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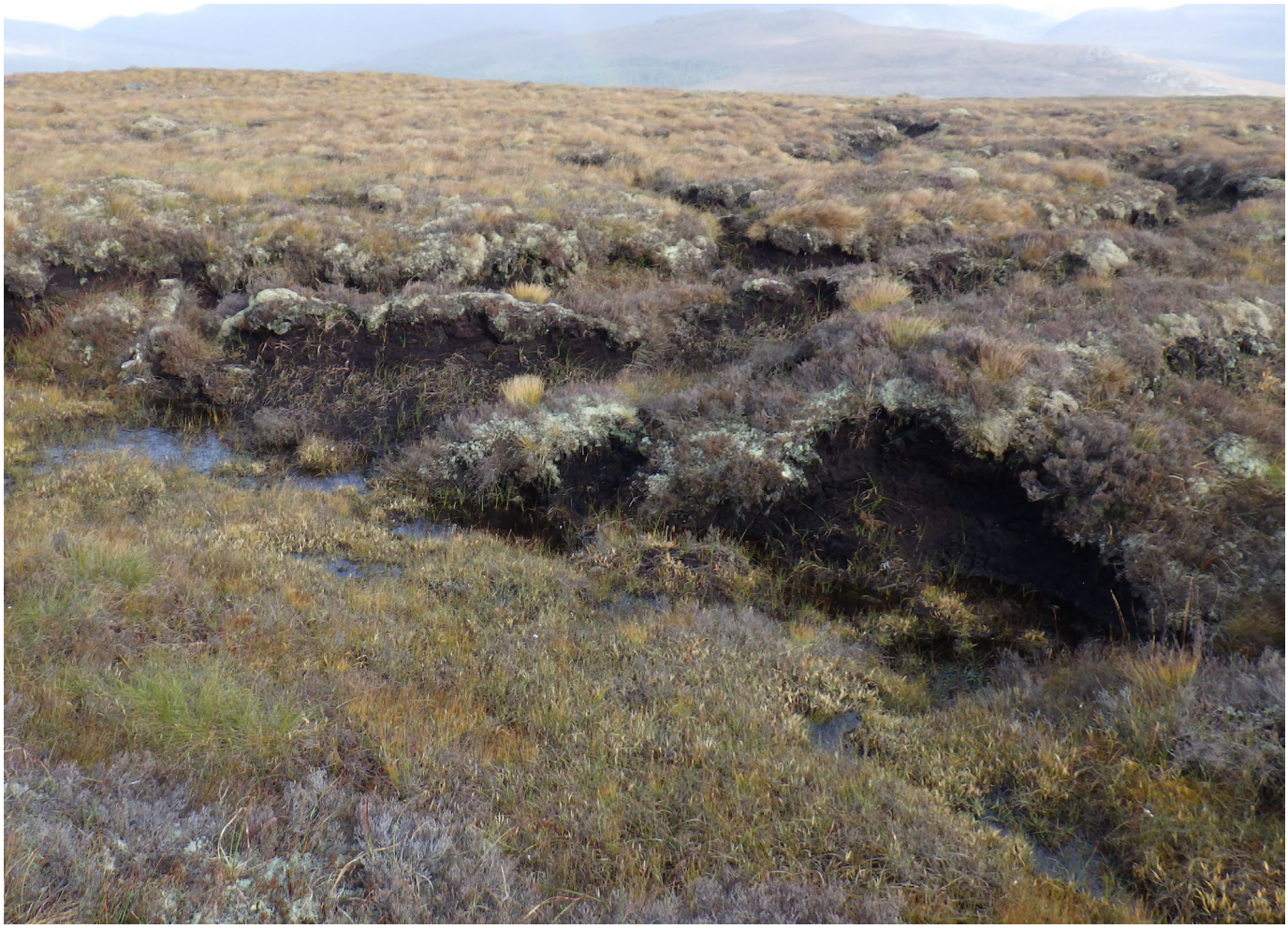
CRUACH CLENAMACRIE WIND FARM

APPENDIX 9.1 PEAT SLIDE RISK ASSESSMENT



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Cruach Clenamacrie Wind Farm: Peat Slide Risk Assessment

Technical Appendix 9.1

2760751-P9.1 (02)

OCTOBER 2024

WRc GENERAL NOTES

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Author	Lucy McCulloch Vanja Eavery	Technical reviewer	Catherine Isherwood
Date:	24/10/2024	Date:	24/10/2024
Project manager	Catherine Isherwood		
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CONTENTS

TABLES

GRAPHS

FIGURES

1 INTRODUCTION

1.1 This report provides a Peat Slide Risk Assessment (PSRA) for Cruach Clenamacrie Wind Farm (hereafter referred to as the Proposed Development) and associated infrastructure.

1.2 This report forms a Technical Appendix to the Environmental Impact Assessment (EIA) Report for the Proposed Development and should be read in conjunction with this document. It has been produced in response to concerns over development in areas of peatland relating specifically to the risk of induced instability within peat caused by the Proposed Development.

1.3 This report describes the existing peatland conditions within the Application Boundary and identifies and assesses the potential impacts that may be caused by the Proposed Development, including potential risks from induced peat stability. Design and mitigation methods to avoid or minimise these risks are set out, along with a number of good construction practices that would be employed during all works at the Proposed Development.

Site Location

1.4 The Proposed Development is located 5km south-east of Connel and 7km east of Oban within the Argyll and Bute Council area. The Site is bordered by Fearnoch Forest to the east, south and west. Access would be gained via the A85, to the north of Dailnamac. The A85 is the key transport route connecting the area with the central belt of Glasgow-Stirling-Edinburgh. The nearest settlement is Fearnoch, located approximately 800 m north-west of the Site access track.

1.5 The land in the Site generally slopes northwards from higher ground in the west and south-east. The area is a characterised by craggy upland with rocky outcrops, areas of oak-birch woodland and several lochs in low-lying hollows. The terrain is hummocky with steep ground in places most noticeably the summit of Cruach Clenamacrie in the west.

Development Proposals

1.6 The Proposed Development infrastructure would include:

- Six wind turbines, with a maximum tip height of 200m, and associated hardstandings;
- Substation;
- Construction compound containing car parking area, control building, PCS units, switch gear unit, battery units;
- New, upgraded and floating access tracks;
- Drainage infrastructure;
- Underground cables;
- Two borrow pits; and
- Temporary laydown areas.

1.7 Full details of the Proposed Development design are provided in **EIA Report Chapter 5: Project Description**.

Aims

1.8 This report aims to undertake a review of available information relevant to the Proposed Development, including all peat depth and peat condition records, in order to provide an assessment of the risk of peat instability within the Application Boundary. Recommendations will be made for mitigation measures and specific construction methods that should be implemented in order to minimise the risk of inducing instability in the peat during construction works and the process of decommissioning and removing existing infrastructure.

Assessment Method

1.9 The assessment has involved the following stages:

- desk study;
- site reconnaissance;
- peat condition assessment;
- hazard and risk assessment;
- detailed assessment; and
- mitigation.

2 DESK STUDY

Information Sources

2.1 The desk study involved a review of available information sources on the ground conditions at the Proposed Development. Information sources included:

- Ordnance Survey (OS) mapping at 1:50,000, 1:25,000;
- Terrain 5 digital terrain model (DTM);
- OpenData mapping;
- Historical OS mapping as available to view online;
- High-resolution orthorectified aerial imagery;
- British Geological Survey (BGS) online geological mapping, 1:50,000 scale;
- Scotland's Soils digital mapping, 1:250,000 scale;
- Data provided by the Client relating to wind farm and renewable energy development nearby;
- Archive data from local newspapers, as available online;
- Peat depth data collected by WRc; and
- Site data held by WRc.

Historical Information

2.2 There are no available records that indicate any historical peat slides in or around the Application Boundary.

2.3 A detailed inspection of available current and historical satellite and aerial photography has been undertaken to identify any signs of recent or former peat or slope instabilities within the development area and its surroundings.

2.4 Some localised evidence of scree is apparent on the slopes of Deadh Choimhead, approximately 700m south-east of the Application Boundary. This relates to the steep and craggy nature of the hill. No similar evidence was identified within the Application Boundary. The presence of scree does not indicate any kind of peat instability.

2.5 No further indications of historical slope instabilities have been identified within or around the Application Boundary.

Climate

2.6 The Proposed Development is situated within the UK Meteorological (Met) Office's Western Scotland Climate District. Much of western Scotland is exposed to strong, rain-bearing westerly winds, particularly in areas along the west coast (Met Office, 2016).

2.7 The Western Scotland Climate District is generally milder and wetter than the east due to the prevailing south-westerly, moisture-bearing North Atlantic winds. Temperatures for the district are variable and depend on factors such as topography and distance from the coast. Mean annual temperatures for the district range between 8.0 to 9.9°C.

2.8 Dunstaffnage Climate Monitoring Station is situated approximately 6.5km north-west of the Proposed Development. Rainfall patterns at the Proposed Development are likely to be similar to those observed at Dunstaffnage (Met Office, 2024).

2.9 Average annual rainfall from 1991-2020 for the Dunstaffnage monitoring station was 1,727.89mm compared to 1,818.14mm for the Western Scotland Climate District. The altitude at Dunstaffnage monitoring station is 3m above Ordnance Datum (AOD).

Topography and Geomorphology

2.10 Slope and geomorphology mapping are provided in **Figures 9.1.1** and **9.1.2**.

2.11 The Site is characterised by upland moor with irregular and undulating landforms. The highest point within the Site is the summit of Cruach Clenamacrie at 273m AOD. The wider area is characterised by similarly undulating areas of relatively high ground, notably Deadh Choimhead to the south at 383m AOD.

2.12 While most of the hill slopes within the Site are relatively gentle, steeper areas are present, notably along the south and south-east of the Application Boundary. Generally, the main Site area slopes northwards from higher ground in the west and south-east. The Site is located in the headwaters areas of the River Lonan, Allt Nathais and Lusragan Burn, meaning that there are a number of small watercourses distributed throughout the Proposed Development.

2.13 The Site access runs through an area of commercial forestry managed by Forestry and Land Scotland. The Site access drops from approximately 190m AOD in the west to 30m AOD at the Site entrance, which is the lowest area within the Application Boundary.

Geology

2.14 Geological information is derived from the BGS GeoIndex online geological mapping at a 1:50,000 scale and the BGS Lexicon of Named Rock Units (BGS, 2024a; BGS, 2024b). Geological mapping is shown on **Figures 9.1.3** and **9.1.4**.

Bedrock Geology

2.15 The Site is situated on bedrock of the Lorn Plateau Volcanic formation, mainly comprising extrusive basalts and andesites, of late Silurian to early Devonian age.

2.16 Some north-east to south-west trending microdiorite and appinitic diorite dykes are present within the Site, which form part of the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite. Some lenses of tuff and agglomerate of the Lorn Plateau Volcanic Formation are found in the far west of the Site.

2.17 There is one minor displacement fault trending north-east to south-west, in the south-west of the Site.

Superficial Geology

2.18 There is very little mapped superficial geology within the Planning Application Boundary. BGS GeoIndex identifies some small areas of peat north of turbine T5 and the construction compound, as well as to the north-west of watercourse crossing WC6.

2.19 No areas of artificial ground are identified within the Application Boundary.

Soils and Peat

2.20 The Soil Survey of Scotland digital soils mapping indicates that the soil coverage within the Application Boundary is predominantly peaty gleys and peaty gleyed podzols of the Sourhope Association (Scotland's Soils, 2024). Peaty gleys are described as poorly drained acidic soils which support wet heathland and rough grassland communities.

2.21 Areas of brown earth soil and a small area of humus-iron podzols with peaty gleys are present along the upper section of the access track. Further details on soils within the Application Boundary are provided in **Table 9.1.1**.

