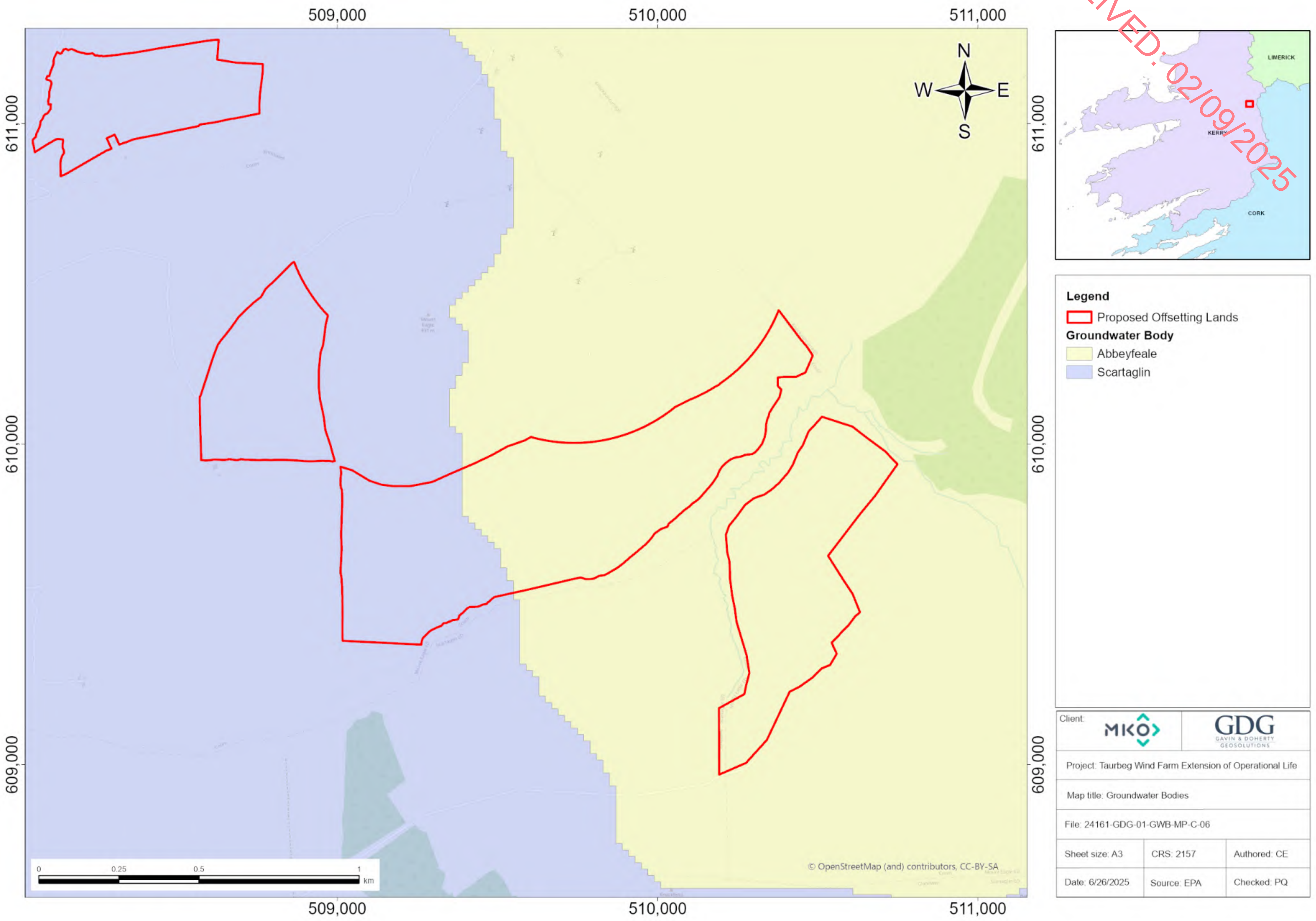

Figure E- 1: Groundwater Bodies (EPA).

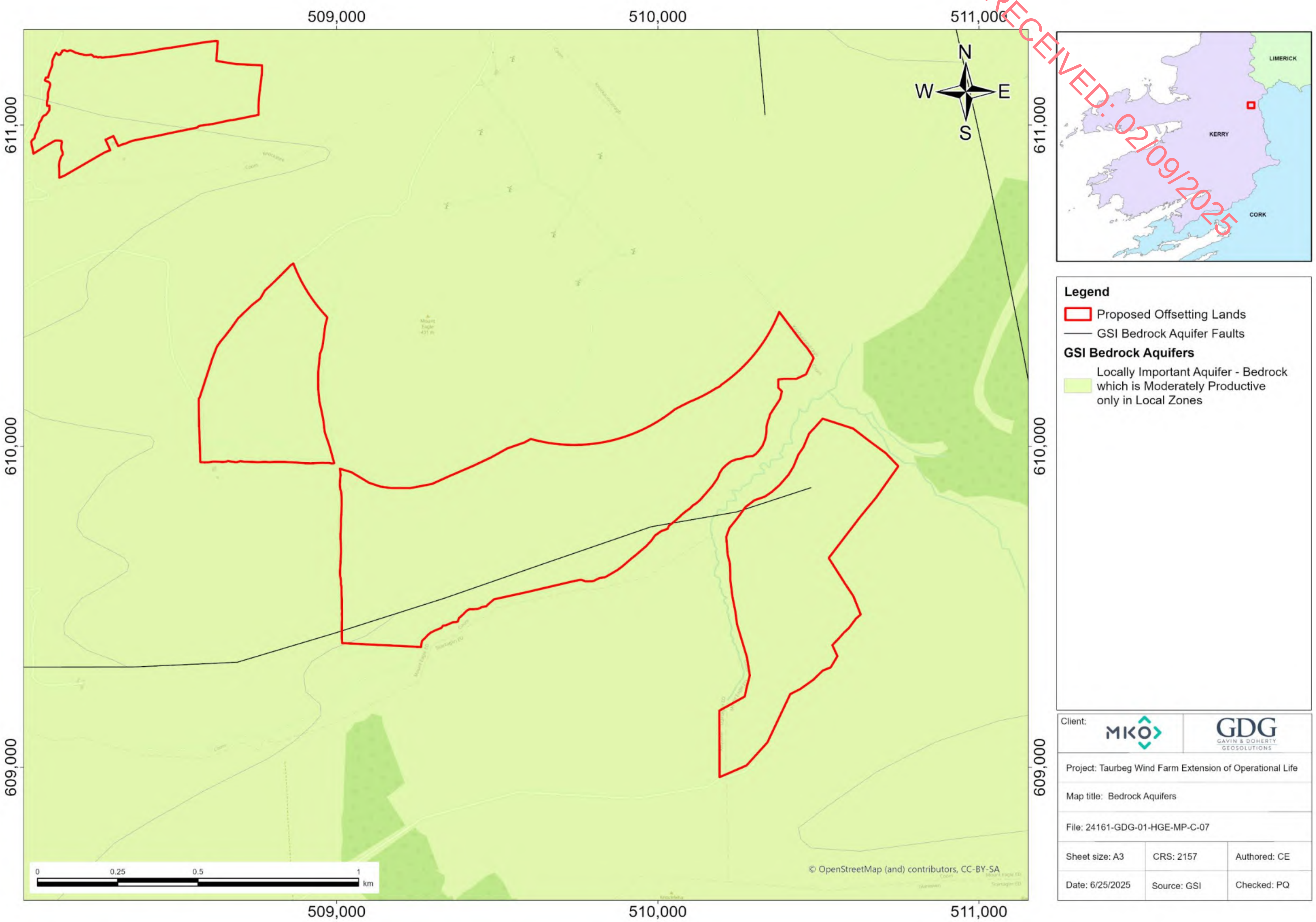

Figure E- 2: Bedrock Aquifers (GSI).

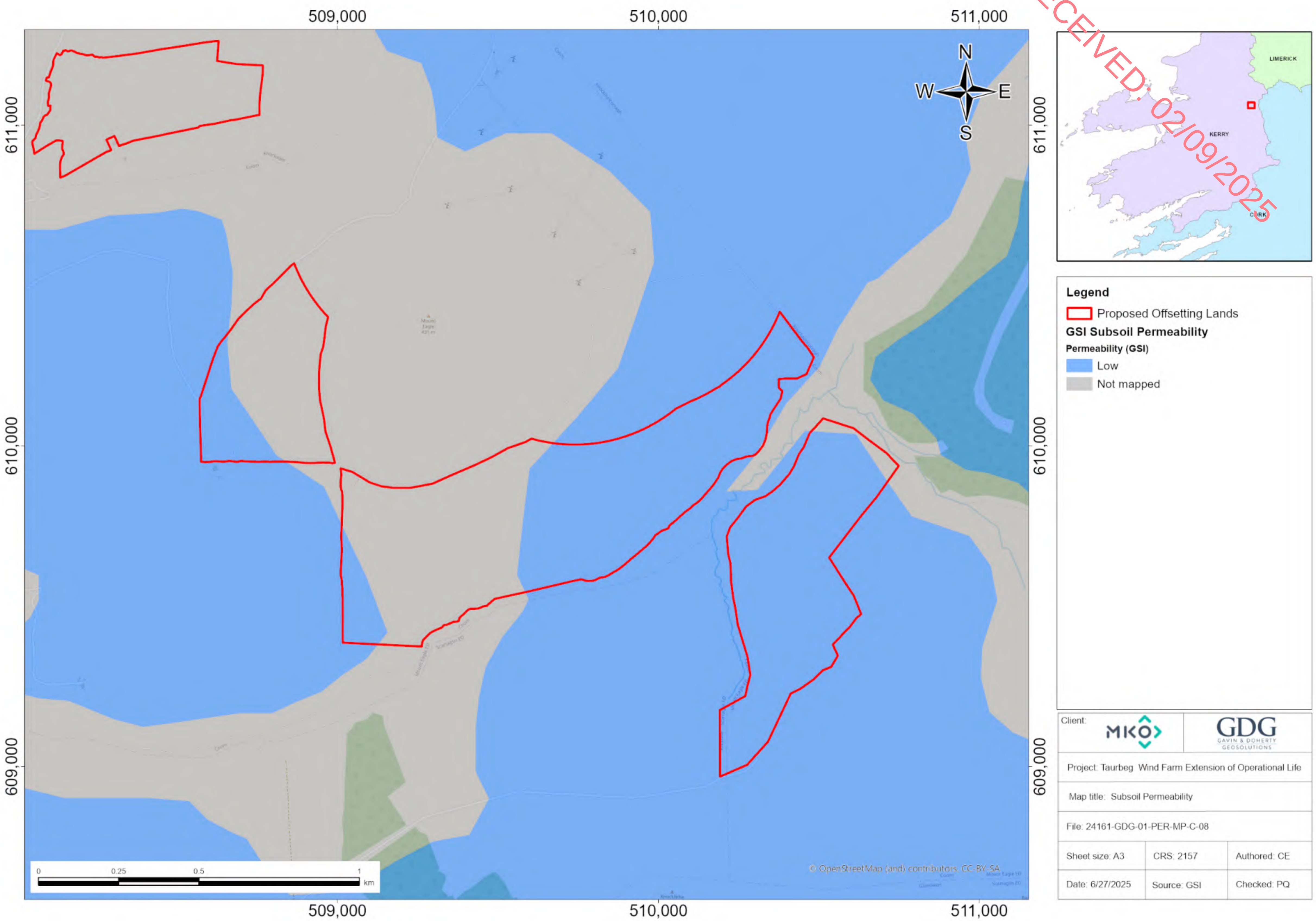

Figure E- 3: Subsoil Permeability (GSI).

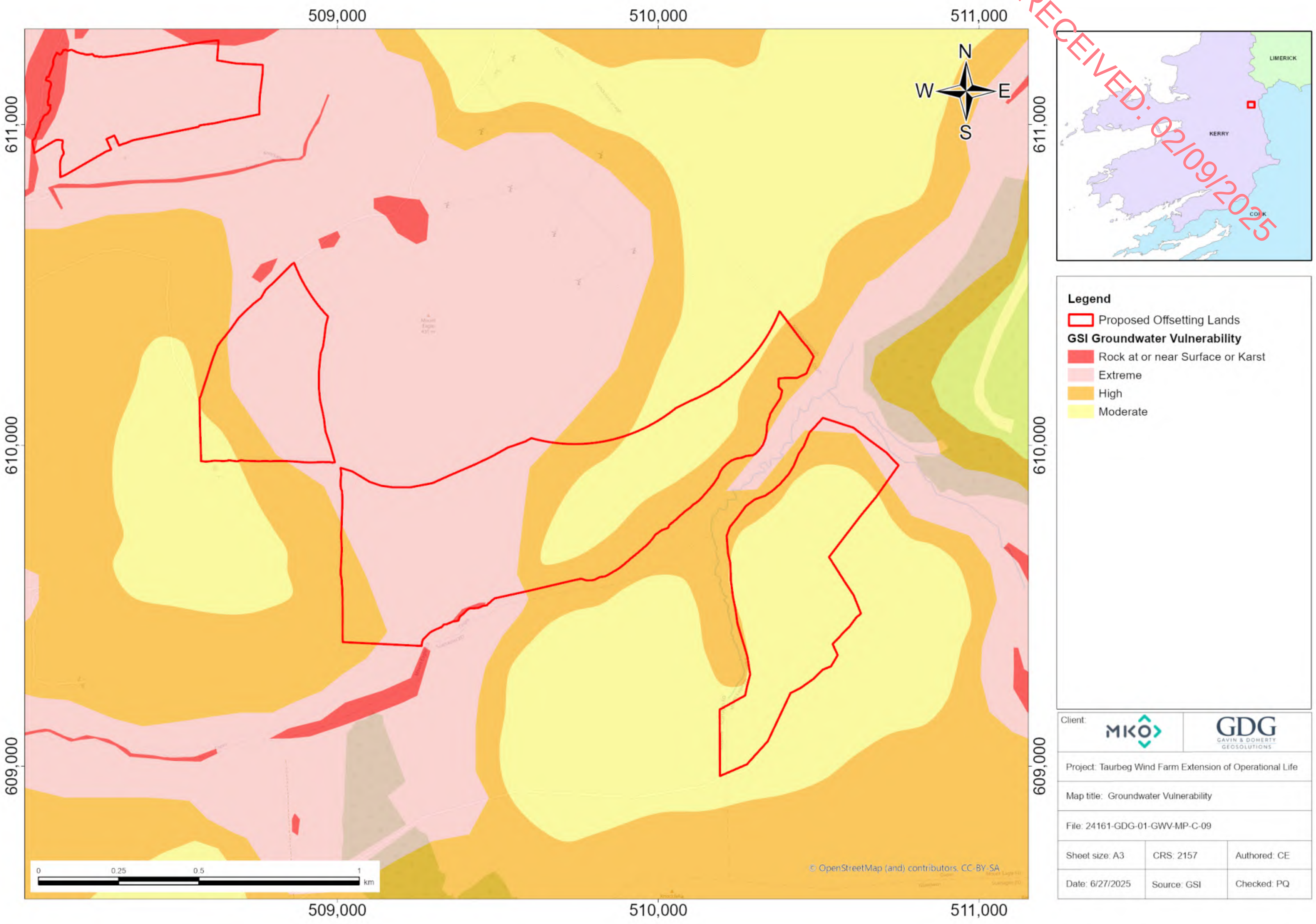

Figure E- 4: Groundwater Vulnerability (GSI).

Appendix F TOPOGRAPHY

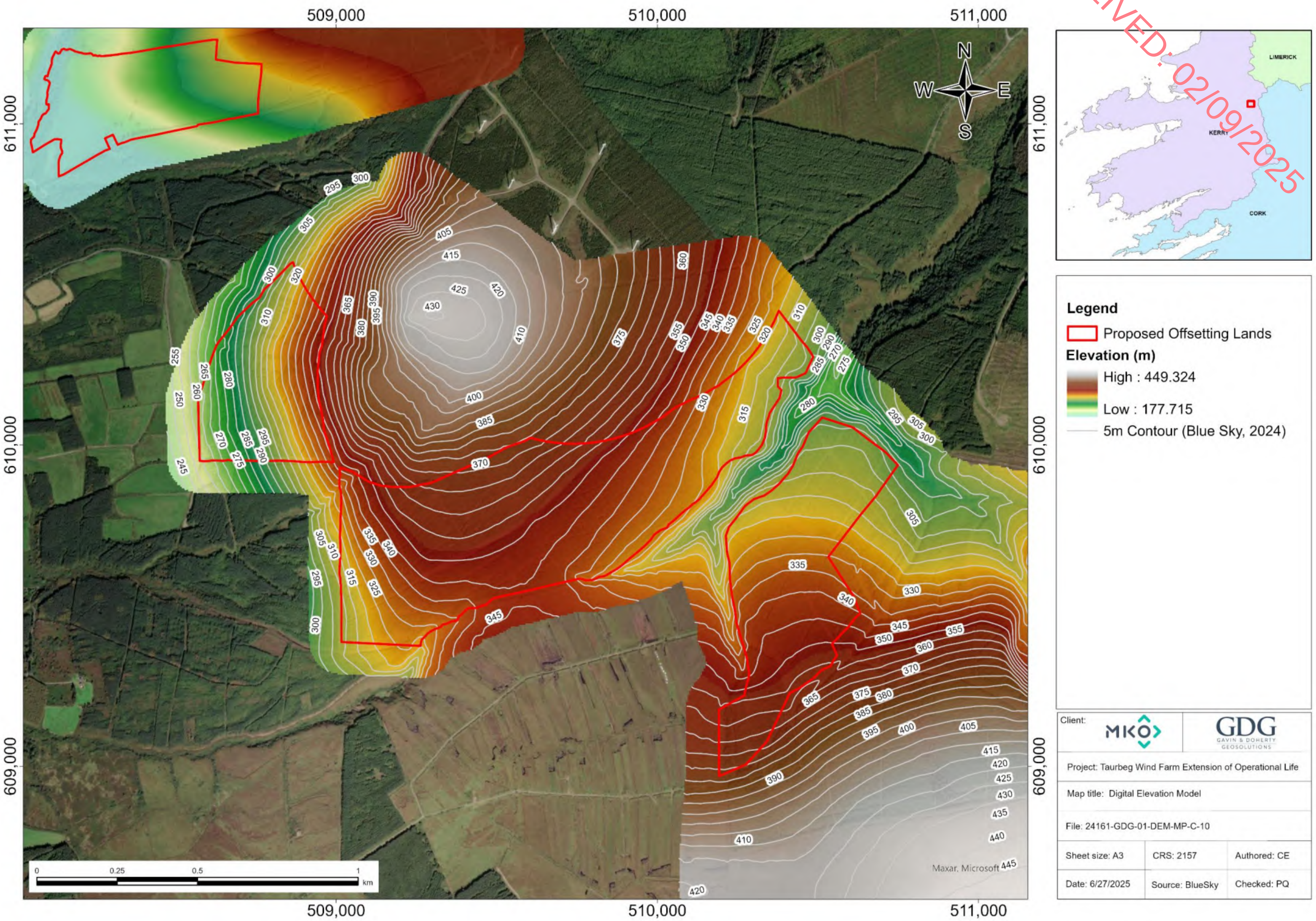

Figure F- 1: Digital Elevation Model (BlueSky, 2024).

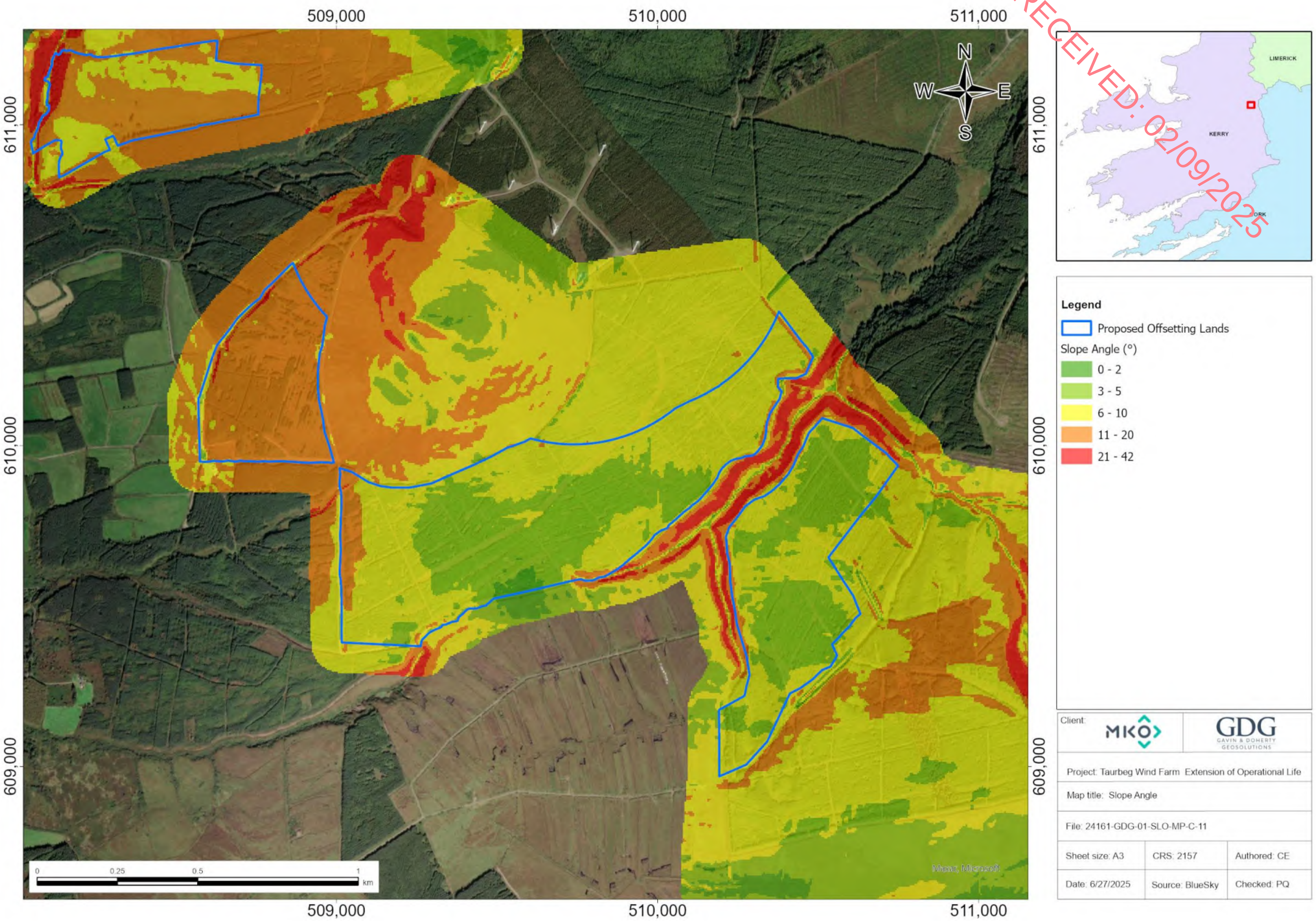

Figure F- 2: Slope Angles (Derived from BlueSky, 2024).

