Harehill Windfarm Repowering

Appendix 9.6 - Peat Slide Risk Assessment Stage 2

ScottishPower Renewables

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Document history

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Contents

1. Introduction

This report details the Peat Stability Assessment undertaken at the proposed Hare Hill Windfarm Repowering. The proposed Development comprises of x23 wind turbine generators (WTG's) with tip heights up to and not exceeding 200 m Above Ordnance Datum (AOD), crane hardstanding's, laydown areas, underground cabling, on-site substation, battery energy storage system, external transformers, temporary construction compound, temporary borrow pit(s), and a meteorological mast. The report is accompanied by the following map information:

- **Figure A.1 Interpolated Peat Depth**
- **Figure A.2 Slope Angle**
- **Figure A.3 Environmental impact Zonation Map**
- **Figure A.4 Peat Slide Risk Ranking**
- **Figure A.5 Factor of Safety**

1.1. Reporting Experience

Author: Orrin Bryers is a Geo-Survey Engineer at Natural Power and experienced geoscientist by training (holding a PhD, MSc, and BSc in the Geosciences). Orrin has also gained work experience as a Geoscience Intern (Capricorn Energy) and as a Research Associate working with geospatial data within a university research group. Orrin has conducted field work and reporting of numerous peat slide risk assessment studies for onshore wind and solar energy projects of similar terrain and ground conditions to Hare Hill.

Approver: Gavin Germaine is a principal geotechnical engineer at Natural Power and an engineering geologist by training (MSc Engineering Geology) with greater than 15 years of relevant geotechnical experience. Gavin is a Chartered Geologist (CGeol) and a Fellow of the Geological Society of London. Over the last decade he has completed multiple peat slide risk assessments for energy and infrastructure projects across the UK and Ireland. Gavin has further provided expert technical advice as part of public inquiry and joined international teams examining new geotechnical investigation techniques for in-situ testing and sampling of peat.

1.2. Objectives and Scope

This Peat Slide Risk Assessment (PSRA) comprises a semi-quantitative assessment. The primary objectives of this report are:

- Present a desk study pertinent to the subject of peat stability assessment at the proposed Development;
- Report on walkover survey and geomorphological mapping exercise to inform the assessment;
- Identify any areas of existing instability or which may pose a risk to the proposed Development;
- Qualitative and quantitative peat slide risk assessment;
- Provide robust and targeted recommendations for any future construction process and mitigate any potential contributory factors to elevated risk of instability.

This report and survey work has been undertaken in general accordance with the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Development, second edition, published by the Scottish Government in April 2017.

Table 1.1-1: PSRA Data Sources

Data Source	Location	Date
BGS – Onshore Geological Map Data: (Linear Features, Mass movement deposits, Artificial ground, superficial deposits, hydrogeology, bedrock geology, faulting,1:50,000 scale, 1:1M Superficial Engineering Geology; 1:1M Bedrock Engineering Geology)	https://mapapps2.bgs.ac.uk/geoindex/home.html	2025
Historical Aerial Photograph Data ESRI Satellite World Imagery Google Earth Professional.	https://server.arcgisonline.com/ArcGIS/rest/services/World_Imagery/MapServer/tile/%7Bz%7D/%7By%7D/%7Bx%7D	2025
Online news archival search	Various web-based search engines	2025

Source: Natural power

Assessment of potential instability at the proposed Development was carried out according to the following work programme:

- Development-wide peat probing survey comprising: An initial site wide peat probe survey within the turbine envelope on a grid resolution of 100 m (May 2024), Phase I Survey.
- Detailed peat probing survey covering areas of peatland and designed infrastructure at higher resolution (10 x 10 m) and proposed access track probing at 50 m spacing with 10 m offsets (November and December 2024), Phase II Survey.
- Assessment of peat undrained shear strength through in-situ hand shear vane testing across representative turbine locations within the design envelope (November 2024).
- Phase II Survey Infill probing, peat coring and in-situ hand shear vane testing along updated access track and turbine hardstanding positions (September 2025).
- Quantitative slope stability assessment based on in-situ shear strength data.
- Assessment of the potential risk of peat failure across the turbine envelope.
- Comparison of the potential risk of peat failure with the site hydrological model including proximity to watercourses and sensitivity of those features.
- Recommendations for detailed design/construction control with specific examination the need for measures to mitigate potential peat failure as part of any future wind farm development.

1.3. Development Description

ScottishPower Renewables is developing a circa 150 MW onshore wind farm at Hare Hill Windfarm Repowering and Extension Project, replacing the existing Hare Hill Windfarm and Hare Hill Windfarm Extension.

The works will comprise:

- Decommissioning of 55 turbines across the original Hare Hill I and Hare Hill II Wind Farms.
- Installation of approximately 23 new wind turbines, and associated foundations, access tracks and electrical infrastructure.

The development is accessed from the A76 east of New Cumnock, via existing Hare Hill Wind Farm site tracks.

The Site comprises the Hare Hill Windfarms, with existing turbines, hardstanding's, and access tracks located on undulating open moorland and land used for commercial forestry in the north.

1.4. Location

The infrastructure is located on the existing Hare Hill I and Hare Hill II Wind Farms, with a max topographical height of the proposed Development being 560 m AOD covering an area of approximately 985 hectares.

Source: Ordnance Survey 1:250k Scale Colour Raster

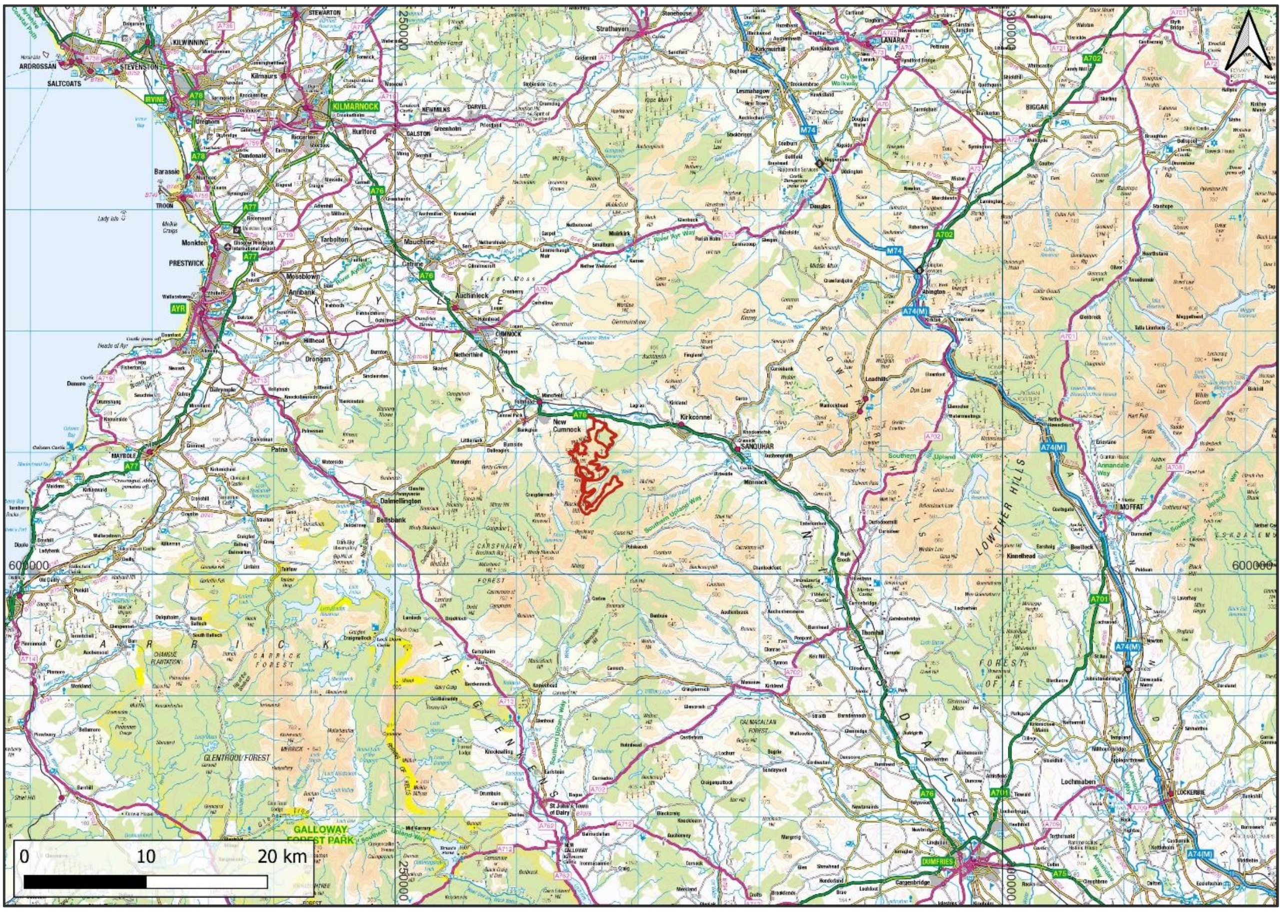


Figure 1.1 : Site Location with Site Boundary (red)

Source: Ordnance Survey 1:25K Scale Raster

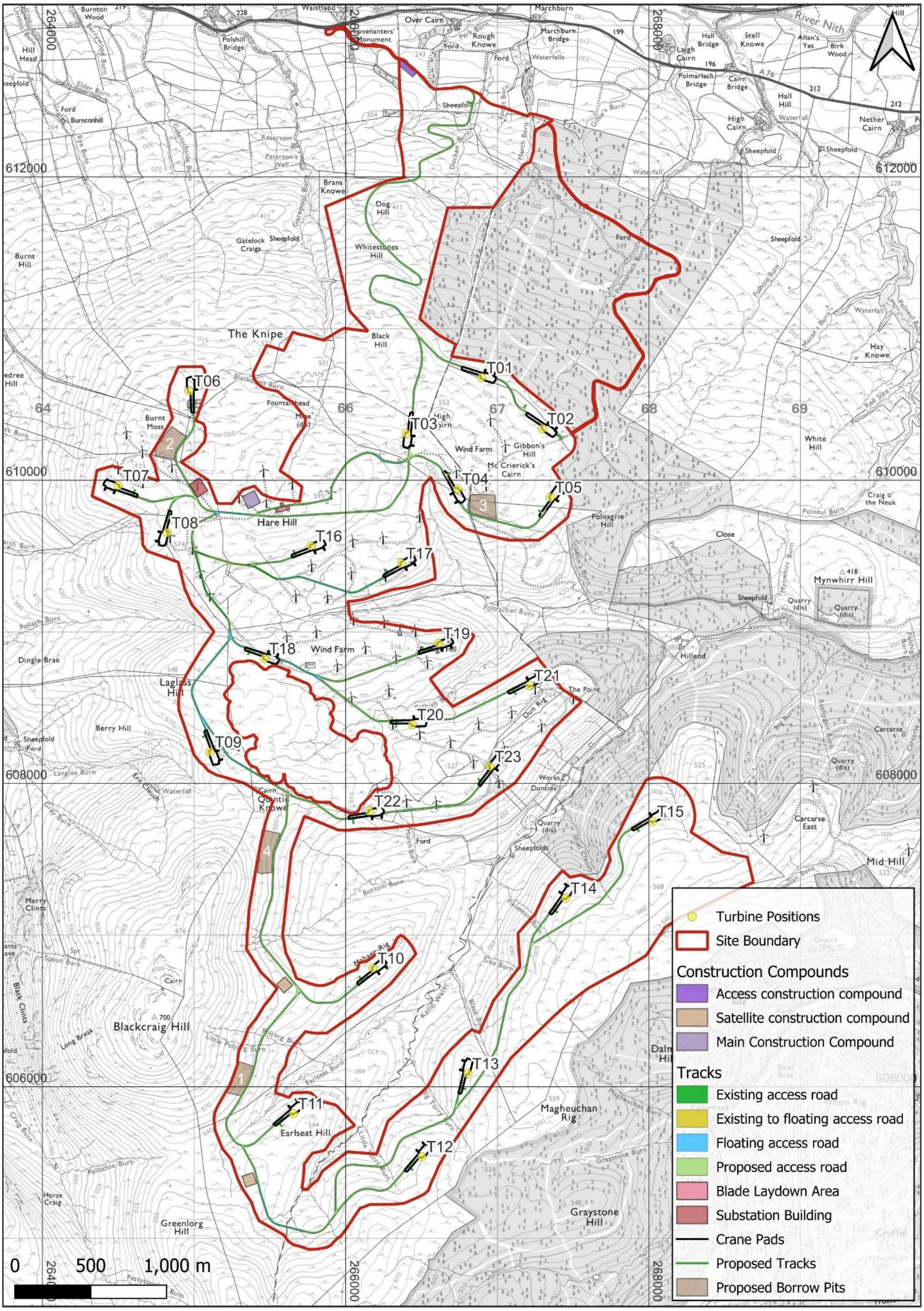


Figure 1.2: Site layout with approximate Turbine Locations and associated infrastructure

1.5. Terrain Description

The proposed Development infrastructure locations occupy elevated positions of gently to moderately undulating upland terrain. The majority of the Site is mantled by peat with depths varying from <0.50 m up to 3.10mbgl. The Site is bound to the north by the A76, to the east by Sandy Knowe Wind Farm and forested areas and to the south and west by Blacklorg hill and Blackcraig hill, respectively.

Peat is present across the majority of the Site, with depths consistently with depths between 0 and 1.00 m noted across most of the site. Deep peat, >2.00 m, was encountered in the centre of flat boggy areas. Peat >0.50 m was encountered at T01, T03, T05, T09, T11, T17, T18, T19, T21 and T22.

The topographic low of the Site is 227 m AOD, at the Site entrance. The topography rises steeply to the lowest lying turbine, T15, at 465 m AOD. The Site is relatively flat lying once at this level, generally rising to the south, with the highest elevations found in the south of the Site.

There are several named burns on Site that feed into the one named water course within the proposed Development, Kello Water. Kello Water flows from the southern edge of the Site, in a northeasterly direction. The proposed Development lies within the watershed of the River Nith.

All proposed turbines are situated on relatively elevated gentle to moderately sloping terrains.

Figure 1.3: Peat hagging near T04

Figure 1.4: Severe peat hags near the existing Hare Hill Windfarm Site track south of T16

Figure 1.5: Peat restoration works located south of T16

Figure 1.6: Facing south from around T15, peat hags and evidence of instability on the north face

2. Methodology

2.1. Geomorphology

Reconnaissance and geomorphological mapping were carried out during November and December 2024. This exercise provided opportunity for geotechnical engineers to visualise the terrain, access geological and soil exposures, examine slope systems, vegetation cover and record any hydrological features impacting peat stability.

No historical peat slides were identified during the site walkover or from interrogation of aerial photographs.

No evidence of cracking, compression features of peat creep was identified during the site walkover. As described and illustrated in Section 1.5, evidence of damaged peat in the form of peat hag collapse were identified on the proposed Development. Although these features are not primarily typically associated with major peat instability, they can increase weathering rates and influence water flow pathways.

From the aerial photography and site visit there was no evidence of slope instability at the proposed Development. Assessment of soil and rock slope stability will be important during future ground investigations including for defining temporary storage locations of overburden material. The BGS does not record any further evidence of slope instability within the site boundary.

The culmination of the field survey and desk-based review of aerial photographs was the production of a geomorphology map, Figure 2.1 below. This map was used in the qualitative stability risk assessment and maps the major features across the development pertinent to the risk model.

Source: Bing Virtual Earth

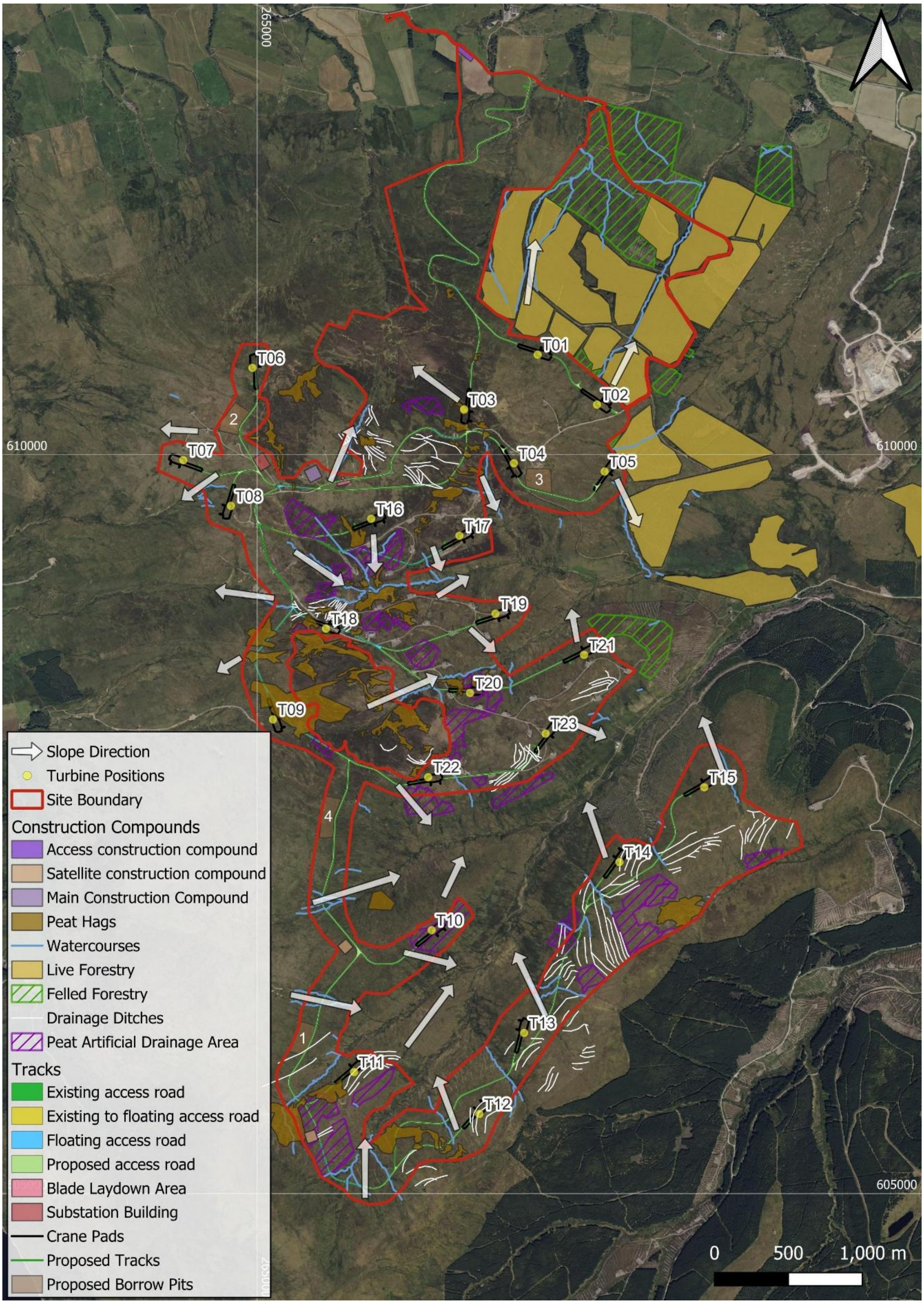


Figure 2.1: Geomorphological Features across the proposed Development

2.2. Peat Surveys

The soil probing coverage has allowed for:

- Development-wide peat probing survey comprising: Stage I probe survey within the turbine envelope on a grid resolution of 100 m (May 2024), 'Phase I Survey'.
- Detailed peat probing survey covering areas of peatland and designed infrastructure at high resolution (10x10 m grid) and proposed access track probing at 50 m spacing with 10m offsets (November and December 2024 and March 2025), 'Phase II Survey'.
- Additional Phase II Survey probing was carried out along the revised access track route at 50 m spacing with 10 m offsets and 10x10 m grids at amended turbine hardstanding locations (T01, T02 and T03) in September 2025.

Peat/soil depths were recorded using probes inserted into the peat and measuring the depth to refusal. This provides a wide-ranging dataset but carrier the following limitations:

- Peat probes may record depth to obstructions (e.g. tree roots, rock clasts) and not the true depth of the peat;
- Peat probes may over-estimate peat depth where the underlying soil strata is very soft;
- Peat probes can underestimate peat depth in very dry deposits due to early refusal of the probe;
- Peat probes do not differentiate between peat and mineral sub-soil;.
- Unable to access positions in dense forests and bogs;
- Unable to undertake peat probes within 10 m of underground services.

In-situ hand shear vane tests were conducted in conjunction with peat cores to provide an estimate of undrained shear strength within the peat at a chosen selection of deeper peat across the Site and at relevant turbine locations where peat was encountered deeper than 0.50 m. Supplementary to this, peat cores have been taken at select locations to provide confirmation of probe depth correlation, material classification and morphology.

Peat depth mapping is shown in Appendix A.1. To prepare the interpolated peat depth mapping; a spatial interpolation method termed 'Ordinary Kriging' was applied.

This is a statistical interpolation function that examines point data (and weights the surrounding measured values) to derive a prediction for unmeasured locations. Ordinary Kriging is considered generally acceptable for geological / soil science applications. Limitations of the Kriging method are widely accepted to be:

- Confidence in the output related to number and density of points within the input dataset.
- Search window needs to be set to limit influence of distant data points.

The interpolation parameters and peat depth data were set and deemed suitable for informing the peat slide risk assessment. Figure A.1 appended to this report, indicates interpolated peat depth across the Site, a total of 8,993 peat probe data points were acquired during all phases of survey within the Site Boundary.

2.3. Slope Mapping

The Slope Angle Map (Appendix A.2) is comprised from digital elevation model data, carrying a grid resolution of at least 5 m. The risk assessment considers slope angle in two aspects. Firstly, the slope angle is used to screen the Site for instability within the slope stability analysis numerical calculation. This is adjoined to qualitative assessment of the slope in terms of a contributory factor to failure. This combined approach ensures a robust assessment of the risk.

3. Geology & Environment

3.1. Superficial deposits

The BGS Geoindex Onshore viewer shows that the majority of the Site is covered by Peat with some areas, notably in the north and eastern edges of the Site Boundary mapped with Till (Diamicton). Rare deposits of Alluvium (Silt, Sand and Gravel) are also mapped along modern river banks near to the Site Boundary in the east and south. Several areas within the Site Boundary have no mapped superficial deposits present, presumably due to near-surface bedrock exposures.

Peat is described by the BGS as partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps.

Till is described by the BGS as unsorted and unstratified drift, generally overconsolidated, deposited directly by and underneath a glacier without subsequent reworking by water from the glacier. It consists of a heterogenous mixture of clay, sand, gravel, and boulders varying widely in size and shape (diamicton).