Table 9.1.1: Soil Types within the Application Boundary

Soil Assoc.	Parent Material	Component Soils	Landforms	Vegetation	Area %
Sourhope	Drifts derived from Old Red Sandstone intermediate lavas	Peaty gleys with dystrophic blanket peat with peaty gleyed podzols	Terraced hills with gentle and strong slopes: moderately rocky	Bog and northern bog heather moor blanket. Atlantic and Boreal heather moor	94.48
Sourhope	Drifts derived from Old Red Sandstone intermediate lavas	Brown earths	Lowlands and hill sides with gentle to very steep slopes: moderately rocky	Acid bent-fescue grassland. Dry Atlantic heather moor. Broadleaved Woodland	4.22
Strichen	Drifts derived from arenaceous schists and strongly metamorphosed argillaceous schists of the Dalradian Series	Humus-iron podzols with peaty gleys	Hummocky valley moraines	Acid bent-fescue grassland. Permanent pastures. Rush Pastures and sedge mires.	1.27
Strichen	Drifts derived from arenaceous schists and strongly metamorphosed argillaceous schists of the Dalradian Series	Peaty gleyed podzols with peaty gleys with dystrophic semi-confined peat	Hummocky valley and slope moraines	Atlantic and Boreal heather moor Heath-rush-fescue grassland. Rush pastures and sedge mires.	0.03

2.22 NatureScot's Carbon and Peatland Map classifies soils into five carbon classes, as well as three classes for mineral soils, non-soil or unknown. The map was consulted to understand where the carbon-rich soils, deep peat and priority peatland habitat are located within the Application Boundary (NatureScot, 2016).

2.23 The map indicates that much of the Site is underlain by Class 2 peatland, considered to be nationally important carbon-rich soils, deep peat and priority peatland habitat. Smaller areas of Class 5 peatland, described as carbon-rich soils and deep peat, are present near the south and south-western parts of the Site and underly the majority of the Site access.

2.24 A section of Class 0 is present underlying the northern end of the Site access. Class 0 is described as mineral soils where peatland habitats are not typically found.

2.25 Details of each peatland class and the associated areas are provided in **Table 9.1.2**. Soils and peat coverage is shown in **Figure 9.1.5**.

Table 9.1.2: Carbon and Peatland Classes Present Within the Application Boundary

Peatland Class	Description	Area %
Class 0	Mineral soil-Peatland habitats are not typically found on such soils.	5.47
Class 2	Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value.	75.88
Class 5	Soil information takes precedence over vegetation data. No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat.	18.65

2.26 A Phase 1 peat depth survey covering the Site was undertaken by WRc in late February and early March 2022. A Phase 2 survey was undertaken by WRc in November 2023 and supplementary Phase 2 surveys were undertaken in February, May and June 2024. The survey results were used to inform the infrastructure design to minimise incursion into areas of deep peat.

2.27 The combined peat depth surveys include a total of 1,740 individual peat depth records. The surveys indicate that the majority of the Site has no peat. Pockets of peat and deep peat up to 7 m deep are scattered throughout the Site and are generally associated with the hollows between the many small hills which characterise the Site. The data indicate that, in places, peat depth can vary substantially over short distances.

2.28 Further details of peat depth and peat depth variation are provided in the Peat Management Plan (**Technical Appendix 10.2**). An overview map of the peat depth distribution within the Proposed Development is on **Figure 9.1.6a** with larger-scale figures provided in **Figures 9.1.6b-f**.

Hydrogeology

2.29 The bedrock unit at the Site is classed as a low productivity aquifer of unnamed extrusive Silurian to Devonian rocks (BGS, 2024a). According to the BGS GeoIndex small amounts of groundwater are present in the near-surface weathered zone and flow is virtually all through fractures and discontinuities. Additionally, where springs are present, there can be a flow rate of up to 2 litres per second (BGS, 2024a).

2.30 Regional groundwater flow will tend to mimic natural topography. As the Site is located on high ground, drainage is directed to north, east, south and west from different parts of the Site, although the majority of the site drains north and north-west.

2.31 The superficial deposits within the Site are limited and, where present, are predominantly peat (BGS, 2024a). Peat bodies will hold some groundwater, but drainage is impeded

and poor. Flow within peat is known to be extremely slow, although it can contribute some limited baseflow to local watercourses.

Hydrology

2.32 The Proposed Development is located within three catchment areas including: Lusragan Burn, River Lonan and Allt Nathais. The majority of the Proposed Development is located within the Allt Nathais catchment in the central and eastern regions.

2.33 The Proposed Development is situated across three catchment areas: the Lusragan Burn, River Lonan and Allt Nathais. The majority of the Site is located within the Allt Nathais catchment, while smaller sections of the Site are within the Lusragan Burn catchment in the north-west and the River Lonan catchment in the south-west. Catchment areas are shown on **Figure 9.1.7**.

Allt Nathais Catchment

2.34 The Allt Nathais is the smallest of the three catchments but drains the largest area within the Application Boundary, including turbines T3, T4, T5 and T6, the construction compound area, substation and Site access. This catchment contains three of the eight watercourses located within the Application Boundary. These watercourses all combine to form the Eas nan Meirleach, a tributary to the Allt Nathais. The Allt Nathais flows directly into Loch Etive approximately 1.2 km north of the Application Boundary.

2.35 An additional unnamed watercourse, which runs parallel to the south-eastern margin of the Application Boundary, forms a tributary to the Allt na Seabhaig. The Allt na Seabhaig is also a tributary to the Allt Nathais.

River Lonan Catchment

2.36 The River Lonan catchment drains the south and south-west of the Site. Three of the watercourses near the western end of the site named Allt Fròga ch, Allt Oishnean and an unnamed tributary drain this area and flow south-west towards to the River Lonan.

2.37 The River Lonan then flows west into Loch Nell approximately 2.9 km south-west of the Application Boundary.

Lusragan Burn Catchment

2.38 The Lusragan Burn catchment drains the north-west of the Site. The remaining unnamed watercourse is a tributary, located just north of Cruach Clenamacrie, which flows northwards into the Allt an t-Sean-achaidh and onwards into the Black Lochs. The outflow from the Black Lochs via the Lusragan Burn eventually reaches the sea at Connel, just upstream of the Falls of Lora, approximately 4.5 km north-west of the Application Boundary.

Aerial Photography

2.39 The high-resolution orthorectified colour aerial imagery from ESRI has been used for this assessment (ESRI, 2024) with additional information from Google maps and Bing maps.

2.40 The Site is dominated by light brown, tan and light green areas, with some sections of dark green and very dark green sections. These colours often form a mosaic with a highly variable pattern of vegetation that changes frequently.

2.41 Light brown and tan colours are associated with the low-lying areas in between the many small hills which are scattered throughout the Site. They represent areas dominated by sedges and grasses, with *Sphagnum* and other bog mosses present in the lower canopy. Light green areas are associated with the hillslopes and summits and represent areas with better drainage, sometimes with more heather-rich vegetation. Very pale green areas are associated with the numerous watercourse channels distributed throughout the Site and are indicative of the flush zones and good natural drainage in these locations.

2.42 The dark green sections are associated with a mixture of self-seeded conifers and native woodland species. These areas are scattered throughout the Site but are most notable to the south of turbine T4 and at the base of the slope north of turbine T6. with some areas of self-seeded conifers scattered throughout the Site. The very dark green sections are found along the Site access track and indicate areas of conifer forestry plantation. Areas of recent clear-fell show as brown with distinct stripes caused by the timber extraction lanes.

Vegetation Mapping

2.43 Most of the Site is dominated by blanket bog habitats, characterised on the ground by a mosaic of heather moorland, marshy grassland and more *Sphagnum* mosses in wetter areas.

2.44 Sections of native woodland and self-seeded conifers are present throughout the Site. The Site access track predominantly consists of plantation conifers.

3 SITE RECONNAISSANCE

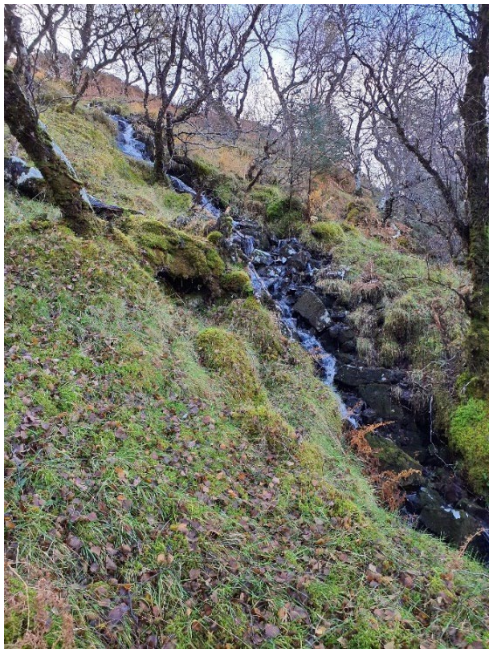
3.1 Walkover surveys were undertaken by RSK in tandem with the Phase 1 and 2 peat surveys in February 2022, November 2023, May 2024 and June 2024.

3.2 The scope of the surveys included a reconnaissance survey within the Application Boundary, plus mapping of the geomorphology and local-scale hydrology of the Site. The survey covered the entire Site, with a particular focus on the Proposed Development area where infrastructure is planned and potential access routes into and across the Site. The weather during the survey was variable, with mostly clear and bright weather and good visibility on the three of the days, and low cloud with showers and reduced visibility on the fourth day.

3.3 The areas described below provide good coverage of the Site and access tracks into the Site, detailing the range of landforms, vegetation and erosion patterns encountered.

	**A) View along the access track into Site, NGR NM 9691 3009.** Photograph shows view along the Site access, to the south-west of watercourse crossing WC6. In the forestry to the left of the track a pocket of deep peat was found. Vegetation consists of conifer plantations for commercial forestry with varied mosses present on the forest floor. Most of the access track is peat free. However, in this location peat with a depth of 7.5-8m was found. The surrounding area has peat ranging from 0.5-5m and remains very localised to this section of the access route.
	**B) View south across the centre of the Site, NRG NM 9490 3022.** Photograph shows view across the central region of the Site where the proposed access track would be located. The landscape is hilly and a lochan is visible, sitting at a lower elevation than the surrounding hills. Vegetation on the hilltops is dominated by shrubs and heather, becoming more sedge and Sphagnum rich towards the foot of the hills. Most peat in this area is <1m, with small pockets of deep peat up to 3.5m deep being found in some places.

	**C) View south from turbine T3, NGR NM 9423 3023.** Photograph shows view across location of proposed track and turbine T4. The landscape is undulating, with many small hills rising steeply from areas of lower ground. A small tributary to Eas nam Meirleach (NGR NM 9440 3037) can be seen running north-east through the centre of the photo. Vegetation in this area is characterised by sedges and heather, with sparse conifers and native trees scattered throughout. Peat is mostly shallow here (<0.5m), with a few patches of deeper peat (0.5-4.5m) dispersed across the field of view. The deeper peat is predominantly associated with the watercourse.
	**D) View east from turbine T4, NGR NM 9439 2979.** Photograph shows view east across Site looking up towards proposed location of turbine T6. The foreground shows vegetation consisting of sedges, grasses, heather, bog myrtle and Sphagnum while an area of native woodland is visible to the right-hand side. In the background, on the hillside, vegetation is characterised by sedges and heather with a scattering of conifers and other small trees. Peat in this area is predominantly shallow (< 1m).
	**E) View east from proposed access track, NGR NM 9344 2948.** Photograph shows view east from the proposed access track, looking west towards the centre of the Site. Vegetation is dominated by grasses and there are young conifer trees scattered across the landscape with intermittent areas of heather. Like much of the Site, the landscape is undulating and hilly. This photograph was taken in a location where peat is generally under 0.5m, with pockets of deeper peat found on the hilly areas towards the back of the photograph.