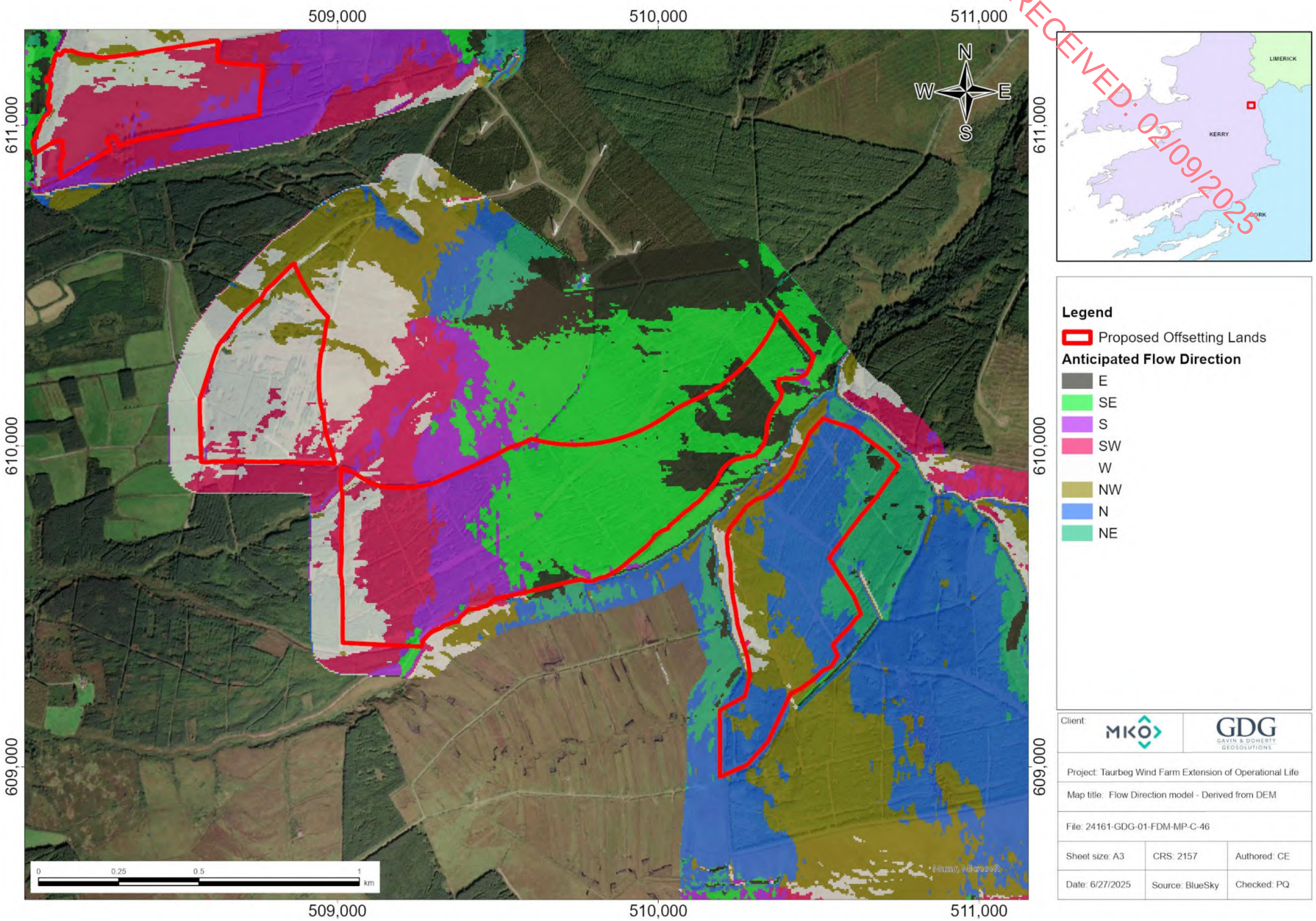

Figure F- 3: Flow Direction model – derived from DEM (BlueSky, 2024).

Appendix G Slope Instability Mapping

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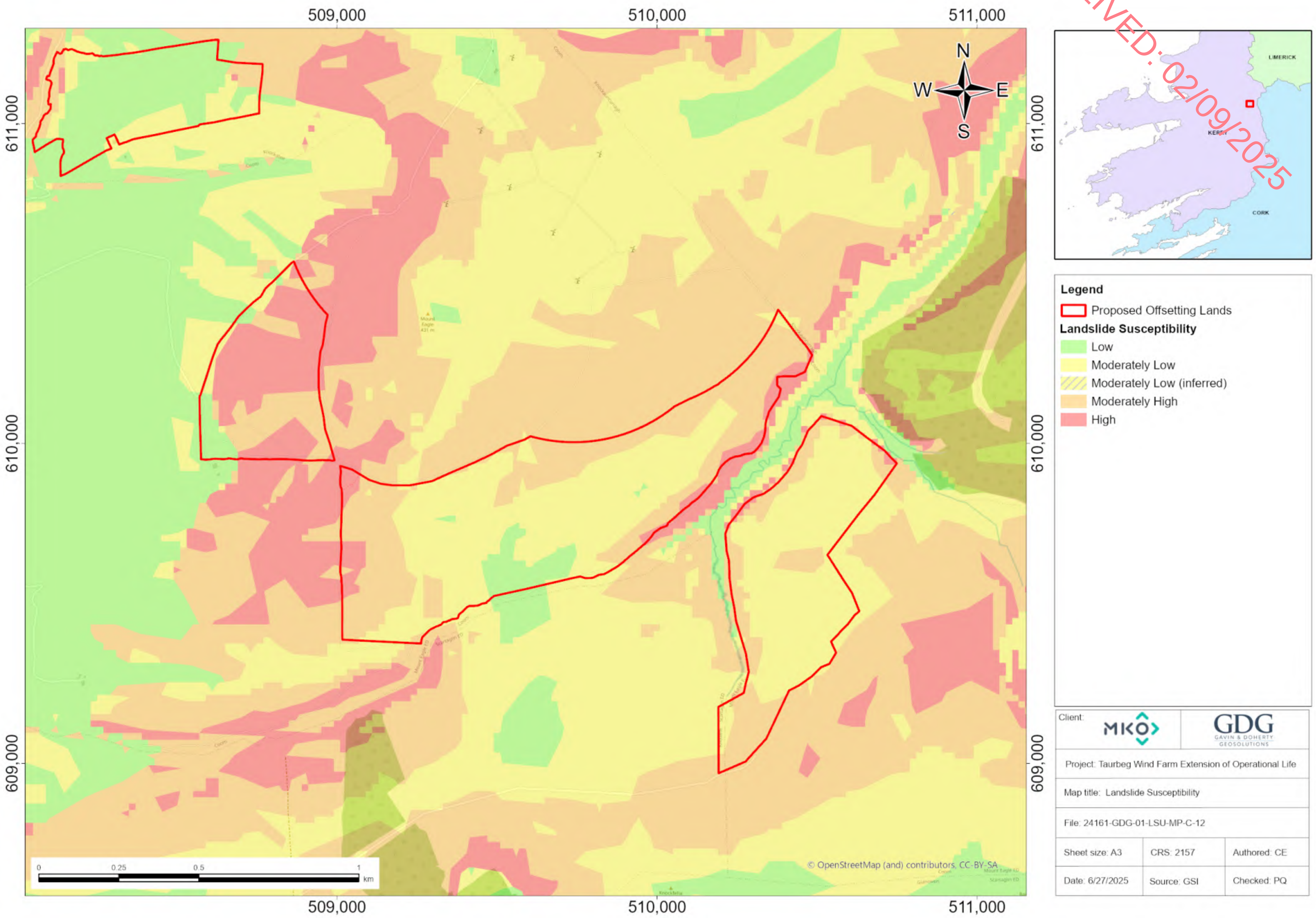

Figure G- 1: Landslide Susceptibility (GSI).

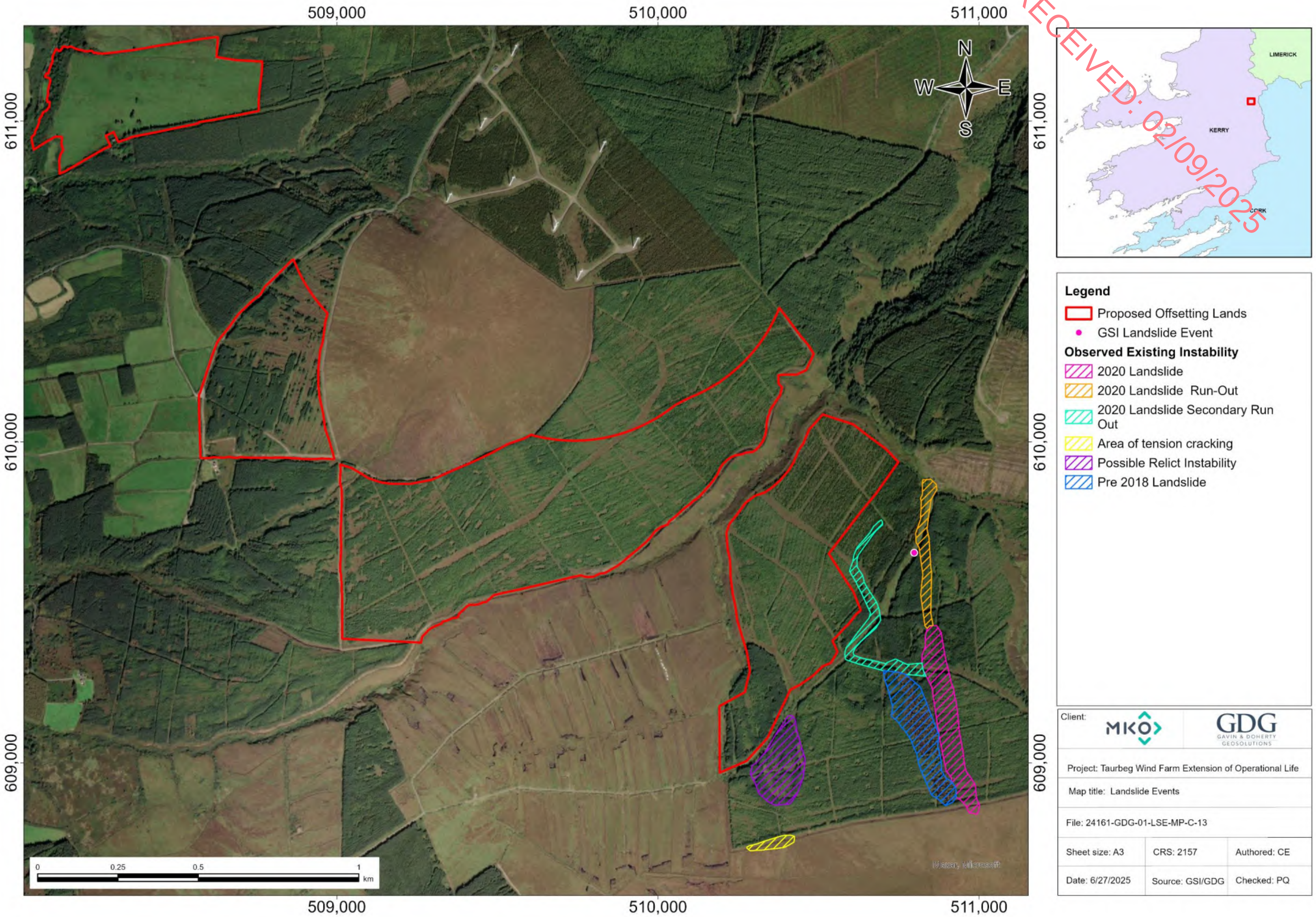

Figure G- 2: Landslide Events (GSI/GDG).

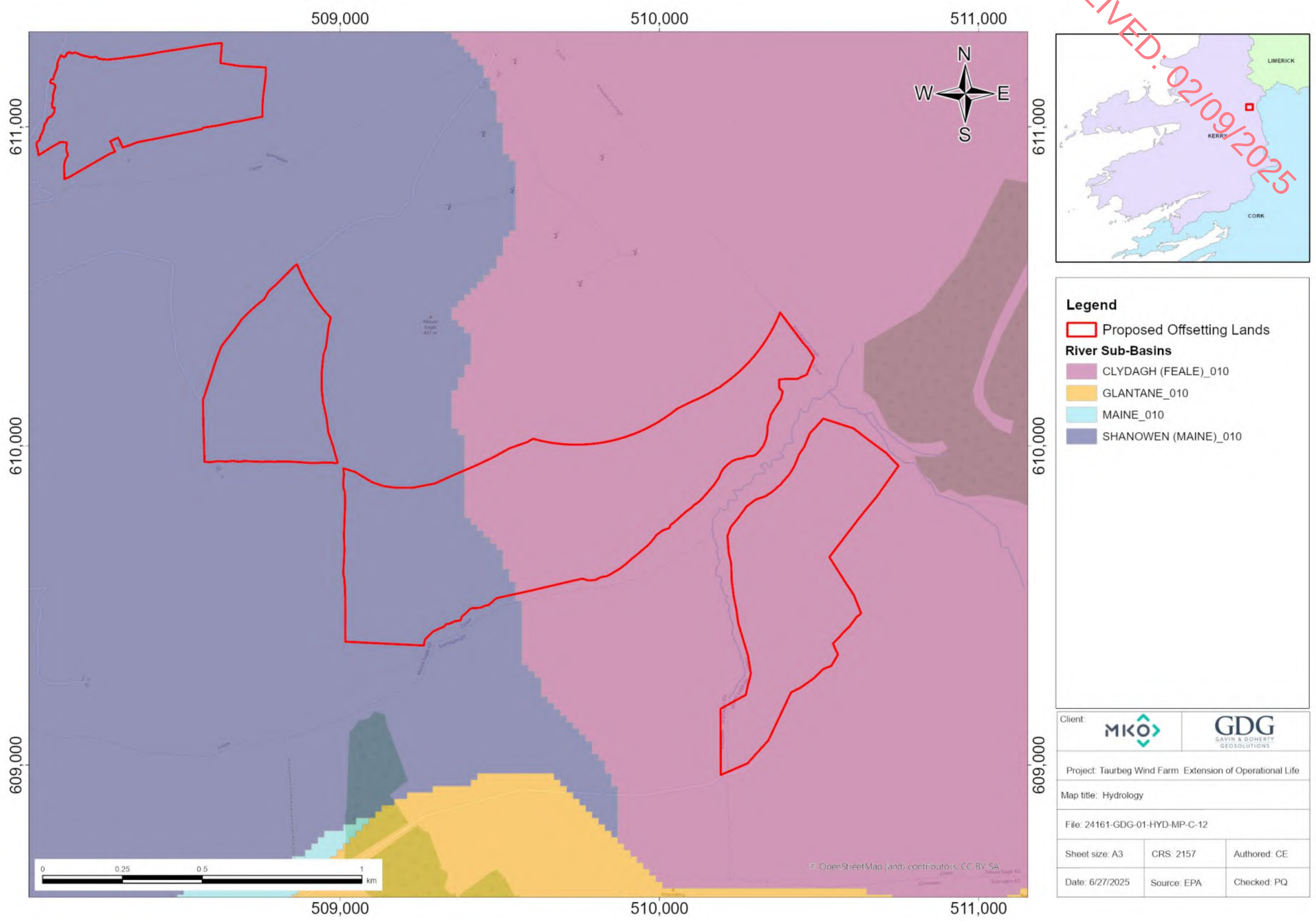

Figure H- 1: Hydrology (EPA).

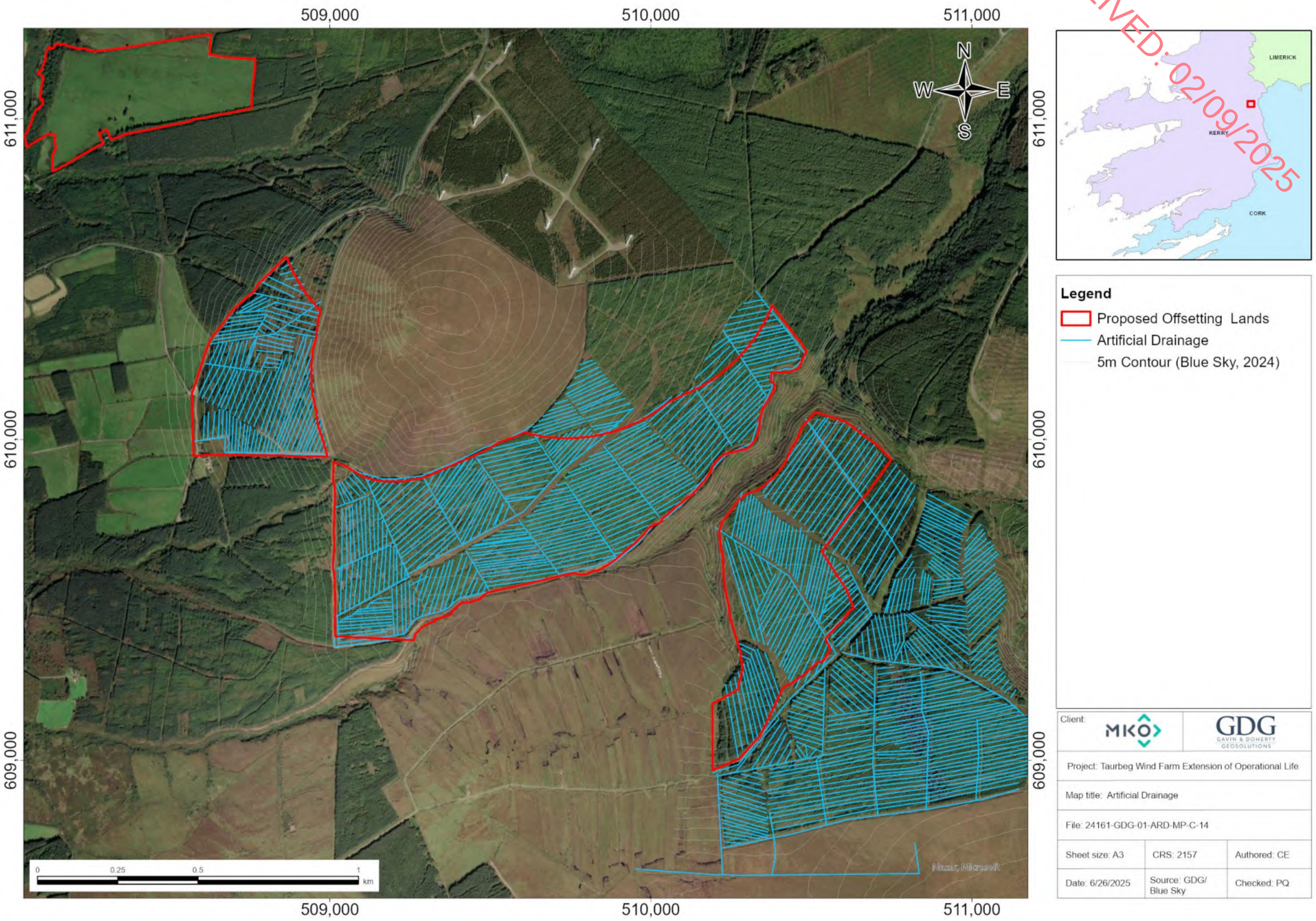

Figure I- 1: Artificial Drainage Network (from site observations and aerial imagery).