Alluvium is given the following description by the BGS: general term for clay, silt, sand and gravel. It is the unconsolidated detrital material deposited by a river, stream or other body of running water as a sorted or semi-sorted sediment in the bed of the stream or on its floodplain or delta, or as a cone or fan at the base of a mountain slope. Synonym: alluvial deposits. Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel. A stronger, desiccated surface zone may be present.

The BGS 1:1M Superficial Engineering Geology Map shows Organic Soil and Fine Till (layered) on the Site. The following information related to engineering properties is provided:

Organic Soil:

Description: Very soft to firm fibrous to amorphous PEAT. Deposits may be selectively worked to shallow depth in some areas. Very low to moderate permeability flow dominantly through matrix.

Foundations: Very poor foundation conditions. Very weak and highly compressible deposits acidic groundwater may pose a risk to buried steel and concrete. Specialist very low load or 'floating' foundations may be suitable in some cases but, where possible, deposits at surface should be removed or pile foundations to stronger deposits employed.

Excavation: Easy digging but poor trafficability may require specialist machinery. Requires immediate support and dewatering. Dewatering will lead to surface lowering and oxidation of peat.

Engineered Fill: Unsuitable for use as fill. May be suitable for reuse as topsoil if mixed with other material.

Site Investigation: Important to determine extent and depth of peat deposits. Groundwater acidity should be determined prior to selection of buried concrete.

Fine Till (layered):

Description: Firm to very stiff or hard slightly gravelly sandy CLAY with interbeds of laminated clay/silt and beds/lenses of sand and gravel. Often fissured, particularly in the upper few metres. Low to high permeability flow dominantly through lenses/interbeds of sand and gravel.

Foundations: Variable but generally good foundation conditions dependant on shear strength, consolidation characteristics and presence of water-bearing sand and silt layers/lenses. Differential settlement possible where foundations overlap fine and coarse soils.

Excavation: Easy digging. Excavations likely to require immediate support due to water-bearing layers/lenses of silt, sand and gravel.

Engineered Fill: Suitable as general cohesive fill depending on plasticity and water content. Generally, should be placed as soon as possible after excavation and subject to minimum construction traffic when wet.

Site Investigation: Important to determine deposit thickness and lithological variation, including the presence of laminated silts and clays and water-bearing sand and gravel layers.

Source: BGS GeoIndex Onshore Viewer

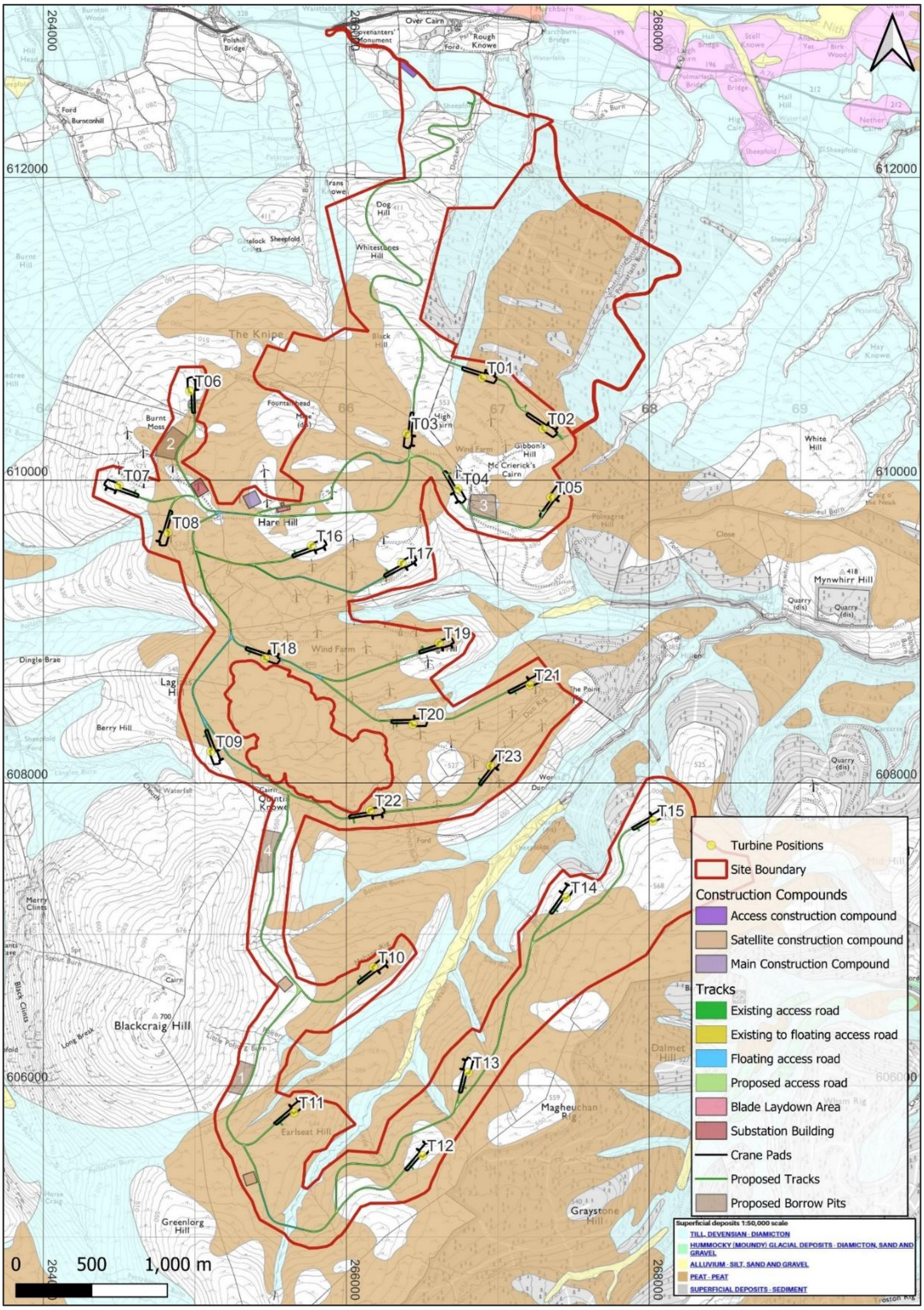


Figure 3.3.1: Superficial deposits

Peat Coverage

Determined by the Natural Power Phase I and II surveys; is shown in the Interpolated Peat Depth Map in Figure A.1 appended to this report.

Peat Details

A total of x11 peat cores were carried out across the Site using a shear gouge. Peat cores were undertaken at turbine centres T01, T03, T07, T10, T11, T13, T14, T15, T19 and two other areas where peat was encountered on Site.

Each core is given a general description, water content estimate (B) and Von Post rating (H) (Table 3.1). Peat accumulation characteristics vary across the Site. The core generally refused at the base of the peat. Hand shear vanes were undertaken at all turbine location where peat was >0.50m. Shear values are generally weak to moderate strength across the locations. An example photograph of peat from the Site is illustrated in Figure 3.2 overleaf.

None of the peat areas are considered dry (they range from B2 to B4 Wetness) and have humification levels between H2 and H6.

Figure 3.2: Photograph of the peat core from T03 (1.25-1.80 m depth below ground level)

Table 3-1: Peat Core Descriptions

Location ID	Top Depth	Bottom Depth	Log
T01 (266897E, 610677N)	0.00	0.40	Very soft dark brown pseudofibrous PEAT (H6/B2)
T03 (266400E, 610306N)	0.25 0.70 1.25	0.70 1.25 1.80	Very soft brown fibrous PEAT (H4/B3) Soft dark brown pseudofibrous PEAT (H6/B2) Soft dark brown pseudofibrous PEAT (H6/B2)
T07 (264499E, 609964N)	0.00	0.40	Soft brown spongey fibrous PEAT (H4/B2)
T10 (266180E, 606782N)	0.00	0.70	Soft brown spongey fibrous PEAT (H4/B3)

Location ID	Top Depth	Bottom Depth	Log
T11 (265655E, 605822N)	0.00	0.60	Soft brown spongey fibrous PEAT (H3/B2)
T13 (266806E, 606087N)	0.00	0.30	Very soft brown spongey fibrous PEAT (H4/B3)
T14 (267451E, 607243N)	0.00	0.40	Very soft dark brown spongey fibrous PEAT (H4/B3)
T15 (268025E, 607750N)	0.00	0.60	Soft brown spongey fibrous PEAT (H3/B2)
T19 (266612E, 608924N)	0.00	0.60	Firm brown spongey fibrous PEAT (H4/B2)
500m West of T01 (270116E, 609044N)	0.00	0.30	Very soft brown spongey fibrous PEAT (H4/B3)
100m NE of CC1 (267351E, 609887N)	0.00	0.50	Soft brown spongey fibrous PEAT (H3/B2)

Samples were collected from peat cores at turbine positions T01, T03, T07, T10, T11, T13, T14, T15, T19 and two other areas where peat was encountered on Site. These samples were sent to the laboratory for testing of Total Organic Carbon, Water Content, Bulk Density and Dry Density. The results from the laboratory testing are available in Appendix B.3. These show that Total Organic Carbon ranges from 25 to 52%, water content ranges from 572 to 822%, Bulk Density ranges from 1.00 to 1.07 Mg/m3 and Dry Density ranges from 0.12 to 0.15 Mg/m3.

3.2. Peat Depth Analysis

Natural Power carried out at total of 8,993 peat probes across the Site during the Phase I and Phase II peat surveys. Of the 8,886 peat probes undertaken, 56 were obstructed by dense forestry, a watercourse, high voltage cable or deep bog. Table 3.2 below presents the combined data collected across both surveys.

Table 3-2: Peat Depth Data

Peat Depth	Number of probes	% (of total)
<0.50m	6,502	72.3
0.50m < x ≤ 1.00m	1,697	18.9
1.00m < x ≤ 2.00m	623	6.9
2.00m < x ≤ 3.00m	135	1.5
>3.00m	36	0.40
Total	8,993	100

Source: Natural Power peat probing survey data

The collected peat probe depths suggest that the majority of the Site is covered by shallow peat, with a peat depth average of 0.48 m. There are a few deep pockets of peat in excess of 3.0 m, with a maximum depth of 4.05 m recorded. The most significant depths of peat within the proposed Development Area are found in the broad flat upland areas and boggy gullies in between T16, T17 and T18, east of T14, east of T09 and west of T20. Proposed infrastructure locations with probing depths less than 0.50 m are considered to not be peat and rather peaty soil or topsoil. In this case there is not considered to be any risk of generating a peat slide at that location. The peat depth interpolation map is appended to this report (Figure A.1).

Peat Depth at Infrastructure Locations

Table 3.3 summarises the peat depths recorded across the proposed wind turbine location, borrow pits, construction compound and substation.

Table 3-3: Peat Depth at Turbines and Ancillary Infrastructure Locations

Depth Range	**0.0 – 0.50 m**	**0.50 – 1.0 m**	**1.0 – 2.0 m**	**>2.0 m**
Location	**Peat Depth (m) Turbine Centre**	**Peat Depth (m) Hardstanding**	**Slope Geometry (°)**	**Comments**
T01	0.80	0.71	11	Moorland
T02	0.40	0.40	5	Moorland
T03	0.60	0.45	6	Moorland
T04	0.30	0.32	7	Moorland
T05	0.70	0.77	4	Moorland
T06	0.30	0.43	5	Moorland
T07	0.12	0.14	11	Moorland
T08	0.35	0.35	8	Moorland
T09	0.55	0.70	5	Moorland
T10	0.45	0.42	6	Moorland
T11	0.55	0.38	9	Moorland
T12	0.10	0.23	6	Moorland
T13	0.28	0.25	6	Moorland
T14	0.31	0.40	9	Moorland
T15	0.37	0.34	12	Moorland
T16	0.35	0.31	8	Moorland
T17	0.52	0.21	5	Moorland
T18	0.32	0.64	4	Moorland
T19	0.35	0.52	2	Moorland
T20	0.22	0.37	9	Moorland
T21	0.60	0.53	10	Moorland
T22	0.32	0.52	7	Moorland
T23	0.40	0.35	8	Moorland
Blade Laydown Area	0.25		2	Moorland

Depth Range	0.0 – 0.50 m	0.50 – 1.0 m	1.0 – 2.0 m	>2.0 m
Location	Peat Depth (m) Turbine Centre	Peat Depth (m) Hardstanding	Slope Geometry (°)	Comments
Main Construction Compound	0.27		7	Moorland
Satellite Construction Compound 1	0.40		6	Moorland
Satellite Construction Compound 2	0.80		3	Moorland
Access Construction Compound	0.33		4	Moorland
Borrow Pit 1 (Blackcraig Hill)	0.20		12	Moorland
Borrow Pit 2 (Burnt Moss)	0.46		3	Moorland
Borrow Pit 3 (West of T04)	0.18		3	Moorland
Borrow Pit 4 (South of Quintin Knowe)	0.30		13	Moorland
Substation Building	0.10		7	Moorland

Peat Depth on Access Tracks

Peat depth recorded across the proposed access tracks are generally deep, with a site wide average of 0.45 m over all proposed new tracks. Deeper areas are confined to localised pockets. Table 3.4 summarises the mean peat depth along discrete sections of the proposed new wind farm access tracks.

Table 3-4: Peat Depth on Access Tracks

Depth Range	0.0 – 0.50 m	0.50 – 1.0 m	1.0 – 2.0 m	>2.0 m
Location	Average Peat Depth (m)	Comments		
Track Section 1: Access track from Whitestones Hill (266315E, 611484N) to Black Hill (266455E, 610989N)	0.80	Pockets of deep peat up to 1.80 m. Several track sections to be floated.		
Track Section 2: Junction to T01 266503E, 610805N) towards T03 (266461E, 610626N)	0.65	Pockets of deep peat up to 1.40 m		
Track Section 3: South T03 hardstanding (266471E, 610351N)	0.58	Pockets of deep peat up to 1.60 m		

Depth Range	0.0 – 0.50 m	0.50 – 1.0 m	1.0 – 2.0 m	>2.0 m

Location	Average Peat Depth (m)	Comments
to T04 hardstanding (266641E, 610059N)		
Track Section 4: Junction to T05 (266479E, 610249N) southbound to new track east of Blade Laydown (266056E, 609788N)	0.55	Pockets of peat up to 1.2 m
Track Section 5: West of Blade Laydown towards junction to T08 and T06 (265355E, 609777N) to (265201E, 609794N)	0.63	Section to be floated
Track Section 6: Junction to T08 (264864E, 609888N) to east of T07 hardstanding (264681E, 609872N)	1.31	Deep pocket of peat (up to 2.70m)
Track Section 7: Northwest of substation building (264880E, 610171N) to T06 south hardstanding (264996E, 610442N)	0.75	
Track Section 8: Track Section west of T16 hardstanding (265107E, 609495N to track requiring upgrade east of existing turbine (265109E,609493N)	0.75	Watercrossing within area of deep peat depth (1-1.80m) at 265489E, 609456N and other pockets of deep peat up to 1.80 m
Track Section 9: West T17 hardstanding (266250E, 609361N to existing track junction 265109E, 609497N)	0.88	2x watercrossings. 1 at 265820E, 609327N in deep peat up to 1.90 m. Area of deep peat up to 3.10 m deep. Track section to be floated.
Track Section 10: East T18 hardstanding (265561E, 608820N) to west T20 hardstanding (266226E, 608420N)	0.60	2x watercrossing at 266182E, 608426N where deep pockets of peat up to 2.40 m.
Track Section 11: North of T09 hardstanding (265044E,608438N) towards T22/Quintin Knowe (265380E, 608083N)	1.14	Pockets of deep peat up to 2.90 m. Track section to be floated.
Track Section 12: Junction west of T22 at Quintin Knowe (265613E, 607847N to 265596E,607704N)	0.77	-
Track Section 13: East of T22 hardstanding (266257E, 607804N) to east of watercourse (266451E, 607829N)	0.50	Watercrossing at 266347E, 607814N. Deep peat pocket up to 1.5 m present east of watercourse
Track Section 14: Southwest T11 hardstanding (265529E, 605759N)	0.75	Watercrossing at 265496E, 605137N. Pockets of deep peat up to 1.80 m.

Depth Range	0.0 – 0.50 m	0.50 – 1.0 m	1.0 – 2.0 m	>2.0 m

Location	Average Peat Depth (m)	Comments
to south of Satellite Construction Compound 2 (265576E, 605095N)		
Track Section 15: South of Satellite Construction Compound 2 (265576E, 605095N) to southwest T12 hardstanding (266385E, 605445N)	0.57	4x watercrossings. Track section to be partially floated.
Track Section 16: Black Burn (266912E, 606104N) to Pikieston Burn, south of T14 (267287E, 607068N)	0.40	5x watercrossings. Localised pockets of peat up to 1.2m deep.
Track Section 17: South of Satellite Construction Compound 1 (265514E, 606411N) to north of BP1 (265407E, 606179N)	0.40	2x watercrossings, pocket of peat up to 2.0m deep

Estimation of Shear Strength

X13no. insitu hand shear vane tests were carried out at peat core sample locations. Each test was carried out using a ‘Geonor H-60’ Vane Tester using a 33mm steel vane.

Figure 3.1 overleaf depicts the peak undrained shear strength data against depth in metres below ground level.

Source: Natural Power, Hand Shear Vane Results

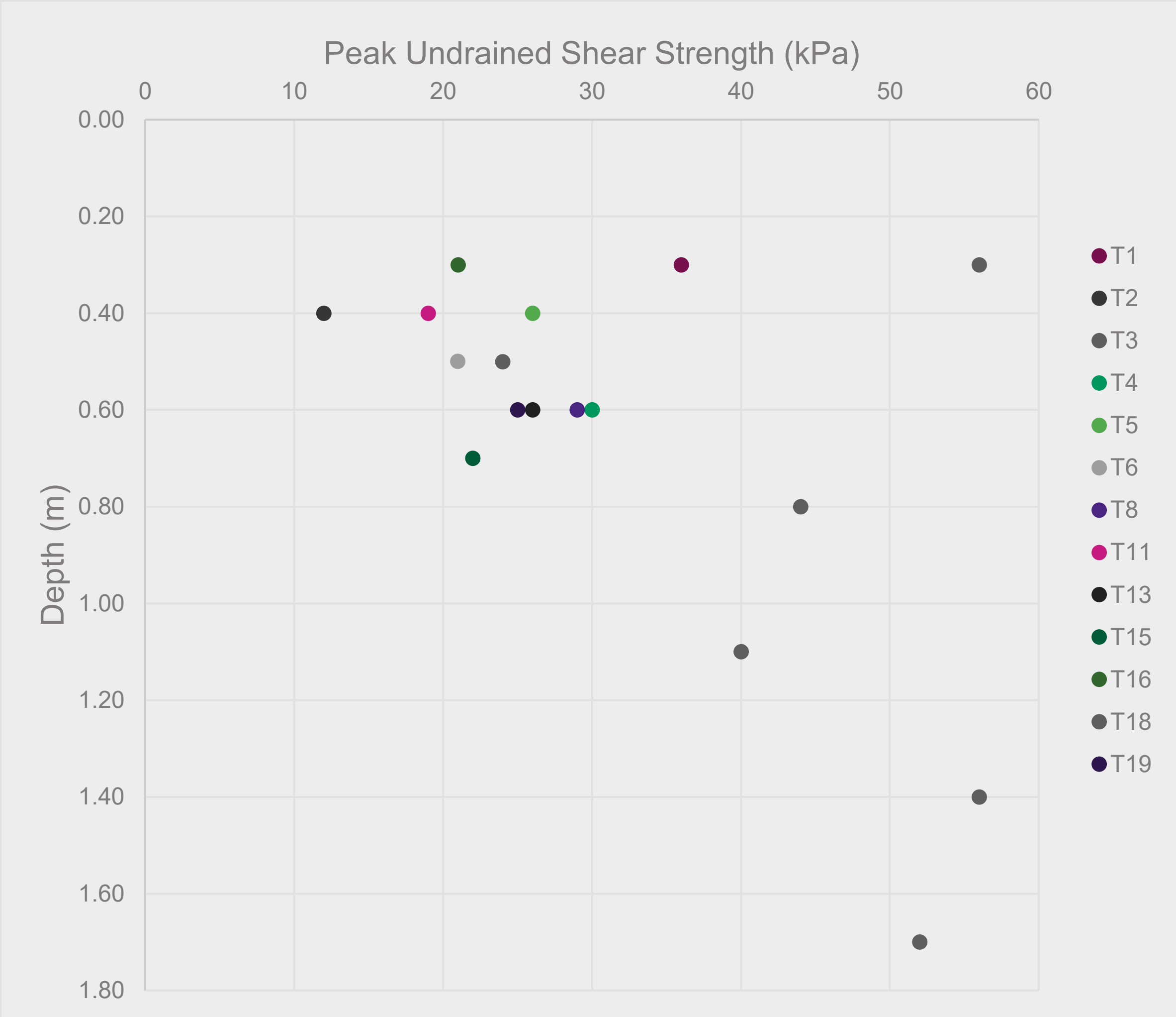


Figure 3.3: Peak Undrained Shear Strength (kPa) vs Depth (mbgl) at Proposed Turbine Locations

Described in accordance with Eurocode Soil description standard (BSEN ISO 14688), the range of shear strengths recorded would be low to high. Values of peak undrained shear strength ranged from 13 to 56 kPa within the peat accumulations displaying a weak linear trend of increasing shear strength with depth. The average value for peak undrained shear strength is 31 kPa. A highly conservative site wide value of 10 kPa is considered a realistic value for slope analysis within the Site. Residual undrained shear strength ranged from 10 to 18 kPa and showed a site wide average of 15 kPa. Hand shear vane results are appended to this report (Appendix B.2).

Humification of Peat

The peat cores undertaken on site are presented in Appendix B.1. The peat has been characterised according to the Von Post classification (Von Post & Granland, 1926), Table 3.5 sets out the Von Post classification.

Table 3.5: Von Post classification

Degree of Humification	Peat Description
H1	Completely unconverted and mud-free peat which when pressed in the hand only gives off clear water. Plant remains are easily identified.
H2	Practically unconverted and mud free peat which when pressed in the hand gives off almost clear colourless water. Plant remains are still easily identifiable.
H3	Very slightly decomposed or very slightly muddy peat which when pressed in the hand gives off marked muddy water, but no peat substance passes through the

Degree of Humification	Peat Description
	fingers. The pressed residue is thickish. Plant remains have lost some of their identifiable features.
H4	Slightly decomposed or slightly muddy peat which when presses in the hand gives off marked muddy water. The pressed residue is thick. Plant remains have lost more of their identifiable features.
H5	Moderately decomposed or muddy peat. Growths structure evident but slightly obliterated. Some amorphous peat substance passes through the fingers when pressed but, mostly muddy water. The pressed residue is very thick.
H6	Moderately decomposed or very muddy peat with indistinct growth structure. When pressed approximately 1/3 of the peat substance passes through the fingers. The remainder extremely thick but with more obvious growth structure than in the case of unpressed peat
H7	Fairly well decomposed or markedly muddy peat but the growth structure can just be seen. When pressed about half the peat substance passes through the fingers. If water is also released this is dark and peaty.
H8	Well decomposed or very muddy peat with very indistinct growth structure. When pressed about 2/3 of the peat substance passes through the fingers and at times a thick liquid. The remainder consists mainly of more resistant fibres and roots.
H9	Practically completely decomposed or mud-like peat in which almost no growths structure is evident. Almost all the peat substance passes through the fingers as a uniform paste when pressed.
H10	Completely decomposed or mud peat where no growth structure can be seen. The entire peat substance passes through the fingers when pressed.