	**E) View south from proposed access track, NGR NM 9349 2944.** Photograph shows view south from the proposed access track, looking towards turbine T2. Conifer plantations are visible in the distance marking the southern edge of the Application Boundary. Deadh Choimhead can be seen rising above the conifer plantation. Vegetation is dominated by grass and small conifers are dotted across the landscape, particularly towards the edge of the plantation boundary. The landscape is undulating and hilly with deep peat present in the hollows and depressions between hills. Peat across this area is generally 0.5m or less, with pockets of peat up to 3m deep found to the west of turbine T1.
	**G) Boggy area east of the construction compound, NGR NM 9529 3048.** Photograph shows a boggy area with a watercourse running through it close to the construction compound. Vegetation is dominated by grasses, with rushes, ferns and aquatic plants. Peat found along this watercourse is predominantly between 0-0.5m with depths of up to 4m in some areas.
	**H) Waterfall south of watercourse crossing WC5, NGR NM 9506 3024.** Photograph shows a waterfall close to the track south of WC5. It is located on a steep hill with exposed bedrock and a width of approximately 0.5m. The vegetation along this slope consists of grasses, mosses with native woodland trees. Deeper peat of up to 3.5m was found at the bottom of the waterfall with peat depths of under 0.5m along the banks visible in this picture.

	**I) Watercourse next to Turbine T4, NGR NM 9424 3020.** Photograph shows watercourse crossing WC1 close to turbine T4 hardstanding. The watercourse is within a defined narrow channel approximately 0.3m wide. The vegetation along this part of the watercourse is predominantly grasses with some rushes and bracken present. At the crossing location, the peat is less than 0.5m deep. Surrounding areas have a similar pattern of peat distribution to the rest of the Site, with areas between 0.5-1m deep and pockets of deeper peat up to 5m.
	**J) Watercourse crossing along track to Turbine T3, NGR NM 9452 3047.** Photograph shows watercourse crossing location along the track to Turbine T3. The watercourse is in a wide and well-defined channel approximately 1.5m wide and 0.2m deep. The vegetation along this part of the watercourse is predominantly grasses with some rushes and bracken present. Trees can be seen along the banks of the watercourse. There is little peat around this area, with most being under 0.5m deep.

4 MAPPING

Peat Depth Survey

4.1 Phase 1 peat depth surveying covering the Site was undertaken by RSK in late February and early March 2022. The survey results were used to inform the infrastructure design to minimise incursion into areas of deep peat.

4.2 A Phase 2 survey was undertaken by RSK in November 2023 and supplementary Phase 2 surveys, to inform infrastructure design, were undertaken in February, May and June 2024. The Phase 2 surveys involved recording peat depths at 50m intervals along the centre line of proposed new access tracks, with 10-25m offsets to either side. Along existing tracks which would require upgrading, peat points were recorded every 50m to either side at a distance of 10-25m from the existing track. Peat depths for turbine bases, hardstandings, compounds, substation and borrow pits were recorded on a 10-20m grid, varying depending on safe access to the locations.

4.3 Access was restricted in some areas as a result of local ground conditions, leading to safety concerns in these locations. This has led to wider spacing of points in some areas than the specified guidance; these areas would be surveyed prior to construction when safe access can be facilitated.

4.4 Peat probing point locations were recorded using a handheld GPS or GPS-enabled tablet with typical accuracy of ±5m and peat depths were measured to an accuracy of ±0.01m. All measurements were recorded to full depth/depth of refusal.

4.5 The peat survey results are summarised in **Table 9.1.3**.

Table 9.1.3: Summary of Peat Depth Probing Results

Peat Depth Range (m)	No. of Points	Percentage of Points
0.00	16	0.92
0.01-0.50	1,298	74.60
0.51-1.00	229	13.16
1.01-1.50	75	4.31
1.51-2.00	41	2.35
2.01-2.50	33	1.89
2.51-3.00	17	0.98
3.01-3.50	15	0.86
3.51-4.00	5	0.29
4.01-4.5	7	0.40
4.51-5.00	0	0
5.01-5.50	0	0
5.51-6.00	1	0.06
6.01-6.50	1	0.06
6.51-7.00	1	0.06

Peat Depth Range (m)	No. of Points	Percentage of Points
>7.00	1	0.06
Total:	**1,740**	**100.0%**

4.6 The peat depth surveys indicate that the majority of the area surveyed had no peat, with 75.52% of the measured locations having topsoil or peaty soil cover up to 0.5m deep. 92.99% of the area surveyed has peat depths of 1.5m or shallower, while only 4.66% of the site has very deep peat (> m), with the deepest recorded depth being 7.53m.

4.7 The peat depth surveys confirm that peat is present in the area but that much of the peat present is shallow in depth (0.5-1.0m). The Site access is mainly across areas with <0.5m deep peat. However, due to the widespread distribution of peat throughout the Site there are areas where the access track must cross pockets of deeper peat. Where this occurs, the peat is generally 0.5-1m deep, with the occasional pocket of peat up to 4.5m deep. Similarly to the track, most of the infrastructure is situated where the peat is <0.5m deep although some small incursions into areas with peat have been required as a result of engineering or other environmental constraints.

Indicative Peat Depth Mapping

4.8 The combined peat depth survey results were used to produce an interpolated peat depth map for the Site (**Figure 9.1.6a-#**).

4.9 The combined peat depth survey results were used to produce an interpolated indicative peat depth map for the study area. The interpolated peat depth map was produced using an inverse distance weighted interpolation across the Site.

4.10 The advantage of using digital interpolation is that the process is fully objective and there can be no subjective influence. However, the process is not able to allow for known variation in peat development in varying topographical settings. As a result, there may be over-estimation of peat development in areas of steep or well drained ground, and potential under-estimation of peat development in the flatter or poorly drained areas. Owing to good resolution of the underlying data, the interpolation appears largely to give a representative indication of peat depth across the Site.

Peat Sampling and Analysis

4.11 Peat core samples were taken during the supplementary Phase 2 peat depth survey in February 2024. Cores were taken at 3 locations and the peat cores were logged using the modified Von Post humification and wetness scale. Core logs and photographs are provided in **Annex 1: Peat core logs**.

4.12 Although three peat core samples were sent for analysis, the analysis results were not considered to be reliable and have not been used in the calculations as a result.

5 PEAT CONDITION

Developments on Peat

Definition of Peat

5.1 Scotland's Soil's (2024) classifies peat as:

> *An accumulation of partially decomposed organic material, usually formed in waterlogged conditions. Peat soils have an organic layer more than 50cm deep from the soil surface which as an organic matter content of more than 60 %.*

5.2 Organic soils that are 50cm or thinner can also support peatland vegetation and as a result are also considered as part of Scotland's broader peatland system in Scotland's national Peatland Plan (NatureScot, 2015). These soils are often described as 'peaty gleys' or 'peaty podzols', reflecting key aspects of the underlying soil. Peaty soils have a higher plant fibre content and are less decomposed than peat.

5.3 Active peatland typically consists of two layers; the surface layer (*acrotelm*) and the deeper layer (*catotelm*). The acrotelm contains the living vegetation and consists of living and partially decayed plant material. It typically has a low but variable hydraulic conductivity and allows some through-flow of water within the plant material. The underlying catotelm is denser, with a very low hydraulic conductivity, and is formed from older decayed plant material. The catotelm varies in structure, in some areas retaining a proportion of fibrous material and in other areas being more humified and amorphous. The degree of humification typically increases with depth.

5.4 Underneath the peat-forming layers, the basal substrate can be a mineral soil, a superficial deposit such as glacial material, or bedrock. There may be a transition zone through a mineral-rich peaty layer at the base of the peat, although this is usually no more than 5cm in thickness.

Importance of Peat

5.5 Covering more than 20% of Scotland's land area, peatland forms a key part of the Scottish landscape. It forms a significant carbon store and is an internationally important habitat.

5.6 Active and healthy peatlands develop continuously, removing carbon dioxide from the atmosphere and storing it within the peat soil. Peatland protection and restoration form key parts of the Scottish Government's Climate Change Plan, which targets restoration of 250,000ha of peatland by 2030 (Scottish Government, 2018). As of March 2020, over 25,000ha of peatland had begun the process of restoration, and in 2020 the government announced a £250 million ten-year funding package to support the restoration of degraded peat (Scottish Government, 2020). Restoration will need to be conducted at a faster pace to reach stated targets.

5.7 Therefore, it is important that developments in peatland areas recognise the importance of peatland as a habitat and carbon store. Careful development planning and infrastructure design can remove or minimise the disturbance of peat, which is in turn a requisite for the development to proceed.

Peat Condition Survey

5.8 Information detailing the condition of the peat present within the Site was collected as part of the conducted peat depth surveys. NatureScot recognises five categories of peatland condition: (1) Near-natural; (2) Modified; (3) Drained; (4) Actively eroding; and (5) Forested/Previously Afforested (NatureScot, 2021).

5.9 The Proposed Development is within an area of upland moorland, although there has been some attempt to drain parts of the Site and some areas demonstrate clear evidence of significant grazing pressure. As a result, most of the turbine area is considered to be a mix of categories 1, 2 and 3. Parts of the turbine area are under woodland, and would be considered to be category 5. The forestry plantations along much of the Site access track and to the east, south and west of the Application Boundary would fall into category 5, and there is significant artificial drainage in these areas.

Proposed Peatland Restoration

5.10 Within the Application Boundary restoration efforts would focus on scrub removal and ditch-blocking. Areas outwith the Application Boundary, are also being considered for restoration. Restoration methods would focus on blocking of natural or artificial drainage channels to encourage re-wetting and regrowth of *Sphagnum* species; removal of trees and tree roots; reprofiling of gully sides and replacement of vegetation; and exclusion of grazers through fencing and livestock management.

5.11 Peatland restoration, habitat management and habitat enhancement proposals for the Proposed Development are discussed in **Technical Appendix 10.5 outline Habitat Management Plan** of the EIA Report.

6 HAZARD AND RISK ASSESSMENT

6.1 For the purposes of this peat slide risk assessment, the following definition of risk has been adopted:

Risk = Probability of a Peat Landslide x Adverse Consequence

6.0 Probability, or likelihood, can be estimated in several ways and should take account of both natural factors and man-made or man-imposed factors that could influence slope stability. Man-made or man-imposed factors can include overgrazing from over-stocking, excavation of drainage ditches or grips, or heather burning for land management purposes. Natural factors can include extreme weather events such as very high intensity rainfall, or prolonged dry periods followed by storms.

6.1 The methods of assessment of likelihood and adverse consequence used here are described below.

Assessing Likelihood

6.2 As peat slope failures are mainly considered to resemble planar translational slides, the assessment of likelihood of a peat landslide makes use of the Infinite Slope Model (Boylan & Long, 2014) to assess stability of the peat across the slopes in the Site, in line with the Scottish Government guidance (Scottish Government, 2017). The Infinite Slope Model assesses slope stability by calculating the forces resisting failure (shear strength or cohesion) and the forces inducing failure (shear stress) and taking a ratio of these, known as the Factor of Safety. The modified Infinite Slope Model equation is as follows:

$$F = \frac{c'}{\gamma\, z \sin\beta \cos\beta}$$

where
- F = Factor of Safety, the ratio of forces resisting a slide to forces causing a slide
- c' = undrained shear strength of the material; kPa
- γ = specific weight of peat, undrained in situ; kN/m^3
- z = peat depth; m
- β = slope of ground surface, assumed to be parallel to the slope of the failure plane; degrees

6.3 If F > 1, the slope is stable; if F < 1 the slope is unstable; if F = 1 the forces are exactly balanced. It is possible to state with some confidence, therefore, that if F > 1.3 the slope is stable and would have some resistance to change.