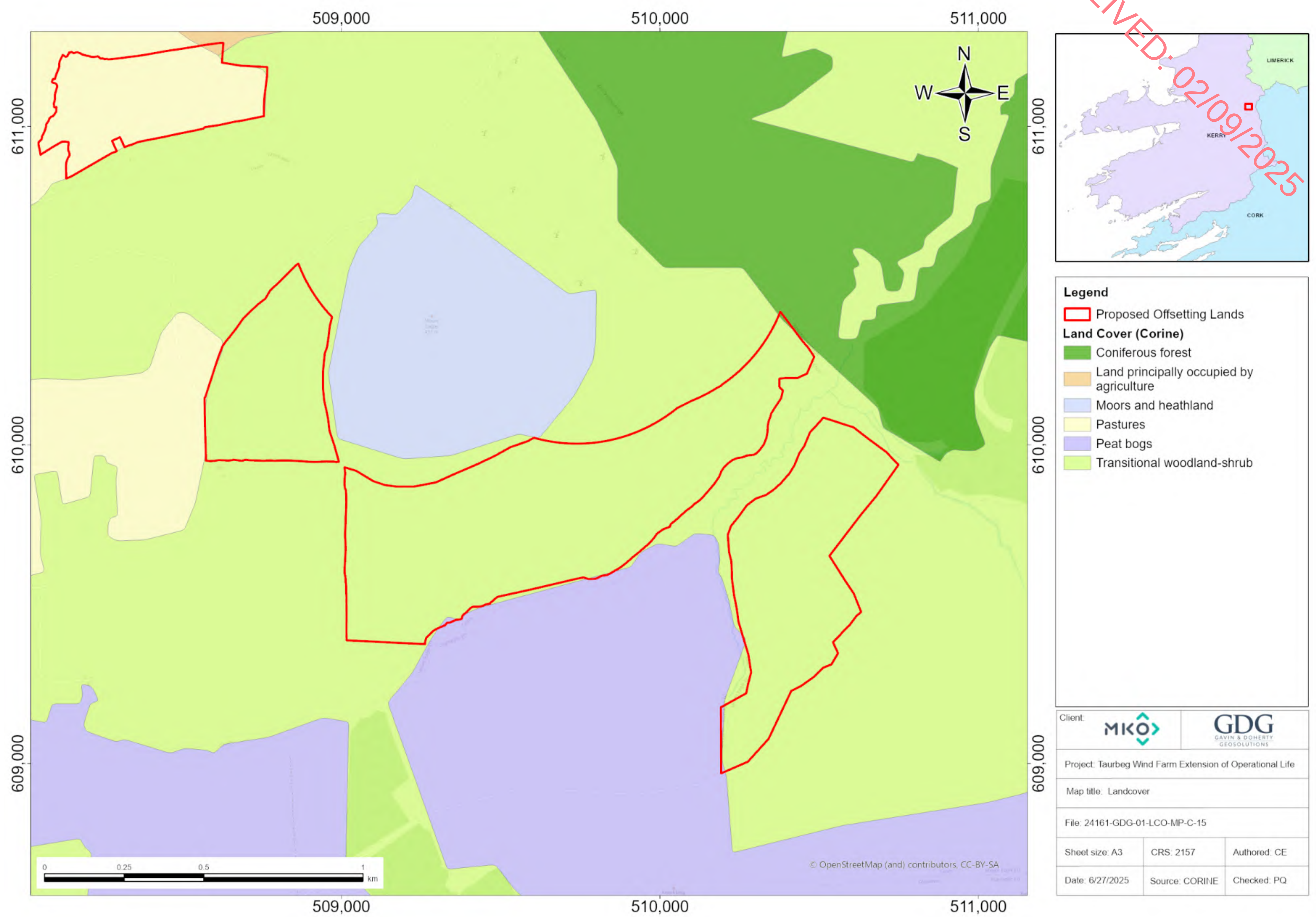

Figure J- 1: Corine Land Cover Mapping (2018).

Appendix K Special Areas of Conservation, Special Protection Areas and Rainfall Gauges

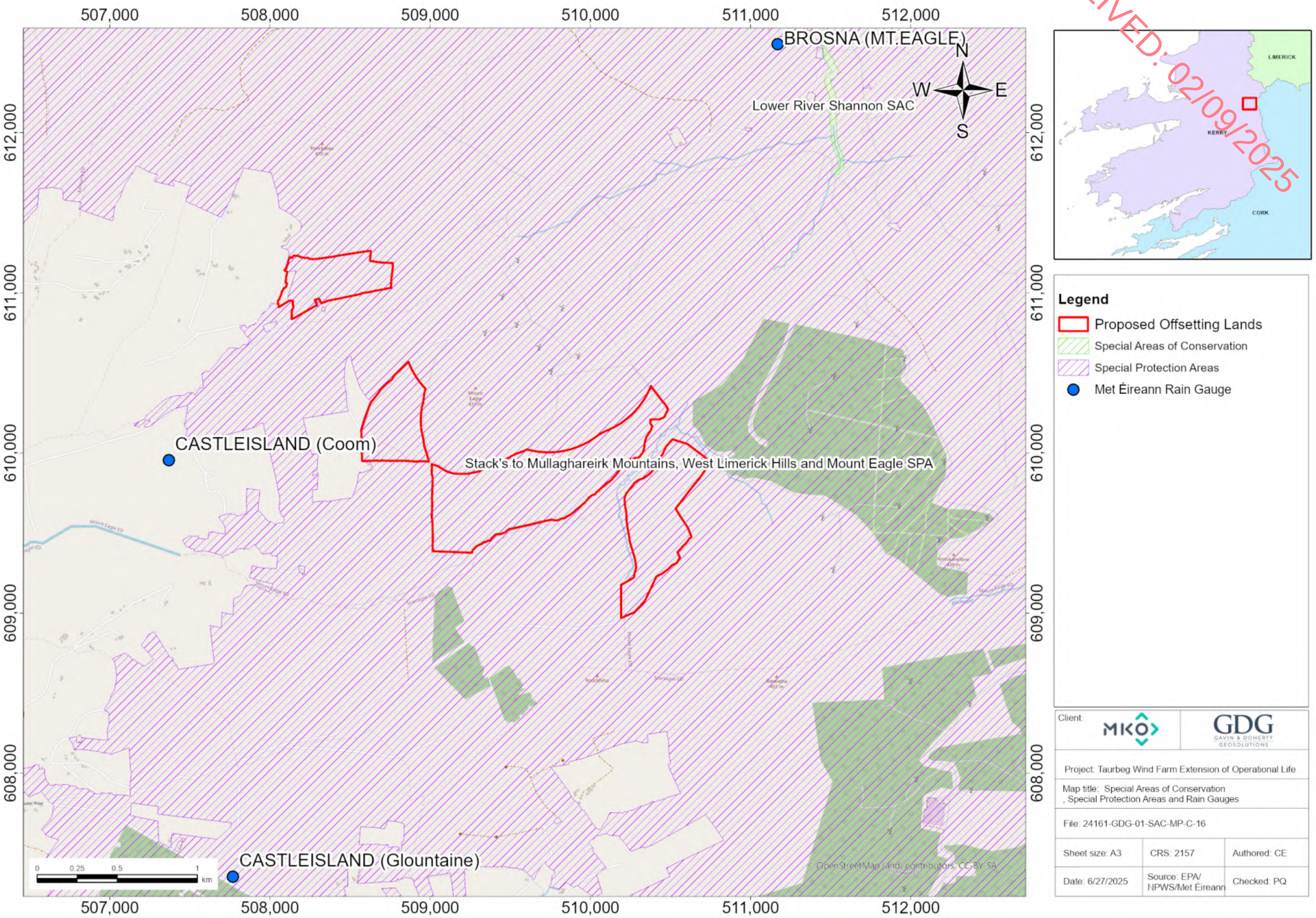

Figure K- 1: Special Areas of Conservation, Special Protection Areas, and Rainfall Gauges (EPA. NPS and Met Éireann).

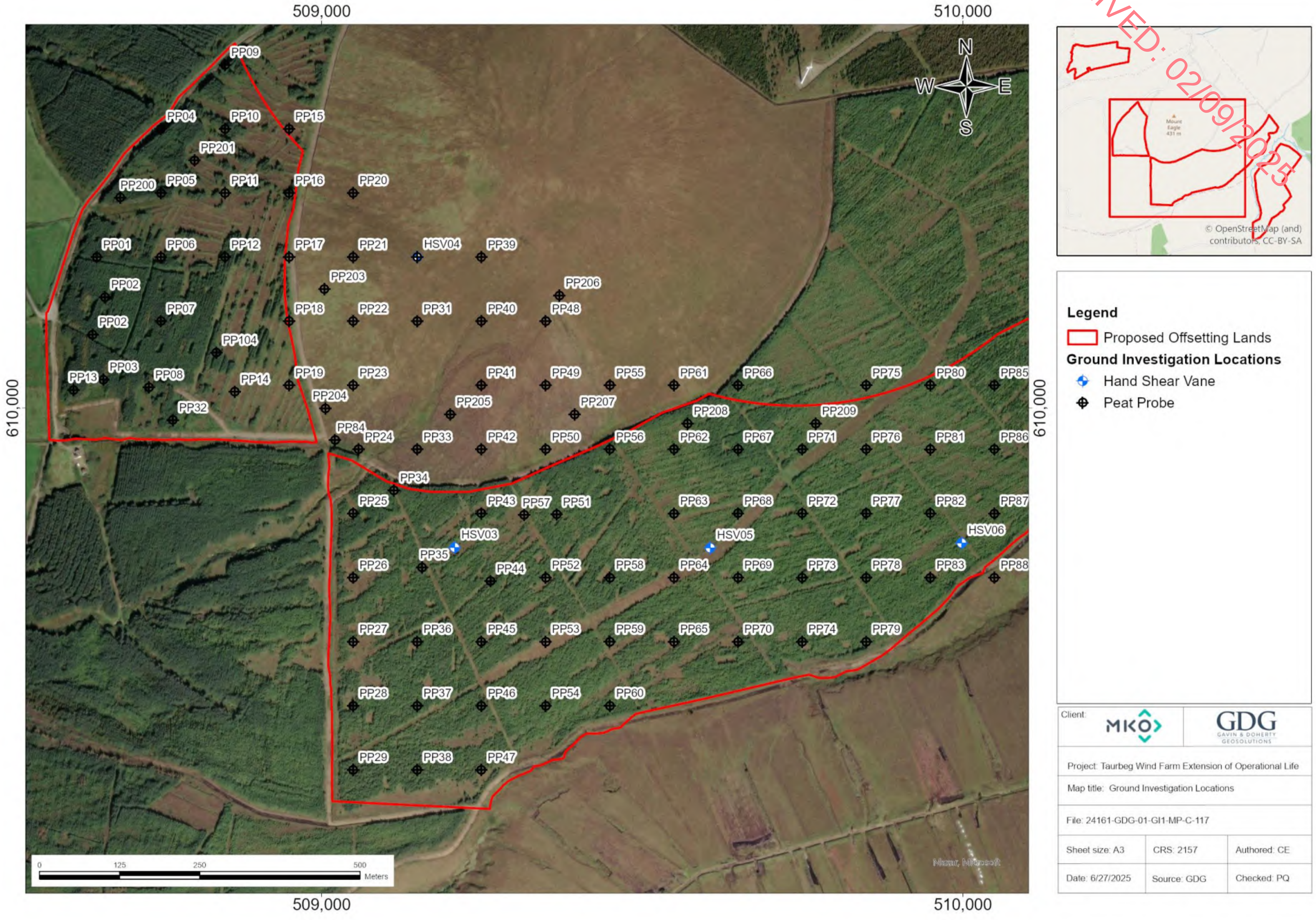

Figure L- 1: Ground Investigation Locations (1 of 2)

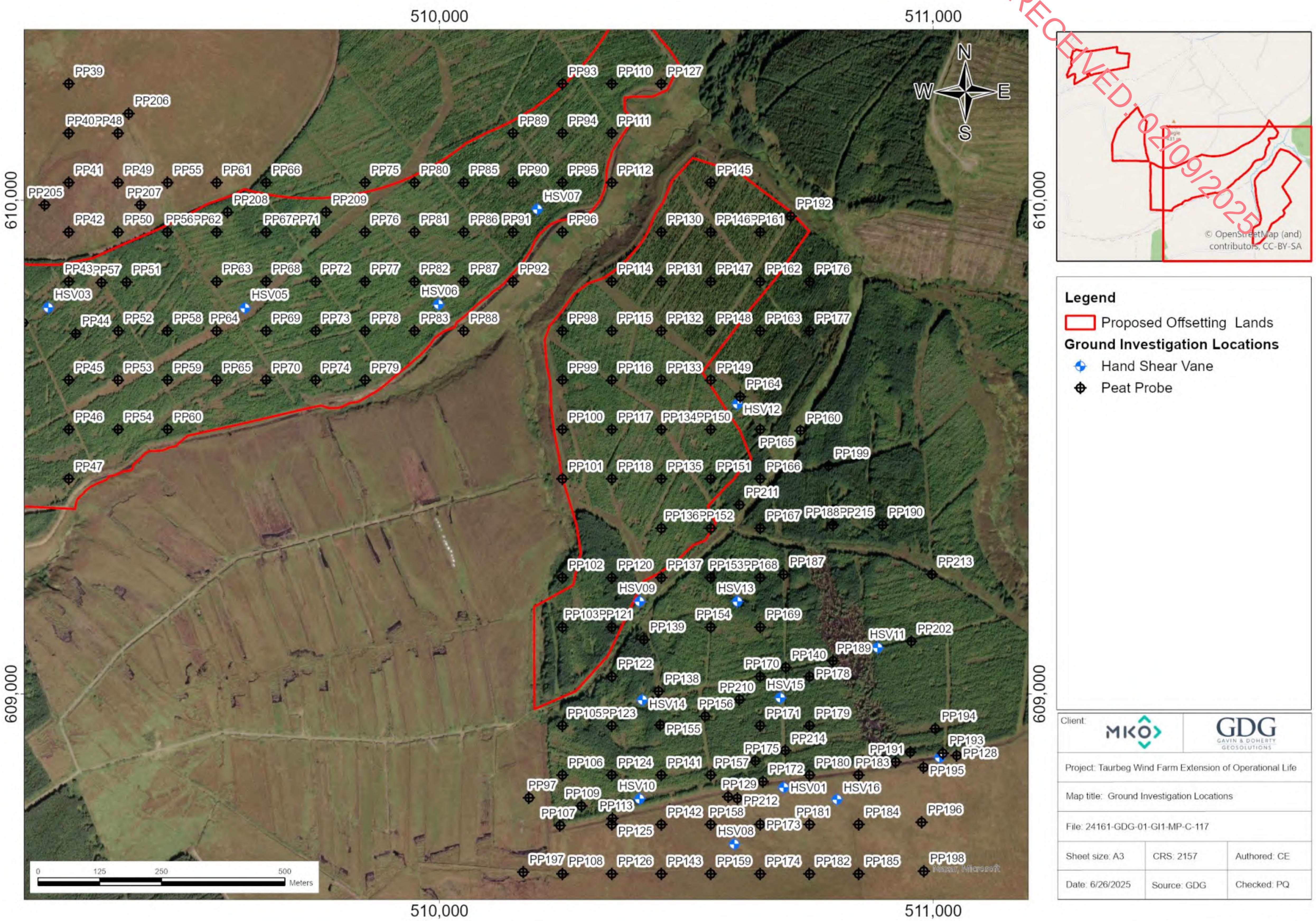

Figure L- 2: Ground Investigation Locations (2 of 2)

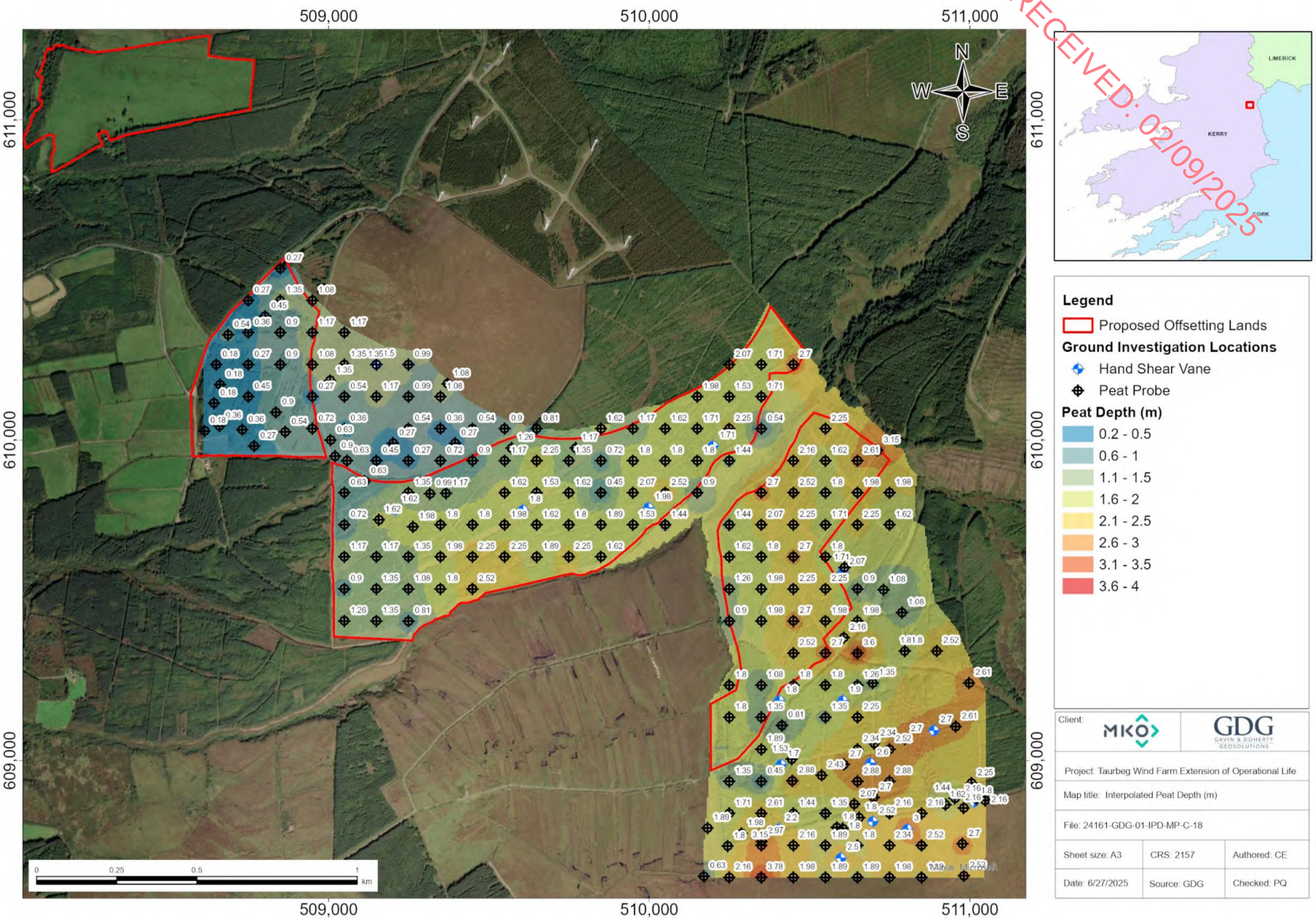

Figure L- 3: Interpolated Peat Depths.

Appendix M Factor of Safety

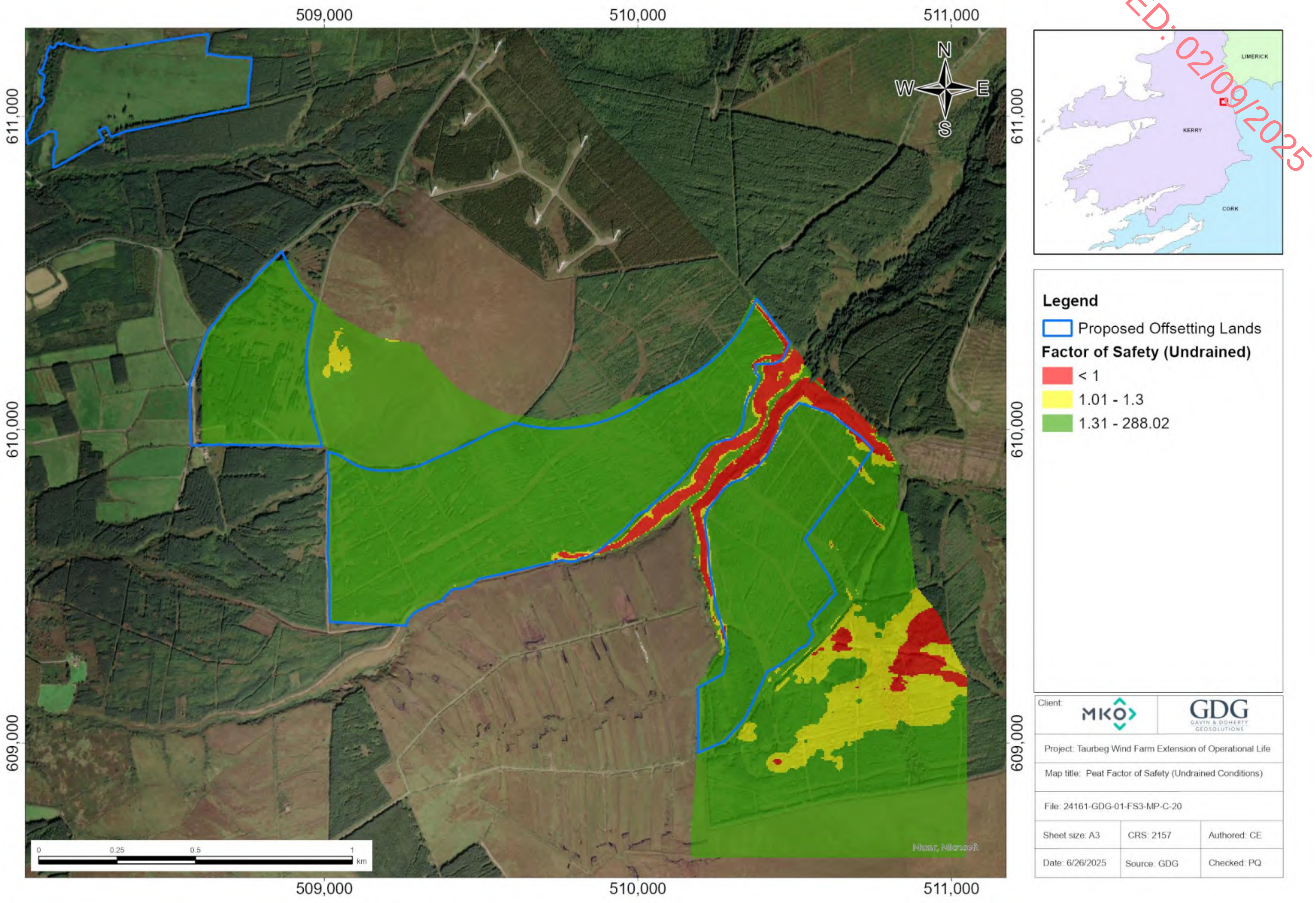

Figure M- 1: Peat Factor of Safety for Undrained Conditions.