The peat encountered on site is generally homogeneous with Von Post classifications between H3 and H6 possessing a general trend of becoming increasingly decomposed within the deeper peat deposits.

3.3. Solid Geology

According to the BGS GeoIndex Onshore map viewer, the Site is predominantly underlain by the Kirkcolm and Blackcraig greywacke formations. The Kirkcolm Formation is described by the BGS as sandstone/siltstone turbidite sequence up to 4,500 m in thickness. The Blackcraig Formation is described as massive wacke and conglomerate up to 1,500 m in thickness.The Harehill Pluton (Granodiorite) underlies most of the original Hare Hill Wind Farm in the northwest of the Site. In the northern area of the Site, there is a northeast-southwest trending dyke of the North Britain Siluro-Devonian Calc-Alkaline Dyke Suite (Microgranodiorite) and in the northeast a unit of Bail Hill Volcanic Group (Trachyandesite) with a similar orientation.

There are a number of faults identified within and surrounding the Site Boundary. These include faulting to the northern and eastern boundary of the Blackcraig Formation, and a regionally extensive thrust / reverse fault in the north of the Site between the Kirkcolm and Marchburn formations trending approximately northeast southwest.

Figure 3.3 below depicts the Solid Geology map with inferred faults over the proposed Development Area.

Source: BGS GeoIndex Onshore Viewer

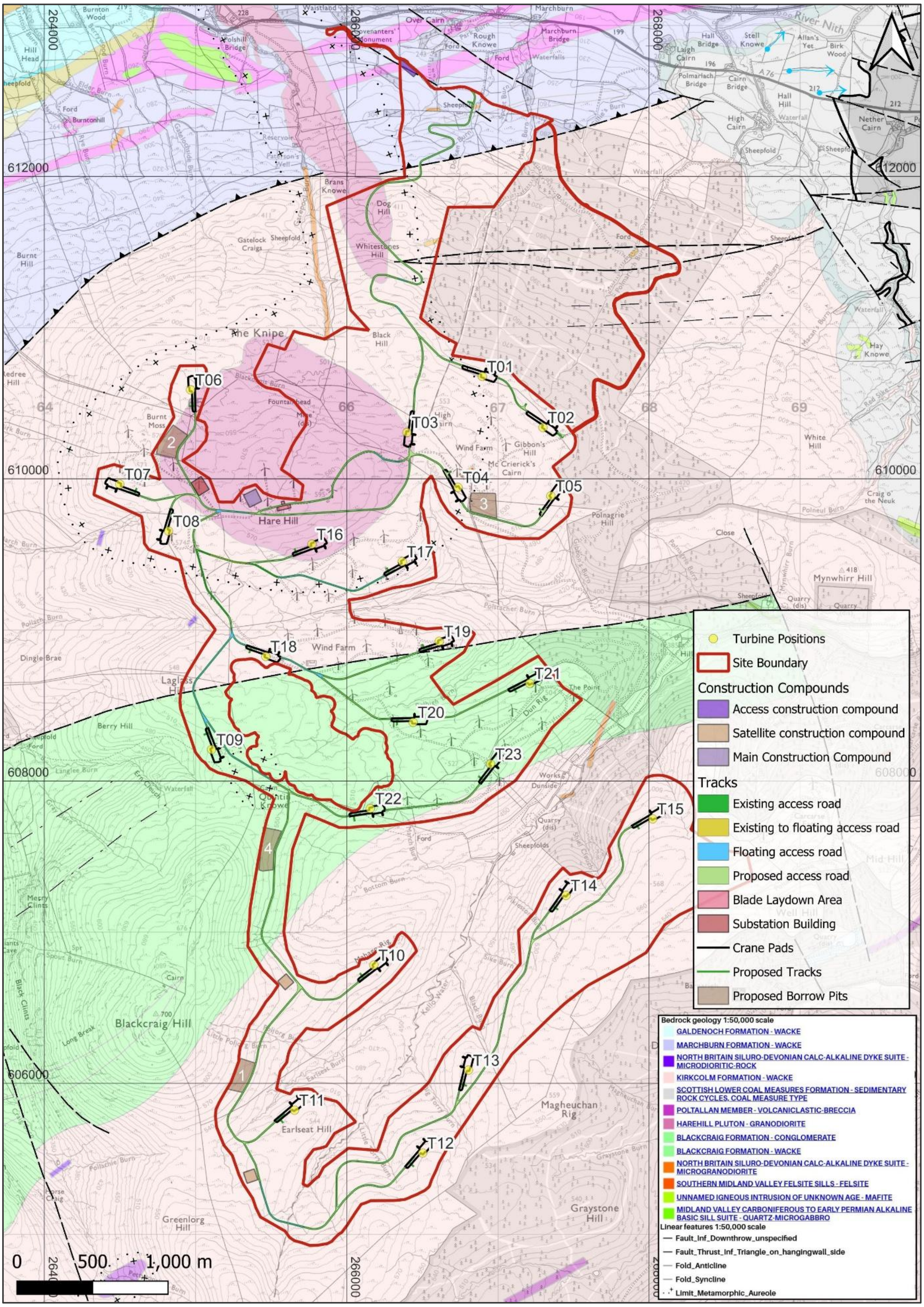


Figure 3.4: Bedrock Geology

3.4. Hydrogeology

The Hydrogeology 1:625k scale BGS map shows indicates that three main wacke formations found on site (Kirkcolm, Blackcraig and Marchburn) comprise a low productivity aquifer, with highly indurated greywackes with limited groundwater in near surface weathered zone and secondary fractures.

The igneous intrusions of granodioritic rock are classified as low productivity with small amounts of groundwater in near surface weathered zone and secondary fractures with rare springs.

3.5. Hydrology Flooding and Draining

There are multiple natural watercourses which intersect the Site and generally drain towards Kello Water, which flows from the southwest to the northeast intersecting the Site Boundary between T17 and T18, then eventually flowing east towards Kirkconnel. These watercourses start as shallow wet flushes sourced from the peat bogs and join to form shallow streams and associated surface water that have shallow vee or incised valley types. The watercourses have been artificially altered in some places, and there are multiple man-made elongate drainage features associated with both commercial forestry and farming practices which can be found across the entire Site Boundary.

The SEPA Scottish Flood and Hazard Risk Information map indicates that there is very minimal risk of flooding from rivers or the sea across the Site. The riverbanks of Kello Water, which flows southeast to northwest, then east to west, and Polstacher burn, which flows east to west in the centre of the Site, both have a medium to high likelihood of flooding (0.5% to 10% chance of flooding per year). There are also occasional small (<50 m diameter) areas in the northern forestry parts of the Site which have medium to high probability surface water flood hazard (a 0.5% to 10% chance that a flood of this magnitude or greater will occur in any given year). This mapping resource is indicative only and does not constitute a detailed flood risk assessment, out-with the scope of this report.

3.6. Designated Sites and Receptors

There is one site of Specific Scientific Interest found on the edge of the Site Boundary, a Geological Conservation Review Site called Hare Hill (The Knipe), located near the northern site boundary between the proposed T3 and T6 locations. Special planning and care will be required during site investigation and construction works that may occur in close proximity to this designated site.

4. Peat Slide Hazard – Risk Assessment Methodology

4.1. Process Contributing to Peat Instability

The key principals of the peat slide risk assessment are presented below. Discussions of the factors which contribute to peat failure have been presented in Table 4.1.

Table 4-1: Contributary Factors to Peat Instability

Factor	Discussion
Groundwater Infiltration	There are two processes which may facilitate groundwater infiltration: Periods of drying, resulting in cracking of the peat surface; and Slope creep resulting in additional tension cracks. Drying out of the upper peat, particularly in areas of thinner peat, is likely to result in the development of near-surface cracks which could facilitate ingress of water into the peat.

Factor	Discussion
Surface Loading	Any mechanisms which increase the surface load on a peat accumulation can increase the likelihood of failure. This can include surface water ponding and surcharge loading, for example; construction works, stockpiling and forestry operations.
Vegetation Loss	Loss of vegetation can have a negative impact, making the peat susceptible to weathering, increasing rates of infiltration and a loss of strength.
Soil Weathering / Erosion	Weathering can weaken in-situ peat materials and destabilise a slope system. This may be in the form of weathering of peat or underlying mineral soils which could reduce shear strength at the peat/ mineral soil interface. Vertical cracking and slope creep may slowly break down peat structure over long periods of time. This can develop into peat 'hagging', which is a strong indication that natural weathering processes are ongoing. Peat hags expose the peat to increased weathering rates and may provide preferential surface water flow pathways. Several areas within the Site Boundary show peat hags, none were identified at proposed infrastructure positions.
Precipitation	The likely failure mechanism following a period of heavy rainfall is linked to the infiltration of surface water. There is a resulting build-up of pore water pressures within the soils and therefore reduced effective shear strength. This may be focussed within the peat accumulation or at the interface between the peat and underlying mineral soil. Secondary effects may include swelling of the peat accumulation and increased loading due to surface water ponding. Snow and subsequent melt can have a similar effect.
Slope Morphology	There are three main effects arising from slope morphology: Firstly, the concentration of tensile stress at the apex of a convex slope predisposes the slope for failure initiation at that point. In a convex slope the material lower down supports the material above which is held in compression. A concave slope has the opposite characteristics as material at the base maintains the apex in tension. Secondly, at the point of maximum slope convexity, because of favourable down-slope drainage conditions, a body of relatively well-drained and relatively strong peat material develops. This body of peat acts as a barrier providing containment for growth of peat upslope. This relatively well drained body of peat can subsequently fail due to a build-up of lateral pressure on the upslope face. In this scenario the slope is not supported from below so eventually the lateral pressures exceed the forces resisting sliding. The apex or point of convexity is also a likely initiation point for slope failure due to the slope tension being concentrated at this point. Thirdly a failure mechanism, analogous to a piping failure underneath a dam, is postulated where springs are present in locations immediately down-slope of the relatively well drained peat body. Under these circumstances high pore pressure gradients within the peat can lead to hydraulic failure and undermining of the relatively well drained peat body resulting in a breach and loss of lateral support to peat upslope. Evolving slope morphology can be significant; for example, in the case of slope undercutting by water erosion. Any mechanism by which mass is removed from a slope toe or deposited on a slope crest will contribute to instability.
Peat Depth & Slope Angle	Peat slides correspond in appearance and mechanism to translational landslides and tend to occur in shallow peat (up to 2.0m) on slopes between (5° – 15°). A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type. MacCulloch, (2005) highlights that a slope angle of 20°

Factor	Discussion
	appears to be the limiting gradient for the formation of deep peat. Therefore, the risk assessment has assigned slope angles >20° to be an unlikely contributory factor to failure. Slope angle indicators and corresponding probability factors have been similarly adapted from MacCulloch, (2005). Boylan et al, (2008) indicates that most peat failures occur on slope angles between 4° and 8°. It is postulated that this may correspond to the slope angles that allow a significant amount of peat to develop that over time becomes potentially unstable. Thus, for this assessment <3degrees has been assigned a low risk.
Hydrology	Natural watercourses and artificial drainage measures have often been identified as a contributory factor of peat failure. Preferential drainage paths may allow the migration of water to a failure plane therefore triggering failure when groundwater pressures become elevated. Within a peat mass, sub surface peat pipes can enable flow into a failure plane and facilitate internal erosion of slopes. It is also noted that in some instances, agricultural works can lead to the disturbance of existing drainage networks and cause failures.
Existing / Relict Failures	The presence of relict failures and any indication of previous instability are often important, indicating that site conditions exist that are conducive to peat failure. Relict peat slides may be dormant over long periods and be re-activated by any number of the contributory factors discussed in this table.
Anthropogenic Effects	Human impact on peat environments can include a range of affects associated with wind farm construction. Activities such as drainage, access tracks across peat, peat cutting, and slope loading are all examples. Rapid ground acceleration is one such example where shear stress may be increased by trafficking or mechanical vibrations. Given the proposed Development is located on an existing wind farm, previous activity is considered as part of this risk assessment.

Source: Natural Power

4.2. Peat Failure Modes

Peat failure in this assessment refers to the mass movement of a body of peat that would have a significant adverse impact on the surrounding environment or infrastructure. This definition excludes localised movement of peat, for example movement that may occur below an access track, creep movement or erosion events and failures in underlying mineral soils.

The potential for peat failure across the development is examined with respect to the activities envisaged during construction and operation of the wind farm. There are several classification systems for the mass movement of peat that were drawn together by PLHRAG, (2017).

Hutchinson (1988) defines the two dominant failure mechanisms namely peat flows and peat slides.

- Peat Flows & Bog Bursts: are debris flows involving large quantities of water and peat debris. These flow down slope using pre-existing channels and are usually associated with raised bog conditions.
- Peat Slides: comprise intact masses of peat moving bodily down slope over comparatively short distances. A slide which intersects an existing surface water channel may evolve into a debris flow and therefore travel further down-slope. Slides are historically more common within blanket bog settings.

Due to the large areas of peat recorded across the development widespread instability comprising peat flows and bog bursts are considered to be the most likely mode of slope failure and further considered by this assessment.

4.3. Geotechnical Principles

The main geotechnical parameters that influence peat stability are:

- Shear strength of peat;
- Peat depth;
- Pore water pressure (PWP);
- Loading conditions.

The stability of any slope is defined by the relationship between resisting and destabilising forces. In the case of a simplified infinite slope model with a translational failure mode, sliding is resisted by the shear strength of the basal failure plane and the element of self-weight acting normal to the failure plane. The stability assessments within this report considers an undrained 'total stress' scenario when the internal angle of friction (φ') = zero.

An undrained peat accumulation may be destabilised by; mass acting down the slope, angle of the basal failure plane and any additional loading events. The ratio between these forces is the Factor of Safety (FoS). When the FoS is equal to unity (1) the slope is in a state of 'limiting equilibrium' and is sensitive to small changes in the contributory factors leading to peat failure.

The infinite slope model as defined in Skempton et al. (1957) has been adapted to determine the FoS of a peat slope. A modified approach has been used; assuming a minimum FoS (Typically 1.3 after, BS6031: 2009).

The infinite slope analysis is based on a translational slide. This analysis adopts total stress (undrained) conditions in the peat. This state applies to short-term conditions that occur during construction and for a time following construction until construction induced pore water pressures (PWP) dissipate. (PWP requires time to dissipate as the hydraulic conductivity can be low in peat deposits). The following assumptions were used in the analysis of peat deposits across the Site:

- The groundwater is resting at ground level;
- Minimum acceptable factor of safety required is 1.3;
- Failure plane assumed at the basal contact of the peat layer;
- Slope angle on base of sliding assumed to be parallel to ground surface and that the depth of the failure plane is small with respect to the length of the slope;
- Thus, the slope is considered as being of infinite length with any end effect ignored;
- The peat is homogeneous.

The analysis method for a planar translational peat slide along an infinite slope was for calculated using the following equation in total stress terms highlighted by MacCulloch, (2005) and originally reported by Barnes, (2000):

$$F = Cu / (\gamma * z * \sin\beta * \cos\beta)$$

Where:

- F = Factor of Safety (FoS)
- Cu = Undrained shear strength of the peat (kPa)
- γ = Bulk unit weight of saturated peat (kN/m3)
- z = Peat depth in the direction of normal stress
- β = Slope angle to the horizontal and hence assumed angle of sliding plane (degrees)

Undrained shear strength values (Cu) are used throughout this assessment. Effective strength values are not applicable for the case of rapid loading of the peat during short term construction phase of works hence the formula cited above, has been adopted. Figure A.5 maps out the calculated FoS for the proposed Development when applying a conservative 10 kPa as the undrained shear strength for peat soils. This mapping includes the predicted FoS where a 20 kPa surcharge is applied to the surface. The factor of safety map with no surcharge shows no part of the proposed Development infrastructure to fall below a factor of safety of 1.3 .

4.4. Risk Assessment Method

Natural Power has undertaken this assessment following the principles of the Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments (Scottish Executive 2017). Updated as a second edition in April 2017, this guide provides best practice methods which should be applied to identify, mitigate and manage peat slide hazard and associated risks in respect of consent application for electricity generation projects in the UK.

This guidance acknowledges risk assessment as an iterative process and as such this assessment should be updated throughout the development as more information becomes available.

A semi quantitative risk assessment has been used to determine the risk of peat failure. The methodology is defined in PLHRAG, (2017) and has been augmented with methods set out by Clayton (2001) & MacCulloch, (2005) Risk factors are summarised on Table 4.2.

The assessment is multi-threaded and uses the numerical stability analysis and presents results for Factor of Safety (FoS) across the proposed Development. The calculated FoS, is complimented with an assessment of the slope angle, peat depth and key geomorphological features. A Peat Stability Risk Zonation map has been produced using GIS computation of these factors. (Appendix A.4). The risk map is used for screening wide areas of the study area, additional engineering judgement has been applied according to discrete conditions within Table 6.1 of this report. Where there is a peat depth of 0.30 m or below, the peat slide risk is deemed negligible, regardless of other factors in the GIS computed model shown in Appendix A.4.

Table 4-2: Risk Factors

Factor	Comment	Criteria	Probability	Scale
Peat Depth* (A)	Peat slides tend to occur in shallow peat (up to 2.0 m) on A great majority of recorded peat landslides in Scotland, England & Wales are of the peat slide type	0 – 0.5 m >3.0 m 0.5 – 1.0 m 2.0 – 3.0 m 1.0 – 2.0 m	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
Slope Angle* (B)	It has been acknowledged that peat slide tends to occur in shallow peat (up to 2.0 m) on slopes between 5° and 15°. Slopes above 20° tend to be devoid of peat or only host a thin veneer deposit.	0° – 3° >20° 4° – 9° 16° – 20° 10° – 15°	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
FoS* (C)	Values are calculated from slope analysis model using characteristic value of 10 kPa derived from hand shear vane in-situ testing. Terrain slope angle and peat depth also input to this factor.	≥ 1.3 1.29-1.20 1.10-1.19 1.00-1.09 <1.0	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
Cracking (D)	Visual assessment undertaken in the field during detailed probing survey and covers the same extends of this survey. Field workers examined for evidence of any major crack networks which may allow surface water to penetrate the peat mass. Reticulate cracking was not investigated as this normally requires intrusive ground investigation to remove the surface fibrous layer.	None Few Frequent Many Continuous	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5

Factor	Comment	Criteria	Probability	Scale
Groundwater (E)	Challenging to evaluate without very detailed mapping and/or intrusive data. Look for entry / exit points. Evidence of surface hollows, collapse features at surface reflecting evidence of sub-surface peat pipe network, audible indicators including the sound of sub-surface running ground water surrounding proposed infrastructure locations	None Few Frequent Many Continuous	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
Surface *Hydrology (F)	Ranging from wet flushes to running burns to hags. Must be evaluated in conjunction with the season and weather preceding the site visit.	None Few Frequent Many Continuous	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
Previous Instability (G)	Visual survey, scale and age are important as small to medium relict failures may be easy to detect but very large ones may require remote imaging. Recent failures should be obvious due to the scar left.	None Few Frequent Many Continuous	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5
Land Management (H)	Anthropogenic influences: forestry operations and removal of vegetation can be associated with de-stabilising peat deposits. This can occur as a result to surface disturbance and remoulding of peat through excavation, vehicle movements and loading. Changes in land use activities may also be associated with changes in drainage conditions. Criteria based on evidence of disturbance of peat deposit, i.e. broken surface, scarring or disrupted hydrology. Given the presence of a pre-existing wind farm and both historic and active forestry operations, a land management factor of ‘2’ (Unlikely) will be used in this assessment.	None Few Frequent Many Continuous	Negligible Unlikely Likely Probable Almost certain	1 2 3 4 5

Note:* Denotes where risk factor applied to GIS model only

Environmental Impact Zones based on proximity buffer zones applied to the main watercourses within the proposed Development. Watercourses have been determined to be a primary sensitive receptor to a peat failure event. Table 4.3 denotes the potential impact scales to the environment. The Environmental Impact Zones map for the proposed Development is found in Appendix A.3.

The distance to main watercourses has been used as the primary means of impact assessment within the risk assessment. Where watercourses are ephemeral/transient or minor artificial features they were not included as direct receptors. The impact distances are based on experience and guidance values provided within MacCulloch, F. (2006).

The approach advocated by MacCulloch is to divide the survey area into Environmental Impact Zones driven by site specific criteria and survey information. It is noted that defining a definitive distance for impact is extremely challenging due to the complex nature of terrain, peat depth, flow mechanics will all influence the flow path characteristics. At present there exists no defined method to accurately define the flow distances. Therefore Table 4.3 provides a framework estimate for the purposes of repeatable and representative semi quantitative risk mapping.

Natural Power considers this approach alongside the multitude of site-specific factors which are considered during the risk assessment a valid approach for this development.

Table 4-3: Environmental Impact Zonation

Criteria	Potential Impact	Scale
Proposed access road/turbine within 50m of watercourse	High	4
Proposed access road/turbine within 50-100m of watercourse	Medium	3
Proposed access road/turbine within 100-150m of watercourse	Low	2
Proposed access road/turbine greater than 150m from watercourse	Negligible	1

Source: Natural Power

For each main infrastructure element, the Risk Ranking is assessed from the combined probability of occurrence for the main contributory factors (where greater than 1), multiplied by the highest impact scale. Table 4.4 identifies the risk ranking based on the national guidance PLHRAG, (2017).

The risk to existing or proposed infrastructure has been scoped out and is not considered a determining factor to the severity of a peat slide over the proposed Development. This is due to the spacing of the proposed layout and the large distance from existing settlements.

Access track sections have screened through the GIS based stability risk model and the elevated risk sections reviewed with further risk analysis and control measures. It is important to highlight that the full scope of the proposed infrastructure layout has been subject to field survey and review of stability risk factors.