6.4 Values assigned to the parameters are provided in **Table 10.1.5**, along with an explanation for their election.

Table 9.1.4: Parameters for the Infinite Slope Model

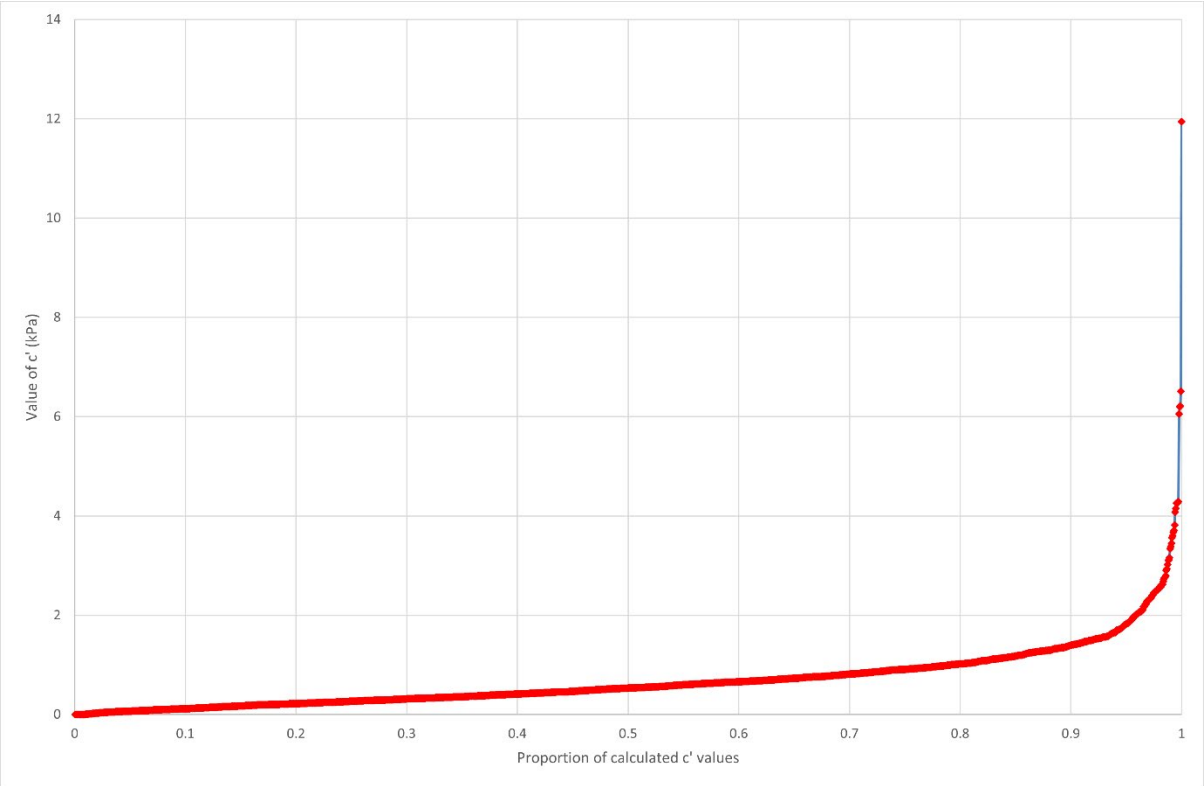
Parameter	Value and Derivation
F	Calculated value
c'	11.94kPa

Parameter	Value and Derivation
	Published shear strength values for peat vary from 4.5 to 60 kPa or more (e.g. Long, 2004). Published values from recent field tests tend to cluster between 10 and 20 kPa with some higher and lower values recorded. The selected value represents the maximum of a back-calculated minimum, c' (see explanation below).
γ	11.25kN/m^3 Derived from density of peat multiplied by acceleration due to gravity (9.81m/s^2). Density of peat varies depending on degree of decomposition and water content; published values range from 500 to 1,400kg/m^3. Peat density values derived from peat core samples collected from the Proposed Development site were unreliable due to the samples being overly compressed during collection. Therefore, a density of 1,150kg/m^3 has been used in these calculations. This is considered to be a reliable estimate based on the current published literature.
z	Where available, measured peat depths have been used. For grid analysis, the maximum interpolated depth within the grid has been taken to provide a conservative estimate.
β	Slope angles have been derived from the DTM for the Site. Grid cell slopes were all derived from the Site DTM. The DTM used for slope angle generation has a resolution of 5m. The slope raster map was generated within the GIS software used for the analysis. Average (mean) slope angles were used for each cell.

6.5 The shear strength, c', has been estimated from site data. This is undertaken by assuming that the slope is just marginally stable at each point where peat depth has been measured, i.e. the slope has F = 1. The Infinite Slope Model equation can be rearranged to derive a value for c', using the other parameters as described in **Table 10.1.5**.

6.6 It is important to note that the calculated values of c' for each location represent the *minimum* shear strength needed for the peat to be stable. In fact, the shear strength may be, and in most cases probably is, considerably higher. For example, on very shallow slopes the peat needs only a very low shear strength to remain stable, whereas on steeper slopes a much higher shear strength is required to hold the peat on the slope. For this reason, the higher estimated values of c' are of more relevance as they are more likely to be representative of the actual shear strength of the peat on the Site. For this assessment, the maximum value of the calculated shear strengths has been used in the stability analysis. This gives a value of 11.94kPa, as stated in **Table 10.1.5**.

6.7 At the Proposed Development, 1,740 locations have been probed during the phases of fieldwork. c' values have been calculated for each of these and the distribution is provided in **Graph 10.1.1**.



Graph 9.1.1: Estimate of minimum shear strength, c'

6.8 In order to produce a Site-wide dataset for Factor of Safety, a grid of 50 x 50m cells was overlain across the Site and a Factor of Safety calculated for each cell. It is a standard and widely recognised GIS technique to use a regular grid for terrain analyses of this kind. It allows a systematic process across the landscape and minimises the subjectivity of the analysis. The 50 x 50m cells are referred to as 'grid cells' throughout the analysis.

6.9 The Factor of Safety, F, has been calculated for each peat probing location and grid cell within the Site. A buffer of 250 m around the Application Boundary has also been included. The Factors of Safety have been divided into classes, which have been used to map the likelihood of a peat landslide occurring at each point and for each grid cell across the Site.

6.10 The calculated Factor of Safety results have been considered together with field observations and geomorphological assessment to take into account additional risk factors including breaks-in-slope, or risk reduction factors such as areas of bedrock exposure. These factors have been applied to the calculated Factor of Safety results and the grid cell classes have been changed as appropriate based on the geomorphological mapping. For cells where additional risk factors and risk reduction factors are both present, no change has been made to the calculated results.

6.11 The results of the modified classification are presented in **Table 10.1.6**. Please note that the modification to calculated FoS to generate an estimate of Likelihood applies only to grid cells, and the point data retain the calculated FoS value.

6.12 The likelihood map is provided in **Figure 9.1.8**.

Table 9.1.5: Summary of Likelihood Ratings

Likelihood	Factor of Safety	No. of Points	% of Points	No. of Cells (FoS)	% of Cells (FoS)
Nil	No Peat	1,314	75.52	1,221 (1567)	37.57 (48.22)
Negligible	2.5+	421	24.19	1,485 (1637)	45.69 (50.37)
Unlikely	1.3-2.499	4	0.23	515 (40)	15.85 (1.23)
Likely	1.1-1.299	0	0.00	23 (0)	0.71 (0.00)
Probable	1.0-1.099	1	0.06	1 (1)	0.03 (0.03)
Almost certain	<1.0	0	0.00	5 (5)	0.15 (0.15)
Totals		1740	100.00	3250	100.00
N.B. Numbers in brackets for the grid cells are the original results from the Infinite Slope Model analysis, to provide a comparison with the Likelihood Rating results					

Assessing Adverse Consequences

6.13 Potential adverse consequences resulting from a peat landslide cover a wide range, from environmental through to economic and, potentially, harm to life. The Scottish Government (2017) gives five examples, as follows:

- Potential for harm to life during construction;
- Potential economic costs associated with lost infrastructure or delays in the construction programme;
- Potential for reputational damage associated with the occurrence of a peat landslide in association with construction activities;
- Potential for permanent, irreparable damage to the peat, in terms of both carbon store and habitat, through mobilisation and loss of peat in a landslide;
- Potential for ecological damage to watercourses and waterbodies subject to inundation by peat debris.

6.14 Adverse consequence has been assessed taking account of environmental sensitivity, including potential consequences to water quality from peaty debris, habitat loss by peat removal and by blanketing of sensitive areas with peat debris, as well as economic significance, including damage to infrastructure and construction delays resulting from a peat landslide, in line with current guidance (Scottish Government, 2017).

6.15 Adverse consequence has been assigned as follows:

- **Very high consequence:** public roads, all buildings, wind turbine foundations, substation, control building, SAC or Ramsar sites, private water supply sources;
- **High consequence:** watercourses and waterbodies, areas of sensitive habitat, turbine hardstandings, car parking areas, auxiliary pads, battery units, switchgear unit, substation hardstanding, PCS units, construction compound, sites designated as SSSI;
- **Moderate consequence:** areas of moderately sensitive habitat, access tracks, GCR sites
- **Low consequence:** areas of low sensitivity habitat, borrow pits; and

- **Very low consequence:** damaged or degraded habitats.

6.16 **Table 10.1.7** provides a summary of the grid cells at the Site assigned to each of the defined consequence ratings. The adverse consequence map is provided in **Figure 9.1.9**.

Table 9.1.6: Summary of Adverse Consequence Ratings

Adverse Consequence	No. of Cells	% of Cells
Very high consequence	94	2.90
High consequence	558	17.20
Moderate consequence	460	14.15
Low consequence	2,138	65.75

Risk Assessment

6.17 The Likelihood and Adverse Consequence are combined to produce an estimate of risk for each grid cell within the Site. The risk assessment matrix used to combine these two parameters is provided in **Table 10.1.8**.

Table 9.1.7: Risk Assessment Matrix

		Adverse Consequence				
		Extremely High	High	Moderate	Low	Very Low
Peat Landslide likelihood	Almost Certain	High	High	Moderate	Moderate	Low
	Probable	High	Moderate	Moderate	Low	Negligible
	Likely	Moderate	Moderate	Low	Low	Negligible
	Unlikely	Low	Low	Low	Negligible	Negligible
	Negligible	Low	Negligible	Negligible	Negligible	Negligible

6.18 Table 10.1.9 provides a summary of the risk ranking for the grid cells across the Site, together with an indication of appropriate mitigation from the Scottish Government (2017). The risk ranking map is provided in **Figure 9.1.10**.

Table 9.1.8: Summary of Risk Ranking and Appropriate Mitigation

Risk Ranking	No. of Grid Cells	% of Grid Cells	Appropriate Mitigation
High	2	0.06	Avoid project development at these locations
Moderate	7	0.22	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible
Low	262	8.06	Project may proceed pending further investigation to refine assessment, and mitigate hazard through relocation or re-design at these locations
Negligible	1758	54.09	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate
No peat	1221	37.57	No peat landslide hazard

6.19 Most of the Site either has no peat or has been assessed as having negligible risk of peat landslide (91.66%). Seven grid cells have been assessed as having a moderate risk of peat landslide and two with a high risk.

6.20 The nine grid cells assessed as having moderate or high risk have been subject to further investigation in order to refine the assessment in these areas. This is detailed in **Section 7: Detailed Assessment and Mitigation**.

Peat Slide Risk Associated with Blasting for Aggregate

6.21 As with many renewable energy developments, rock extraction for the Proposed Development is proposed to be achieved by blasting. It is recognised that shock waves from blasting have the potential to travel through the bedrock and could, potentially, be associated with triggering instability in peat areas at some distance from the borrow pit sites. Both borrow pit sites have been located within areas of limited peat, to restrict the potential for induced peat slide adjacent to the borrow pit areas.

6.22 All blasting will be under the supervision of a qualified and experienced blast engineer. The smallest practicable amount of explosive would be used in order to minimise shock waves resulting from the blast. Additional pre-drilling of the blast face may be appropriate to provide a higher level of control of the blast, particularly if this allowed use of smaller amounts of explosive; this would be undertaken on the advice of the blast engineer on the site.

6.23 Significant excavation works would be restricted when blasting for aggregate is planned at any of the borrow pit locations. Restrictions would be imposed as follows:

- Borrow Pit BPA1: restrictions affecting works on the substation and construction compound areas and access tracks up to 500m from the borrow pit site.
- Borrow Pit BPA2: restrictions affecting works on access tracks up to 500m from the borrow pit site.

6.24 Works would only continue after appropriate inspections have determined that ground instability has not arisen as a result of the blast.