***Area 3 contains no peat and so has not been assigned a peat FoS value, as this area was not included in the peat thickness interpolation.**

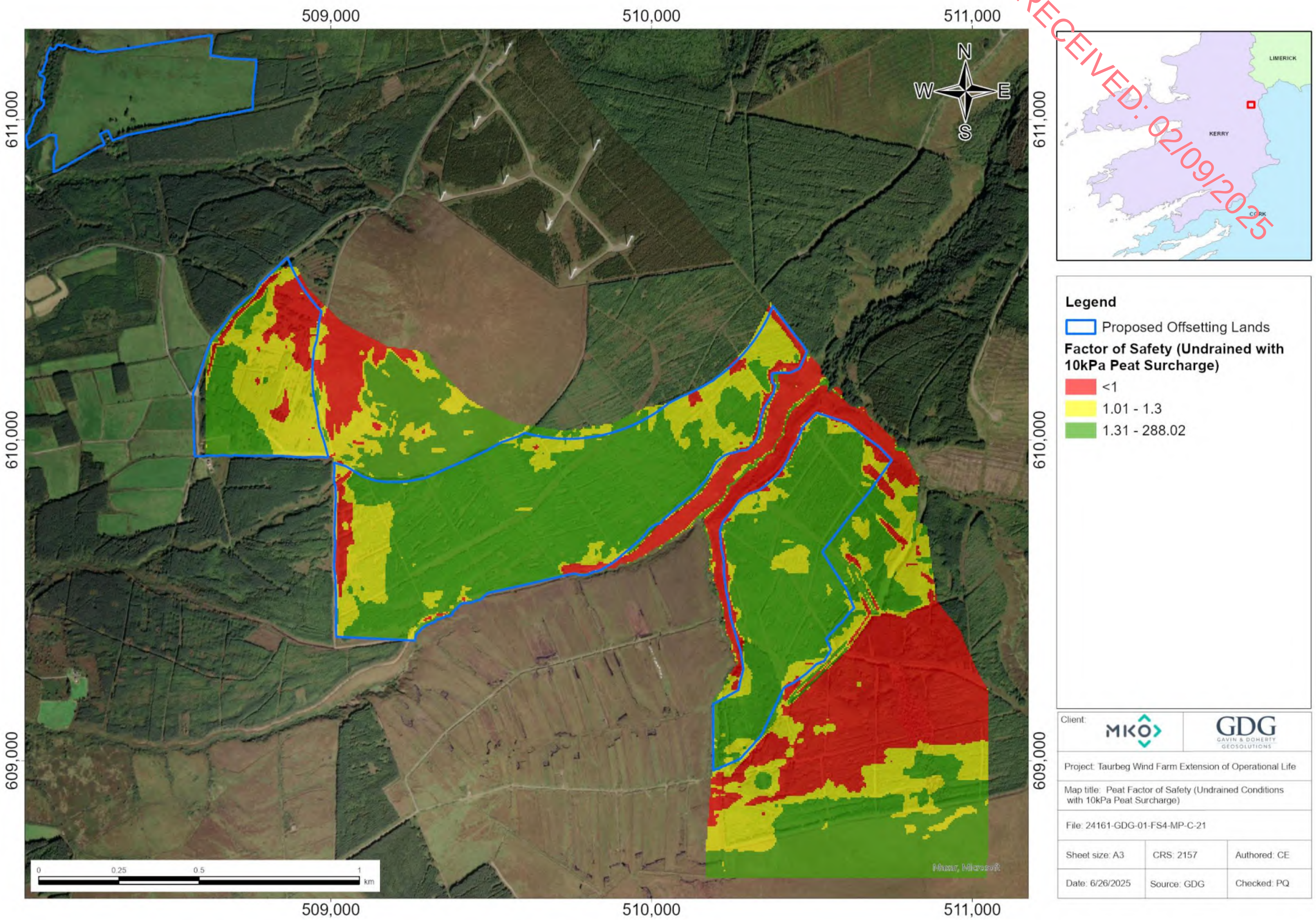

Figure M- 2: Peat Factor of Safety for Undrained Conditions with 10kPa Surcharge.

***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.**

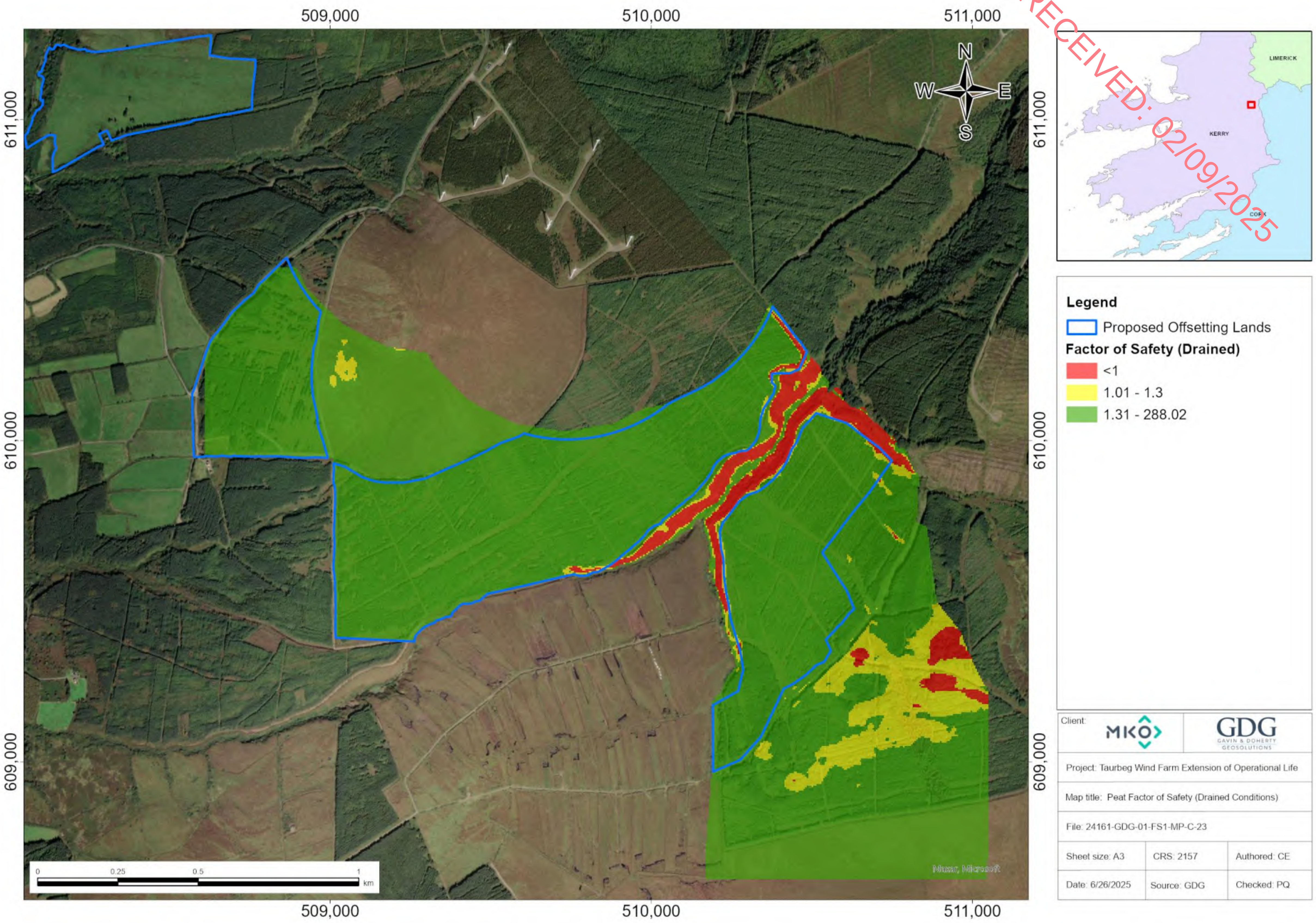

Figure M- 3: Peat Factor of Safety for Drained Conditions.

***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.**

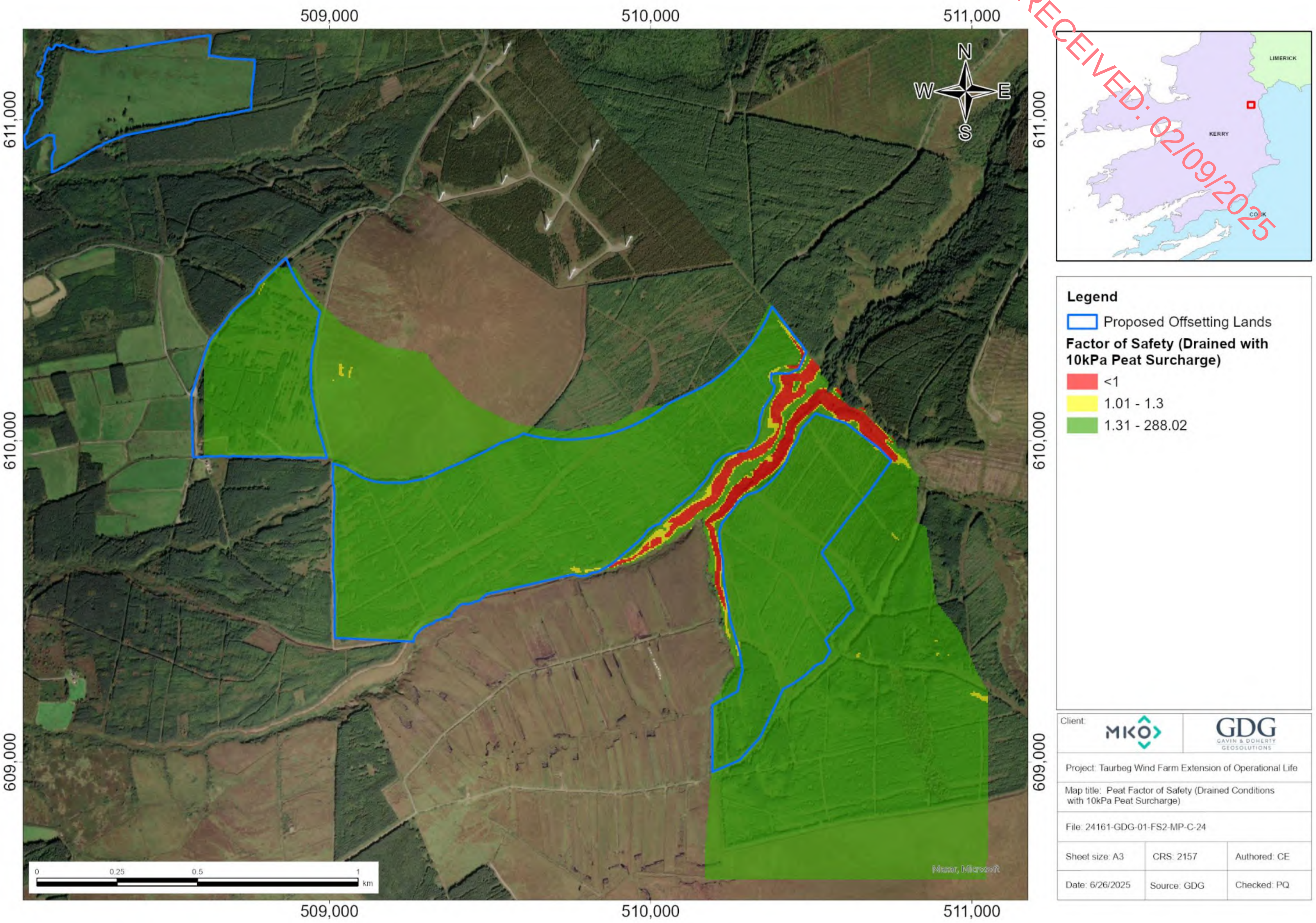

Figure M- 4: Peat Factor of Safety for Drained Conditions with 10kPa Surcharge.

***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**

Table M- 1: Factor of Safety for Undrained Conditions for GI Locations Within the Proposed Offsetting Measures Boundary.

GI Location	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/m³)	(m)		(m)		Rad
HSV03	6.1	0.994	0.107	4	10	1.6	2.33	1	1.44	0.106839
HSV05	6.9	0.993	0.120	4	10	1.8	1.87	1	1.20	0.119919
HSV06	5.5	0.995	0.095	4	10	2.0	2.13	1	1.42	0.095198
HSV07	6.4	0.994	0.111	4	10	1.7	2.11	1	1.33	0.111654
PP01	11.8	0.979	0.204	4	10	0.2	11.13	1	1.70	0.205394
PP02	11.8	0.979	0.204	4	10	0.2	11.15	1	1.70	0.205083
PP02	11.3	0.981	0.196	4	10	0.2	11.55	1	1.76	0.197561
PP03	11.9	0.979	0.206	4	10	0.4	5.51	1	1.46	0.207534
PP04	17.4	0.954	0.298	4	10	0.3	5.20	1	1.11	0.302947
PP05	13.2	0.974	0.228	4	10	0.4	5.00	1	1.32	0.230062
PP06	15.5	0.964	0.266	4	10	0.3	5.77	1	1.23	0.2697
PP07	14.8	0.967	0.256	4	10	0.5	3.60	1	1.12	0.2586
PP08	10.8	0.982	0.187	4	10	0.4	6.05	1	1.60	0.18822
PP09	13.3	0.973	0.230	4	10	0.3	6.62	1	1.41	0.232014
PP10	13.2	0.974	0.228	4	10	1.4	1.33	1	0.77	0.230239
PP11	14.3	0.969	0.247	4	10	0.9	1.86	1	0.88	0.249392
PP12	12.2	0.977	0.212	4	10	0.9	2.15	1	1.02	0.213386
PP13	10.6	0.983	0.184	4	10	0.18	12.26	1	1.87	0.185528
PP14	14.6	0.968	0.252	4	10	0.54	3.04	1	1.07	0.254478
PP16	10.2	0.984	0.178	4	10	1.17	1.95	1	1.05	0.178839
PP19	12.5	0.976	0.216	4	10	0.72	2.63	1	1.10	0.217664
PP25	14.0	0.970	0.242	4	10	0.63	2.71	1	1.05	0.244168
PP26	13.7	0.972	0.237	4	10	0.72	2.41	1	1.01	0.239187
PP27	10.3	0.984	0.179	4	10	1.17	1.94	1	1.05	0.180252
PP28	9.5	0.986	0.166	4	10	0.9	2.72	1	1.29	0.166438
PP29	8.8	0.988	0.152	4	10	1.26	2.11	1	1.17	0.153023
PP32	12.4	0.977	0.214	4	10	0.27	7.07	1	1.50	0.216145
PP34	8.7	0.989	0.150	4	10	0.63	4.27	1	1.65	0.150972
PP35	8.1	0.990	0.141	4	10	1.62	1.77	1	1.09	0.141533
PP36	8.7	0.989	0.151	4	10	1.17	2.29	1	1.23	0.151701
PP37	8.5	0.989	0.149	4	10	1.35	2.02	1	1.16	0.149192
PP38	6.3	0.994	0.110	4	10	1.35	2.70	1	1.55	0.110655
PP43	5.3	0.996	0.092	4	10	1.35	3.24	1	1.86	0.092037
PP44	4.5	0.997	0.079	4	10	1.98	2.57	1	1.71	0.078934
PP45	6.3	0.994	0.110	4	10	1.35	2.70	1	1.55	0.110659
PP46	6.3	0.994	0.109	4	10	1.08	3.41	1	1.77	0.109564
PP47	4.2	0.997	0.073	4	10	0.81	6.75	1	3.02	0.073435
PP51	4.4	0.997	0.076	4	10	1.17	4.52	1	2.44	0.075931
PP52	4.2	0.997	0.073	4	10	1.8	3.04	1	1.95	0.07337
PP53	4.1	0.997	0.072	4	10	1.98	2.83	1	1.88	0.071672
PP54	5.4	0.996	0.094	4	10	1.8	2.37	1	1.52	0.09431
PP56	5.7	0.995	0.100	4	10	0.9	4.47	1	2.12	0.100024
PP57	4.5	0.997	0.079	4	10	0.99	5.15	1	2.56	0.078835
PP58	4.0	0.998	0.070	4	10	1.8	3.16	1	2.03	0.07054
PP59	3.7	0.998	0.064	4	10	2.25	2.78	1	1.93	0.064102
PP60	3.3	0.998	0.058	4	10	2.52	2.75	1	1.97	0.057862
PP62	5.9	0.995	0.103	4	10	1.17	3.34	1	1.80	0.103156
PP63	5.2	0.996	0.090	4	10	1.62	2.75	1	1.70	0.090299
PP64	3.9	0.998	0.068	4	10	1.98	2.98	1	1.98	0.068015
PP65	2.8	0.999	0.048	4	10	2.25	3.70	1	2.56	0.048077
PP67	6.5	0.994	0.114	4	10	2.25	1.57	1	1.09	0.11394
PP68	4.7	0.997	0.082	4	10	1.53	3.21	1	1.94	0.081932
PP69	3.1	0.999	0.053	4	10	1.62	4.64	1	2.87	0.053357
PP70	2.9	0.999	0.050	4	10	1.89	4.26	1	2.79	0.049762
PP71	6.9	0.993	0.121	4	10	1.35	2.47	1	1.42	0.120998
PP72	4.4	0.997	0.076	4	10	1.62	3.26	1	2.02	0.076031
PP73	3.1	0.999	0.055	4	10	1.8	4.07	1	2.62	0.054664
PP74	3.7	0.998	0.065	4	10	2.25	2.74	1	1.90	0.065067
PP76	4.5	0.997	0.078	4	10	0.72	7.17	1	3.00	0.077831
PP77	4.0	0.998	0.070	4	10	0.45	12.82	1	3.98	0.069578
PP78	4.7	0.997	0.082	4	10	1.89	2.58	1	1.69	0.08237
PP79	6.3	0.994	0.109	4	10	1.62	2.27	1	1.40	0.109609
PP80	7.9	0.990	0.138	4	10	1.17	2.50	1	1.35	0.138384
PP81	4.8	0.996	0.084	4	10	1.8	2.65	1	1.70	0.084342
PP82	4.4	0.997	0.076	4	10	2.07	2.54	1	1.71	0.076442
PP83	5.3	0.996	0.092	4	10	1.53	2.84	1	1.72	0.092573
PP85	6.5	0.994	0.113	4	10	1.62	2.20	1	1.36	0.113297
PP86	4.9	0.996	0.086	4	10	1.8	2.59	1	1.67	0.086202
PP87	4.5	0.997	0.078	4	10	2.52	2.03	1	1.46	0.078345
PP89	8.0	0.990	0.139	4	10	1.98	1.47	1	0.97	0.139702
PP90	6.3	0.994	0.110	4	10	1.71	2.15	1	1.35	0.109837
PP91	5.3	0.996	0.092	4	10	1.8	2.43	1	1.56	0.092046
PP94	6.3	0.994	0.110	4	10	1.53	2.38	1	1.44	0.1106
PP95	5.8	0.995	0.100	4	10	2.25	1.78	1	1.23	0.100605
PP98	4.9	0.996	0.086	4	10	1.44	3.24	1	1.91	0.086238
PP99	5.8	0.995	0.101	4	10	1.62	2.45	1	1.51	0.101668
PP100	6.8	0.993	0.119	4	10	1.3	2.68	1	1.50	0.119378
PP103	4.8	0.996	0.084	4	10	1.8	2.65	1	1.70	0.084381
PP104	13.4	0.973	0.232	4	10	0.9	1.97	1	0.93	0.233714
PP110	6.7	0.993	0.117	4	10	1.7	2.01	1	1.27	0.117367
PP111	8.5	0.989	0.148	4	10	1.7	1.60	1	1.01	0.148724
PP114	6.2	0.994	0.108	4	10	2.7	1.37	1	1.00	0.108666
PP115	4.8	0.997	0.083	4	10	2.07	2.34	1	1.58	0.082905
PP116	5.6	0.995	0.097	4	10	1.8	2.29	1	1.47	0.097482
PP117	4.8	0.996	0.084	4	10	1.98	2.42	1	1.61	0.083895
PP118	2.8	0.999	0.049	4	10	1.98	4.11	1	2.73	0.049175
PP120	6.0	0.995	0.104	4	10	1.08	3.59	1	1.86	0.1039
PP121	4.8	0.996	0.084	4	10	1.35	3.52	1	2.02	0.084468
PP127	8.7	0.988	0.151	4	10	2.7	0.99	1	0.72	0.151809
PP130	3.9	0.998	0.069	4	10	2.16	2.70	1	1.85	0.068702
PP131	4.6	0.997	0.080	4	10	2.52	2.00	1	1.43	0.079731
PP132	5.1	0.996	0.088	4	10	2.25	2.02	1	1.40	0.088594
PP133	5.5	0.995	0.096	4	10	2.7	1.55	1	1.13	0.096389
PP134	3.1	0.999	0.054	4	10	2.25	3.30	1	2.29	0.053895
PP135	3.6	0.998	0.062	4	10	2.7	2.38	1	1.74	0.062472
PP136	3.9	0.998	0.068	4	10	2.52	2.34	1	1.68	0.06803
PP145	5.2	0.996	0.091	4	10	2.25	1.97	1	1.36	0.090841
PP146	4.0	0.998	0.070	4	10	1.62	3.55	1	2.20	0.069683
PP147	3.9	0.998	0.068	4	10	1.8	3.26	1	2.10	0.06837
PP148	5.0	0.996	0.086	4	10	1.71	2.72	1	1.72	0.086459
PP150	6.0	0.994	0.105	4	10	2.25	1.70	1	1.18	0.105291
PP151	3.9	0.998	0.068	4	10	1.98	2.97	1	1.97	0.068278
PP152	4.6	0.997	0.080	4	10	2.7	1.85	1	1.35	0.080537
PP161	3.6	0.998	0.063	4	10	2.61	2.44	1	1.77	0.062898
PP162	3.0	0.999	0.052	4	10	1.98	3.91	1	2.60	0.051796
PP192	9.4	0.987	0.162	4	10	3.15	0.79	1	0.60	0.1632
PP200	12.4	0.977	0.215	4	10	0.54	3.53	1	1.24	0.216417
PP201	12.4	0.976	0.216	4	10	0.45	4.22	1	1.31	0.217245
PP208	7.9	0.990	0.138	4	10	1.26	2.33	1	1.30	0.138083
PP209	8.3	0.989	0.145	4	10	1.17	2.38	1	1.28	0.145596

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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 M- 2: Factor of Safety for Drained Conditions for GI Locations Within the Proposed Offsetting Measures Boundary.