Table 4-4: Risk Ranking and Actions

Degree of Humification	Peat Description
17 - >25	High: Avoid project development at these locations.
11 - 16	Medium: Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible.
5 - 10	Low: Project may proceed pending further investigation to refine risk assessment and mitigate hazard through relocation or re-design at these locations.
1 - 4	Negligible: Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

5. Slope Stability Analysis

5.1. Introduction

Assessing the desk study information, site layout and ground investigation data; a preliminary infinite slope analysis and subsequent peat slide risk assessment has been undertaken. Slope stability was assessed at turbine locations using slope angle measurements, peat depth, and undrained shear strength measured using an in-situ hand shear vane. This assessment should be viewed as semi – quantitative as it draws on both qualitative assumptions and numerical parameters.

For each proposed turbine location, the recorded peak undrained shear strength values have been input into the infinite slope model in order to calculate the potential factor of safety against peat slide. Where no shear vane test was undertaken a conservative strength of 10 kPa has been adopted.

5.2. Numerical Slope Analysis

A preliminary numerical slope analysis has been undertaken. Numerical slope stability was assessed across the development location using slope angle measurements (DTM derived), peat depth, and the minimum undrained shear strength measured using an in-situ hand shear vane. In addition, a 20 kPa surcharge has been modelled thus the sensitivity of slopes to failure is assessed under construction conditions. GIS modelling was used to produce a Factor of Safety (FoS) map for the proposed Development (Appendix A.5).

The existing natural slope condition has been calculated to be stable by the analysis and was observed to be so around the proposed wind turbine infrastructure locations.

In the absence of more detailed subsurface data, the surface slope angle has been used as a reference to the likely slope surface angle at the base of the peat in the analysis. Further advanced in-situ test methods should be considered as part of a detailed site investigation phase usually carried out post-consent. The potential of disturbing sensitive peat deposits during pre-construction survey access should also be considered during future phases of intrusive investigation work.

The FoS accounts for a 20 kPa surcharge representing scenarios at infrastructure such as temporary storage stockpiles. The Peat Management Plan details mitigation measures for peat stockpiling. Slope stability assessments would be carried out during design phase for site tracks, hardstands and other relevant structures ensuring the proposed design results are safe, stable and environmentally compliant. It is Natural Power's view that, if during design phase structures are proposed (i.e. floating tracks) additional numerical stability assessment should be carried out by the appointed designer.

Table 5.1: Numerical Slope Analysis

Location	Peak Shear Strength (Cu)	Unit Weight (γ) *	Depth of peat (z)	Slope Geometry	Factor of Safety (FoS = Cu / γ z sinβ cosβ)	
	kPa	kN/m³	metres	ß°	No Applied Load	Surcharge 20kPa
T1	18	10	0.80	11	24.03	6.86
T2	12	10	0.40	5	34.55	5.76
T3	25	10	0.60	6	80.16	18.50
T4	30	10	0.30	7	82.67	10.78
T5	26	10	0.70	6	53.38	13.84
T6	21	10	0.30	5	80.62	10.52
T7	10^	10	0.30	11	44.49	2.52
T8	29	10	0.35	8	60.12	8.95
T9	10^	10	0.10	5	20.94	4.52
T10	10^	10	0.45	6	21.38	3.93
T11	19	10	0.70	3	22.36	4.82
T12	10^	10	0.45	3	96.19	4.58
T13	26	10	0.65	4	89.32	10.97

Location	Peak Shear Strength (Cu)	Unit Weight (γ) *	Depth of peat (z)	Slope Geometry	Factor of Safety (FoS = Cu / γ z sinβ cosβ)	
	kPa	kN/m³	metres	ß°	No Applied Load	Surcharge 20kPa
T14	10^	10	0.40	10	20.88	2.80
T15	22	10	0.50	12	29.24	4.56
T16	21	10	0.55	3	43.54	6.48
T17	10^	10	0.35	5	22.15	4.57
T18	24	10	0.45	7	107.78	14.87
T19	25	10	0.40	11	204.79	30.50
T20	10^	10	0.20	5	29.42	2.92
T21	10^	10	0.40	5	9.75	2.25
T22	10^	10	0.35	12	25.83	3.56
T23	10^	10	0.4	9	18.14	3.02

**Site wide value of 10 kPa used where no turbine specific values available.*

^Assumed conservative peak shear strength where no test was undertaken.

Source: Natural Power

The numerical stability analysis indicates no potential for translational peat slide at proposed turbine and infrastructure locations under current equilibrium or modelled surcharge loading conditions.

Wind Turbines: FoS values for the turbine locations, when allowing for a 20 kPa surcharge load have been derived. The lowest FoS with no applied load was calculated at 9.75 kPa for T21. The lowest FoS with a 20 kPa surcharge is 2.25 for T21. The natural slope condition has been calculated to be stable and was observed to be so around the wind turbine locations during the field survey. Due to shallow peat depths observed at the majority of turbines, the risk is negligible and no factor of safety has been derived.

6. Peat Slide Risk Assessment

Risk rankings for the proposed Development infrastructure positions are presented in Table 6.1. Across each turbine the qualitative risk scoring has been provided along with key inset map information.

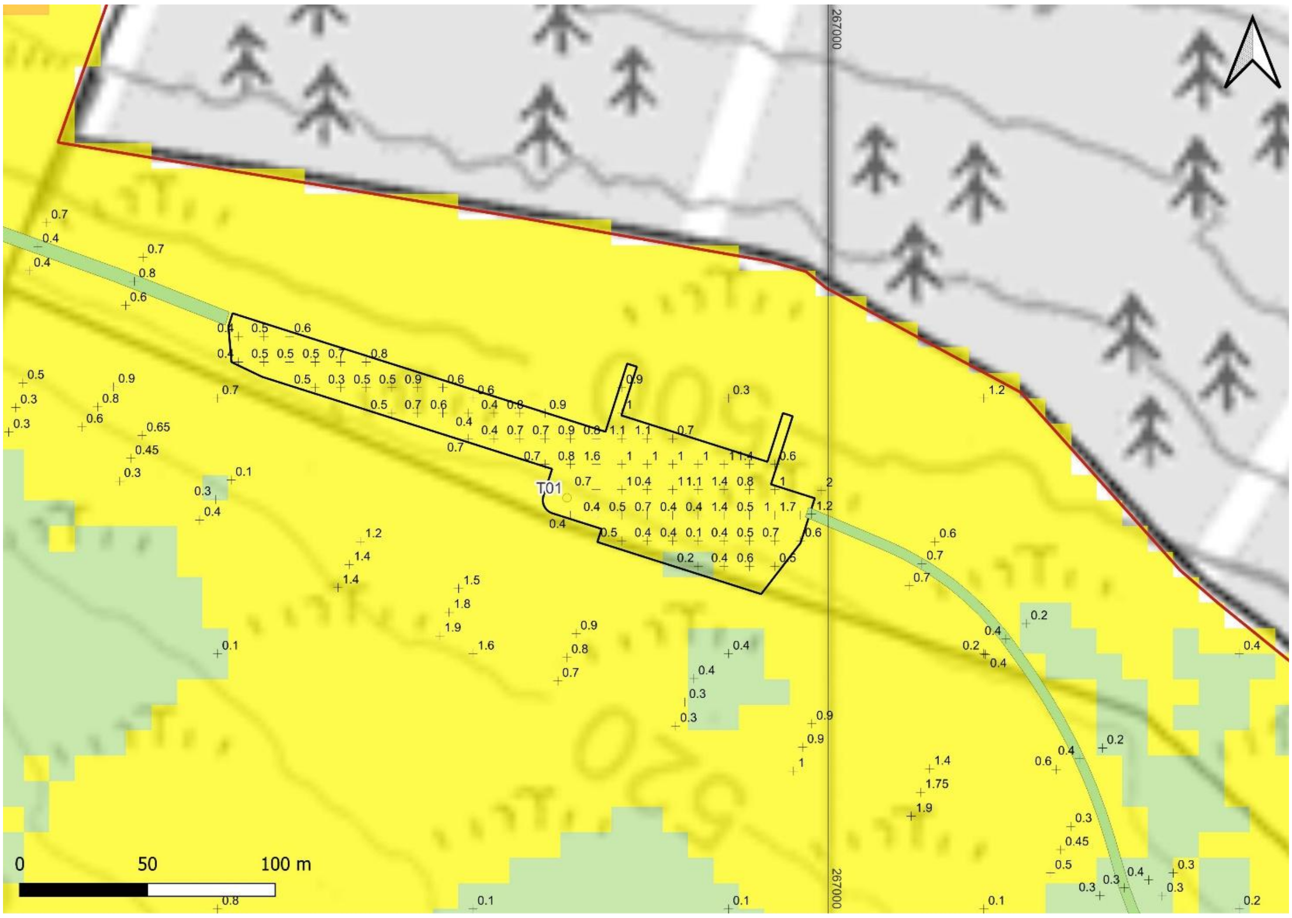
The Peat Stability Risk Zonation map (Appendix A.4) provides a representation of the risk zonation across the Site and includes all infrastructure elements. The map is based on a Site wide GIS analysis and should not be viewed in isolation without the narrative of this report. The Risk Mapping does not show residual risk following implementation of targeted or routine control measures.

The indicative residual risk rating is provided assuming implementation of appropriate mitigation measures. Further detail of the risk assessment is highlighted within the preliminary geotechnical risk register presented in Table 6.3.

Table 6-1: Hazard Ranking for Proposed Turbine and Ancillary Infrastructure Locations

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T01	1	1	Peat Depth (Mean = 0.80m)	3	3+5+2 = 10 (Low)
			Slope Angle (11°)	5	

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

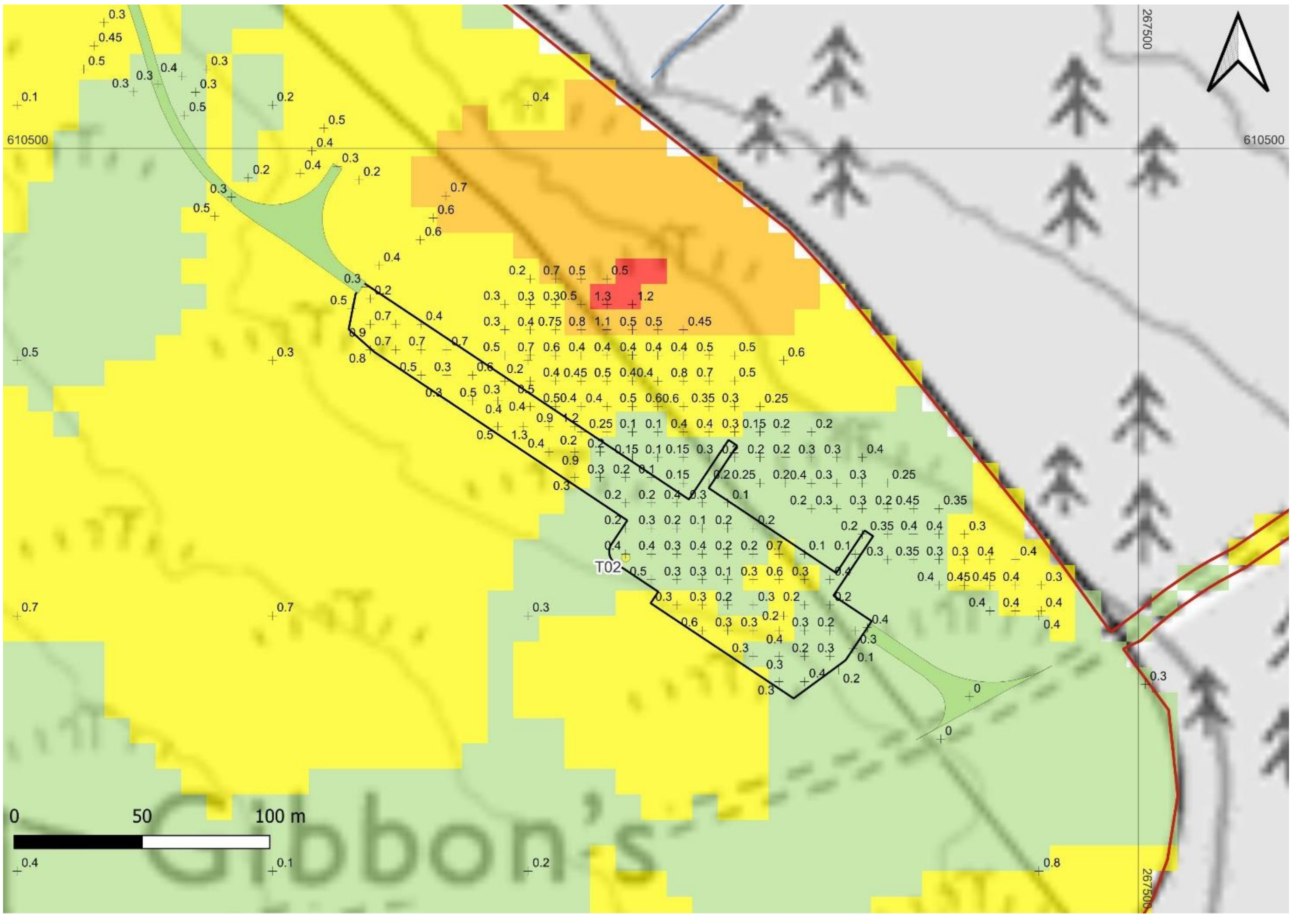


T01 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding and peat depths on average around the proposed turbine location are 0.80 m with pockets of deep peat up to 1.7 m. Care should be taken when stockpiling peat during the construction process around this turbine due to the pockets of deep peat in the western side of the hardstanding and overall steep gradients.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T02	1	2	Peat Depth (Mean = 0.30m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (7°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

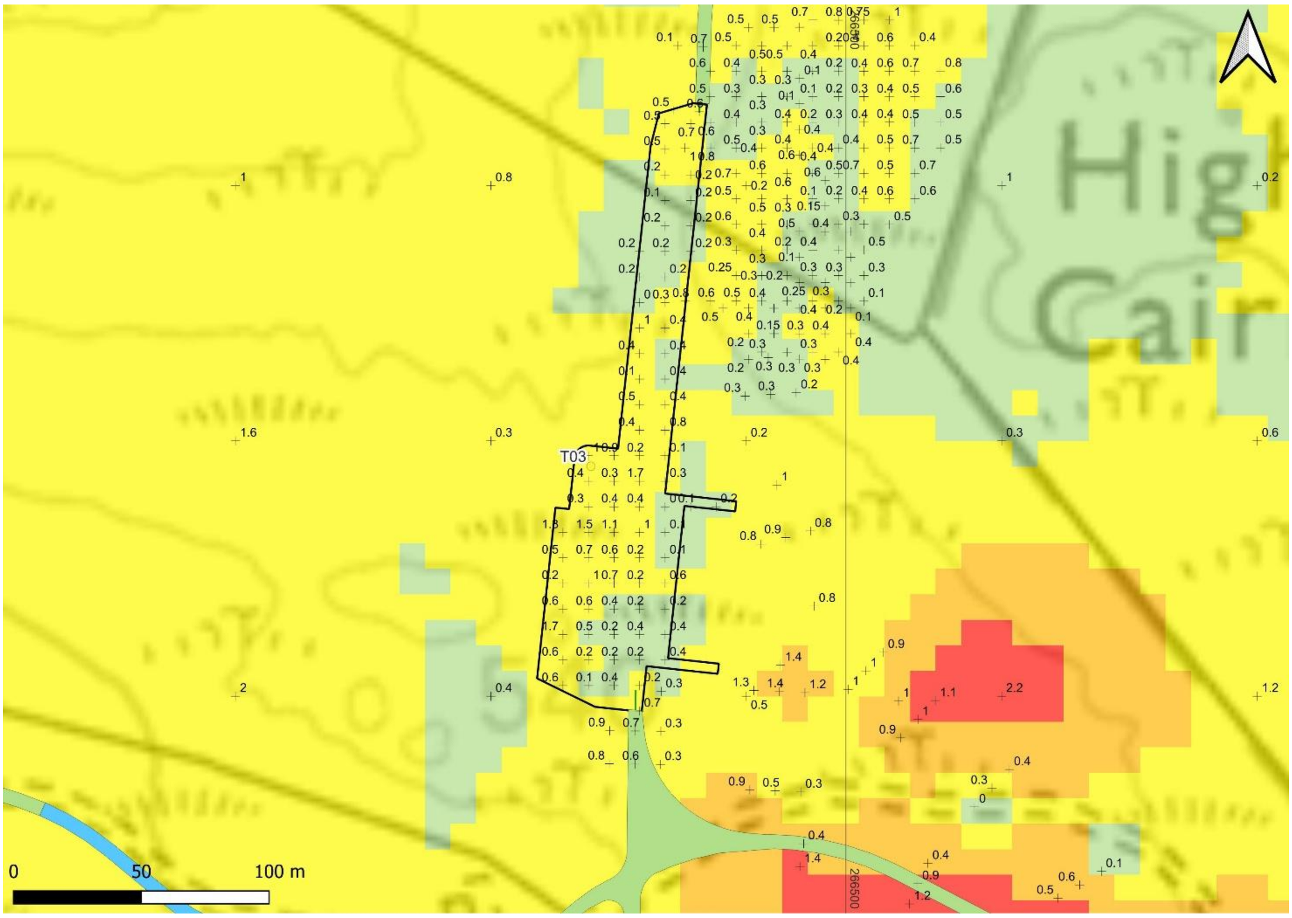


T02 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is steep and coincident with some areas where peat is over 0.50 m which make them conducive for peat sliding so care should be taken when stockpiling peat around the hardstanding.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T03	1	1	Peat Depth (Mean = 0.60m)	3	3+3+2 = 8 (Low)
			Slope Angle (6°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

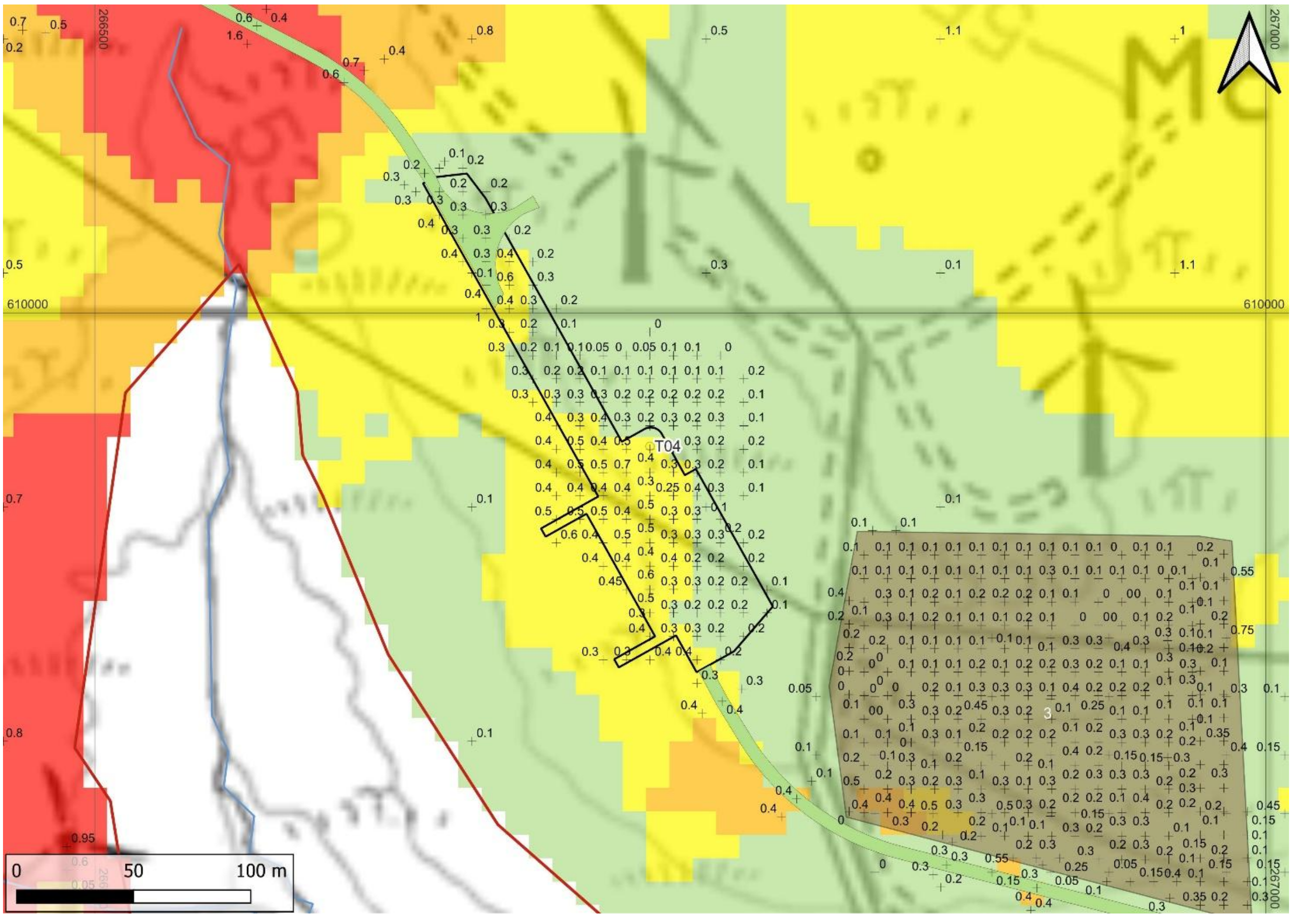


T03 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle and peat depth is conducive for peat sliding so care should be taken when stockpiling peat around areas with steeper gradients. There are also areas of deep peat in the central areas of the hardstanding up to 1.7m deep.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T04	1	2	Peat Depth (Mean = 0.30m)	1	No peat (Negligible)
			Slope Angle (7°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