6.25 Visual peat monitoring would be undertaken by the Environmental Clerk of Works (ECoW) or alternative nominated site staff following periods of blasting, to inspect nearby infrastructure locations for any signs of potential instability. This would include recording any signs of cracking or mounding of peat, which can be the early signs of slippage. It is recommended that infrastructure and peat areas within 500m of the blasting location are visited, with additional locations if relevant as recommended by the ECoW.

6.26 Blasting may be restricted in periods of significant wet weather, upon the advice of the blast engineer. Wet weather definitions are provided in **Technical Appendix 9.2** of the EIA Report.

6.27 Blasting has been undertaken previously within the Site by FLS in order to extract aggregate for track construction and maintenance, and for construction of other existing infrastructure. No induced instabilities have been reported as a result of this activity, and no signs of induced ground instability were observed during any of the site surveys.

7 DETAILED ASSESSMENT AND MITIGATION

Detailed Assessment

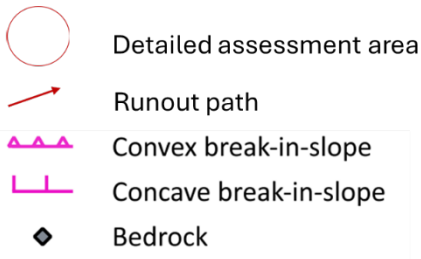
7.1 Seven grid cells have been identified as having a moderate risk of peat landslide, while two cells have been identified as having a high risk. These cells have been considered in greater detail as seven separate groups. The areas identified for detailed assessment are indicated on **Figure 9.1.10**.

7.2 The inspection for each group includes a detailed inspection of the highlighted cells, the cells immediately around and downslope of them, the measured peat depths and slope angles present, drainage features and the nature of the proposed nearby infrastructure. Mitigation measures are recommended to reduce or control the risk for the areas.

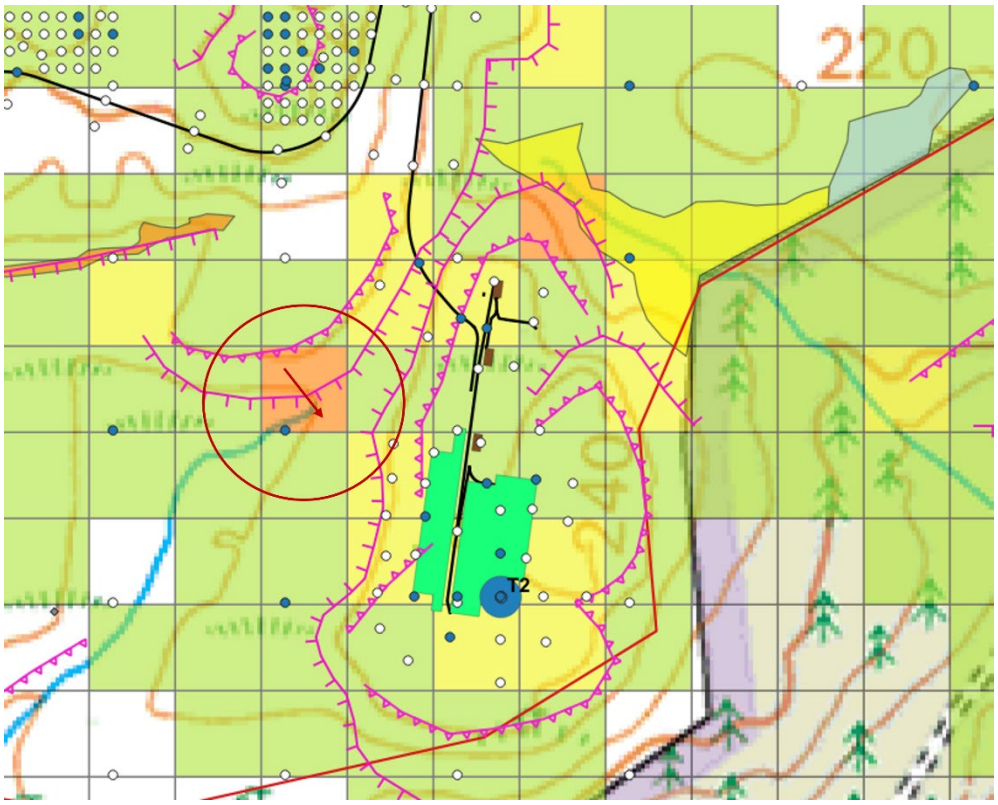
7.3 Following detailed consideration, the risk ranking has been re-appraised in the light of the presented information and proposed mitigation. Each description is accompanied by a map of the cells and their immediate surrounding. The grid cells in each map are 50 x 50 m, to give an indication of scale. Green cells have negligible risk; yellow cells have low risk; orange cells have moderate risk; red cells have high risk. Blank cells have no peat as defined in the Scottish Government Guidelines (Scottish Government, 2017).

7.4 The points on the maps show the calculated Likelihood rating for the locations with directly measured peat depths, where white is no peat; blue is negligible; green is unlikely; yellow is likely; orange is probable; and red is almost certain.

7.5 Other symbols used on the maps are described below:



Detailed Assessment: Area 1



One cell, located west of the access track leading to turbine T2, has been assigned Moderate Risk. The assigned risk level relates to the sensitivity of the receptor, the Allt Frogach, and its associated High consequence rating.

Calculated Likelihood for the cell is Likely, reflecting the combination of interpolated peat depth, slope within the cells and the presence of convex and concave breaks-in-slope.

The maximum peat depth record in the cell is 1.65m, with average slope angle of 15.56°.

Potential runout from any failure: Any failure in this or adjacent cells would travel south-east down slope and enter the watercourse. A failure could affect the integrity of the channel, may cause temporary damming of the watercourse and would be likely to cause a reduction in water quality downstream.

It is unlikely that peat upslope of the identified cell would be destabilised in the event of a failure, as peat in this area is patchy and variable in thickness, including areas with no peat present.

The nearest proposed infrastructure, the access track and turbine T2, is located east of the cell on the opposite side of the Allt Frogach on the summit of a small hill and is out of the direct line of potential effect, meaning it would not be affected by any instability in this area.

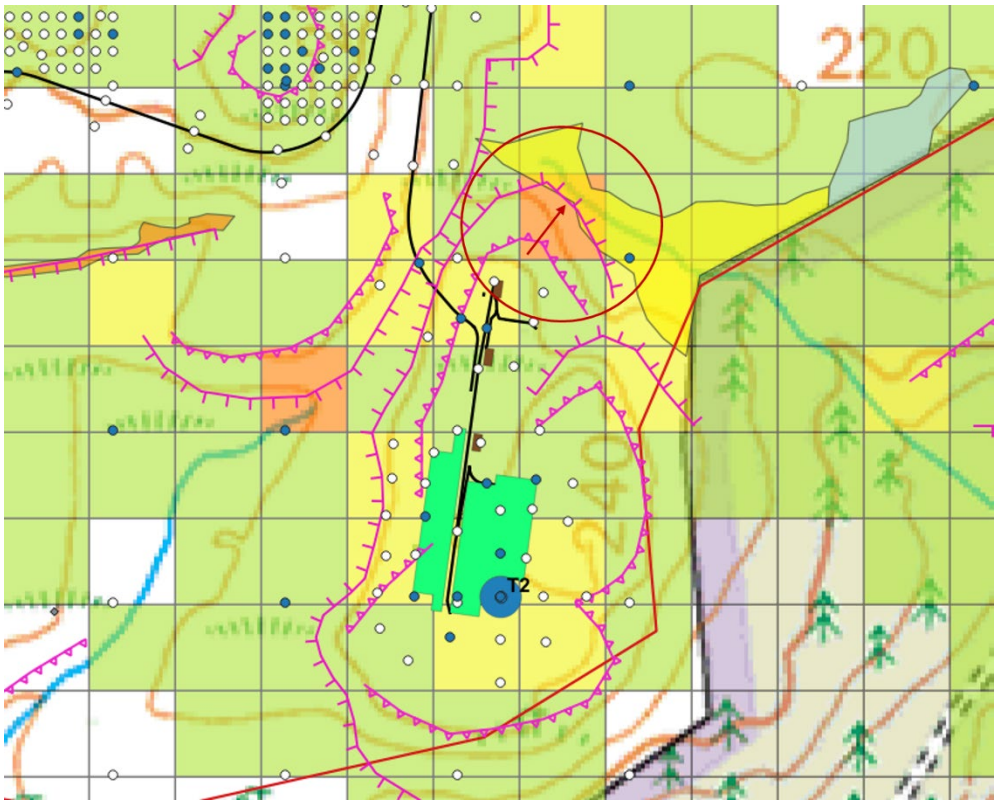
Mitigation

The elevated risk ranking is largely a result of the High consequence status of the watercourse and the increased likelihood based on the breaks-in-slope. It is considered that the assessment does not accurately reflect the risk status at this location as there is no work planned in this or adjacent cells. The work would be under the supervision of the Environmental Clerk of Works (EcoW) at all times and a watching brief would be maintained during all construction works in this immediate area.

Revised risk ranking

Low

Detailed Assessment: Area 2



One cell, located north-west of the turning head to the north of turbine T2, has been assigned Moderate Risk. The assigned risk level relates to the sensitivity of the receptor, an unnamed tributary to the Allt Oishnean, and its associated High consequence rating. The cell also includes an area of M25 moderately sensitive potential GWDTE habitat.

Calculated Likelihood for the cell is Likely, reflecting the combination of interpolated peat depth, slope within the cell and the presence of convex and concave breaks-in-slope.

The maximum interpolated peat depth in the cell is 2.10m, with average slope of 14.86°.

Potential runout from any failure: Any failure in this cell would travel north-east down slope and enter the watercourse. A failure could affect the integrity of the channel, may cause temporary damming of the watercourse and would be likely to cause a reduction in water quality downstream.

The nearest proposed infrastructure, the access track and turning head north of turbine T2, is located directly south-west of the cell. Local peat records indicate there is no peat immediately upslope of this cell and that there is no risk of destabilising peat upslope.

Mitigation

Closer inspection of the highlighted cell indicates that interpolated peat depths are likely to be deeper than actual peat depths, as the nearby records are patchy and include areas with no peat. There are no direct peat depth records within the highlighted cell.

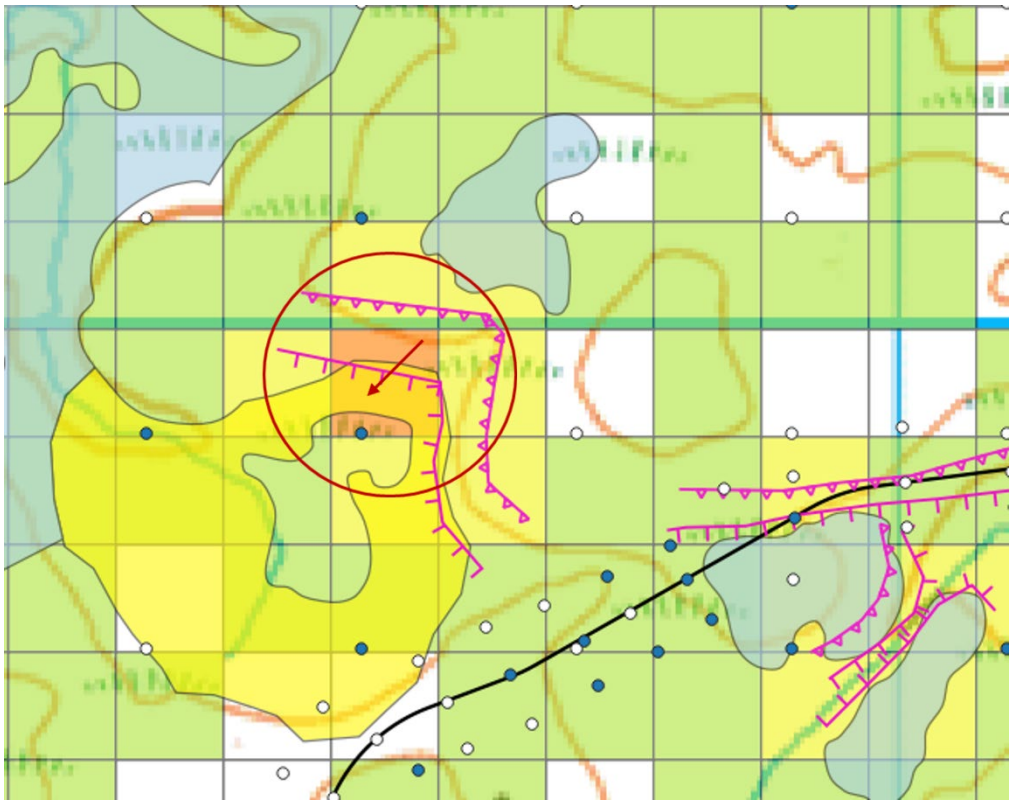
The elevated risk ranking is largely a result of the coincidence of the High consequence status of the watercourse and the increased likelihood based on the breaks-in-slope. It is considered that the assessment does not accurately reflect the risk status at this location as a result of the over-estimation of peat depths arising from the interpolation.