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)	Υ (kN/m³)	(m)	Υ (kN/m³)	(m)	(º)								
HSV03	4	10	1.6	9.8	1.62	6.1	0.994	0.989	0.107	25	0.466	2.42	1	3.15
HSV05	4	10	1.8	9.8	1.80	6.9	0.993	0.986	0.120	25	0.466	1.95	1	2.63
HSV06	4	10	2.0	9.8	1.98	5.5	0.995	0.991	0.095	25	0.466	2.23	1	3.12
HSV07	4	10	1.7	9.8	1.71	6.4	0.994	0.988	0.111	25	0.466	2.20	1	2.92
PP01	4	10	0.2	9.8	0.18	11.8	0.979	0.958	0.204	16	0.287	11.16	1	2.87
PP02	4	10	0.2	9.8	0.18	11.8	0.979	0.959	0.204	25	0.466	11.19	1	3.61
PP02	4	10	0.2	9.8	0.18	11.3	0.981	0.961	0.196	13	0.231	11.57	1	2.74
PP03	4	10	0.4	9.8	0.36	11.9	0.979	0.958	0.206	24	0.445	5.55	1	3.02
PP04	4	10	0.27	9.8	0.27	17.4	0.954	0.911	0.298	25	0.466	5.23	1	2.29
PP05	4	10	0.36	9.8	0.36	13.2	0.974	0.948	0.228	25	0.466	5.04	1	2.80
PP06	4	10	0.27	9.8	0.27	15.5	0.964	0.929	0.266	25	0.466	5.80	1	2.56
PP07	4	10	0.45	9.8	0.45	14.8	0.967	0.935	0.256	25	0.466	3.63	1	2.34
PP08	4	10	0.36	9.8	0.36	10.8	0.982	0.965	0.187	25	0.466	6.09	1	3.41
PP09	4	10	0.27	9.8	0.27	13.3	0.973	0.947	0.230	25	0.466	6.66	1	2.97
PP10	4	10	1.35	9.8	1.35	13.2	0.974	0.948	0.228	25	0.466	1.37	1	1.64
PP11	4	10	0.90	9.8	0.90	14.3	0.969	0.939	0.247	25	0.466	1.89	1	1.86
PP12	4	10	0.90	9.8	0.90	12.2	0.977	0.955	0.212	25	0.466	2.19	1	2.17
PP13	4	10	0.18	9.8	0.18	10.6	0.983	0.966	0.184	25	0.466	12.31	1	3.98
PP14	4	10	0.54	9.8	0.54	14.6	0.968	0.937	0.252	25	0.466	3.08	1	2.24
PP16	4	10	1.17	9.8	1.17	10.2	0.984	0.968	0.178	25	0.466	2.00	1	2.27
PP19	4	10	0.72	9.8	0.72	12.5	0.976	0.953	0.216	25	0.466	2.68	1	2.35
PP25	4	10	0.63	9.8	0.63	14.0	0.970	0.942	0.242	25	0.466	2.74	1	2.21
PP26	4	10	0.72	9.8	0.72	13.7	0.972	0.944	0.237	25	0.466	2.45	1	2.14
PP27	4	10	1.17	9.8	1.17	10.3	0.984	0.968	0.179	25	0.466	1.99	1	2.25
PP28	4	10	0.90	9.8	0.90	9.5	0.986	0.973	0.166	25	0.466	2.78	1	2.78
PP29	4	10	1.26	9.8	1.26	8.8	0.988	0.977	0.152	25	0.466	2.17	1	2.55
PP32	4	10	0.27	9.8	0.27	12.4	0.977	0.954	0.214	25	0.466	7.11	1	3.18
PP34	4	10	0.63	9.8	0.63	8.7	0.989	0.977	0.150	25	0.466	4.33	1	3.55
PP35	4	10	1.62	9.8	1.62	8.1	0.990	0.980	0.141	25	0.466	1.83	1	2.38
PP36	4	10	1.17	9.8	1.17	8.7	0.989	0.977	0.151	25	0.466	2.35	1	2.67
PP37	4	10	1.35	9.8	1.35	8.5	0.989	0.978	0.149	25	0.466	2.08	1	2.51
PP38	4	10	1.35	9.8	1.35	6.3	0.994	0.988	0.110	25	0.466	2.78	1	3.38
PP43	4	10	1.35	9.8	1.35	5.3	0.996	0.992	0.092	25	0.466	3.34	1	4.07
PP44	4	10	1.98	9.8	1.98	4.5	0.997	0.994	0.079	25	0.466	2.69	1	3.76
PP45	4	10	1.35	9.8	1.35	6.3	0.994	0.988	0.110	25	0.466	2.78	1	3.38
PP46	4	10	1.08	9.8	1.08	6.3	0.994	0.988	0.109	25	0.466	3.49	1	3.85
PP47	4	10	0.81	9.8	0.81	4.2	0.997	0.995	0.073	25	0.466	6.88	1	6.58
PP51	4	10	1.17	9.8	1.17	4.4	0.997	0.994	0.076	25	0.466	4.64	1	5.33
PP52	4	10	1.80	9.8	1.80	4.2	0.997	0.995	0.073	25	0.466	3.17	1	4.30
PP53	4	10	1.98	9.8	1.98	4.1	0.997	0.995	0.072	25	0.466	2.96	1	4.15
PP54	4	10	1.80	9.8	1.80	5.4	0.996	0.991	0.094	25	0.466	2.47	1	3.35
PP56	4	10	0.90	9.8	0.90	5.7	0.995	0.990	0.100	25	0.466	4.57	1	4.61
PP57	4	10	0.99	9.8	0.99	4.5	0.997	0.994	0.079	25	0.466	5.26	1	5.59
PP58	4	10	1.80	9.8	1.80	4.0	0.998	0.995	0.070	25	0.466	3.29	1	4.47
PP59	4	10	2.25	9.8	2.25	3.7	0.998	0.996	0.064	25	0.466	2.93	1	4.26
PP60	4	10	2.52	9.8	2.52	3.3	0.998	0.997	0.058	25	0.466	2.91	1	4.37
PP62	4	10	1.17	9.8	1.17	5.9	0.995	0.989	0.103	25	0.466	3.43	1	3.92
PP63	4	10	1.62	9.8	1.62	5.2	0.996	0.992	0.090	25	0.466	2.85	1	3.73
PP64	4	10	1.98	9.8	1.98	3.9	0.998	0.995	0.068	25	0.466	3.12	1	4.37
PP65	4	10	2.25	9.8	2.25	2.8	0.999	0.998	0.048	25	0.466	3.90	1	5.68
PP67	4	10	2.25	9.8	2.25	6.5	0.994	0.987	0.114	25	0.466	1.66	1	2.40
PP68	4	10	1.53	9.8	1.53	4.7	0.997	0.993	0.082	25	0.466	3.32	1	4.25
PP69	4	10	1.62	9.8	1.62	3.1	0.999	0.997	0.053	25	0.466	4.81	1	6.31
PP70	4	10	1.89	9.8	1.89	2.9	0.999	0.998	0.050	25	0.466	4.45	1	6.15
PP71	4	10	1.35	9.8	1.35	6.9	0.993	0.985	0.121	25	0.466	2.55	1	3.10
PP72	4	10	1.62	9.8	1.62	4.4	0.997	0.994	0.076	25	0.466	3.38	1	4.43
PP73	4	10	1.80	9.8	1.80	3.1	0.999	0.997	0.055	25	0.466	4.24	1	5.77
PP74	4	10	2.25	9.8	2.25	3.7	0.998	0.996	0.065	25	0.466	2.88	1	4.20
PP76	4	10	0.72	9.8	0.72	4.5	0.997	0.994	0.078	25	0.466	7.29	1	6.53
PP77	4	10	0.45	9.8	0.45	4.0	0.998	0.995	0.070	25	0.466	12.95	1	8.63
PP78	4	10	1.89	9.8	1.89	4.7	0.997	0.993	0.082	25	0.466	2.69	1	3.72
PP79	4	10	1.62	9.8	1.62	6.3	0.994	0.988	0.109	25	0.466	2.36	1	3.07
PP80	4	10	1.17	9.8	1.17	7.9	0.990	0.981	0.138	25	0.466	2.57	1	2.93
PP81	4	10	1.80	9.8	1.80	4.8	0.996	0.993	0.084	25	0.466	2.76	1	3.74
PP82	4	10	2.07	9.8	2.07	4.4	0.997	0.994	0.076	25	0.466	2.66	1	3.78
PP83	4	10	1.53	9.8	1.53	5.3	0.996	0.991	0.092	25	0.466	2.94	1	3.76
PP85	4	10	1.62	9.8	1.62	6.5	0.994	0.987	0.113	25	0.466	2.28	1	2.97
PP86	4	10	1.80	9.8	1.80	4.9	0.996	0.993	0.086	25	0.466	2.70	1	3.66
PP87	4	10	2.52	9.8	2.52	4.5	0.997	0.994	0.078	25	0.466	2.15	1	3.23
PP89	4	10	1.98	9.8	1.98	8.0	0.990	0.981	0.139	25	0.466	1.53	1	2.13
PP90	4	10	1.71	9.8	1.71	6.3	0.994	0.988	0.110	25	0.466	2.23	1	2.97
PP91	4	10	1.80	9.8	1.80	5.3	0.996	0.992	0.092	25	0.466	2.53	1	3.43
PP94	4	10	1.53	9.8	1.53	6.3	0.994	0.988	0.110	25	0.466	2.47	1	3.15
PP95	4	10	2.25	9.8	2.25	5.8	0.995	0.990	0.100	25	0.466	1.87	1	2.72
PP98	4	10	1.44	9.8	1.44	4.9	0.996	0.993	0.086	25	0.466	3.34	1	4.18
PP99	4	10	1.62	9.8	1.62	5.8	0.995	0.990	0.101	25	0.466	2.54	1	3.31
PP100	4	10	1.26	9.8	1.26	6.8	0.993	0.986	0.119	25	0.466	2.76	1	3.26
PP103	4	10	1.80	9.8	1.80	4.8	0.996	0.993	0.084	25	0.466	2.76	1	3.74
PP104	4	10	0.90	9.8	0.90	13.4	0.973	0.946	0.232	25	0.466	2.01	1	1.98
PP110	4	10	1.71	9.8	1.71	6.7	0.993	0.986	0.117	25	0.466	2.09	1	2.78
PP111	4	10	1.71	9.8	1.71	8.5	0.989	0.978	0.148	25	0.466	1.66	1	2.19
PP114	4	10	2.70	9.8	2.70	6.2	0.994	0.988	0.108	25	0.466	1.46	1	2.22
PP115	4	10	2.07	9.8	2.07	4.8	0.997	0.993	0.083	25	0.466	2.45	1	3.48
PP116	4	10	1.80	9.8	1.80	5.6	0.995	0.991	0.097	25	0.466	2.39	1	3.24
PP117	4	10	1.98	9.8	1.98	4.8	0.996	0.993	0.084	25	0.466	2.53	1	3.54
PP118	4	10	1.98	9.8	1.98	2.8	0.999	0.998	0.049	25	0.466	4.30	1	6.04
PP120	4	10	1.08	9.8	1.08	6.0	0.995	0.989	0.104	25	0.466	3.68	1	4.06
PP121	4	10	1.35	9.8	1.35	4.8	0.996	0.993	0.084	25	0.466	3.63	1	4.43
PP127	4	10	2.70	9.8	2.70	8.7	0.988	0.977	0.151	25	0.466	1.05	1	1.59
PP130	4	10	2.16	9.8	2.16	3.9	0.998	0.995	0.069	25	0.466	2.84	1	4.09
PP131	4	10	2.52	9.8	2.52	4.6	0.997	0.994	0.080	25	0.466	2.12	1	3.17
PP132	4	10	2.25	9.8	2.25	5.1	0.996	0.992	0.088	25	0.466	2.12	1	3.08
PP133	4	10	2.70	9.8	2.70	5.5	0.995	0.991	0.096	25	0.466	1.64	1	2.50
PP134	4	10	2.25	9.8	2.25	3.1	0.999	0.997	0.054	25	0.466	3.48	1	5.07
PP135	4	10	2.70	9.8	2.70	3.6	0.998	0.996	0.062	25	0.466	2.53	1	3.86
PP136	4	10	2.52	9.8	2.52	3.9	0.998	0.995	0.068	25	0.466	2.48	1	3.72
PP145	4	10	2.25	9.8	2.25	5.2	0.996	0.992	0.091	25	0.466	2.07	1	3.01
PP146	4	10	1.62	9.8	1.62	4.0	0.998	0.995	0.070	25	0.466	3.69	1	4.83
PP147	4	10	1.80	9.8	1.80	3.9	0.998	0.995	0.068	25	0.466	3.40	1	4.62
PP148	4	10	1.71	9.8	1.71	5.0	0.996	0.993	0.086	25	0.466	2.83	1	3.77
PP150	4	10	2.25	9.8	2.25	6.0	0.994	0.989	0.105	25	0.466	1.79	1	2.60
PP151	4	10	1.98	9.8	1.98	3.9	0.998	0.995	0.068	25	0.466	3.10	1	4.35
PP152	4	10	2.70	9.8	2.70	4.6	0.997	0.994	0.080	25	0.466	1.96	1	2.99
PP161	4	10	2.61	9.8	2.61	3.6	0.998	0.996	0.063	25	0.466	2.59	1	3.92
PP162	4	10	1.98	9.8	1.98	3.0	0.999	0.997	0.052	25	0.466	4.09	1	5.73
PP192	4	10	3.15	9.8	3.15	9.4	0.987	0.974	0.162	25	0.466	0.85	1	1.33
PP200	4	10	0.54	9.8	0.54	12.4	0.977	0.954	0.215	25	0.466	3.57	1	2.63
PP201	4	10	0.45	9.8	0.45	12.4	0.976	0.954	0.216	25	0.466	4.27	1	2.78
PP208	4	10	1.26	9.8	1.26	7.9	0.990	0.981	0.138	25	0.466	2.40	1	2.82
PP209	4	10	1.17	9.8	1.17	8.3	0.989	0.979	0.145	25	0.466	2.45	1	2.78

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 N Peat Stability Risk Assessment

N.1 Likelihood Score

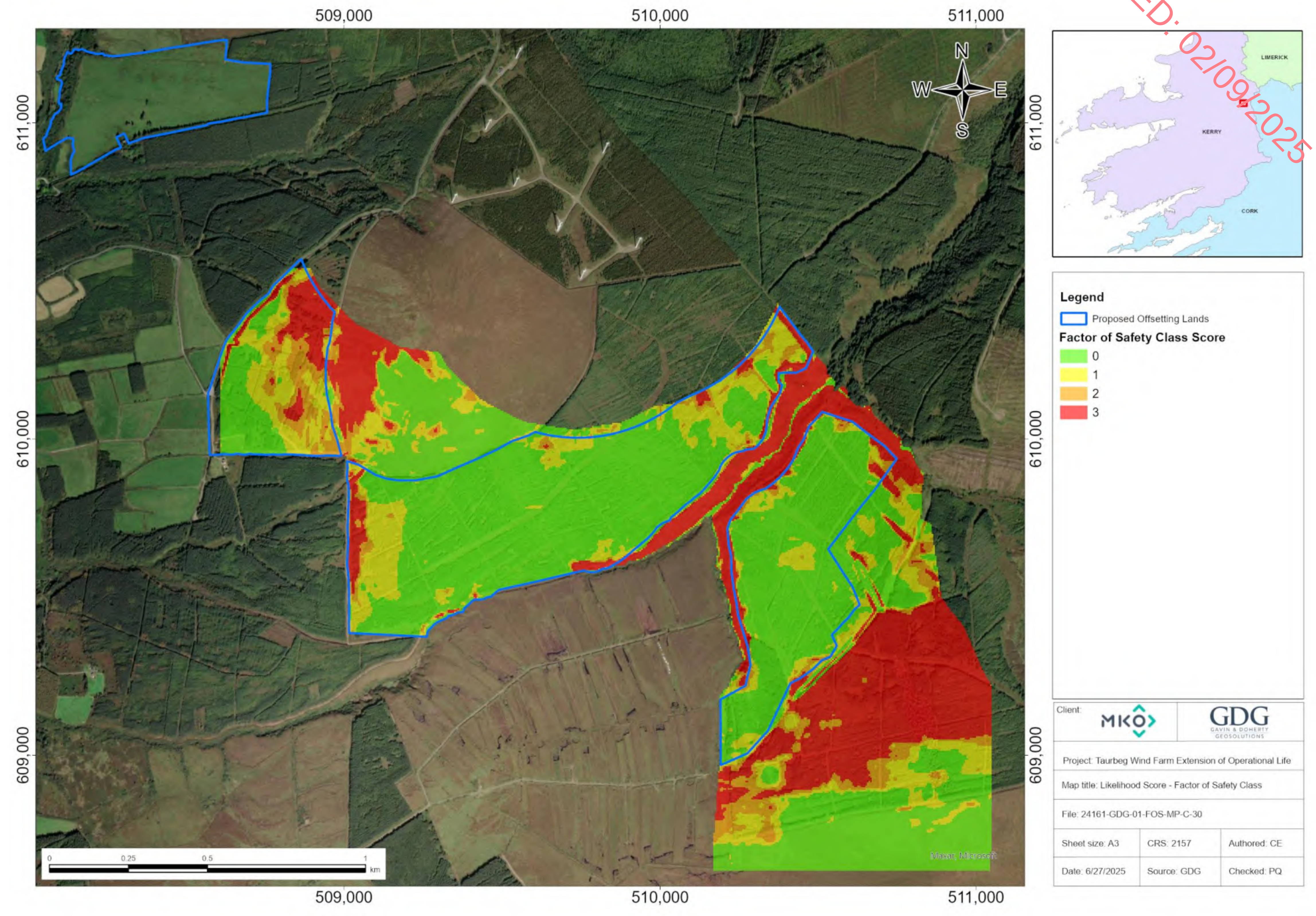

Figure N- 1: Peat Landslide Likelihood Score – Factor of Safety Class.

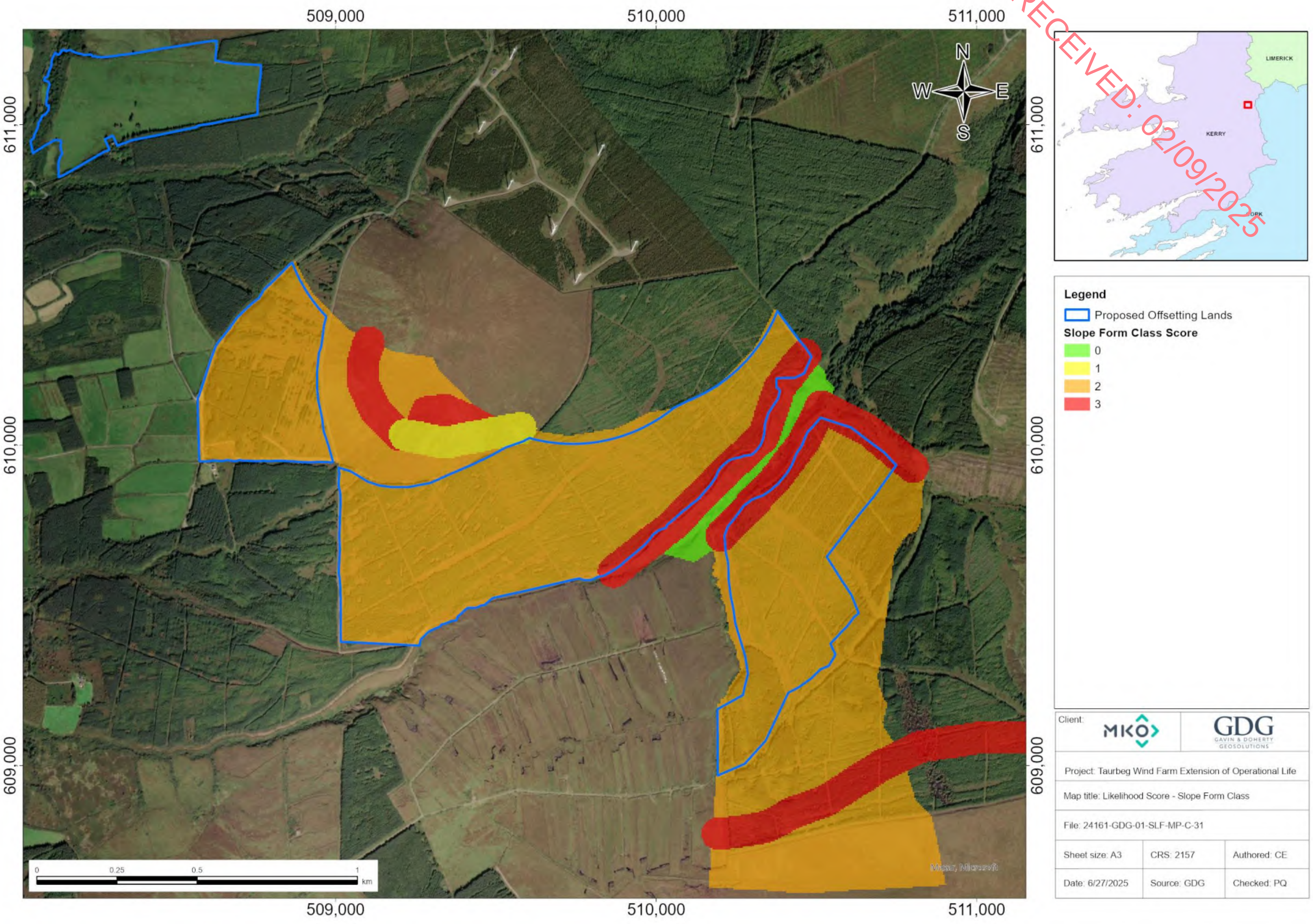

Figure N- 2: Peat Landslide Likelihood Score – Slope Form Class.