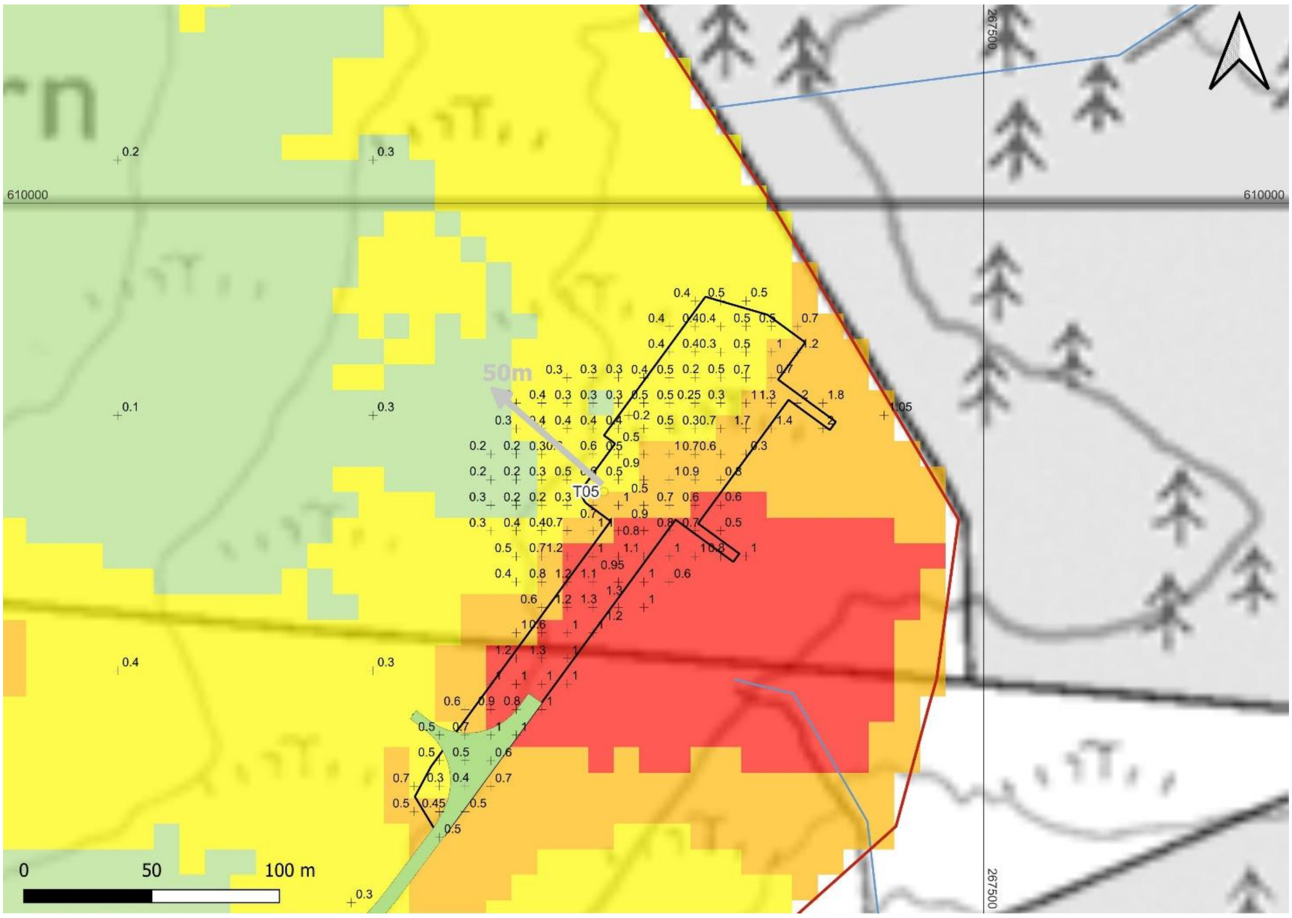
T04 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Peat depth is negligible to very shallow across the turbine hardstanding location however given the areas of steeper gradient and proximity of some parts to the watercourse to the west, care should be taken when choosing stockpiling locations.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T05	1	3	Peat Depth (Mean = 0.70m)	3	3+3+2 * (3) = 24

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
			Slope Angle (4°)	3	(High)
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



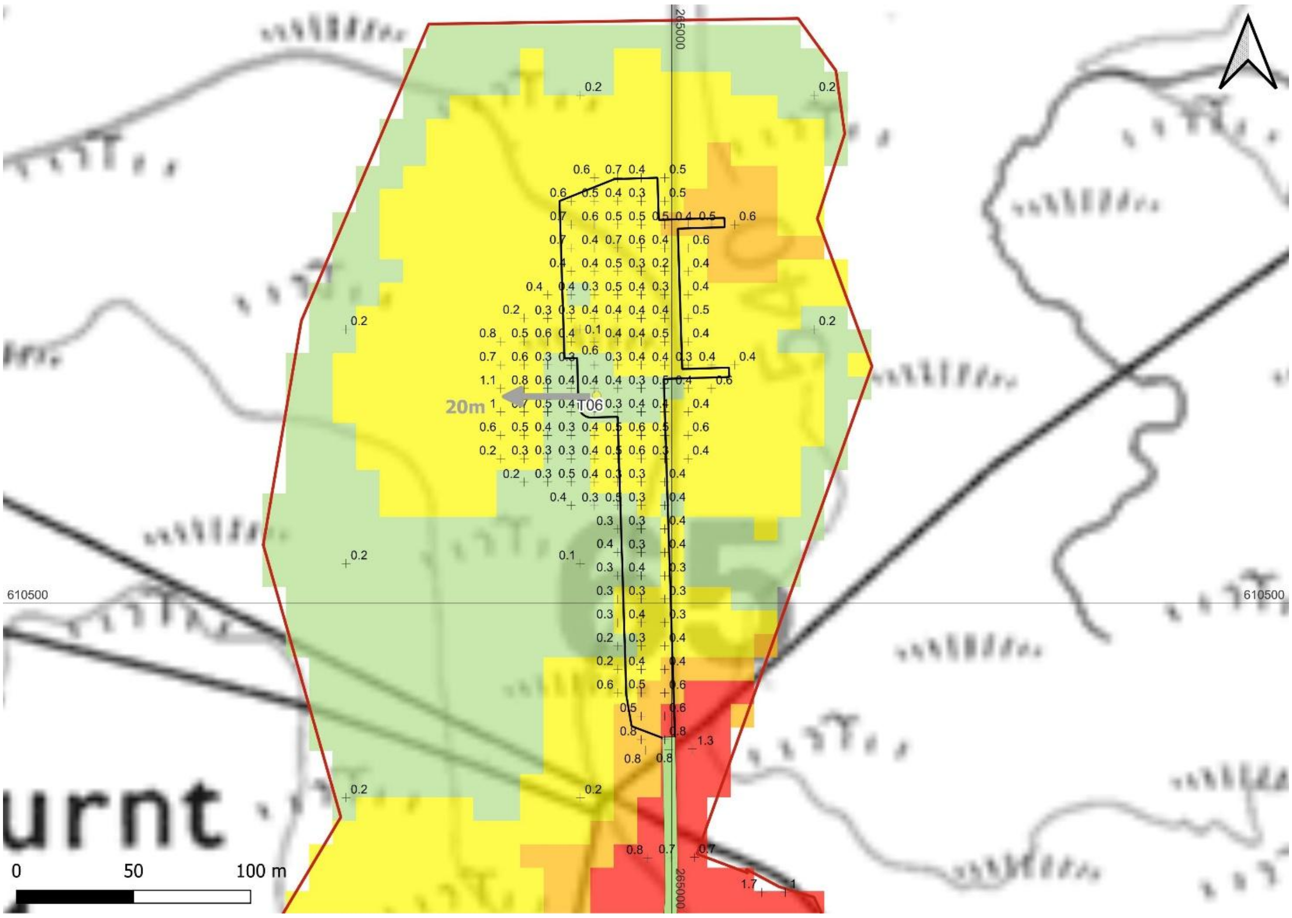
T05 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Micrositing the turbine centre 50 m to the northwest would reduce the environmental ranking from ‘3’ to ‘2’ moving infrastructure away from the watercourse to the southeast and the peat depth ranking from ‘3’ to ‘1’ as the interpolation shows depths of <0.50 m to the northwest. This would reduce the overall risk ranking from ‘High’ to ‘Low’.

Care should be taken when stockpiling peat during the construction process around this turbine due to the pockets of deep peat and steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T06	1	2	Peat Depth (Mean = 0.30m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (5°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



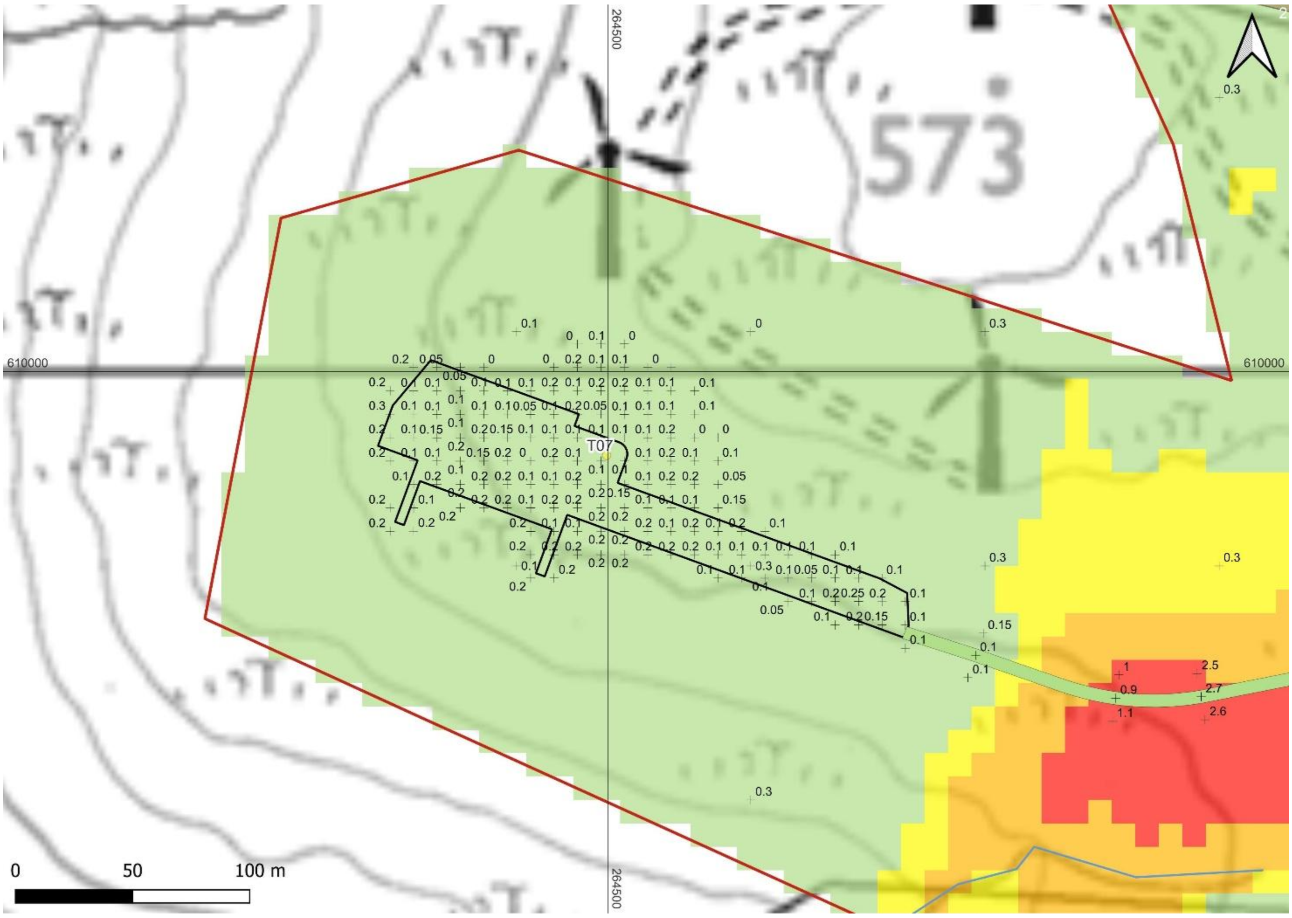
T06 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

This location would benefit from a microsite of 20 m to the west as parts of the hardstanding in the east are within the 100 – 150 m watercourse buffer / environmental risk ranking ‘2’ This micrositing would reduce this environmental risk ranking to ‘1’ and the overall risk for all of the infrastructure to ‘Low’.

The slope angle is conducive for peat sliding so care should be taken when stockpiling peat around areas with steep gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T07	1	1	Peat Depth (Mean = 0.12m)	1	No peat (Negligible)
			Slope Angle (11°)	5	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



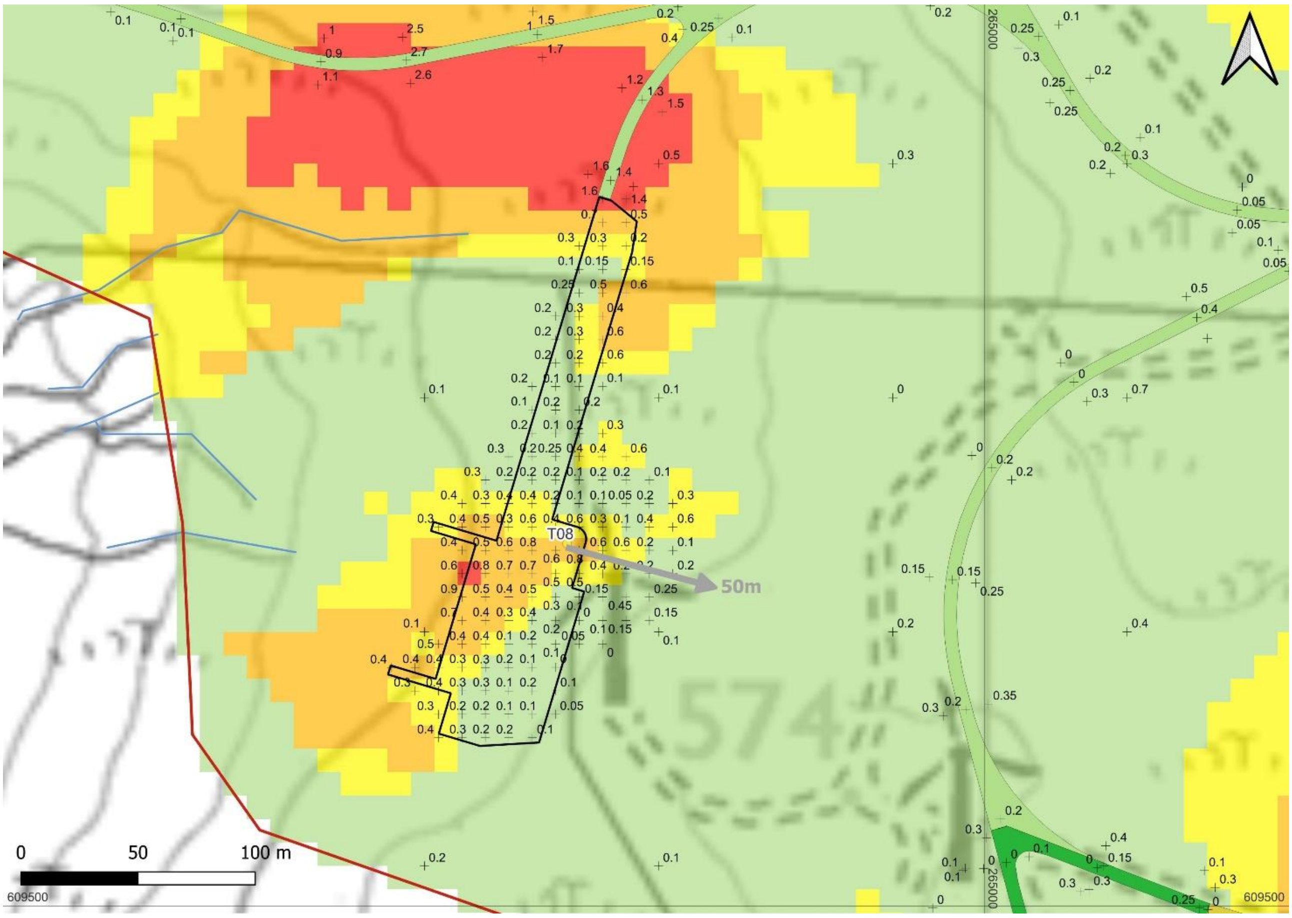
T07 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Peat depth is negligible to very shallow across the turbine hardstanding location however given the areas of steeper gradient care should be taken when choosing stockpiling locations.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T08	1	3	Peat Depth (Mean = 0.35m)	1	3+2 * (3) = 15

Locatio n	Development Infrastructure	Environmenta l	Contributary Factors (Probability/Exposure)		Risk Ranking
			Slope Angle (8°)	3	(Medium)
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

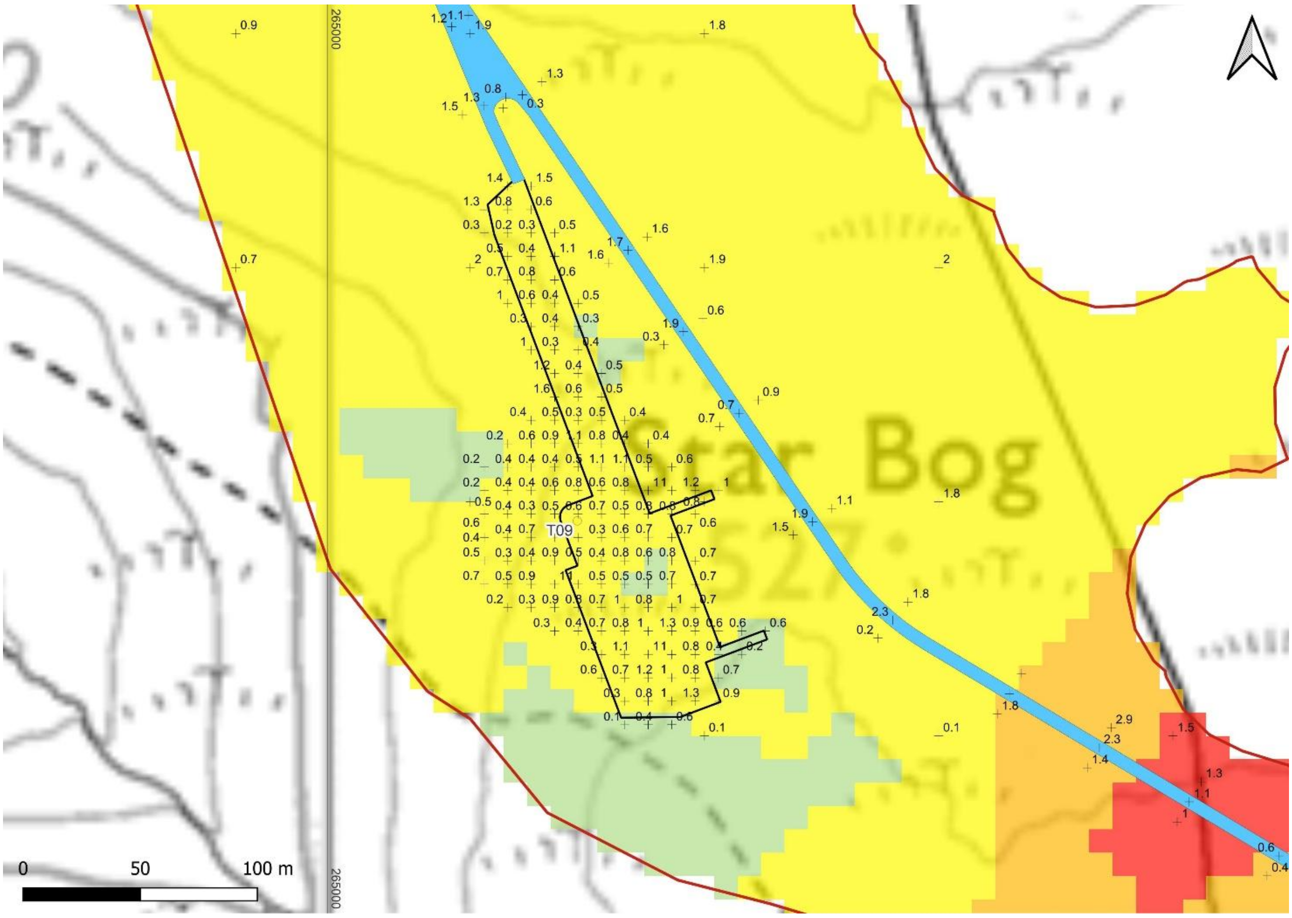


T08 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Micrositing the turbine position 50 m to the east as pictured above would reduce the environmental risk ranking from ‘3’ to ‘2’ and the overall risk ranking would be ‘Low’. The peat depth ranking would also likely negligible given the probes to the east are on average 0 – 0.30 m and this would avoid the areas of peat up to 0.90 m in the current hardstanding configuration. The slope angle is conducive for peat sliding, care should be taken when stockpiling peat around the temporary construction compound to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T09	1	1	Peat Depth (Mean = 0.55m)	3	3+3+2 = 8 (Low)
			Slope Angle (5°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

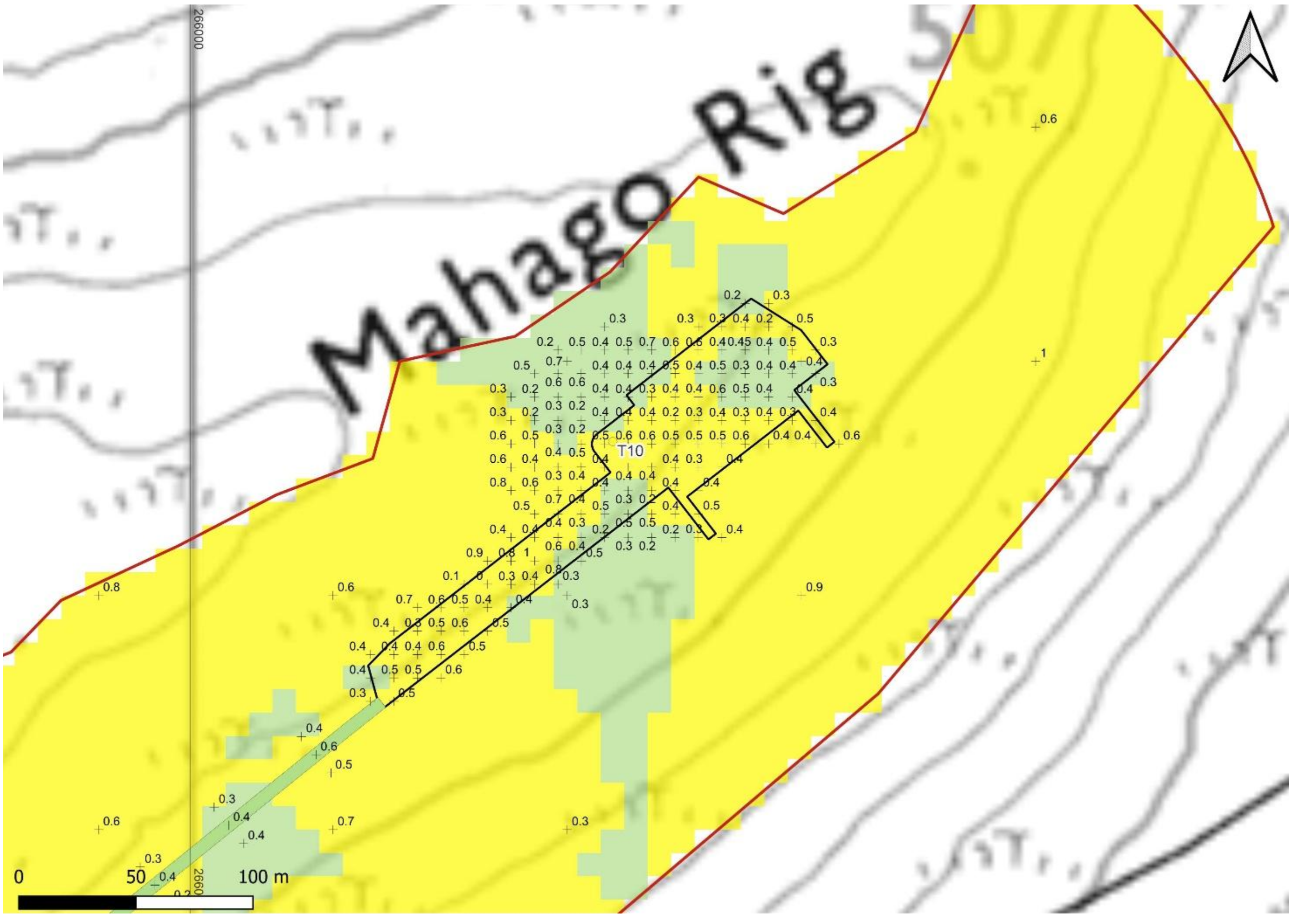


T09 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding care should be taken when stockpiling peat at this infrastructure. There is an area in the southern part of the hardstanding where deeper peat (up to 1.30 m) is present, stockpiling should be carefully considered here.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T10	1	1	Peat Depth (Mean = 0.45m)	1	3+2 = 5 (Low)
			Slope Angle (6°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