The work would be under the supervision of the Environmental Clerk of Works (EcoW) at all times and a watching brief would be maintained during all construction works in this immediate area.

Revised risk ranking

Low

Detailed Assessment: Area 3



One cell, located north of the access track in the central part of the Site, has been assigned Moderate Risk. The assigned risk level relates to the Almost Certain Likelihood rating calculated for the cell, reflecting the combination of interpolated peat depth, slope present within the cell and the presence of a concave break-in-slope.

Calculated Consequence for the cell is Moderate, reflecting the sensitivity of the receptor, an area of M25 moderately sensitive habitat.

The maximum peat depth record in the cell is 5.70m, with an average slope of 12.06°.

Potential runout from any failure: Any failure in this cell would travel south-west down slope and would be likely to terminate on the flat ground below the cell.

The nearest proposed infrastructure, the access track, is located south-east of the cell and is outwith the direct line of potential effect. An unnamed watercourse is located 35m south-west of the cell. Runout may reach the watercourse, although this is unlikely due to an area of flat ground between the bottom of the slope and the watercourse channel.

Mitigation

Closer inspection of the highlighted cell indicates that the peat depth measurement was taken in the south-west of the cell, while the steep slope is located in the northern part of the cell.

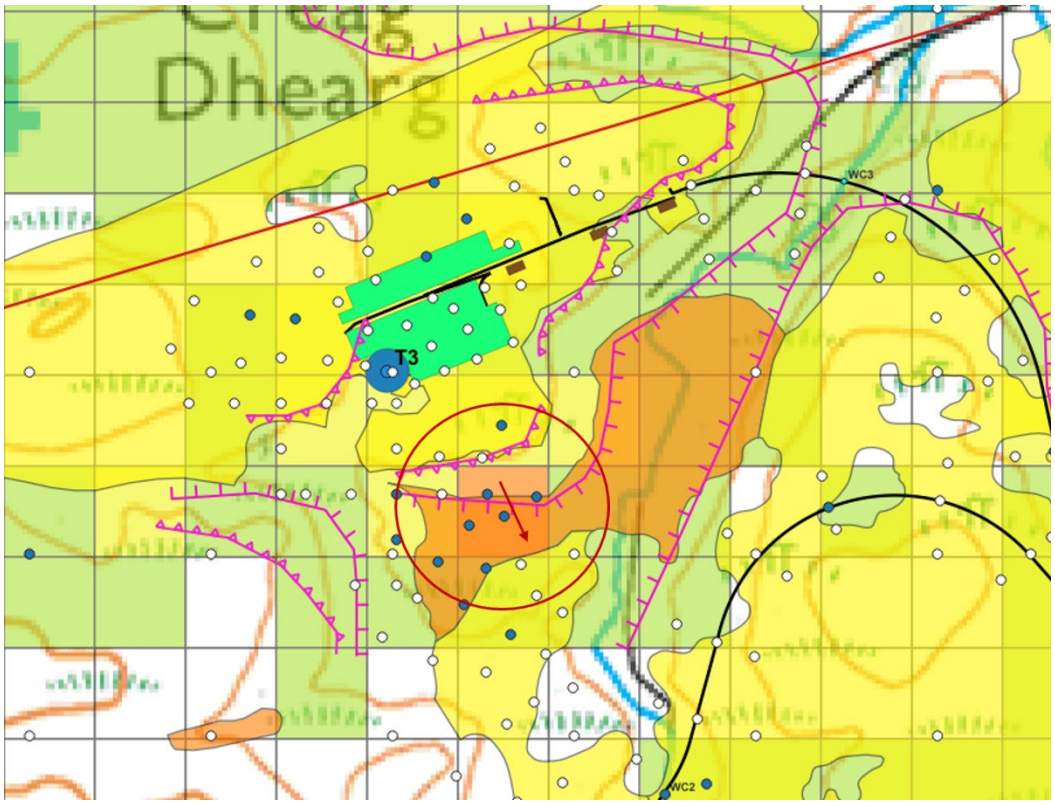
The elevated risk ranking is primarily due to the Almost Certain Likelihood which has been calculated due to the deep peat and steep slope. It is considered that the assigned Likelihood at this location is an overestimation arising from an assumption that the deep peat and steep slope are in the same location within the cell, which is not the case.

Additionally, since no construction works are planned in this or adjacent cells it is considered that the risk ranking assigned to this cell has been overestimated.

Revised risk ranking

Low

Detailed Assessment: Area 4



One cell located south-east of turbine T3 has been assigned Moderate Risk. The assigned risk level relates to the sensitivity of the receptor, an area of M23 potentially high GWDTE, and its associate High consequence rating.

Calculated Likelihood for the cell is Likely reflecting the combination of interpolated peat depth, slope present within the cell and the presence of a concave break-in-slope.

The maximum peat depth record in the cell is 3.13m, with an average slope of 9.12°.

Potential runout from any failure: Any failure in this cell would travel south-east downslope. There is a possibility of peat debris reaching the watercourse channel although it is more likely to terminate on the flat ground beforehand.

The nearest infrastructure is turbine T3, located approximately 54m upslope. Any failure in this or adjacent cells could destabilise the slope and impact the infrastructure in this area, although there is limited peat in this area to destabilise.

Mitigation

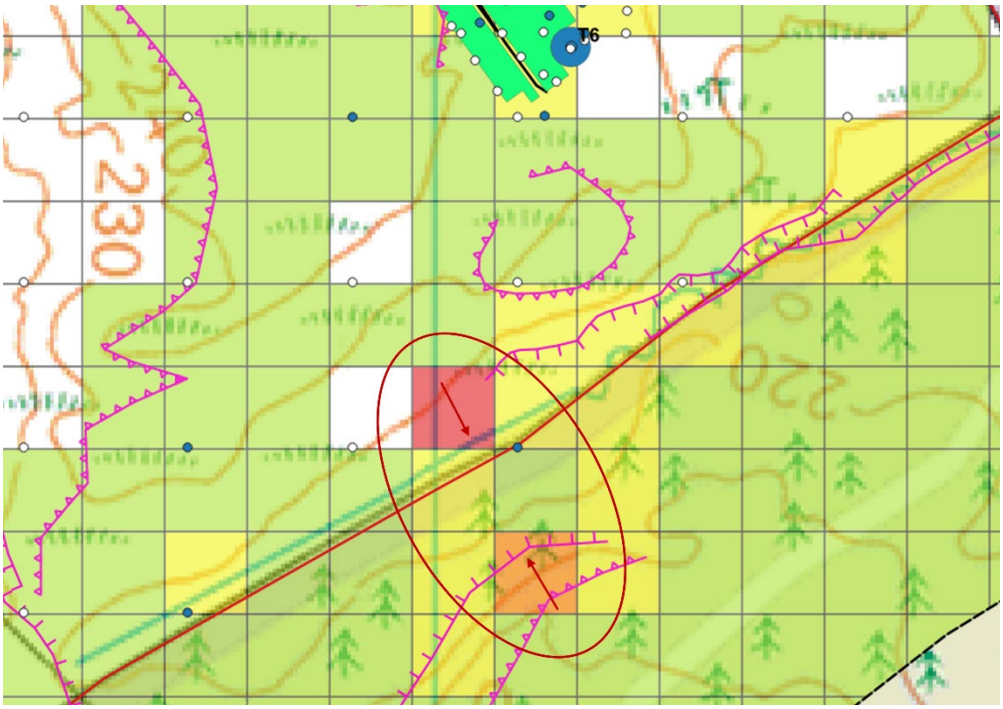
Closer inspection of the cell indicates that the deepest peat measurements were recorded in the southern half of the cell while shallower/no peat is associated with the northern half, coinciding with the steep slope in this area. It is therefore likely that the Likelihood rating for this cell has been overestimated, arising from an assumption that the deep peat and steep slope are in the same location within the cell, which is not the case.

Additionally, since no construction works are planned in this or adjacent cells it is considered that the risk ranking assigned to this cell has been overestimated. However, as a precaution all construction works at T3 would be under the supervision of the ECoW at all times and a watching brief would be maintained during all construction works in this immediate area.

Revised risk ranking

Low

Detailed Assessment: Area 5



Two cells to the south-west of turbine T6 have been assigned a High and Moderate Risk. They are located north and south of the Application Boundary respectively.

The assigned risk level for the northern cell relates to the high Likelihood and Consequence ratings. Calculated Consequence for the northern cell is High, reflecting the sensitivity of the receptor, an unnamed watercourse. Calculated Likelihood is Almost Certain, reflecting the combination of interpolated peat depth, slope within the cell and presence of a concave break-in-slope. The interpolated peat depth for the cell is 6.63m, with an average slope of 10.63°.

The assigned risk level for the southern cell relates to the high Likelihood for the cell. Calculated Consequence is low, reflecting the lack of sensitive receptors in this area. Calculated Likelihood is Almost Certain reflecting the combination of interpolated peat depth, slope within the cell and the presence of convex and concave breaks-in-slope. The interpolated peat depth for the cell is 3.95m, with an average slope of 20.07°.

Potential runout from any failure: Any failure in these cells would travel south-east or north-west into the watercourse. A failure could affect the integrity of the channel, may cause temporary damming of the watercourse and would be likely to cause a reduction in water quality downstream.

The nearest proposed infrastructure is turbine T6, located over 160m to the north.

Mitigation

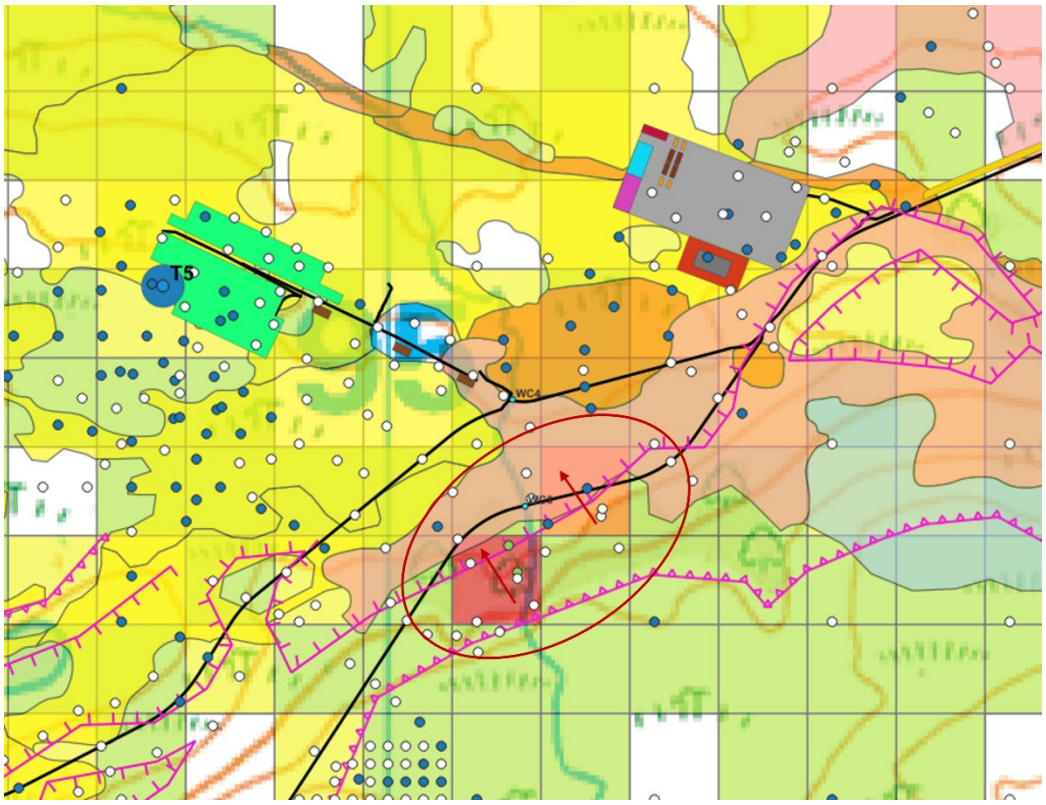
Closer inspection of the highlighted cells indicates that the interpolated peat depth is likely to be deeper than actual peat depth, as the nearby records are generally <0.6 m, with deep peat being associated with the watercourse channel, rather than with the steep slopes found within the cells.