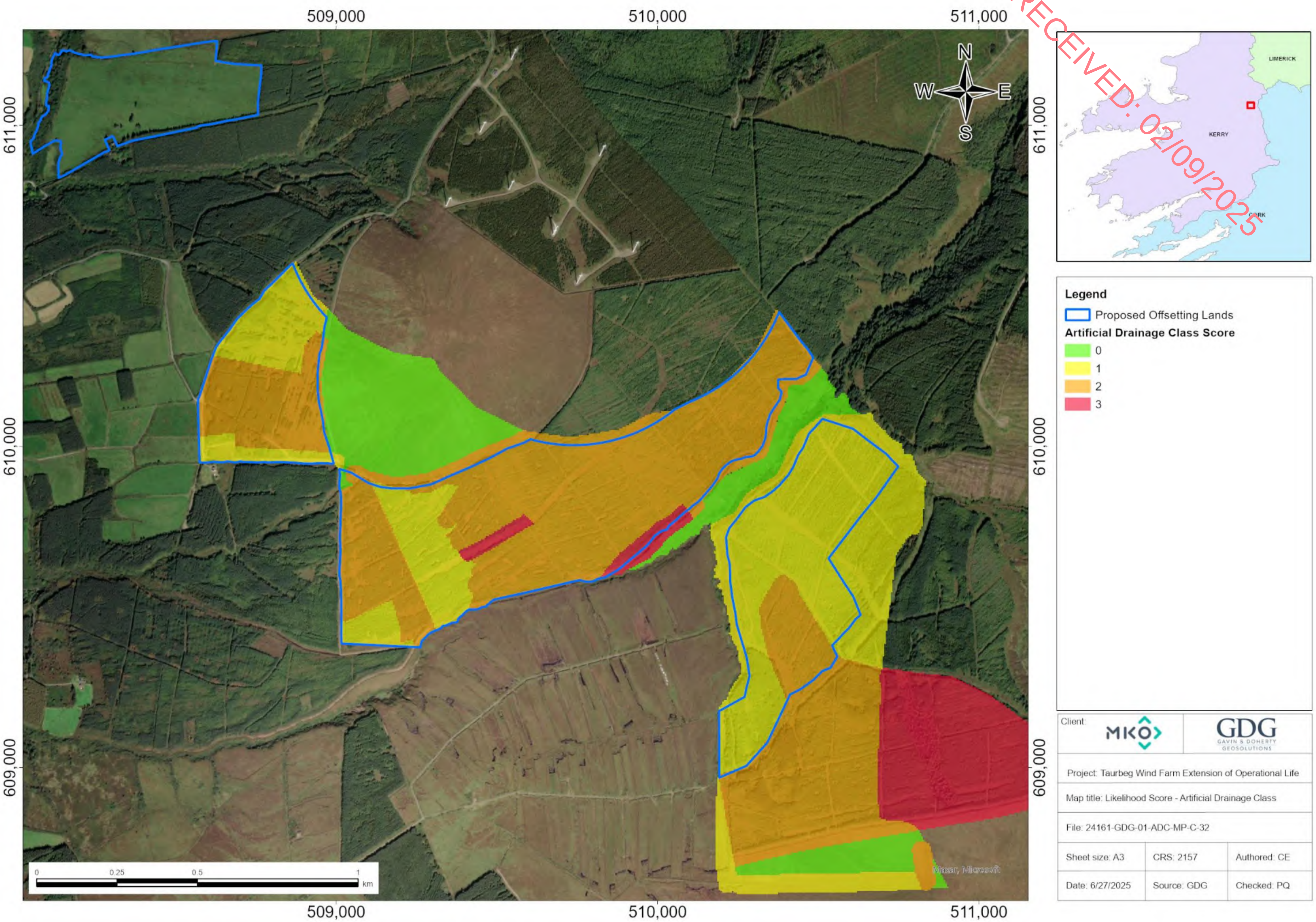

Figure N- 3: Peat Landslide Likelihood Score – Artificial Drainage Class.

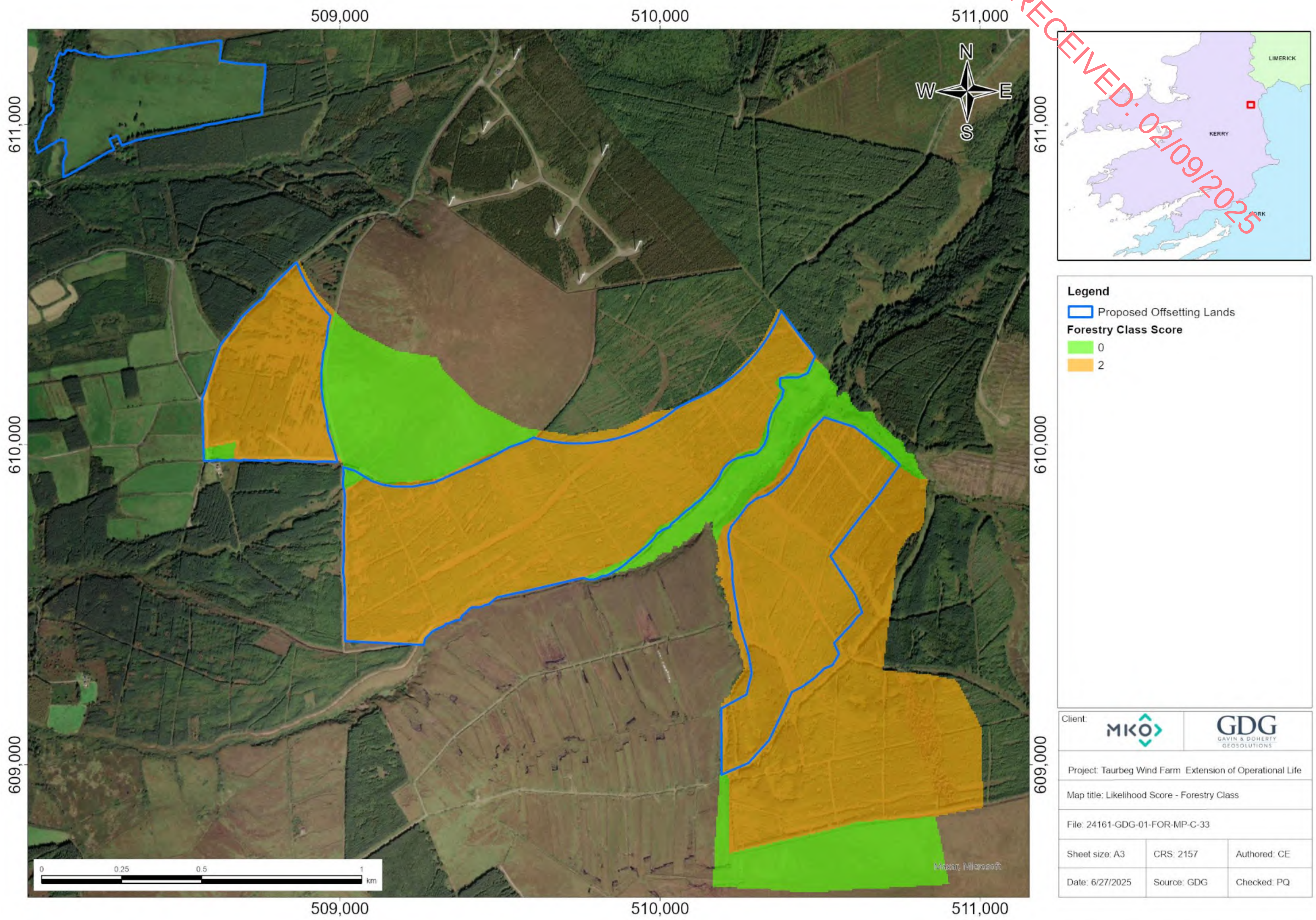

Figure N- 4: Peat Landslide Likelihood Score – Forestry Class.

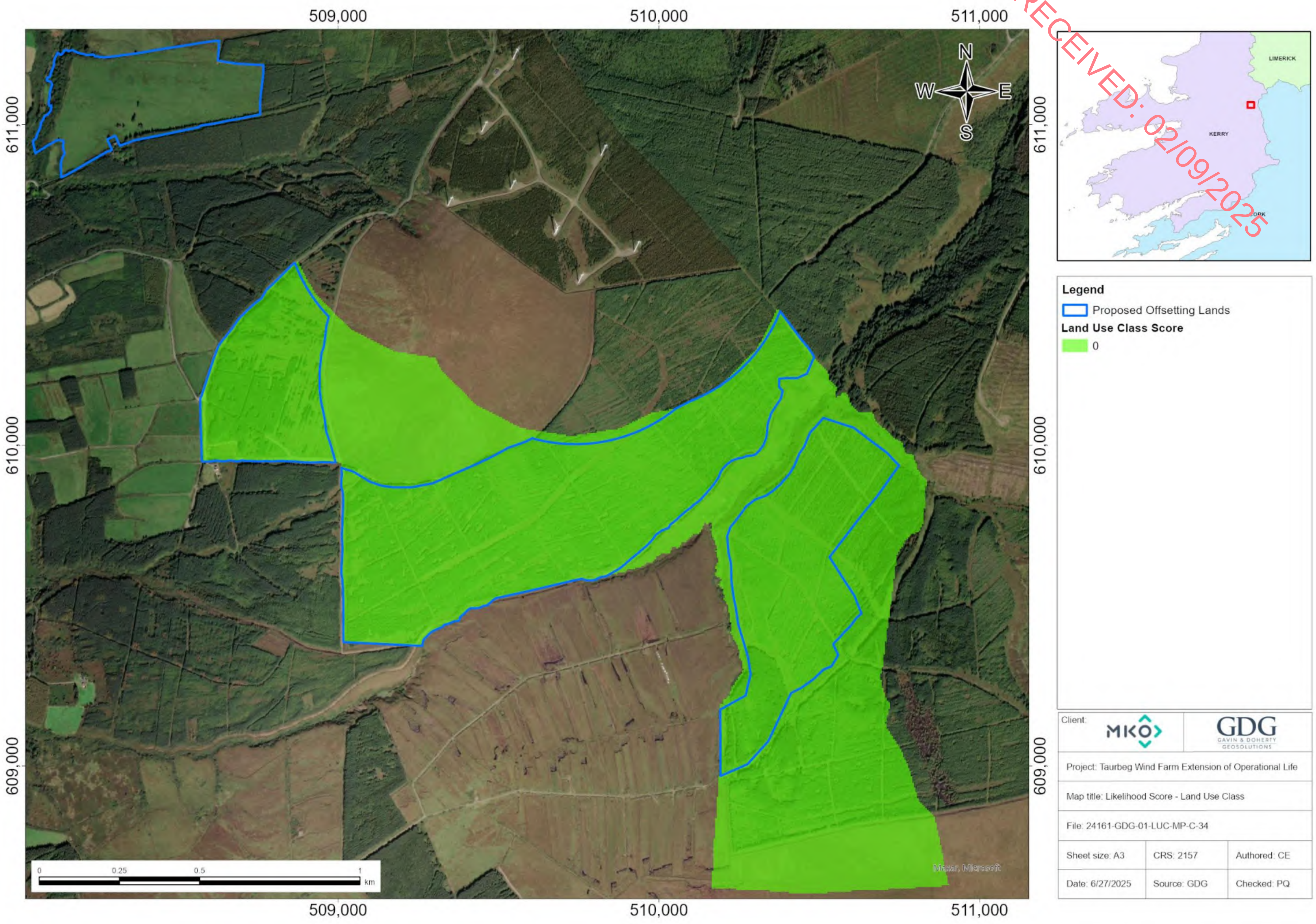

Figure N- 5: Peat Landslide Likelihood Score – Land Use Class.

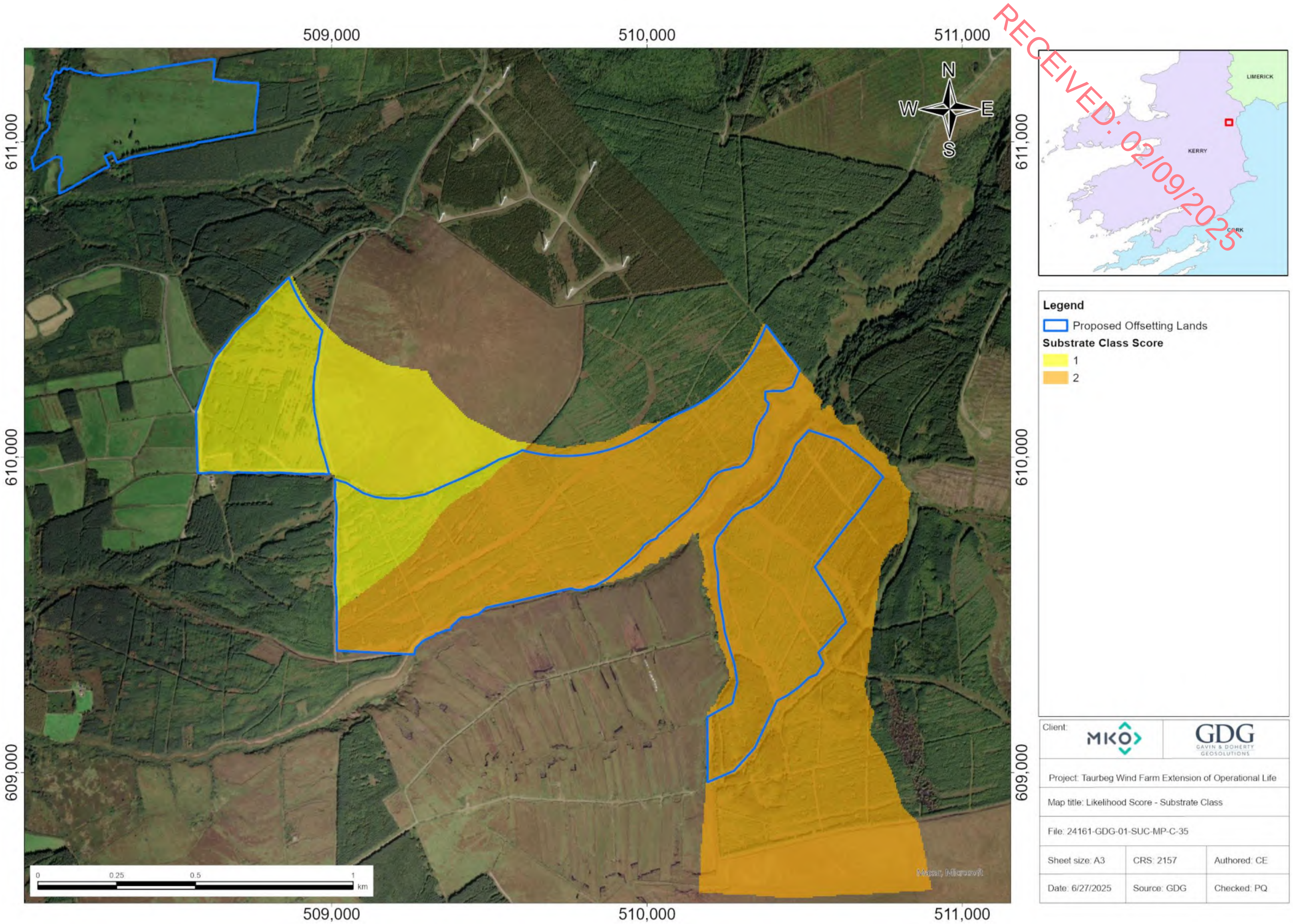

Figure N- 6: Peat Landslide Likelihood Score – Substrate Class.

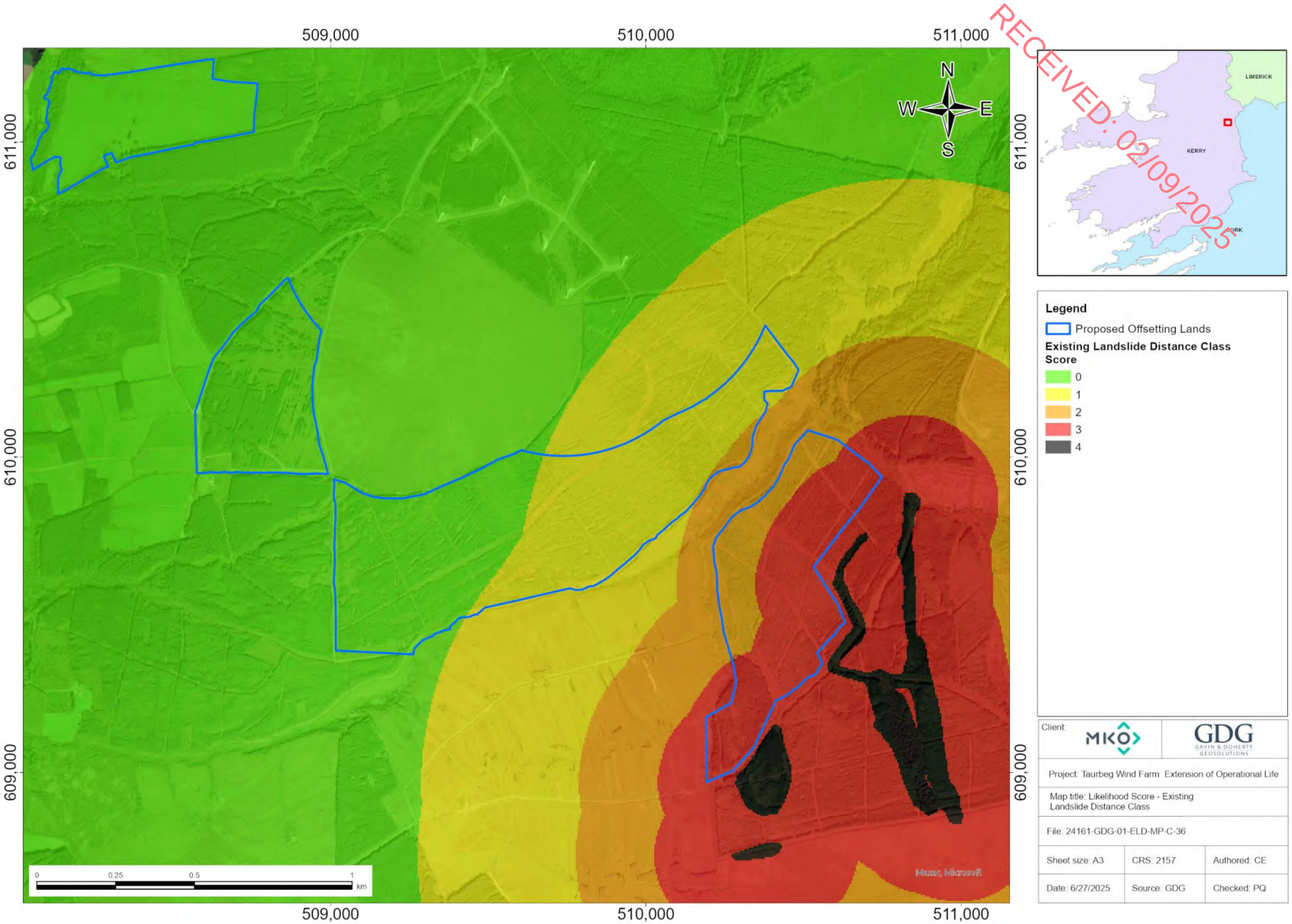

Figure N- 7: Peat Landslide Likelihood Score – Existing Landslide Distance Class

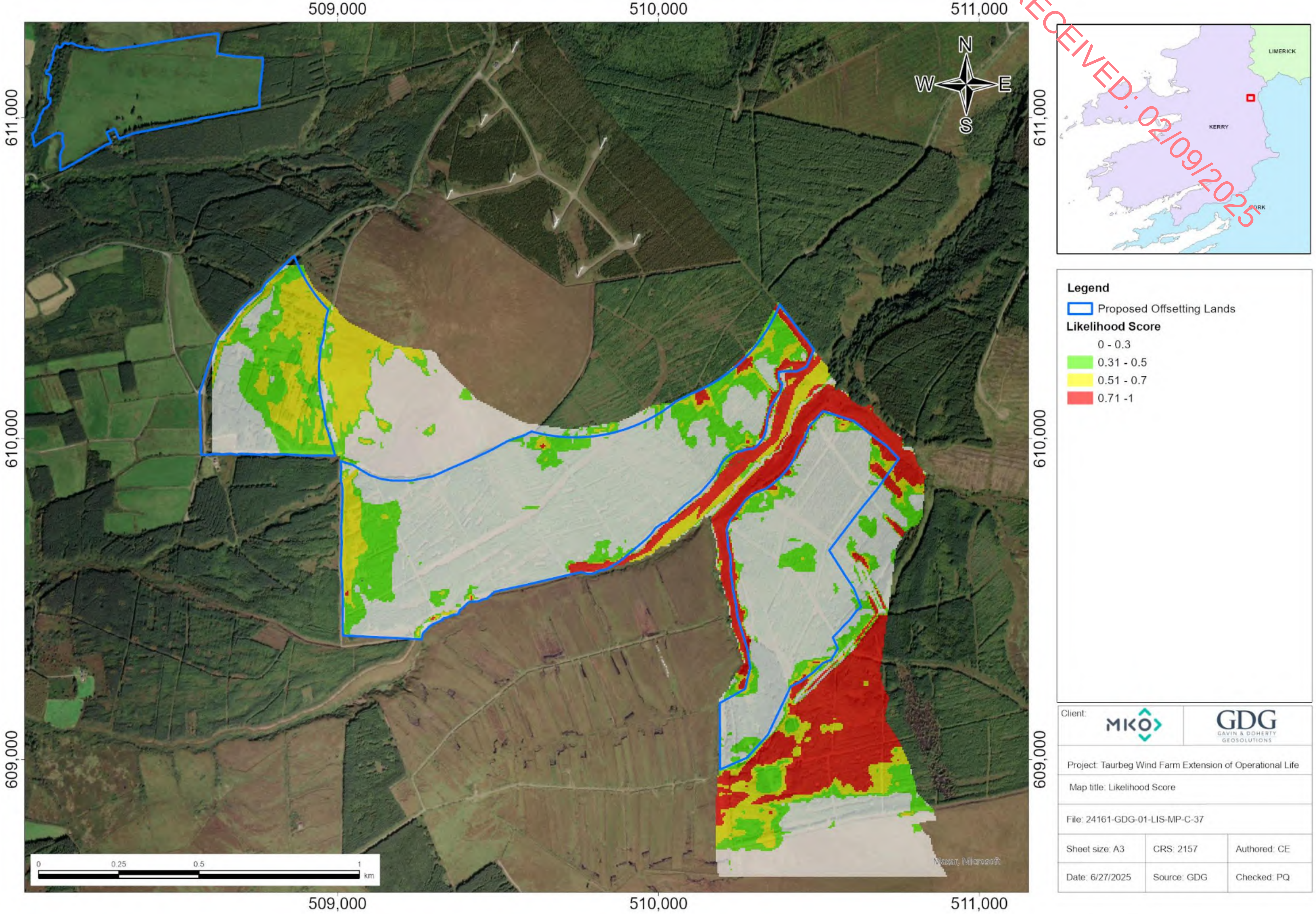

Figure N- 8: Peat Landslide Likelihood Score.