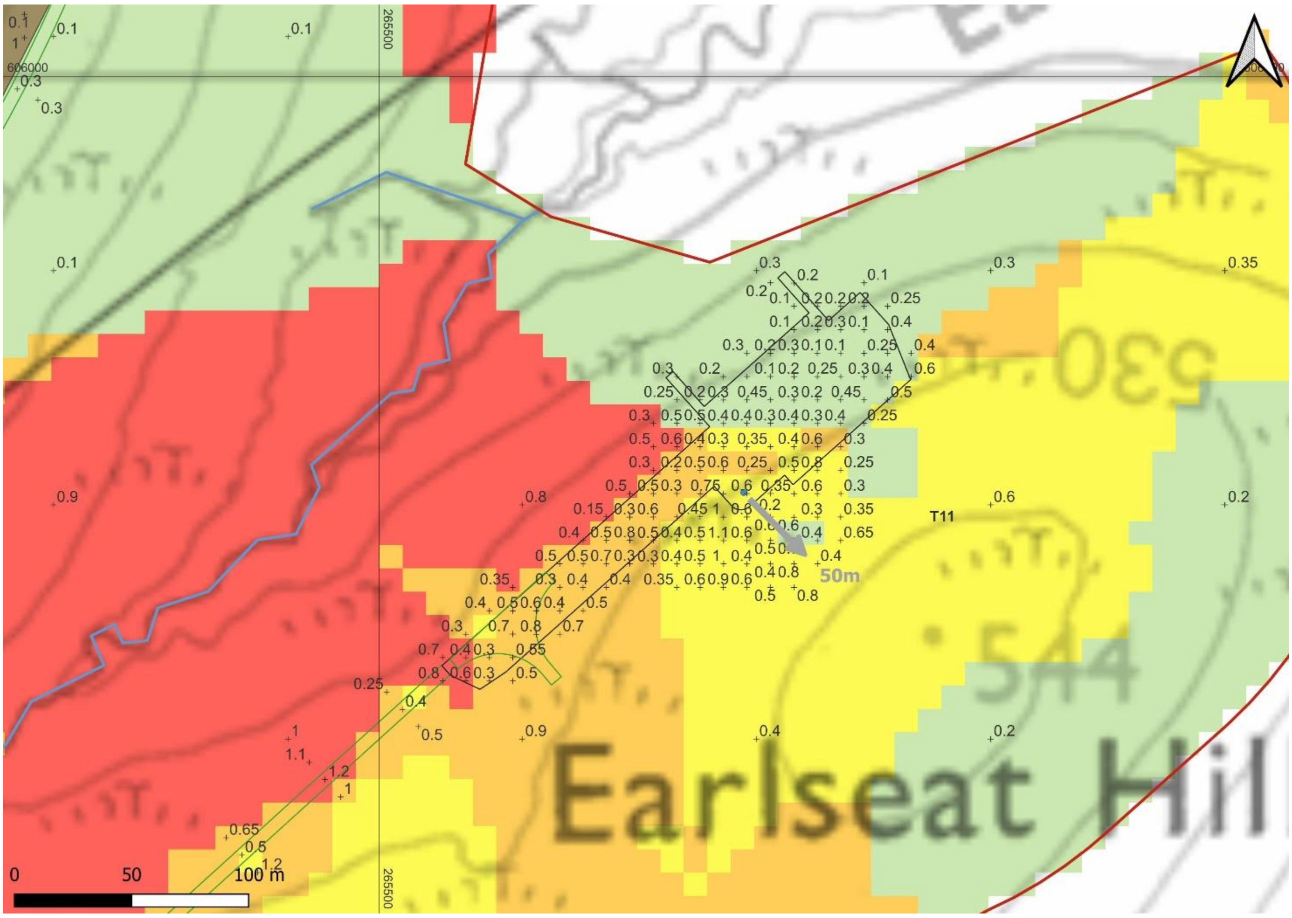


T10 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding so care should be taken when stockpiling peat around the infrastructure locations to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T11	1	3	Peat Depth (Mean = 0.55m)	3	3+3+2 * (3) = 24 (High)
			Slope Angle (9°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



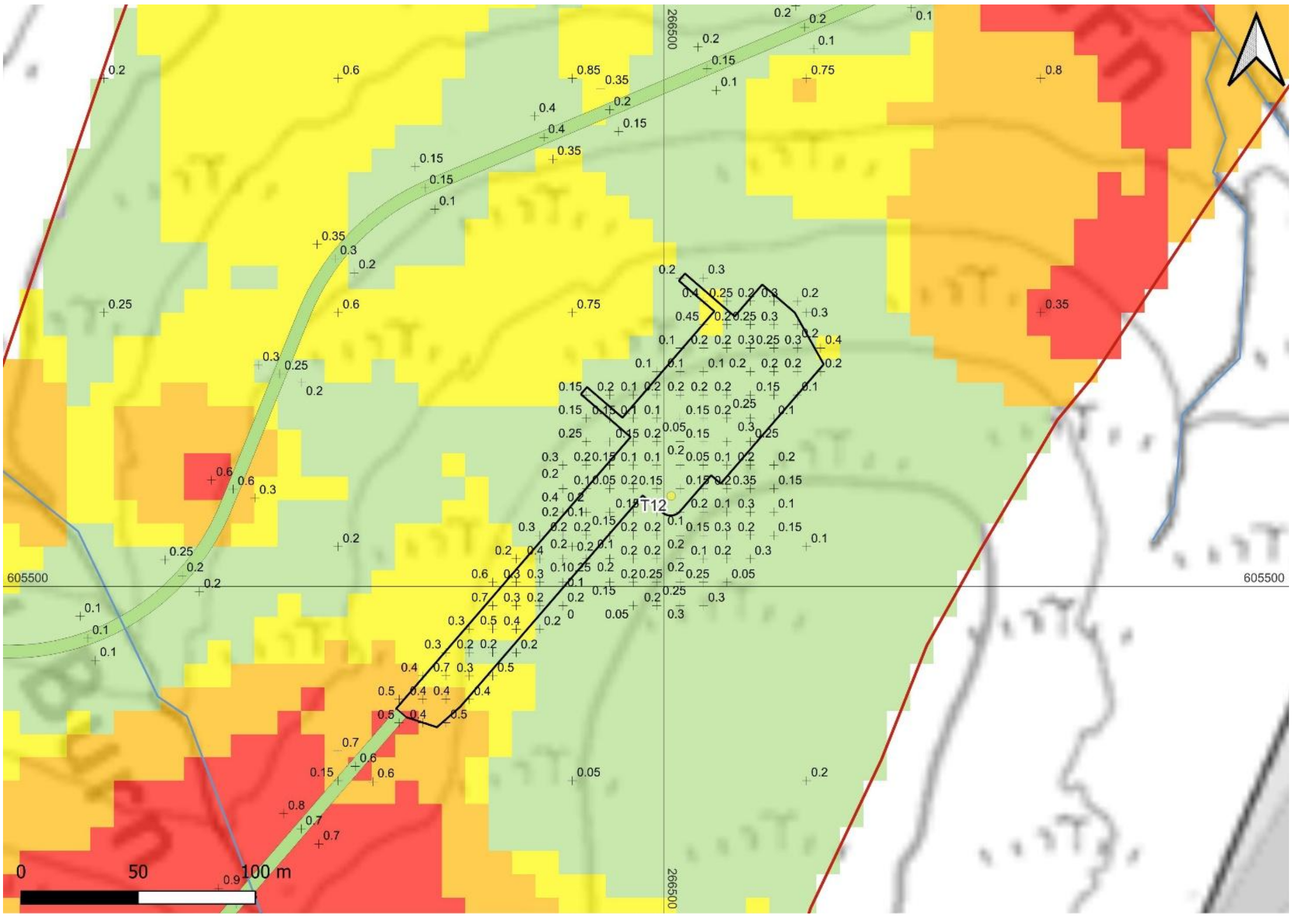
T11 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Micrositing the turbine centre location 50 m to the southeast would reduce the environmental risk ranking from ‘3’ to ‘1’ and therefore the overall ranking to ‘Low’.

The slope angle is conducive for peat sliding and there are areas of peat over 1.0 m depth so care should be taken when stockpiling during the construction process around this turbine.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T12	1	2	Peat Depth (Mean = 0.10m)	1	No peat (Negligible)
			Slope Angle (6°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

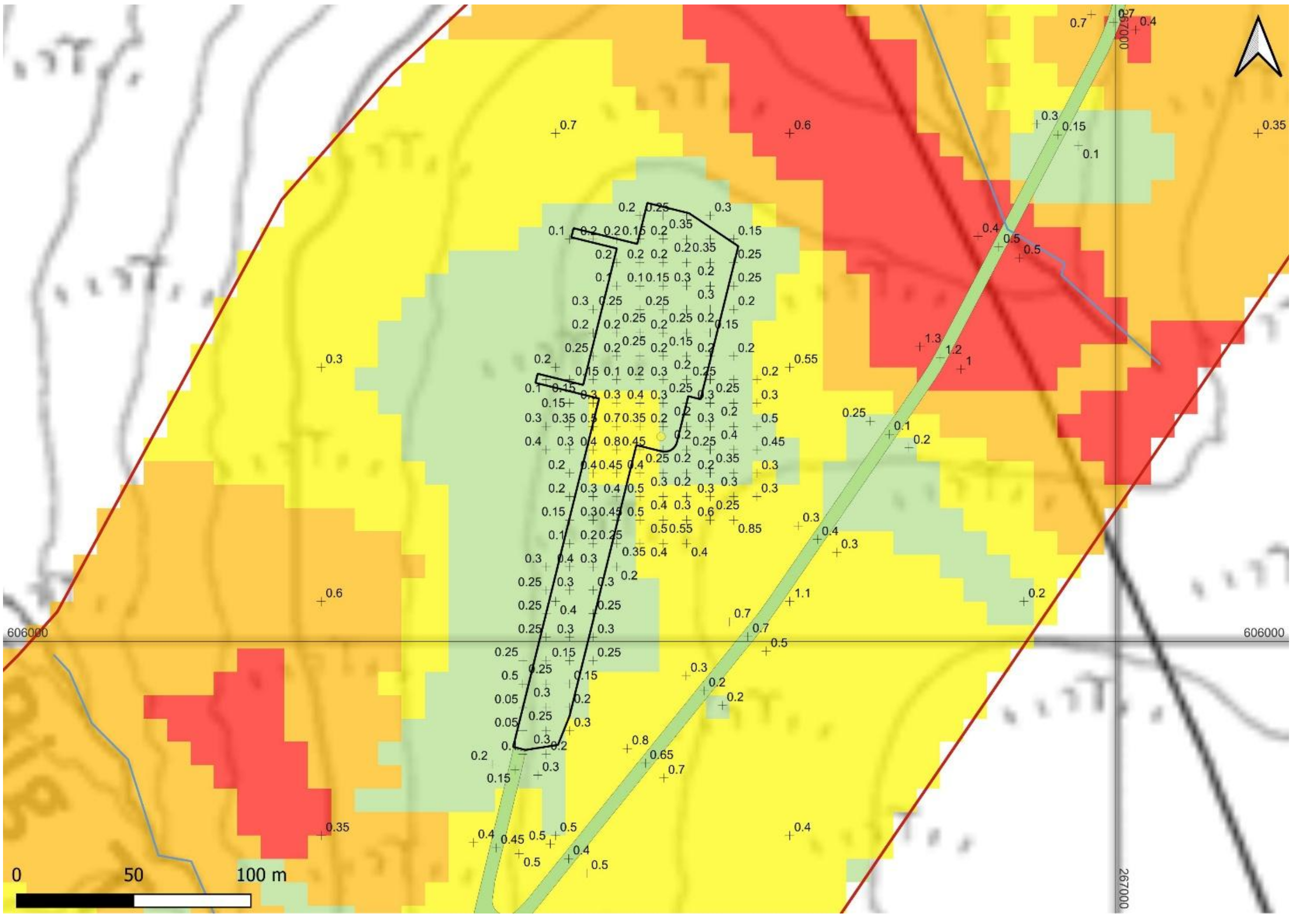


T12 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Peat depth is negligible to very shallow across the turbine hardstanding location however given the slope angle is conducive to peat sliding care should be taken during stockpiling so there are small areas of 'Medium' risk in the southwest corner of the hardstanding. Care should be taken during the construction process in this area in particular due to the proximity to the watercourse. Special mitigation measures should be implemented to avoid contamination such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T13	1	2	Peat Depth (Mean = 0.28m)	1	No peat (Negligible)
			Slope Angle (6°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

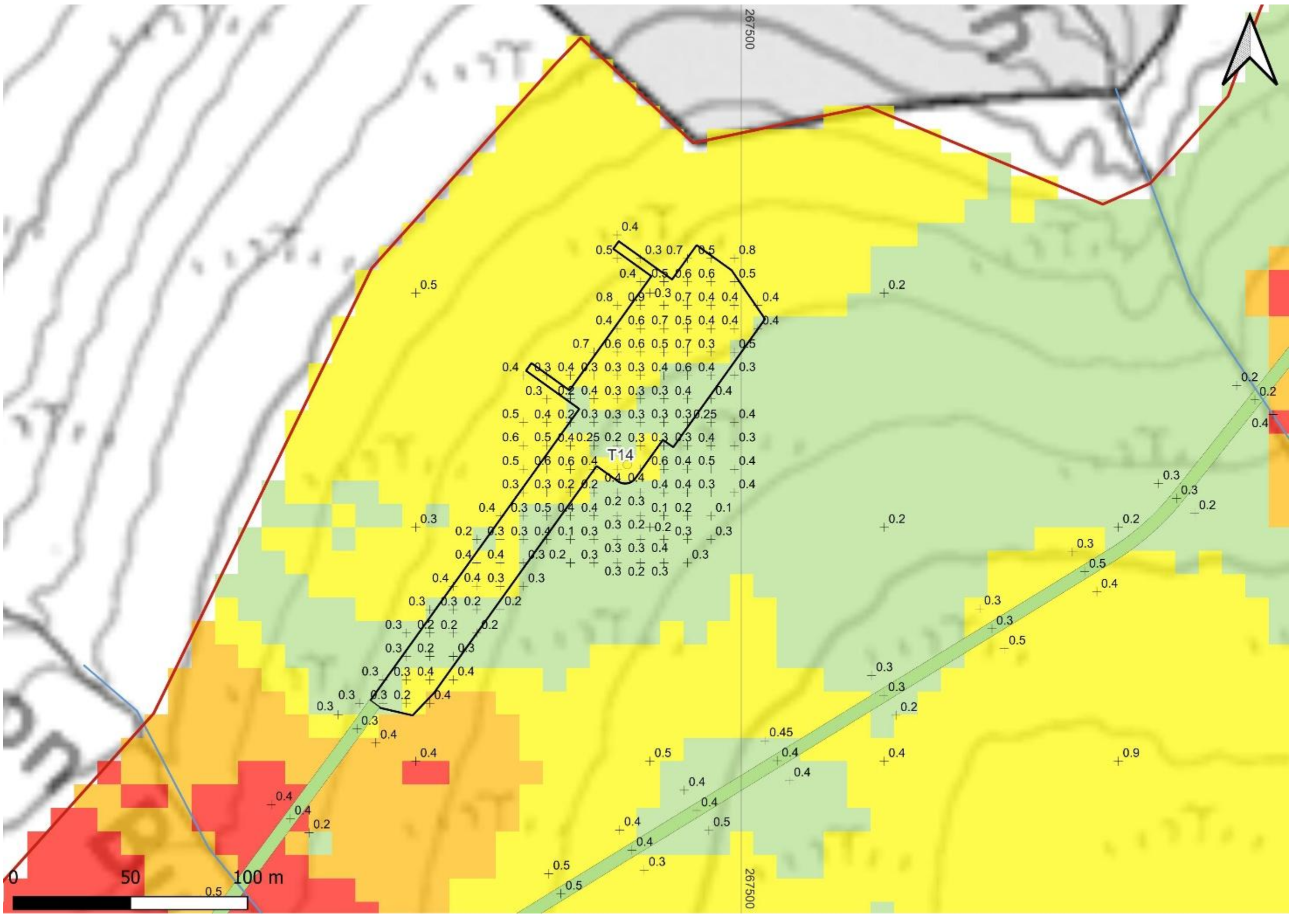


T13 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Peat depth is negligible to very shallow across the turbine hardstanding location however given the slope angle is conducive to peat sliding care should be taken during stockpiling.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T14	1	2	Peat Depth (Mean = 0.31m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (9°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

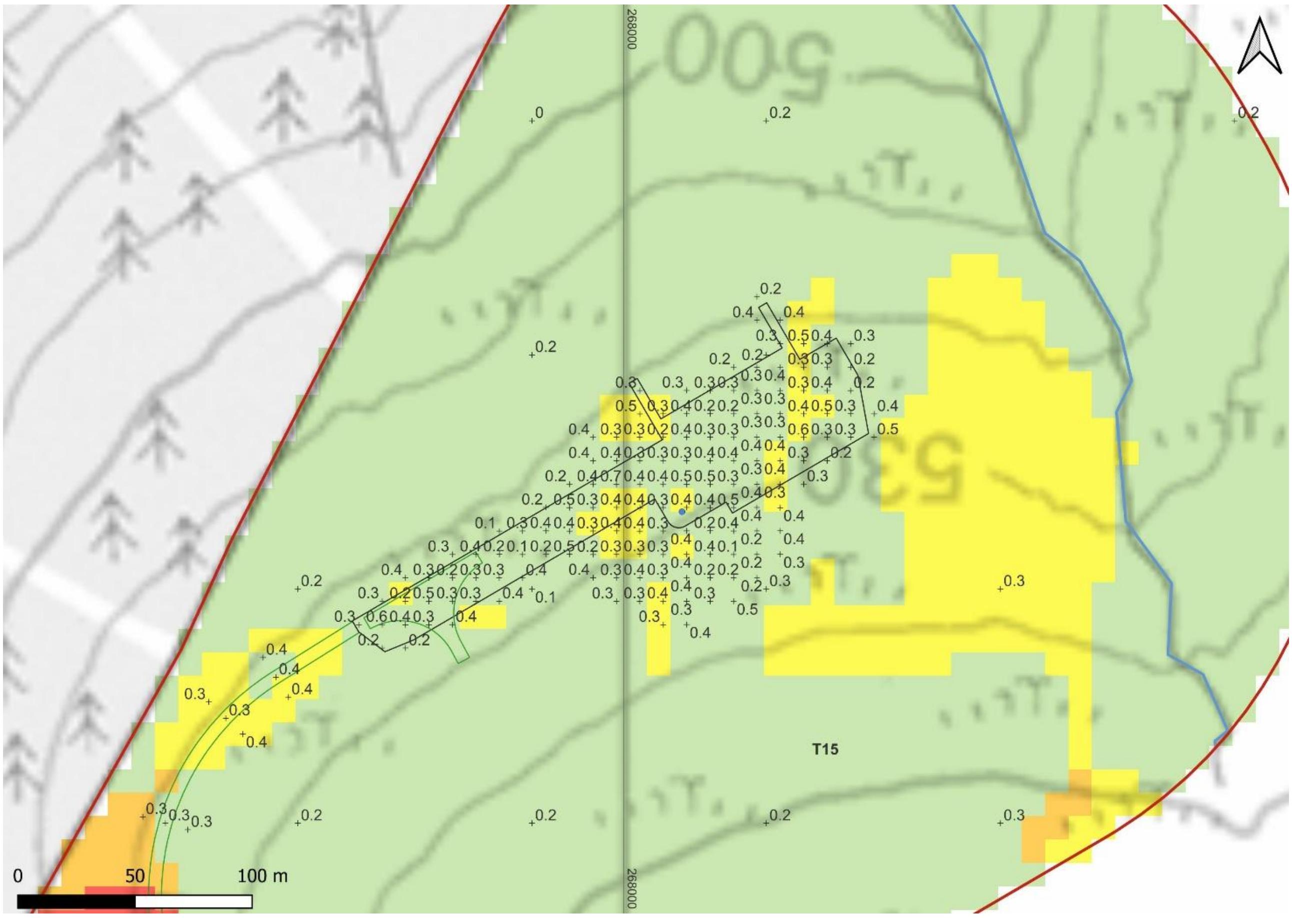


T14 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding so care should be taken when stockpiling peat to avoid areas of steeper gradients within the hardstanding area. The southwestern part of the hardstanding is within the 150 – 100 m watercourse buffer, special mitigation measures should be implemented here to avoid contamination such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T15	1	2	Peat Depth (Mean = 0.35m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (12°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