The elevated risk ranking is largely a result of the coincidence of the High consequence status of the watercourse and the increased likelihood from the breaks-in-slope. It is considered that the assessment does not accurately reflect the risk status at this location as a result of the over-estimation of peat depth arising from the interpolation. Additionally, there is no work proposed in close proximity to either cell, which further decreases the Likelihood of destabilisation of peat in this area.

Revised risk ranking

Low

Detailed Assessment: Area 6



Two cells on the access track at watercourse crossing WC5 have been assigned High and Moderate Risk. They are located to the west and east of WC5 respectively.

The assigned risk level for the western cell relates to the high Likelihood and Consequence of peat slide in this area. Calculated Consequence is High, reflecting the sensitivity of the receptor, an unnamed watercourse. An area of W4 highly sensitive habitat and a small section of access track are also present in the north-west of the cell. Calculated Likelihood is Almost Certain, reflecting the combination of measured peat depth, slope angle and the presence of convex and a concave breaks-in-slope. The maximum peat depth record in the cell is 3.50m, with average slope of 19°.

The assigned risk level for the eastern cell relates to the high Consequence for the cell. Calculated Consequence is High, reflecting the sensitivity of the receptors, an area of W4, highly sensitive habitat and a section of access track within the cell. Calculated Likelihood is Likely reflecting the combination of peat depth, slope angle and the presence of a concave break-in-slope. The maximum peat depth record in the cell is 3.50m, with average slope of 11°.

Potential runout from any failure: Any failure in these cells would travel north-west down-slope on either side of the watercourse. A failure could affect the integrity of the channel, may cause temporary damming of the watercourse and may to cause a reduction in water quality downstream.

The nearest proposed infrastructure is the access track which sits within both cells and watercourse crossing WC5 which is located to the north of the western cell. In addition, as second section of access track is located downslope and may be affected by a failure.

Mitigation

The peat depth records for this area confirm that there is a small, localised and confined pocket of peat around the watercourse at this location. Areas both upslope (to the south-east) and downslope (to the north-west) have no peat. The section of access track within the highlighted cells is located outwith the pocket of peat.

Although both cells have steep slope and deep peat present, these are not located in the same part of the cell, with the steep slopes in the southern section and the deep peat

nearer the northern part of the cell. It should be noted that the point Likelihood ratings within both cells do not indicate any concern, with most being no peat or negligible, and two points with low Likelihood ratings.

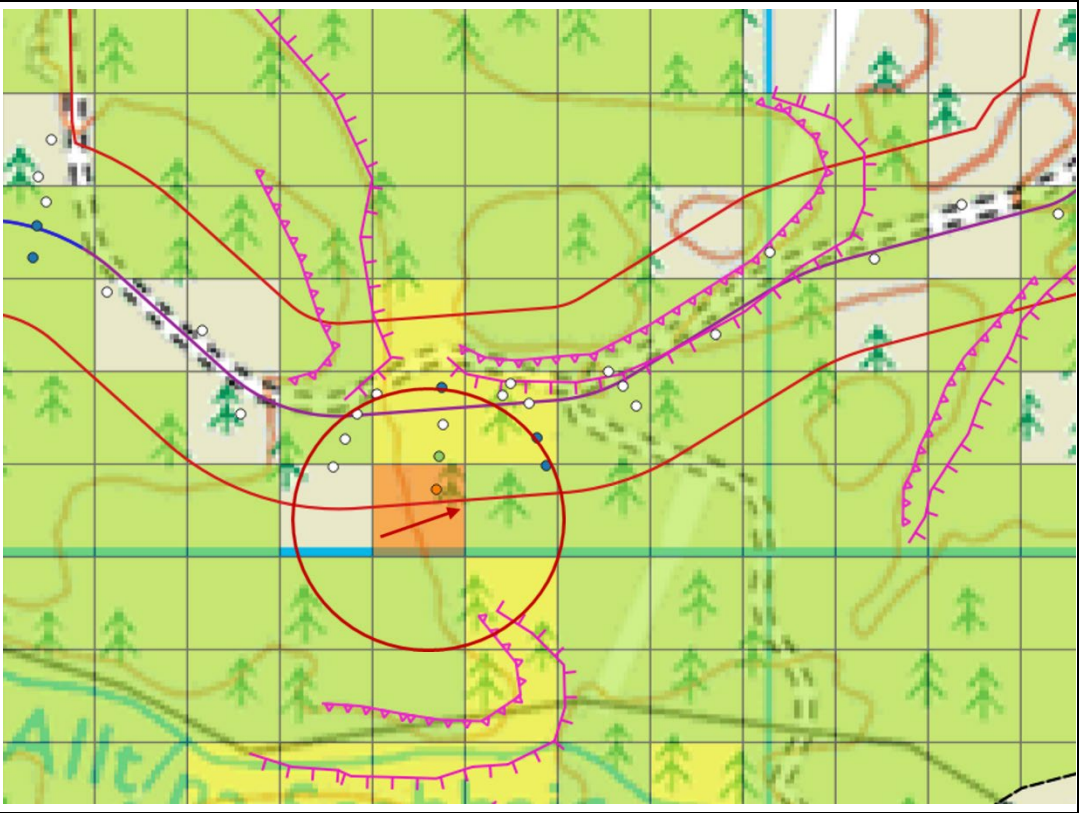
All construction works in this area would be under the supervision of the ECoW at all times and a watching brief would be maintained during all construction works in this immediate area. The pocket of deep peat would be marked off as an area of no access, to avoid disturbance to the softer peat material. Micrositing of the track further to the north to increase the separation distance between the track and the breaks-in-slope would be considered if practical in relation to other environmental and engineering constraints.

Regular monitoring of the slope to the south-east of the proposed track, and adjacent to the watercourse channel would be undertaken to check for warning signs of developing instability.

Revised risk ranking

Low.

Detailed Assessment: Area 7



One cell, located south of the Site access, has been assigned Moderate Risk. The assigned risk level relates to the Almost Certain calculated Likelihood, reflecting the combination of peat depth and slope present within the cell.

Calculated Consequence is Low due to a lack of sensitive receptors within the cell.

The maximum peat depth record in the cell is 7.53m, with an average slope of 8.22°. Peat depth records in this area indicate that the depth varies considerably over very short distances.

Potential runout from any failure: Any failure in this cell would travel eastwards downslope and would terminate on the wide area of flat ground.

This area is indicated to have generally low slope angles and variable peat. as a result it is unlikely that a failure in this area would destabilise peat from upslope.

The nearest infrastructure is the access track, located approximately 30 m to the north of the highlighted cell.

Mitigation

The access track is located to the north of the highlighted risk cell and is entirely within an area with no peat. No construction works or activity are proposed within the highlighted cell. There were no signs of instability or potential instability identified in this area during survey works.

All construction works in this area would be under supervision of the ECoW at all times and a watching brief would be maintained during all construction works in this immediate area. Due to the very deep peat in this cell and the proximity to the access track additional care would be taken. Micrositing of the track further to the north to increase the separation distance between the track and the highlighted cell would be considered if practical in relation to other environmental and engineering constraints.

Revised risk ranking

Low

Mitigation

7.6 The following mitigation measures would be implemented to ensure that slope stability is maintained across the Site and to minimise the risk of inducing a peat slide.

7.7 Construction work would make use of current best practice guidance relating to developments in peatland areas. A risk management system, such as a geotechnical risk register, would be developed as part of the post-consent detailed design works. This would be maintained through all subsequent stages of the project and updated as necessary whenever new information becomes available. During construction, members of project staff would undertake advance inspections and carry out regular monitoring for signs of peat landslide indicators. A geotechnical specialist would be on call to provide advice, if required by Site conditions.

7.8 Micrositing would be used to avoid possible problem areas. This would be assisted by additional verification of peat depths, to full depth, in any highlighted areas where construction work is required. Track drainage would be installed in accordance with published good practice documentation and would be minimised in terms of length and depth in order to minimise concentration of flows.

7.9 Construction activities would be restricted during periods of wet weather, particularly for any work occurring within 20m of a watercourse or within areas of identified deeper peat (>1.0m). Careful track design would ensure that the volume and storage timescale for excavated materials would be minimised as far as practicable during construction works.

7.10 Monitoring checks would be undertaken along identified higher-risk watercourse channels following periods of heavy rain and/or high flow. These would look for any recent signs of bank instability that may affect the flow or lead to a larger destabilisation of the nearby bank area. Any identified instabilities would be brought to the attention of the Environmental Clerk of Works as soon as possible.

7.11 Vegetation cover would be re-established as quickly as possible on track and infrastructure verges and cut slopes, by re-laying of excavated peat acrotelm, to improve slope stability and provide erosion protection. Additional methods, including hydroseeding and/or use of a biodegradable geotextile, would be considered in specific areas, if necessary.

7.12 Construction staff would be made aware of peat slide indicators and emergency procedures. Emergency procedures would include measures to be taken in the event that an incipient peat slide is detected.

7.13 Key early indicators of peat instability are:

- Tension cracks in the upper layers or to full depth of peat may indicate an accumulation of stress in peat soils. In addition, cracking can provide a route for surface water to infiltrate rapidly through the peat body, contributing to elevated pore water pressure and lubrication along lines of weakness.
- Compression ridges, usually indicative of displacement upslope which has led to formation of ridges within the peat body.
- Peat creep, usually visible as tilting of fence posts or young trees. This may be accompanied by tension cracking and/or compression ridges.

Infrastructure Design

7.14 Careful and informed infrastructure design forms a key measure for prevention of induced instability in peat. The collated peat depth information has been used to inform the proposed infrastructure layout throughout the design process. Incursion into areas of deeper peat has been kept to a practical minimum by careful design and will be reinforced by careful micrositing, in order to minimise disruption to peatland ecosystems and hydrology, and to avoid the risk of induced peat instability.

7.15 Access tracks are anticipated to be constructed using established cut-and-fill construction methods for peat of 1.0m deep or less, with floating construction intended for the small area of deep peat identified on the Site access. Any peat present along the cut-and-fill track routes would be excavated and stored for use in reinstatement of trackside verges and other elements of project infrastructure where appropriate.

7.16 Trackside ditches would be constructed as required. For tracks parallel or sub-parallel to contours, best practice recommendations are for a ditch along the uphill side only, with cross-drains installed at regular intervals below the track to minimise flow concentration. Cross-drains would discharge onto vegetated ground where possible, to encourage spread of surface flow rather than focused flow and the consequent development of new drainage channels. Tracks crossing contours may require ditches or swales on both sides. In all cases, lengths and depths of trackside drainage would be minimised, particularly in areas where peat deeper than 1.0m is present. There would be a requirement for some trackside drainage to minimise track surface erosion and damage.