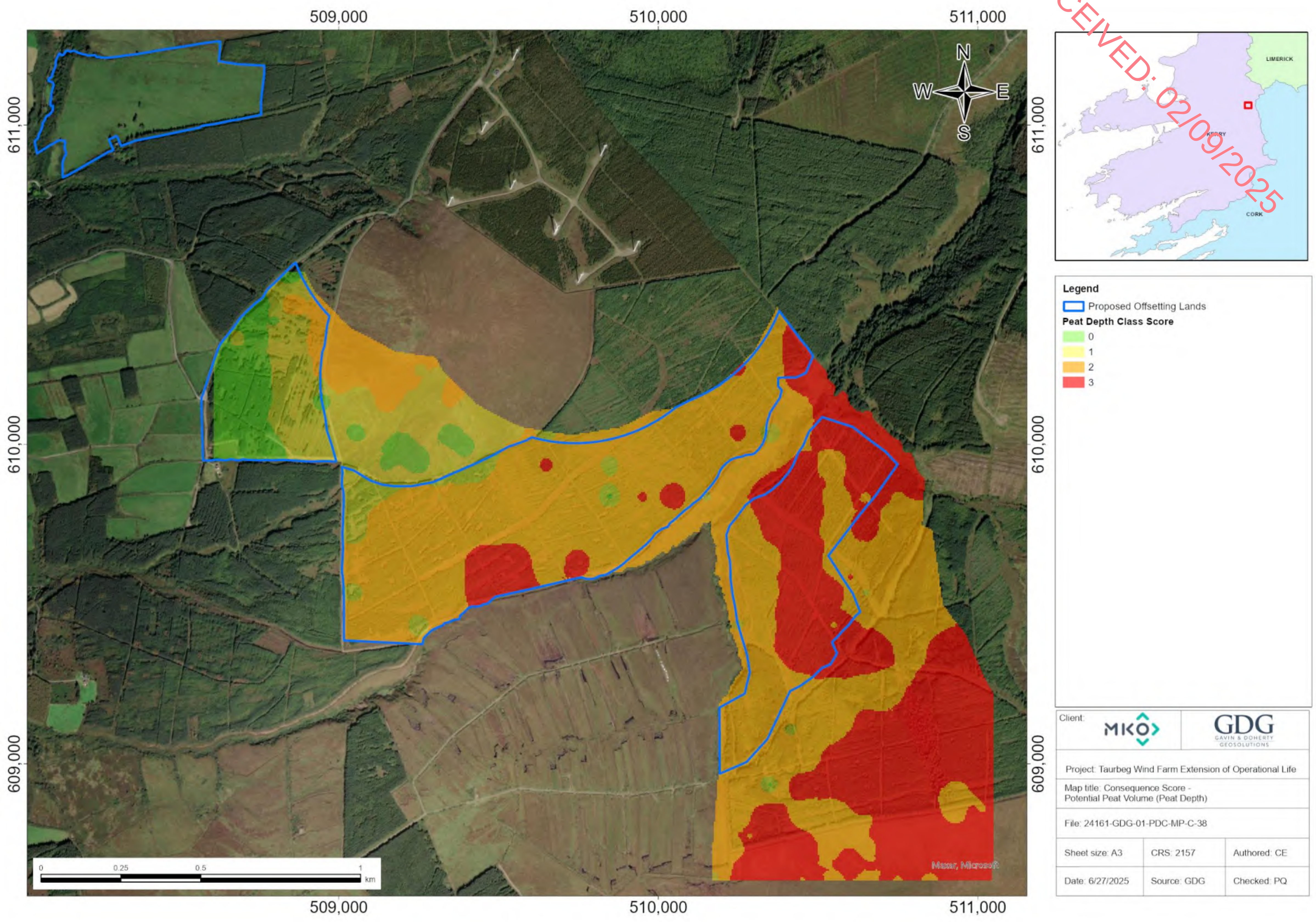

Figure N- 9: Peat Landslide Adverse Consequence Score – Potential Peat Volume (Peat Depth) Class.

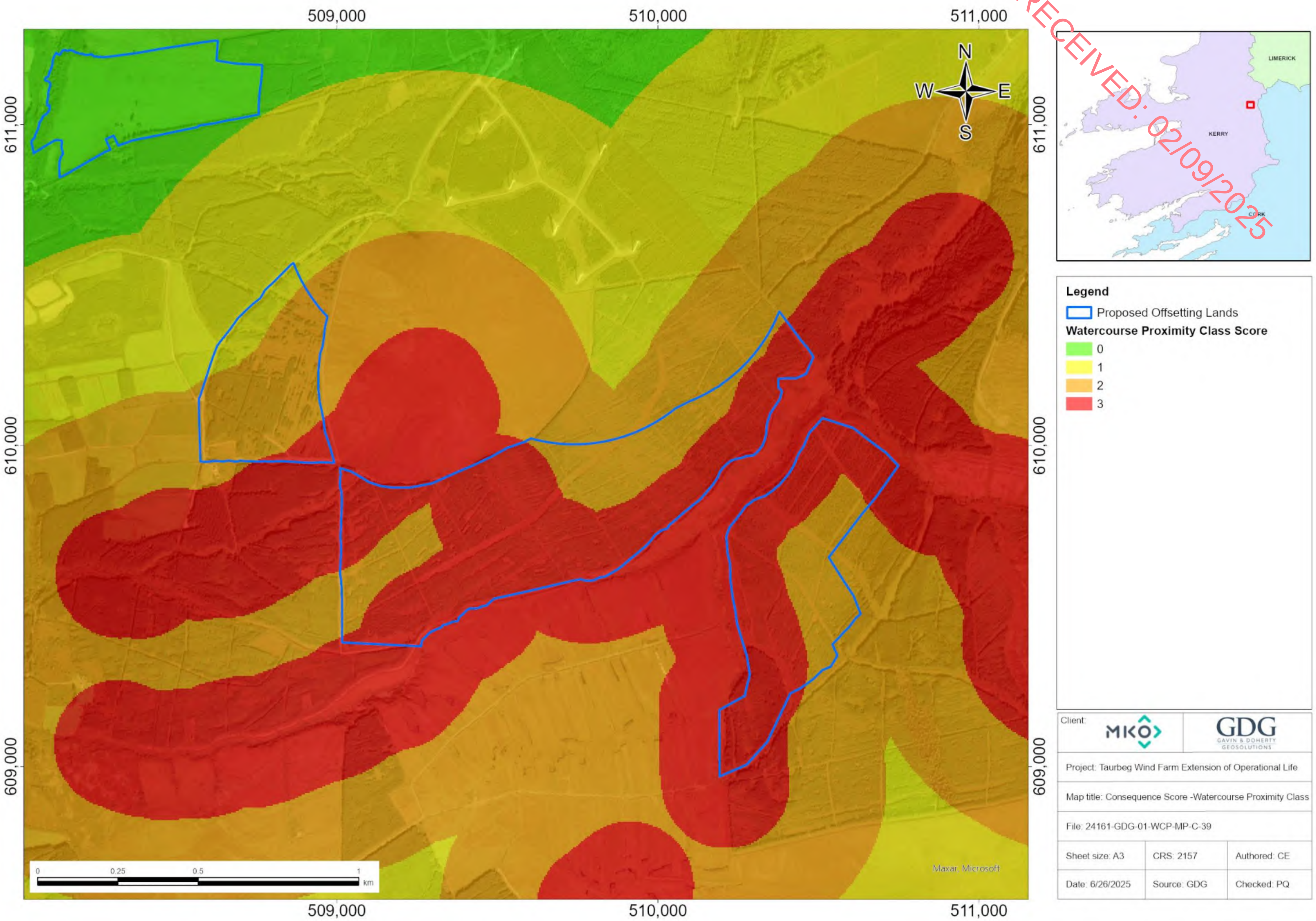

Figure N- 10: Peat Landslide Adverse Consequence Score – Watercourse Proximity Class.

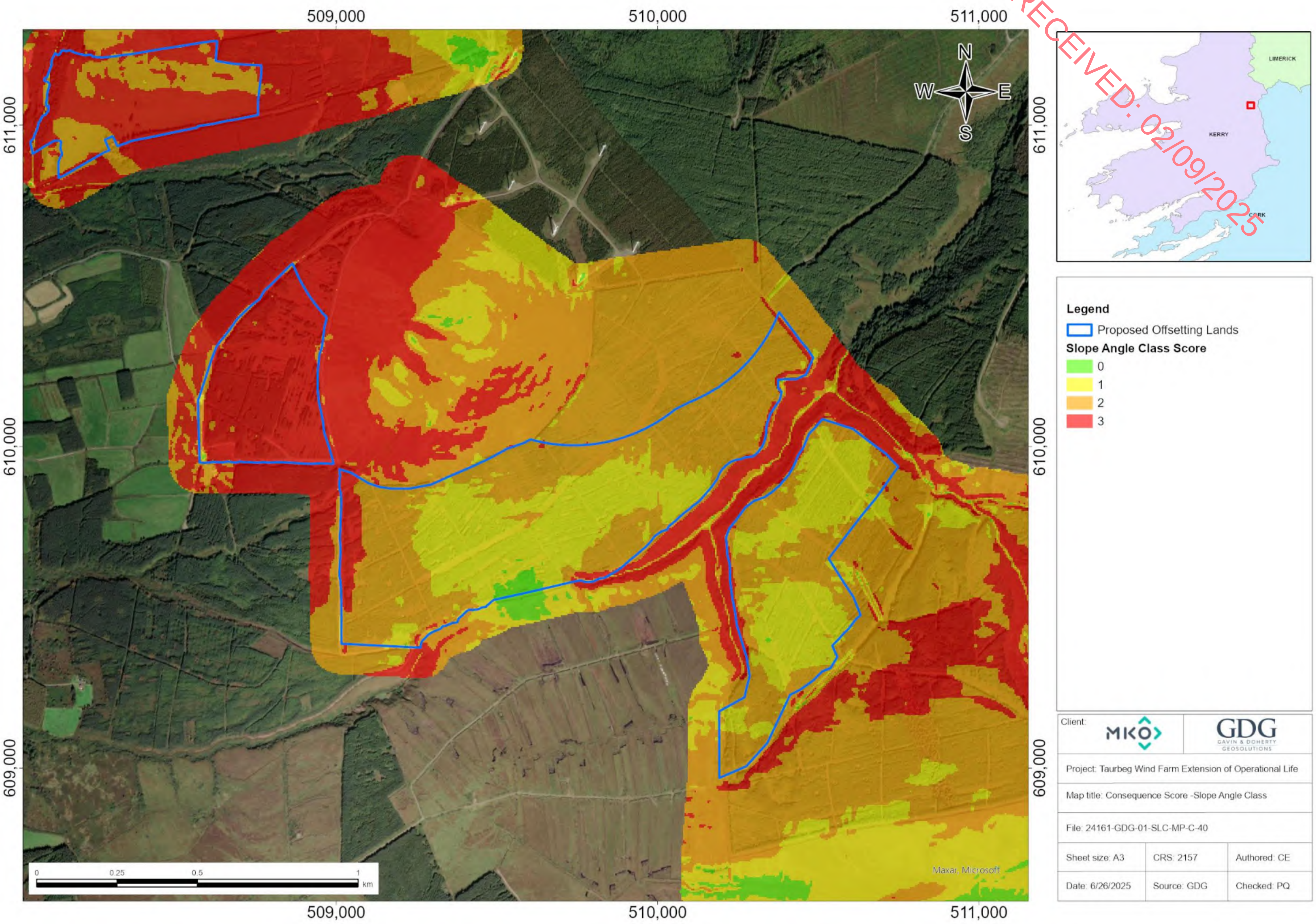

Figure N- 11: Peat Landslide Adverse Consequence Score – Slope Angle Class.

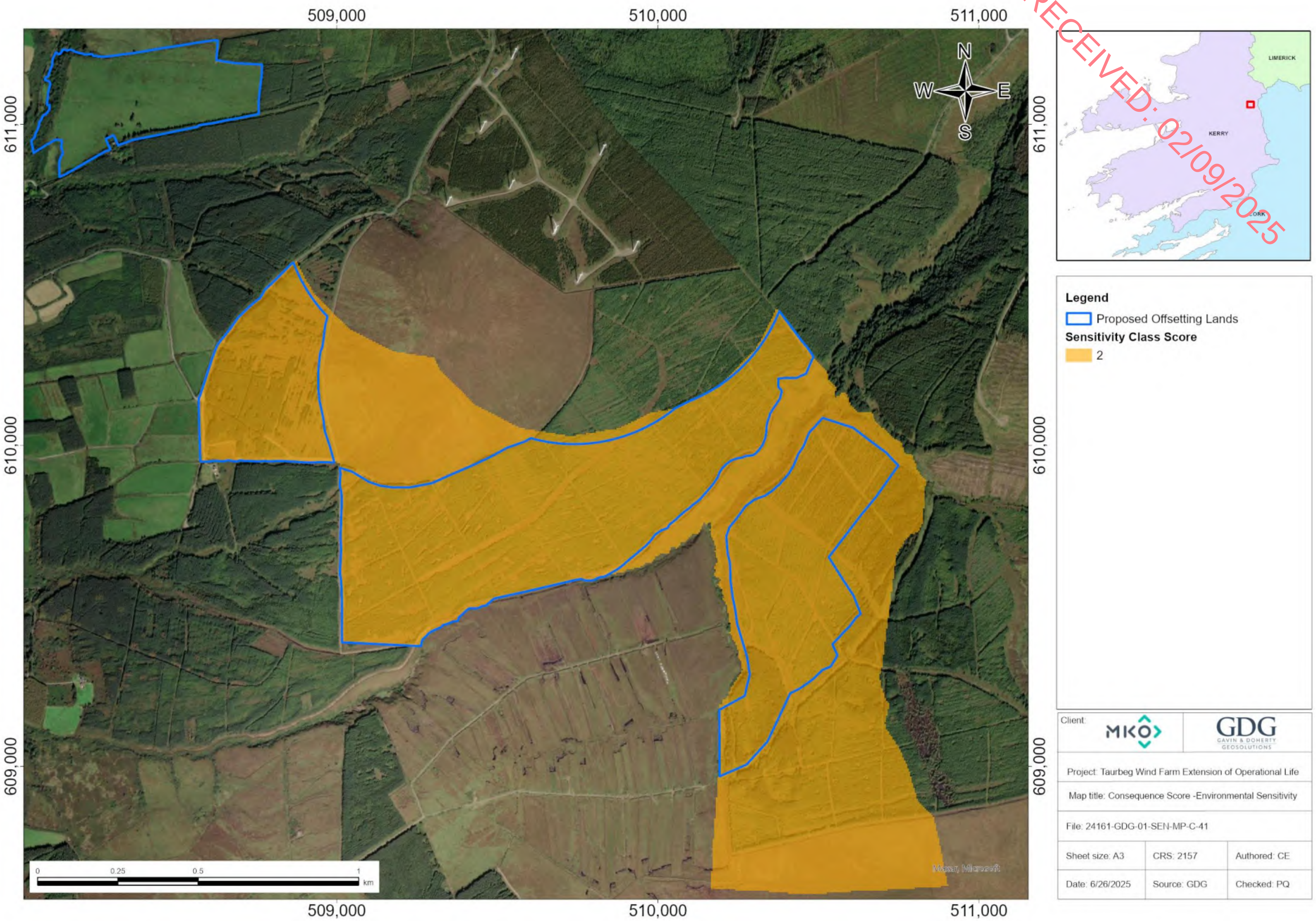

Figure N- 12: Peat Landslide Adverse Consequence Score – Environmental Sensitivity Class.

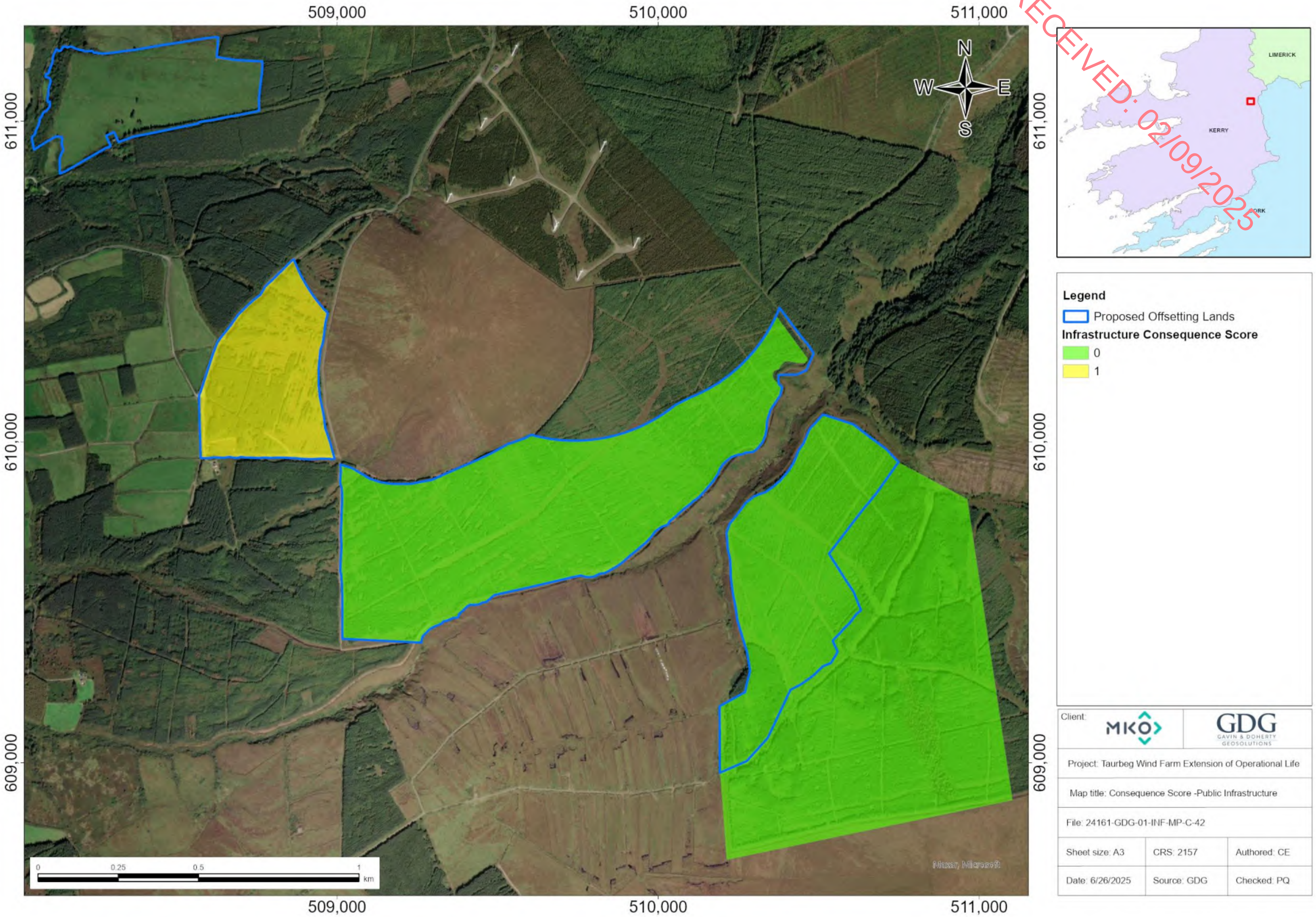

Figure N- 13: Peat Landslide Adverse Consequence Score – Public Infrastructure Class.