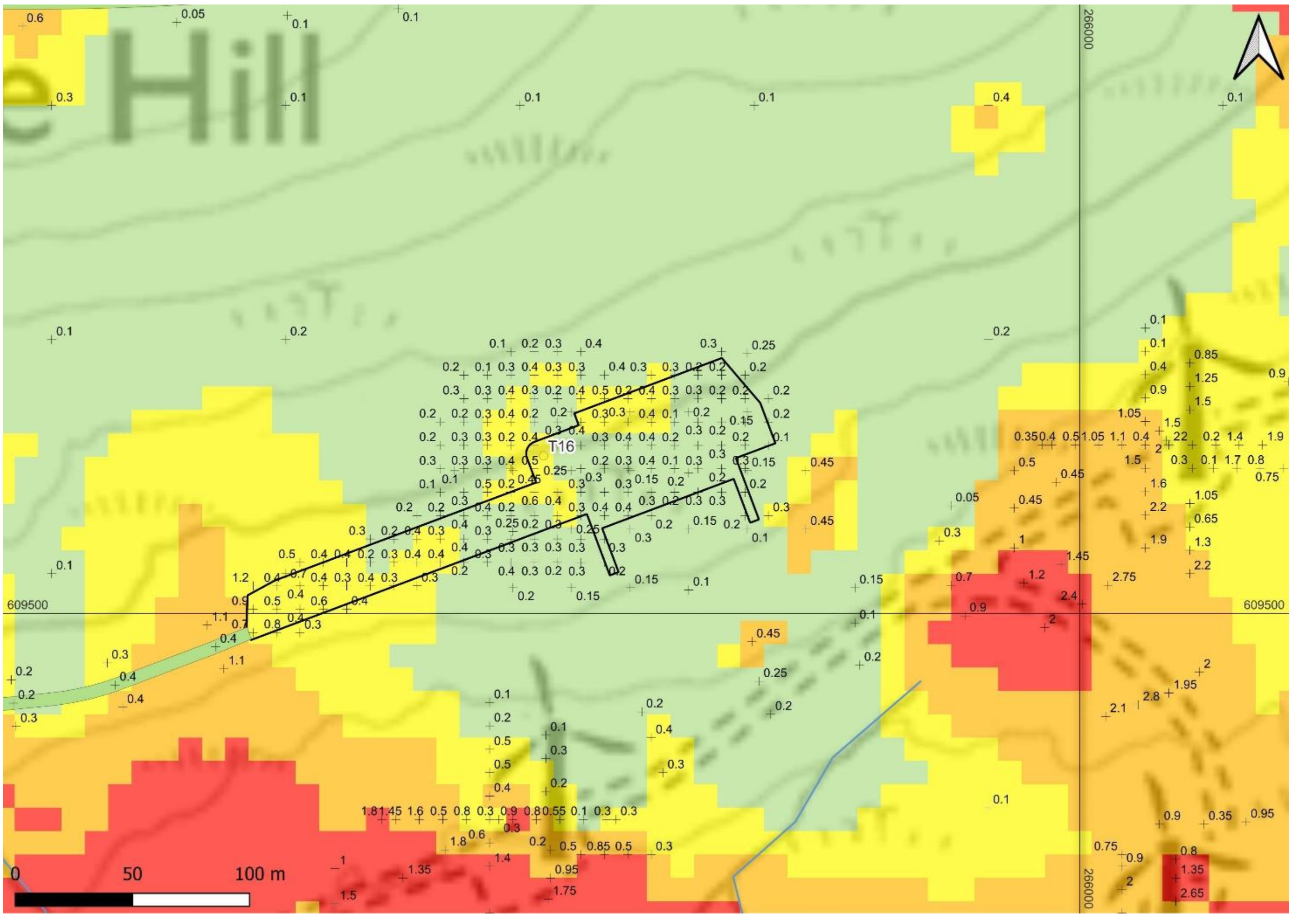


T15 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding, care should be taken when stockpiling peat during the construction process around this turbine due to the steeper gradients. The northeastern corner of the hardstanding is within the 100 – 150 m watercourse buffer, special mitigation measures should be implemented here to avoid contamination such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T16	1	2	Peat Depth (Mean = 0.35m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (8°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

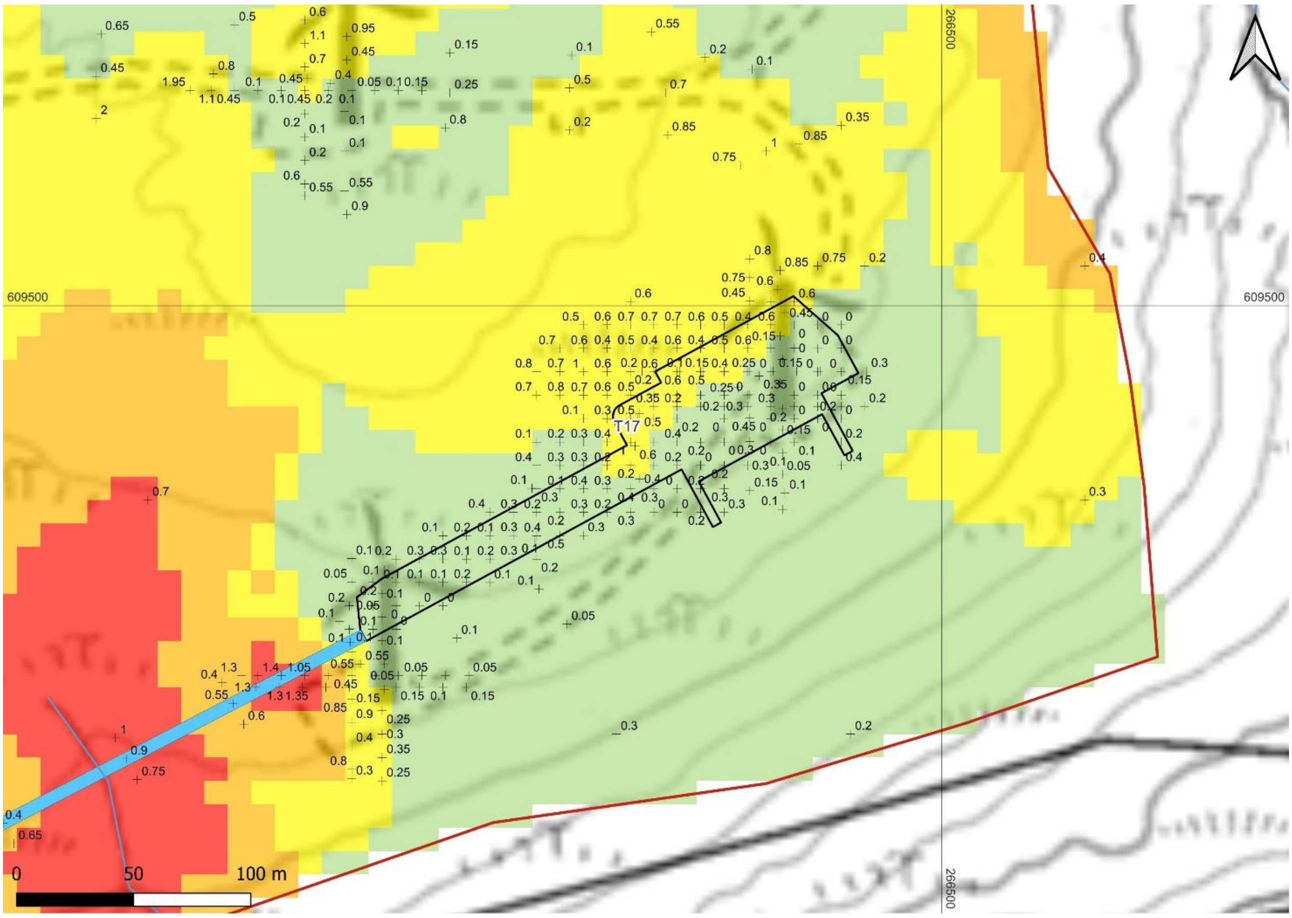


T16 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding. care should be taken when stockpiling peat during the construction process around this turbine due to the steeper gradients. Several areas of the hardstanding area are located within the 100 – 150 m watercourse buffer, special mitigation measures should be implemented here to avoid contamination such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T17	1	1	Peat Depth (Mean = 0.52m)	3	3+3+2 = 8 (Low)
			Slope Angle (5°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



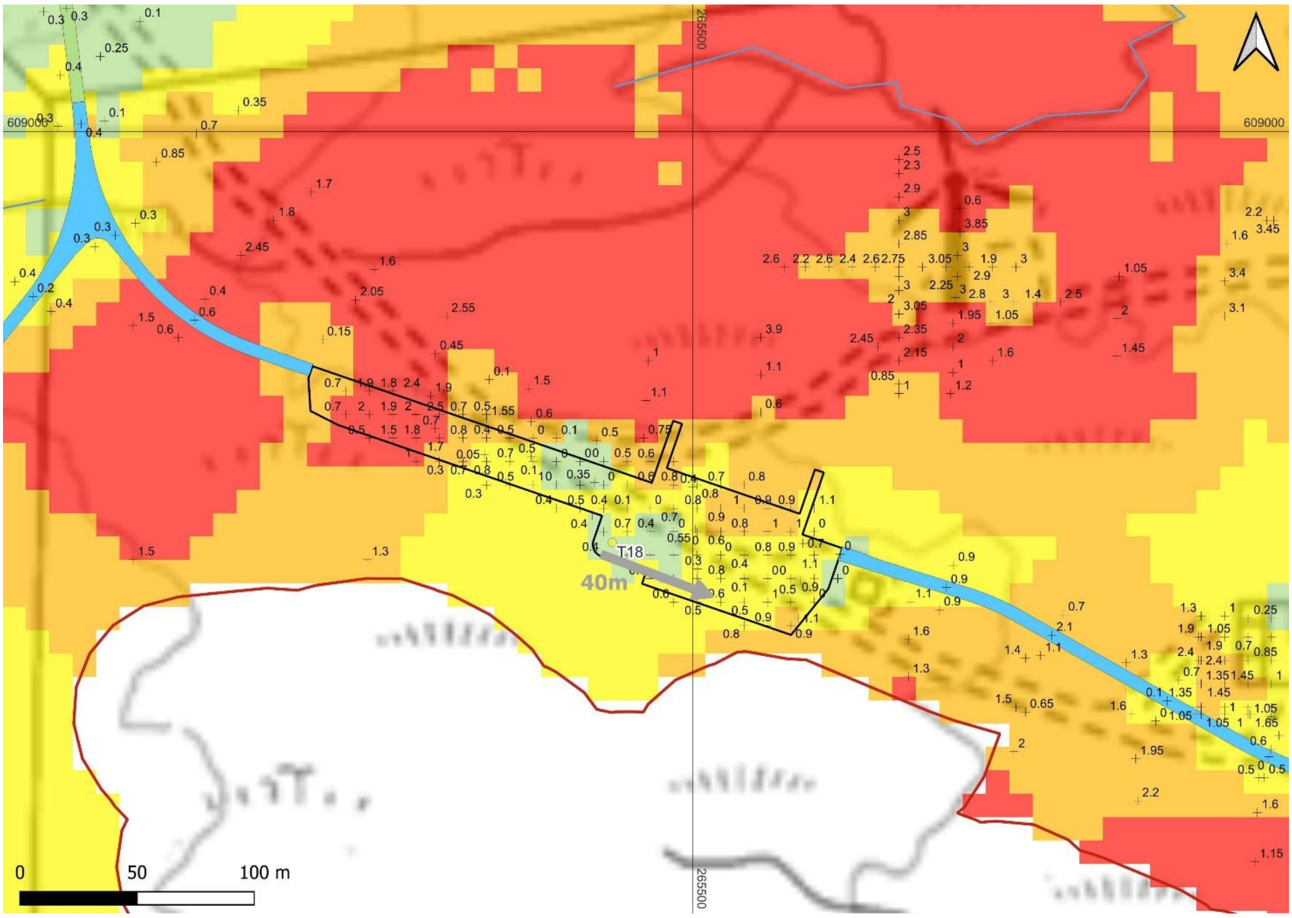
T17 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding, care should be taken when stockpiling peat especially in the eastern areas of the hardstanding where the ground is steeper.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T18	1	2	Peat Depth (Mean = 0.32m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (4°)	3	

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

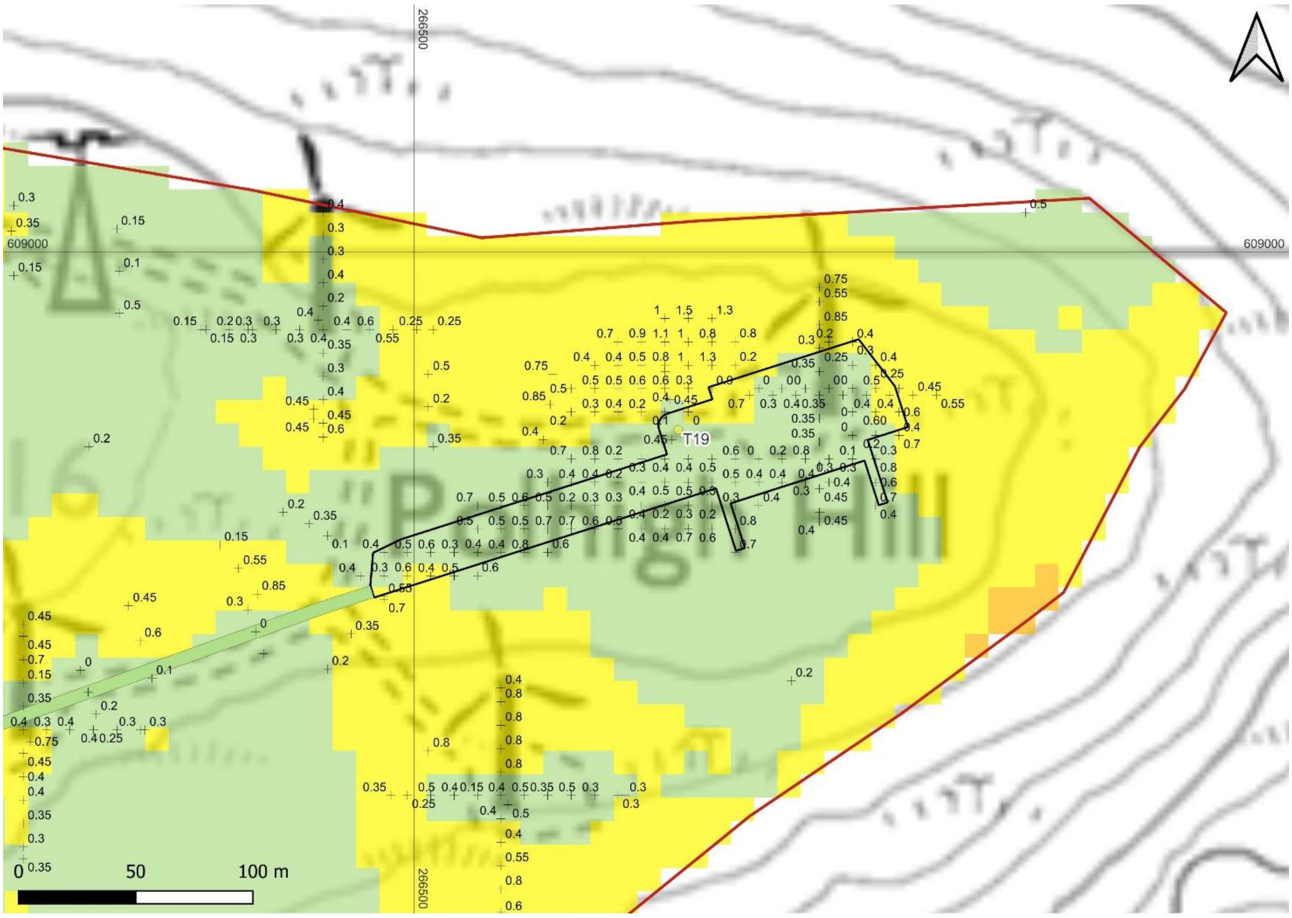


T18 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

There is an area of deep peat (up to 2.5 m) in the western side of the hardstanding where the risk is mapped as high. Micrositing 40 m to the southeast would ensure none of the hardstanding area is within any high-risk areas by avoiding this pocket of deep peat which could be designed as floated track. The eastern areas of the hardstanding near the turbine centre are located within the 100 – 150 m watercourse buffer, special mitigation measures should be implemented here to avoid contamination to the watercourse to the south such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T19	1	1	Peat Depth (Mean = 0.35m)	1	2 (Negligible)
			Slope Angle (2°)	1	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



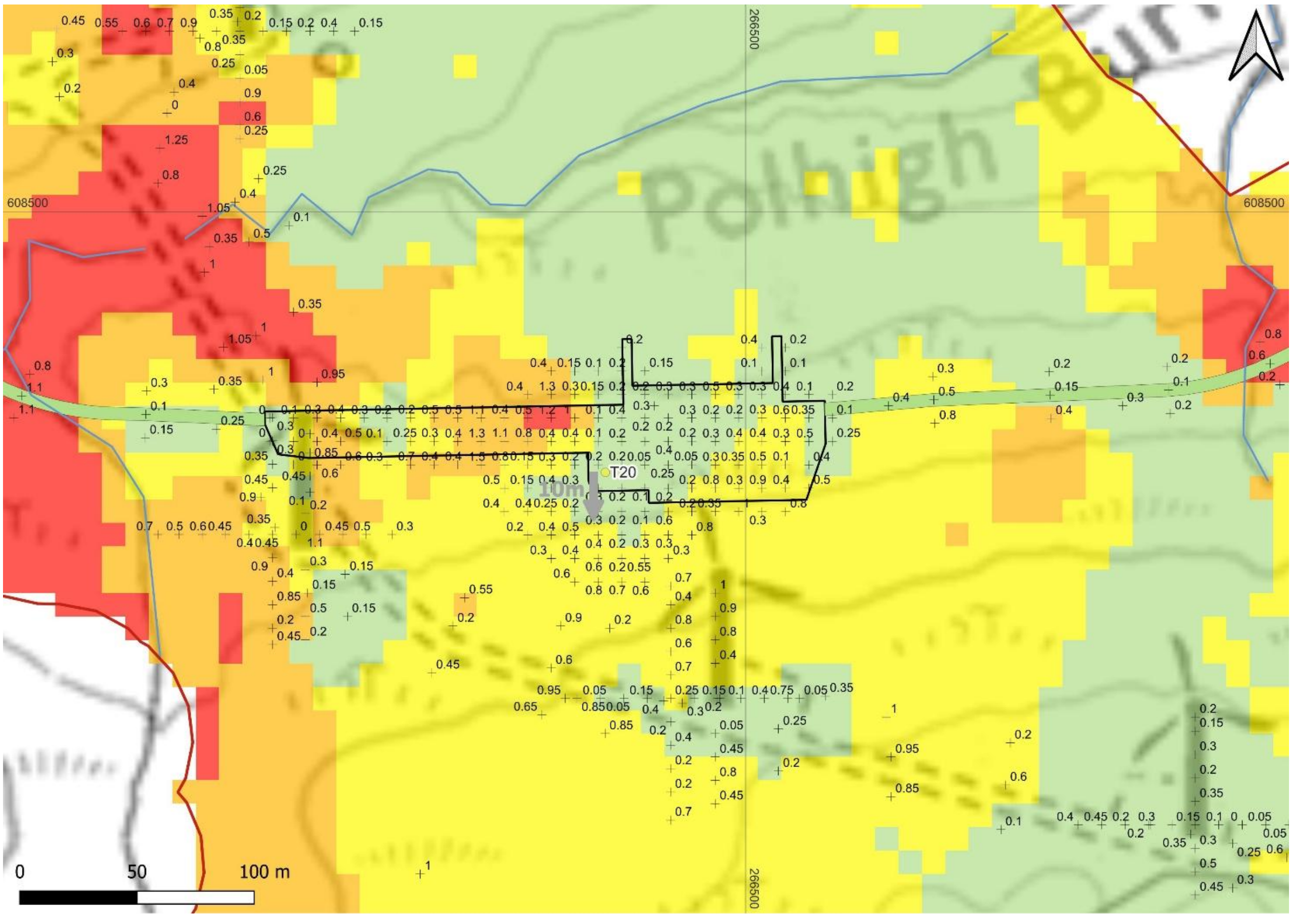
T19 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

There are areas where the slope angle is conducive for peat sliding so care should be taken when stockpiling peat around here to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T20	1	3	Peat Depth (Mean = 0.22m)	1	No Peat (Negligible)
			Slope Angle (9°)	3	

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



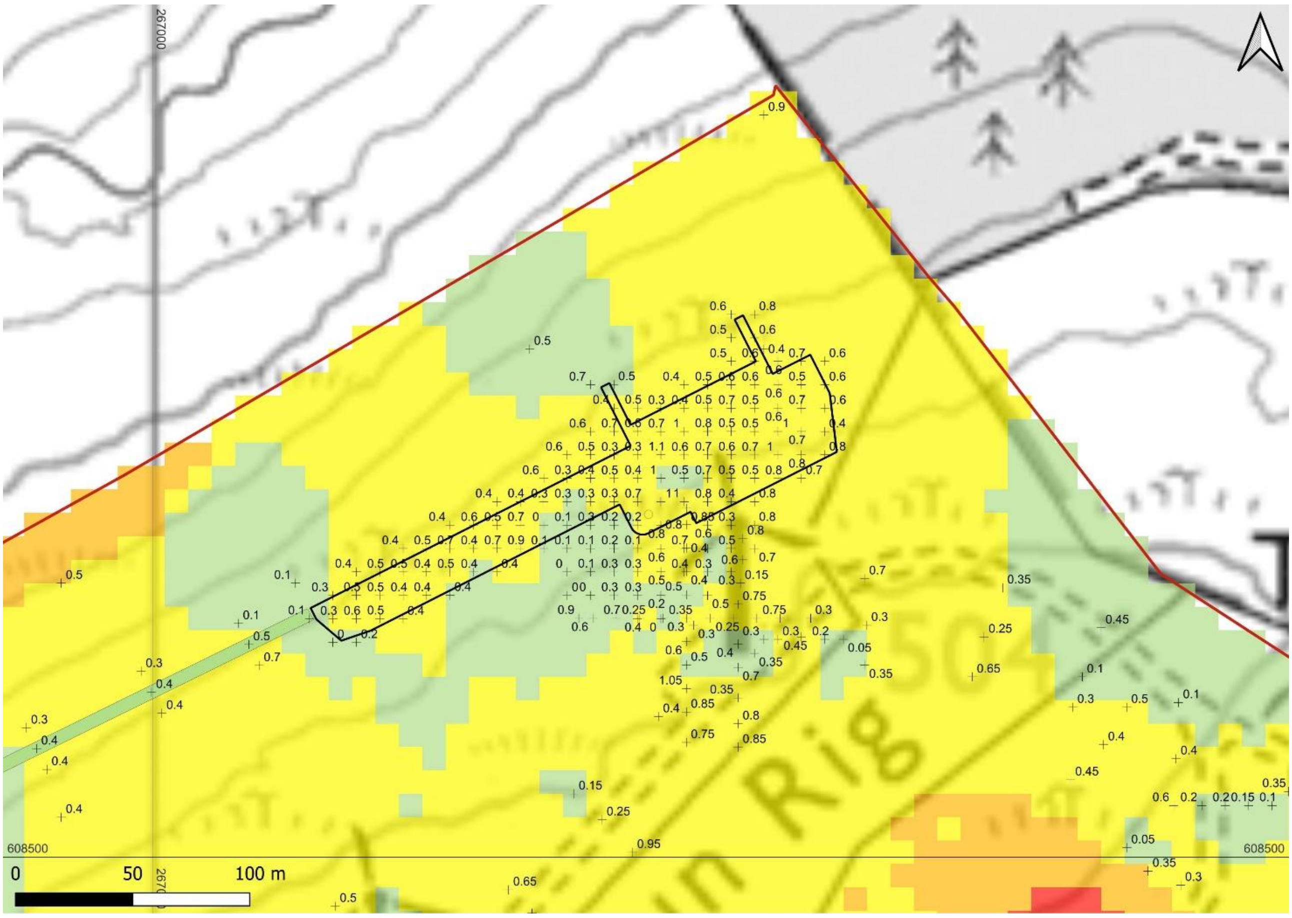
T20 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

There is a small area of high risk mapped within the hardstanding area of T20. This could be avoided by micrositing the turbine and hardstanding position 10 m to the south.