8 CONCLUSIONS

8.1 A detailed assessment of peat slide risk has been carried out for the Proposed Development. All proposed new and upgraded infrastructure have been covered by the assessment.

8.2 The assessment found that the majority of the Site has a Negligible or Low risk of peat landslide.

8.3 Nine cells, forming seven groups, have been identified as having Moderate or High risk of peat instability. These have been individually appraised in greater detail taking into account location-specific details. In most cases, the apparent risk is an artefact of the assessment mechanism, which uses maximum peat depth and average slope for each grid cell. In several cells, the areas of interpolated deep peat were found to over-estimate the likely peat depth in these areas. The highlighted cells were also located in areas with distinct breaks-in-slope and watercourse channels which gave them a higher Likelihood rating as a result of the changing slope angles.

8.4 The reassessed risk of instability is Low for all cells rather than the initial assessment of High or Moderate.

8.5 For all areas, mitigation measures have been recommended to control the peat landslide hazard, including good construction practice and micrositing. Some identified risk areas are set back from proposed infrastructure and peatslide risk can be best controlled by avoiding any intrusion into these areas. It is recommended that construction areas are demarcated and all site staff are made aware of the requirement to stay within the marked construction corridor at all times. Revised risk rankings taking into account location specific details and mitigation measures are Low across the Site.

8.6 Good construction methods and appropriate micrositing would also be effective at controlling residual peat landslide risk for lower risk locations at the Site. Providing that the recommended mitigation measures are put in place and adhered to, the risk of peat landslide as a result of the Proposed Development is not significant.

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10 ANNEX 1: PEAT CORE LOGS

Notes to Accompany Peat Coring Results
Peat coring was undertaken by WRc on 1 February 2024 at three locations which had been identified by WRc prior to the Site visit.

Main Findings
Coring locations C1, C2 and C3 were located within areas of identified peat located adjacent to borrow pit BPA1, near turbine T5 and the construction compound, respectively. Ground conditions at C1 were slightly boggy, at C2 were well drained and at C3 were slightly boggy to boggy. Vegetation at C1 was dominated by grass, at C2 included grass, sphagnum mosses and some heather, and at C3 was a mixture of grass and sphagnum mosses.

Generally, peat was more decomposed at depth and the moisture content of cores ranged from moderate to very high.

Cores from C1 returned peat to a depth of 1.4 m below ground level (bgl). This consisted of a layer of slightly decomposed peat which transitioned to moderately decomposed peat at 0.50 m bgl and highly decomposed peat at 1.00 m bgl up to a depth of 1.40 m bgl. From 1.00-1.40 m bgl the peat had such high moisture content that it was not possible to recover a proper core.

Cores from C2 returned peat to a depth of 2 m bgl. The upper 0.5 m consisted of almost entirely undecomposed peat with moderate moisture content. From 0.5 m bgl the peat became progressively more decomposed, becoming completely decomposed at 1.50-2.00 m bgl, at which point the peat was once again too wet to obtain a core.

Cores from C3 returned peat to a depth of 2.5 m bgl. This consisted of layer of almost entirely undecomposed peat with moderate moisture content which extended to 0.30 m bgl. Below this, the peat became increasingly decomposed, and at 2.25-2.50 m bgl was completely decomposed. Moisture content increased with depth.

Photographs of all recovered cores are included at the end of this document. Of note, the base of the core is always shown in the right side of the photo.

Peat Core Logs

ID	X	Y	Peat Depth (m)	Notes
C1	195243	730472	1.4	Sampled 0-0.50 m. 0.00-0.5 m (bgl): H4 B3, slightly decomposed peat which, when squeezed, releases very muddy brown water. No peat is passed between the fingers, but plant remains are slightly pasty and have lost some of their identifiable features. Moderate moisture content. 0.50-1.00 m bgl: H5 B4, moderately decomposed peat which, when squeezed, releases very muddy water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognize certain features. The residue is very pasty. High moisture content. 1.00-1.40 m bgl: H7 B5, highly decomposed peat. Contains a lot of amorphous material with very faintly recognisable plant structure. When squeezed, about one-half of the peat escapes between the fingers. The water, if any is released, is very dark and almost pasty. Very high moisture content. Too wet to obtain core.

ID	X	Y	Peat Depth (m)	Notes
C2	194872	730397	2.02	Sampled 0.5-1.00 m. 0.00-0.20 m bgl: H2 B3, almost entirely undecomposed peat which, when squeezed, releases clear or yellowish water. Plant remains still easily identifiable. No amorphous material present. Moderate moisture content. Mid brown with plant roots. 0.20-0.50 m bgl: H2/H3 B3, almost entirely undecomposed peat to very slightly decomposed peat. When squeezed, releases clear/yellowish to muddy brown water-no peat passes between the fingers. Plant remains are identifiable and no amorphous material is present. Moderate moisture content. Mid to dark brown. 0.50-0.80 m bgl: H5 B4, moderately decomposed peat which, when squeezed, releases very muddy water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognise certain features. The residue is very pasty. High moisture content. Mid to dark brown. 0.80-1.00 m bgl: H6 B4/B5, moderately highly decomposed peat with a very indistinct plant structure. When squeezed, about one-third of the peat escapes between the fingers. The residue is very pasty but shows the plant structure more distinctly than before squeezing. High to very high moisture content. Mid to dark brown. 1.00-1.35 m bgl: H7 B5, highly decomposed peat. Contains a lot of amorphous material with very faintly recognisable plant structure. The water, if any is released, is very dark and almost pasty. Very high moisture content. Mid brown. 1.35-1.50 m bgl: H8 B5, very highly decomposed peat with a large quantity of amorphous material and very indistinct plant structure. When squeezed, about two-thirds of the peat escapes between the fingers. A small quantity of pasty water may be released. The plant material remaining in the hand consists of residues such as roots and fibres that resist decomposition. Very high moisture content. Dark brown. Difficult to obtain core due to very high moisture content. 1.50-2.00 m bgl: H10 B5, completely decomposed peat with no discernible plant structure. When squeezed, all the wet peat escapes between the fingers. Very high moisture content. Too wet to obtain core.

ID	X	Y	Peat Depth (m)	Notes
C3	195138	730420	2.54	Sampled 1.00-1.50 m. 0.00-0.30 m bgl: H2 B3, almost entirely undecomposed peat which, when squeezed, releases clear or yellowish water. Plant remains still easily identifiable. No amorphous material present. Moderate moisture content. Mid brown with lots of plant material present. 0.30-0.50 m bgl: H5 B4, moderately decomposed peat which, when squeezed, releases very muddy water with a very small amount of amorphous granular peat escaping between the fingers. The structure of the plant remains is quite indistinct although it is still possible to recognise certain features. The residue is very pasty. High moisture content. Mid brown. 0.50-0.75 m bgl: H5/H6 B3, moderately decomposed peat to moderately highly decomposed peat with quite indistinct to very indistinct plant structure. When squeezed very muddy water may be released and up to one-third of the peat escapes between the fingers. The residue is pasty. Moderate moisture content. Mid to dark brown. 0.75-1.00 m bgl: H7 B4, highly decomposed peat. Contains a lot of amorphous material with very faintly recognisable plant structure. The water, if any is released, is very dark and almost pasty. High moisture content. 1.00-1.35 m bgl: H7 B4, highly decomposed peat. Contains a lot of amorphous material with very faintly recognisable plant structure. The water, if any is released, is very dark and almost pasty. High moisture content. Mid to dark brown. 1.35-1.50 m bgl: H7 B4, highly decomposed peat. Contains a lot of amorphous material with very faintly recognisable plant structure. The water, if any is released, is very dark and almost pasty. High moisture content. Mid to dark brown. 1.50-1.80 m bgl: H8 B5, very highly decomposed peat with a large quantity of amorphous material and very indistinct plant structure. When squeezed, about two-thirds of the peat escapes between the fingers. A small quantity of pasty water may be released. The plant material remaining in the hand consists of residues such as roots and fibres that resist decomposition. Very high moisture content. Mid to dark brown. 1.80-2.00 m bgl: H9 B5, practically fully decomposed peat in which there is hardly any recognisable plant structure. When squeezed, it is a fairly uniform paste. Very high moisture content.

ID	X	Y	Peat Depth (m)	Notes
				2.00-2.25 m bgl: H9 B5, practically fully decomposed peat in which there is hardly any recognisable plant structure. When squeezed, it is a fairly uniform paste. Very high moisture content. 2.25-2.50 m bgl: H10 B5, completely decomposed peat with no discernible plant structure. When squeezed, all the wet peat escapes between the fingers. Very high moisture content- mainly liquid.

Location: C1	Depth: 0.00-0.50 m bgl	Date:01/02/2024

Notes: Core interior showing fibrous, slightly decomposed peat.

Location: C1	Depth: 0.50-1.00 m bgl	Date: 01/02/2024

Notes: Core interior showing moderately decomposed peat with indistinct plant structure.

Location: C2	Depth: 0.00-0.50 m bgl	Date: 01/02/2024

Notes: Core interior showing almost entirely undecomposed peat with easily identifiable plant remains overlying almost entirely undecomposed peat to very slightly decomposed peat with identifiable plant remains.

Location: C2	Depth: 0.50-1.00 m bgl	Date: 01/02/2024

Notes: Core interior showing moderately decomposed peat with indistinct plant structure overlying moderately highly decomposed peat with very indistinct plant structure.

Location: C2	Depth: 1.00-1.50 m bgl	Date: 01/02/2024

Notes: Core interior showing highly decomposed peat with very faintly recognisable plant structure overlying very highly decomposed peat with very indistinct plant structure.

Location: C2	Depth: 1.50-2.00 m bgl	Date: 01/02/2024

Notes: Core interior showing that peat was too wet to obtain a proper core. The small amount able to be extracted shows that the peat is completely decomposed with no discernible plant structure.

Location: C3	Depth: 0.00-0.50 m bgl	Date: 01/02/2024

Notes: Core interior showing almost entirely undecomposed peat with easily identifiable plant remains overlying moderately decomposed peat with quite indistinct plant remains.

Location:C3	Depth: 0.50-1.00 m bgl	Date: 01/02/2024

Notes: Core interior showing moderately decomposed peat to moderately highly decomposed peat with quite indistinct to very indistinct plant structure. This is overlying highly decomposed peat with very faintly recognisable plant structure.

Location: C3	Depth: 1.00-1.50 m bgl	Date: 01/02/2024

Notes: Core interior showing highly decomposed peat with very faintly recognisable plant structures.

Location: C3	Depth: 1.5-2.00 m bgl	Date: 01/02/2024

Notes: Core interior showing very highly decomposed peat with very indistinct plant structures overlying practically fully decomposed peat with hardly any recognisable plant structure.

Location:C3	Depth: 2.00-2.50 m bgl	Date: 01/02/2024

Notes: Core interior showing practically fully decomposed peat with hardly any recognisable plant structure overlying completely decomposed peat with no discernible plant structure.

11 ANNEX 2: AUTHOR EXPERIENCE

This report was produced by Lucy McCulloch and Vanja Eavery, under the supervision of Catherine Isherwood.

Field surveys were undertaken by Giles Exley, Lucy McCulloch, Rhys Lithgow, Emma Barrie and Catherine Isherwood, supported by Eilidh Vass Payne, Vanja Eavery and Douglas Morrison All are members of professional institutions and are working towards chartership. Emma Barrie and Rhys Lithgow are both Registered Environmental Practitioners with IEMA. All have significant experience of peat surveying and classification from wind farm developments, peatland restoration surveys, overhead line route studies and ground investigation works, and other infrastructure projects including substation development and major road alignments.

Catherine Isherwood is a Chartered Geologist with an MA and PhD in Geological Sciences from the University of Cambridge and an MSc in Hydrogeology from Newcastle University. She has over 18 years' experience in environmental impact assessment and the assessment of peat and slope stability.

The report has been reviewed and authorised by Catherine Isherwood.

The assessment method was developed with input from a Chartered Engineer and a Chartered Environmentalist with a combined experience of more than 35 years.