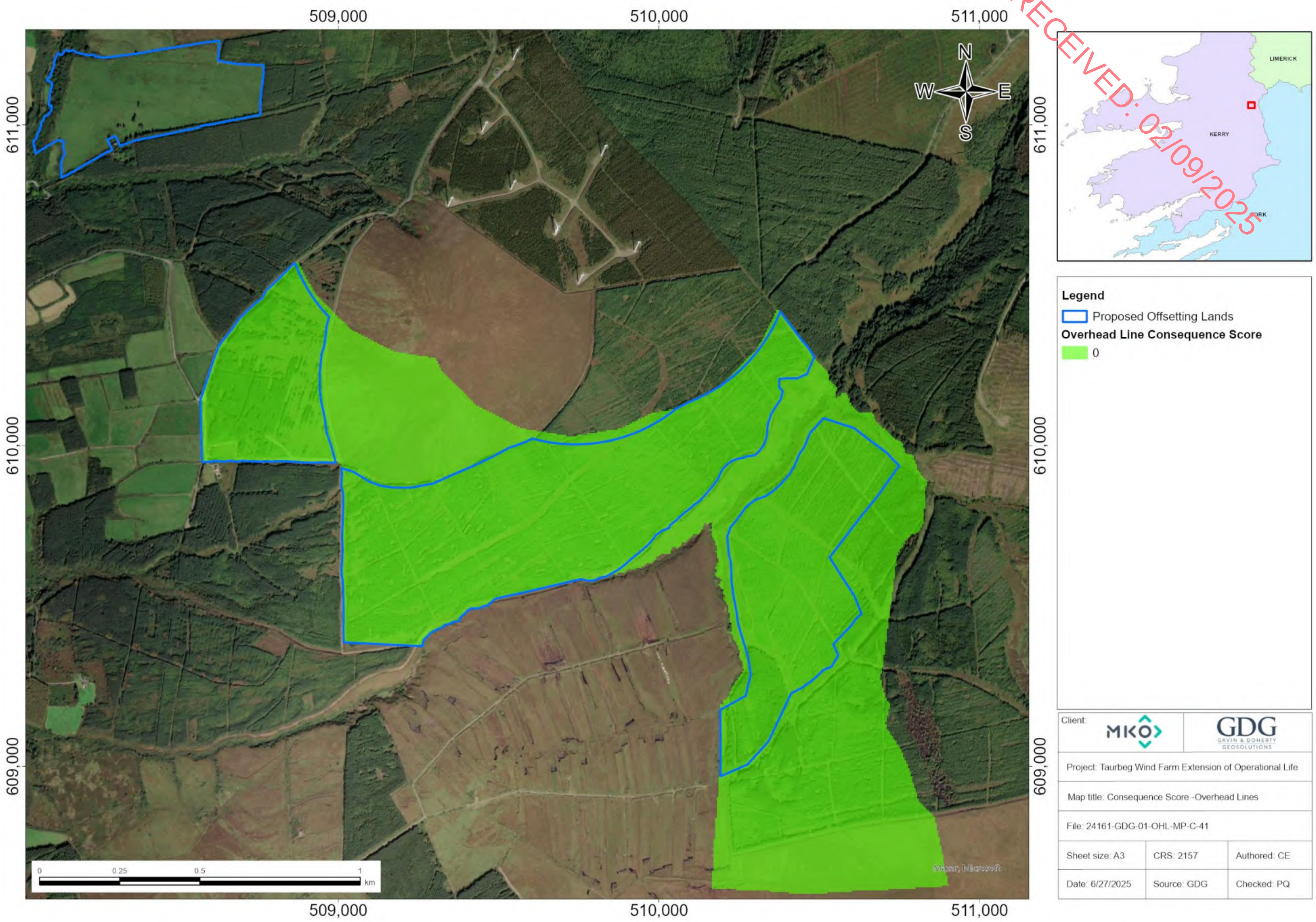

Figure N- 14: Peat Landslide Adverse Consequence Score – Overhead Line Class.

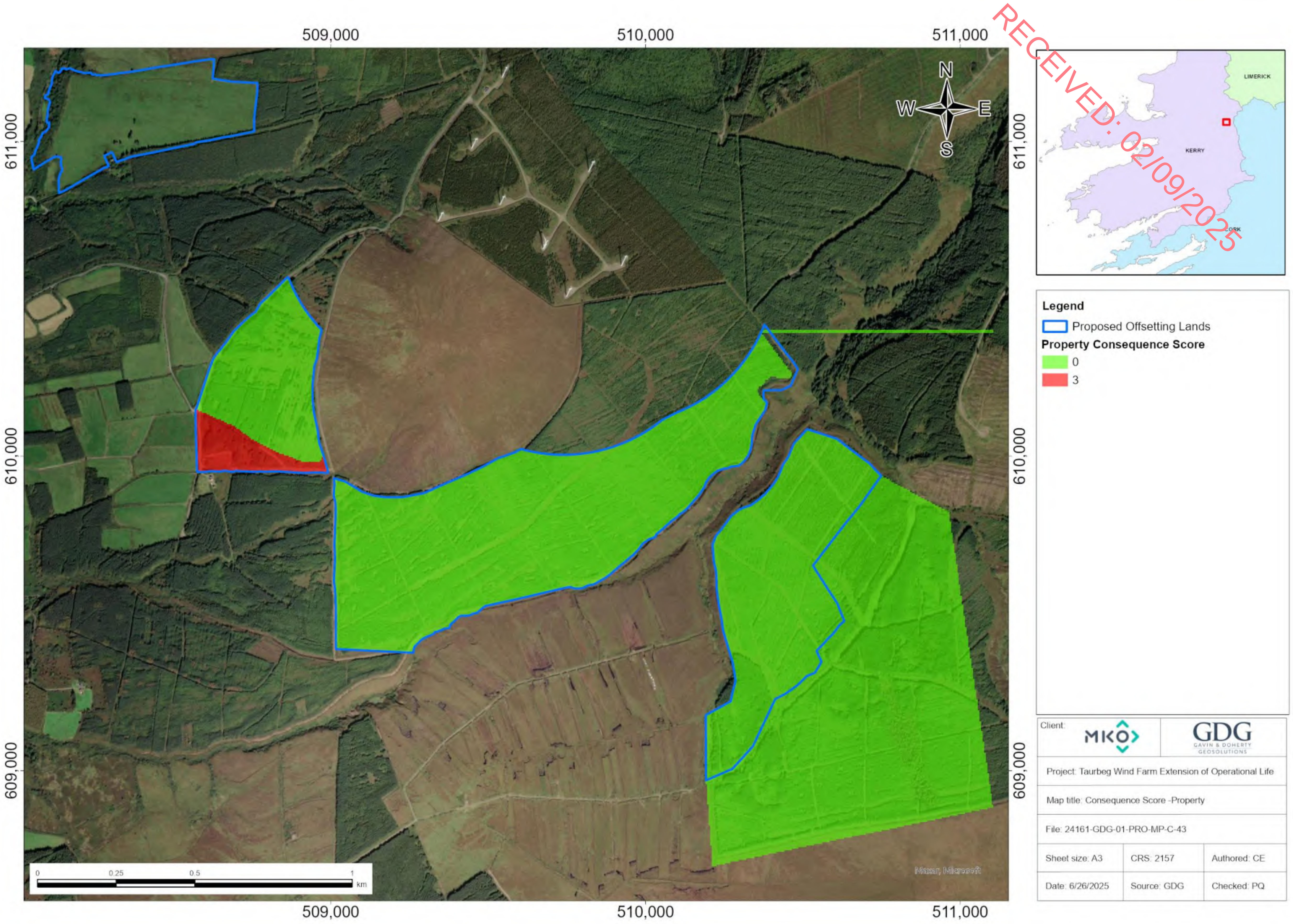

Figure N- 15: Peat Landslide Adverse Consequence Score – Buildings/Property Class.

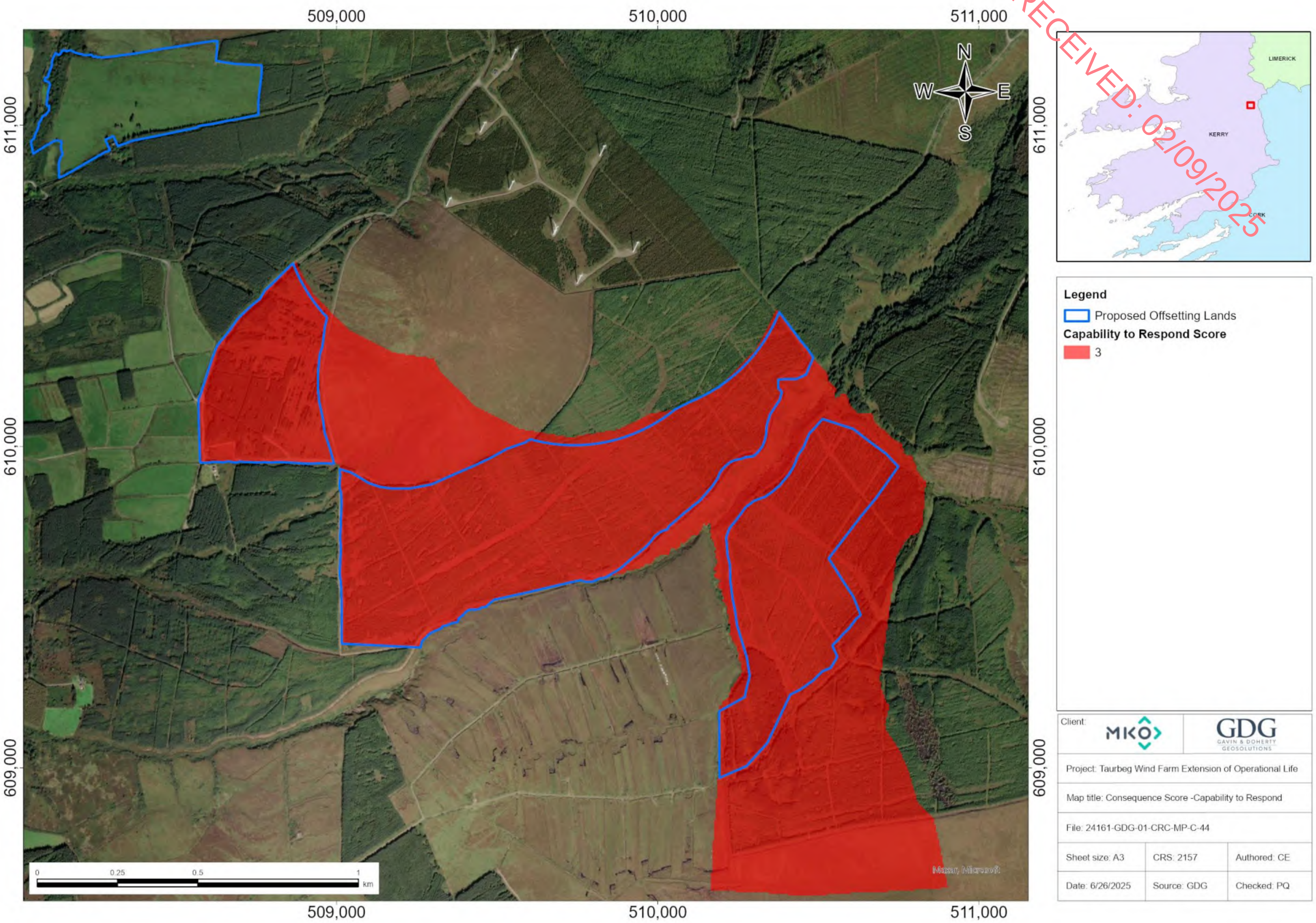

Figure N- 16 Peat Landslide Adverse Consequence Score – Capability to Respond Class.

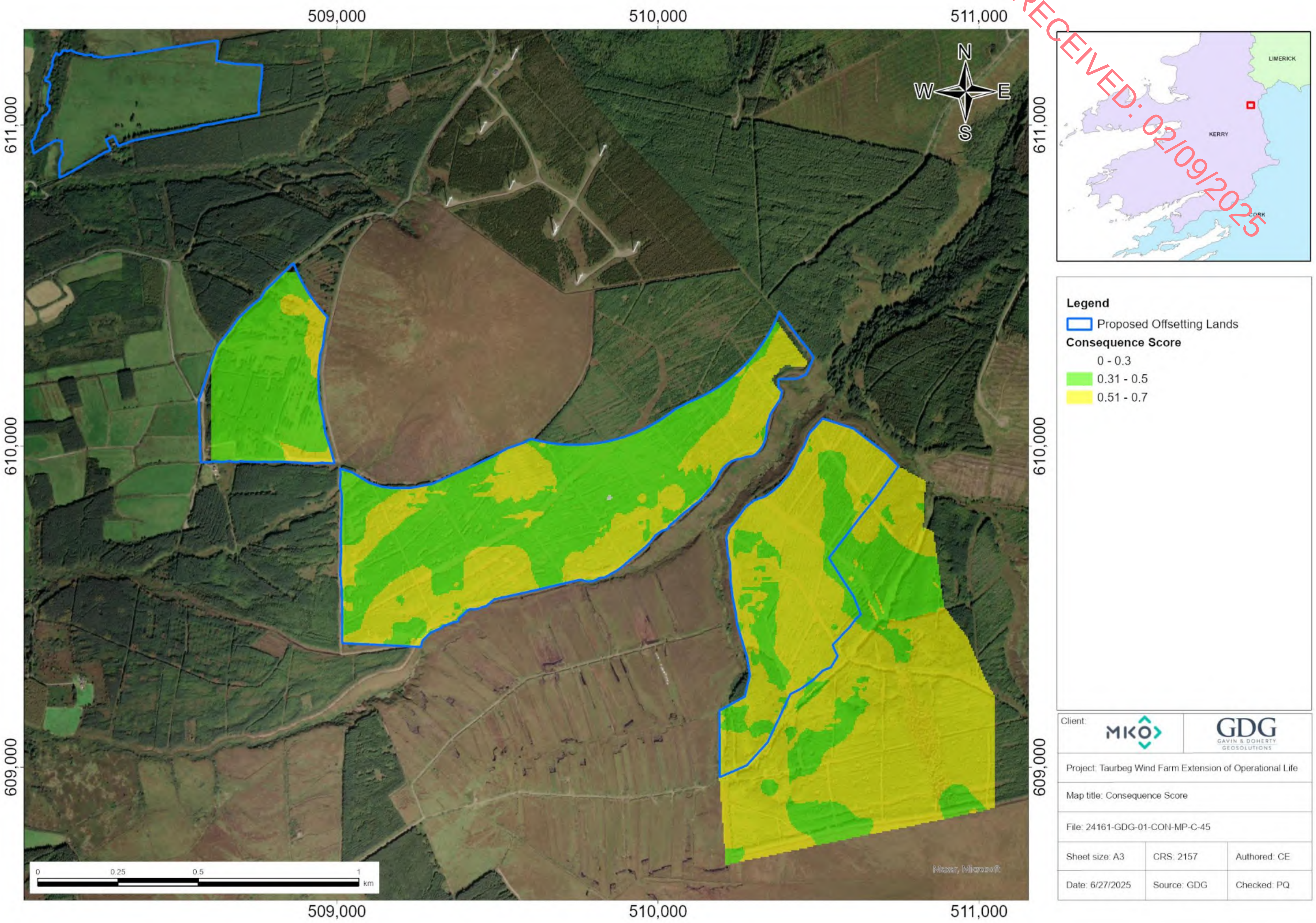

Figure N- 17: Peat Landslide Adverse Consequence Score.

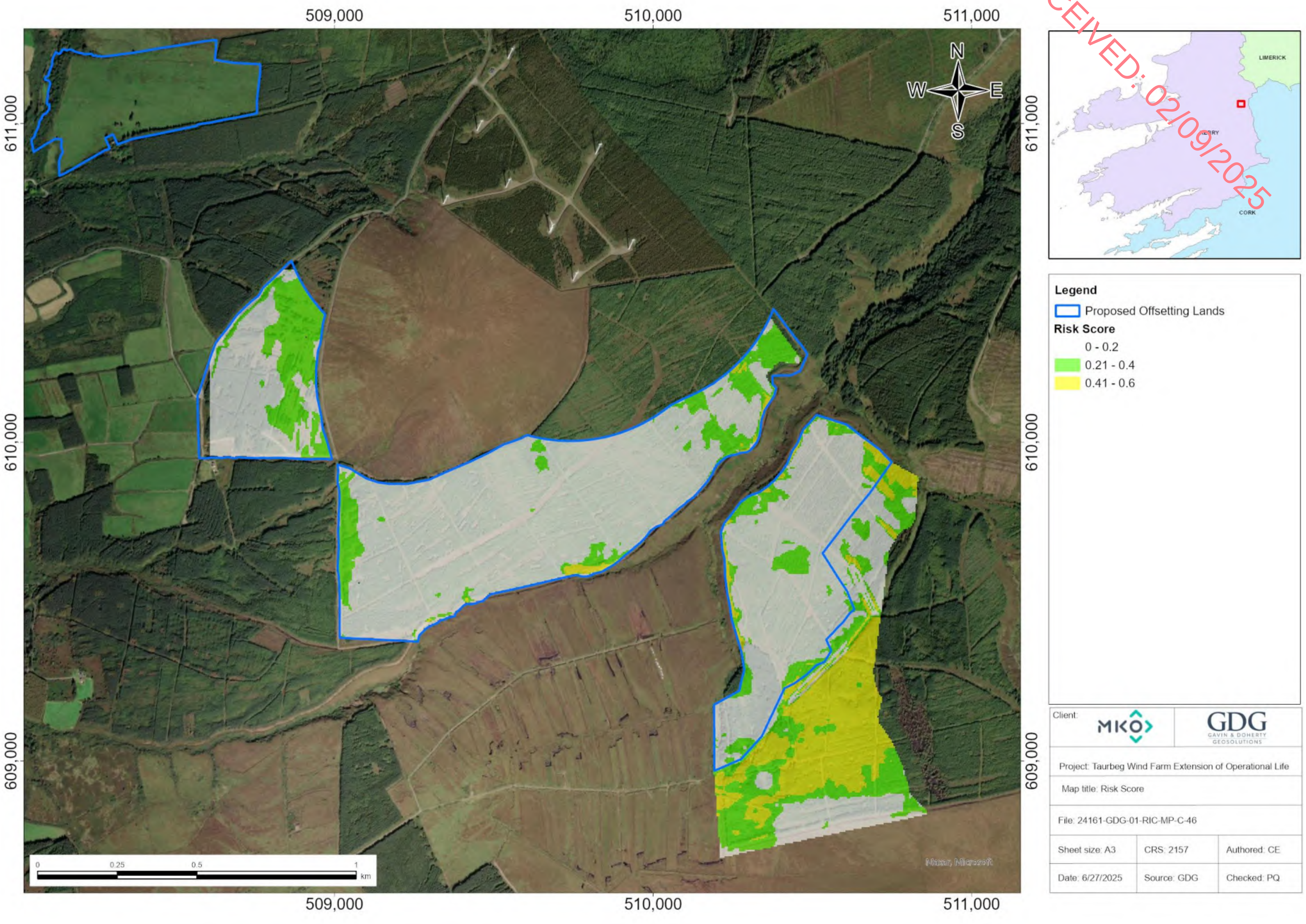

Figure N- 18: Qualitative Risk Score.

Appendix O Safety Buffer Areas and Felled Material Restriction areas

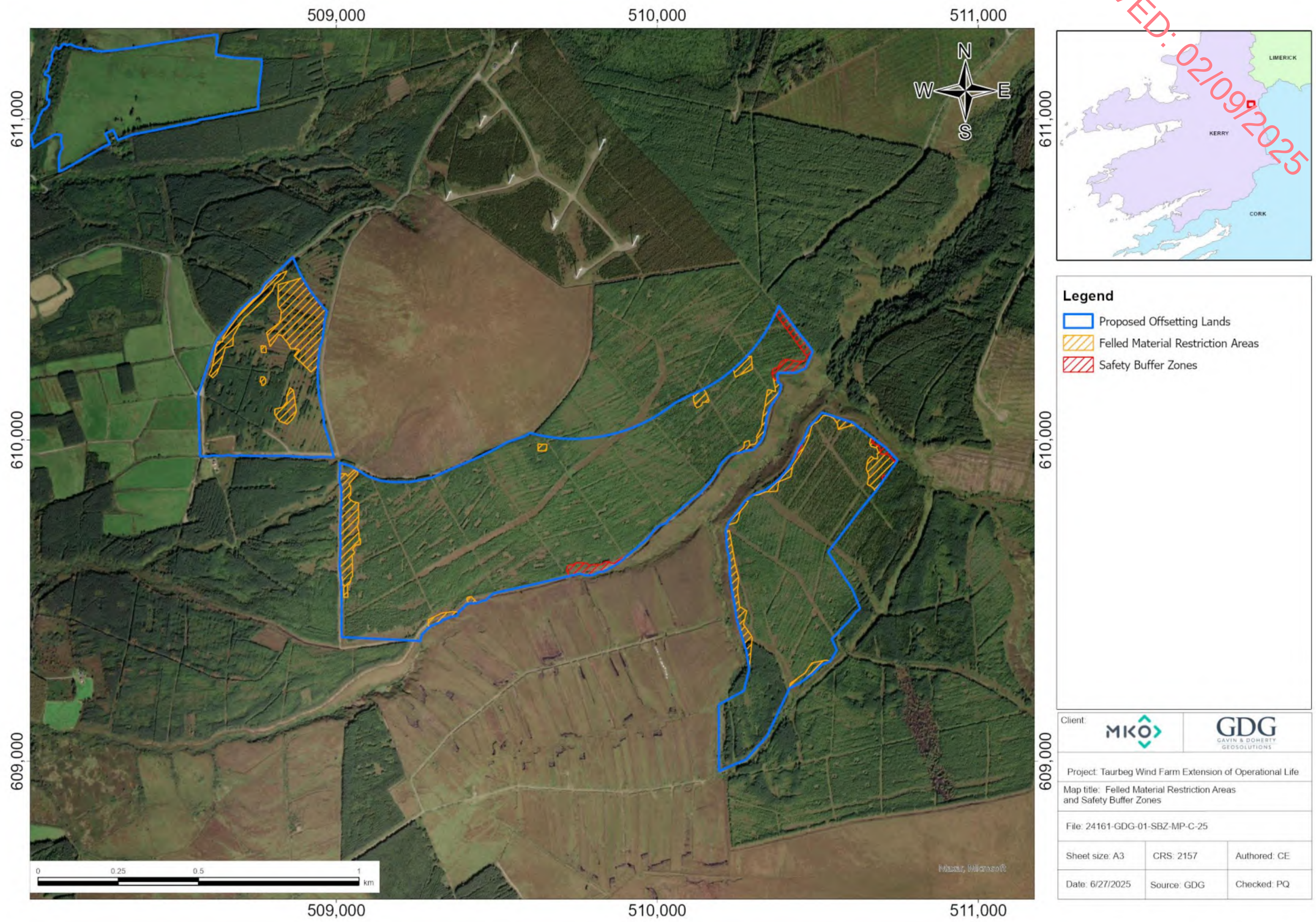

Figure O- 1: Safety Buffer and Felled Material Restriction areas.

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