The central and western areas of the hardstanding are located within the 50 – 100 m watercourse buffer and have isolated pockets of peat up to 1.30 m deep, special mitigation measures should be implemented here to avoid contamination to the watercourse to the south such as limiting stockpiles, drainage ditching and silt fencing. Care should be taken during construction to avoid or limit stockpiling at these higher risk locations.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T21	1	1	Peat Depth (Mean = 0.60m)	3	3+5+2 = 10 (Low)
			Slope Angle (10°)	5	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



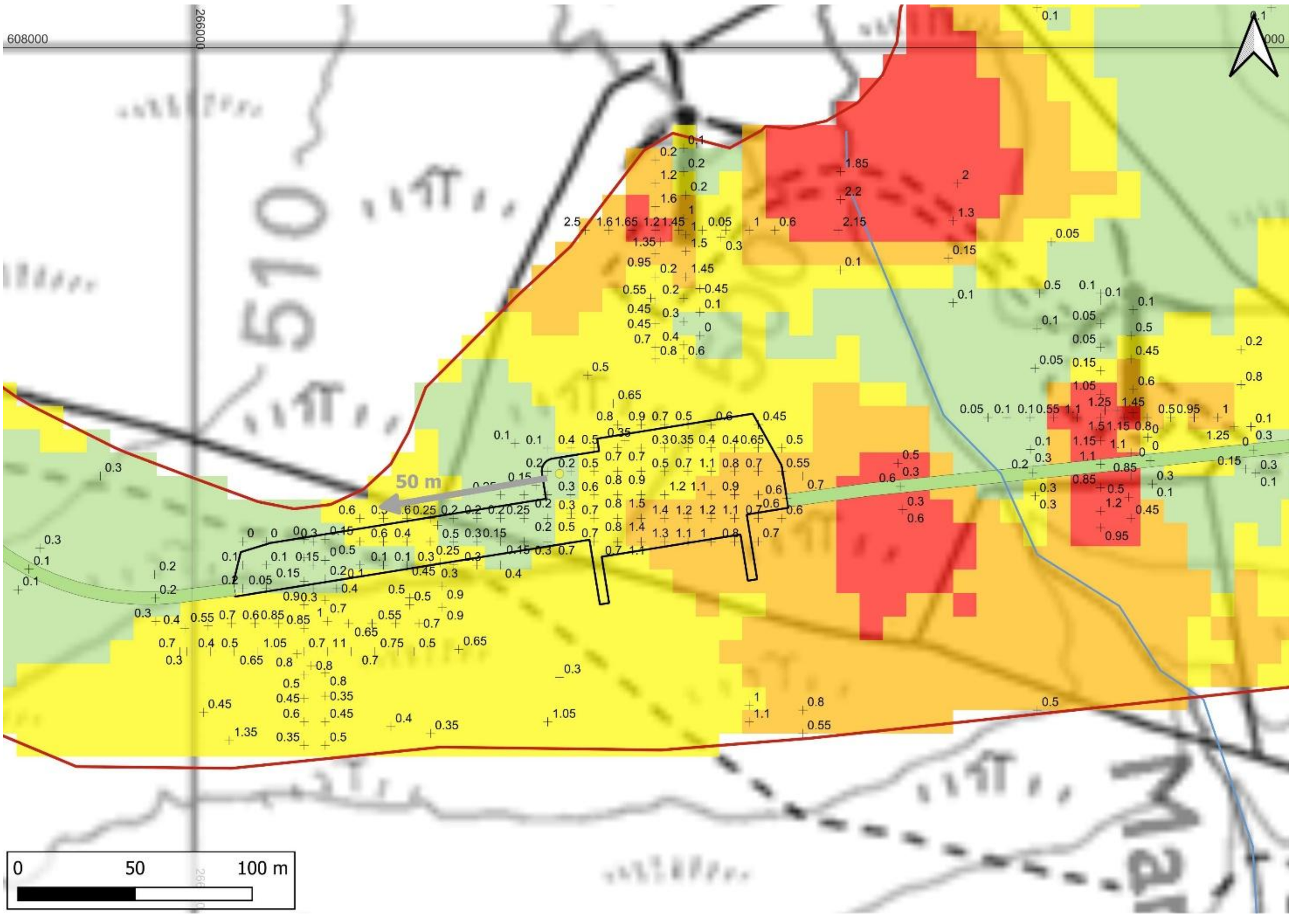
T21 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding so care should be taken when stockpiling peat around the hardstanding areas.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
T22	1	2	Peat Depth (Mean = 0.32m)	1	3+2 * (2) = 10 (Low)
			Slope Angle (7°)	3	
			FoS	1	

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



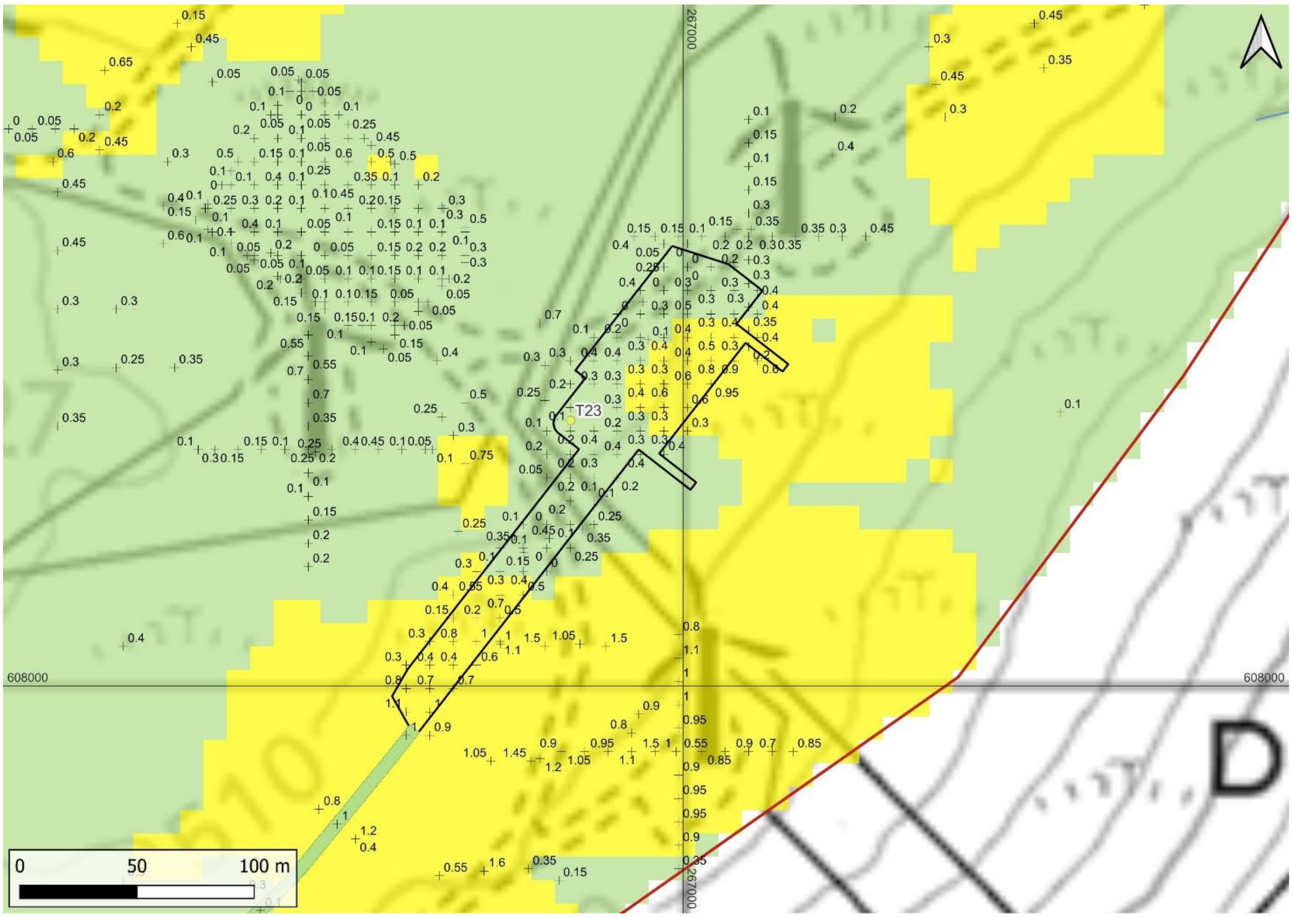
T22 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Parts of the eastern hardstanding are located within 'Medium' risk due to being within the 50 – 100 m watercourse buffer and the presence of isolated pockets of peat up to 1.50 m deep. To reduce the overall risk of the hardstanding, a 50 m micrositing to the west is recommended which would move the infrastructure further away from the deeper peat and watercourse. In any case, special mitigation measures should be implemented here to avoid contamination to the watercourse to the east such as limiting stockpiles, drainage ditching and silt fencing.

The slope angle is also conducive for peat sliding in the western side of the hardstanding so care should be taken here during the stockpiling peat to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
T23	1	1	Peat Depth (Mean = 0.40m)	1	3+2 = 5 (Low)
			Slope Angle (8°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



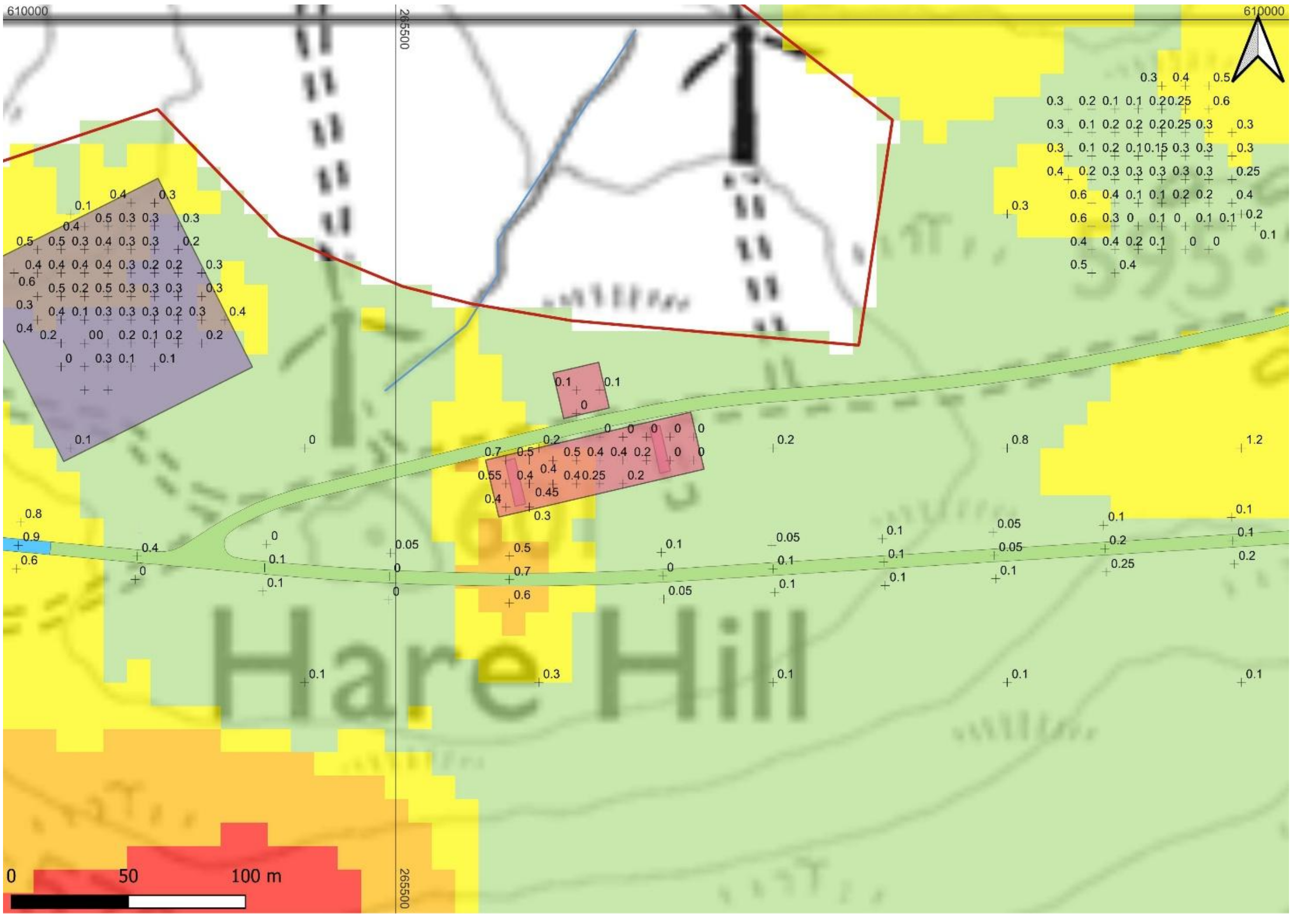
T23 Location – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding across the hardstanding area so care should be taken when stockpiling peat to avoid steeper gradients in particular in the southwest where there are pockets of peat up to 1.10 m deep.

Location	Development Infrastructure	Environmental	Contributory Factors (Probability/Exposure)		Risk Ranking
	1	3	Peat Depth (Mean = 0.25m)	1	No Peat

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Blade Laydown Area			Slope Angle (2°)	1	(Negligible)
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



Blade Laydown Area – OS Mapping 1:25,000 – 1:1250 Scale

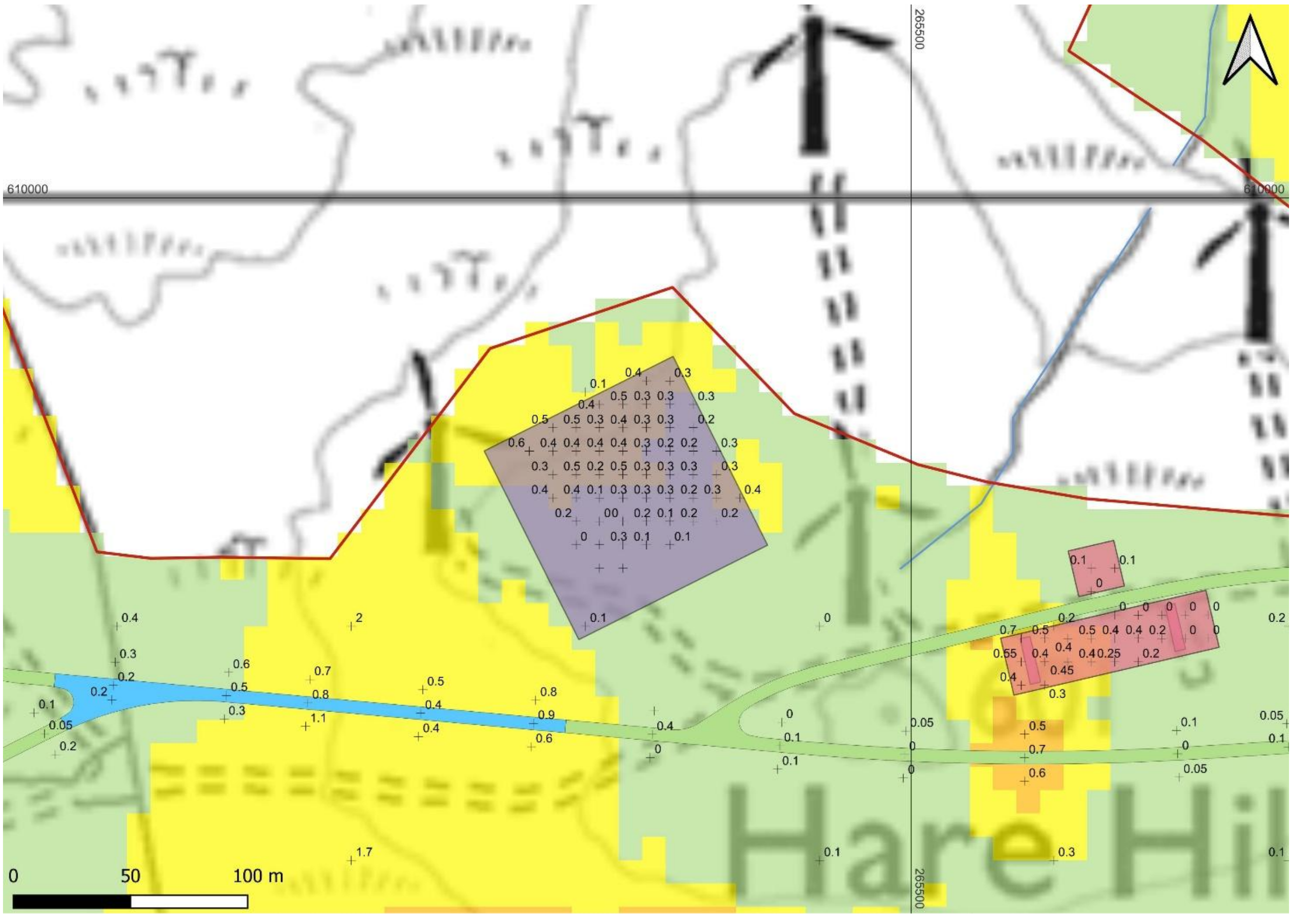
Location Specific Mitigation:

Parts of the laydown area within the 50 – 100 m watercourse buffer and there is relatively shallow peat (up to 0.70 m deep) present. Special mitigation measures should be implemented here to avoid contamination to the watercourse to the northwest such as limiting stockpiles, drainage ditching and silt fencing.

Location Specific Mitigation:

The slope angle is conducive for peat sliding in particular towards the eastern side of the proposed compound. Care should be taken here when stockpiling during the construction process due to the steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Main Constructio n Compound	1	2	Peat Depth (Mean = 0.27m)	1	No Peat (Negligible)
			Slope Angle (7°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

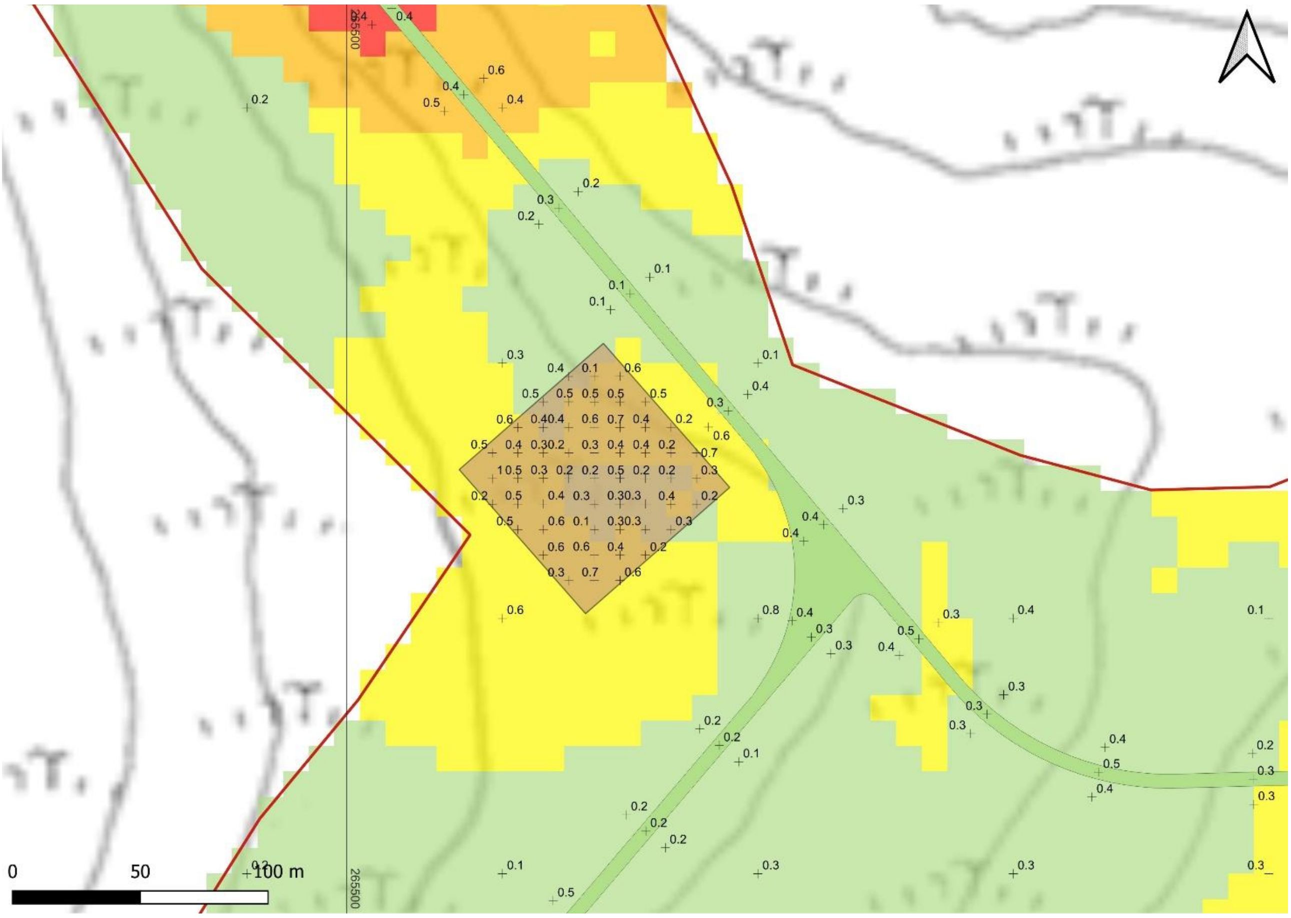


Main Construction Compound – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Most of the proposed compound position is within the 100 – 150 m watercourse buffer. Special mitigation measures should be implemented here to avoid contamination to the watercourse to the southeast such as limiting stockpiles, drainage ditching and silt fencing.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Satellite Construction Compound 1	1	1	Peat Depth (Mean = 0.40m)	1	3+2 = 5 (Low)
			Slope Angle (6°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



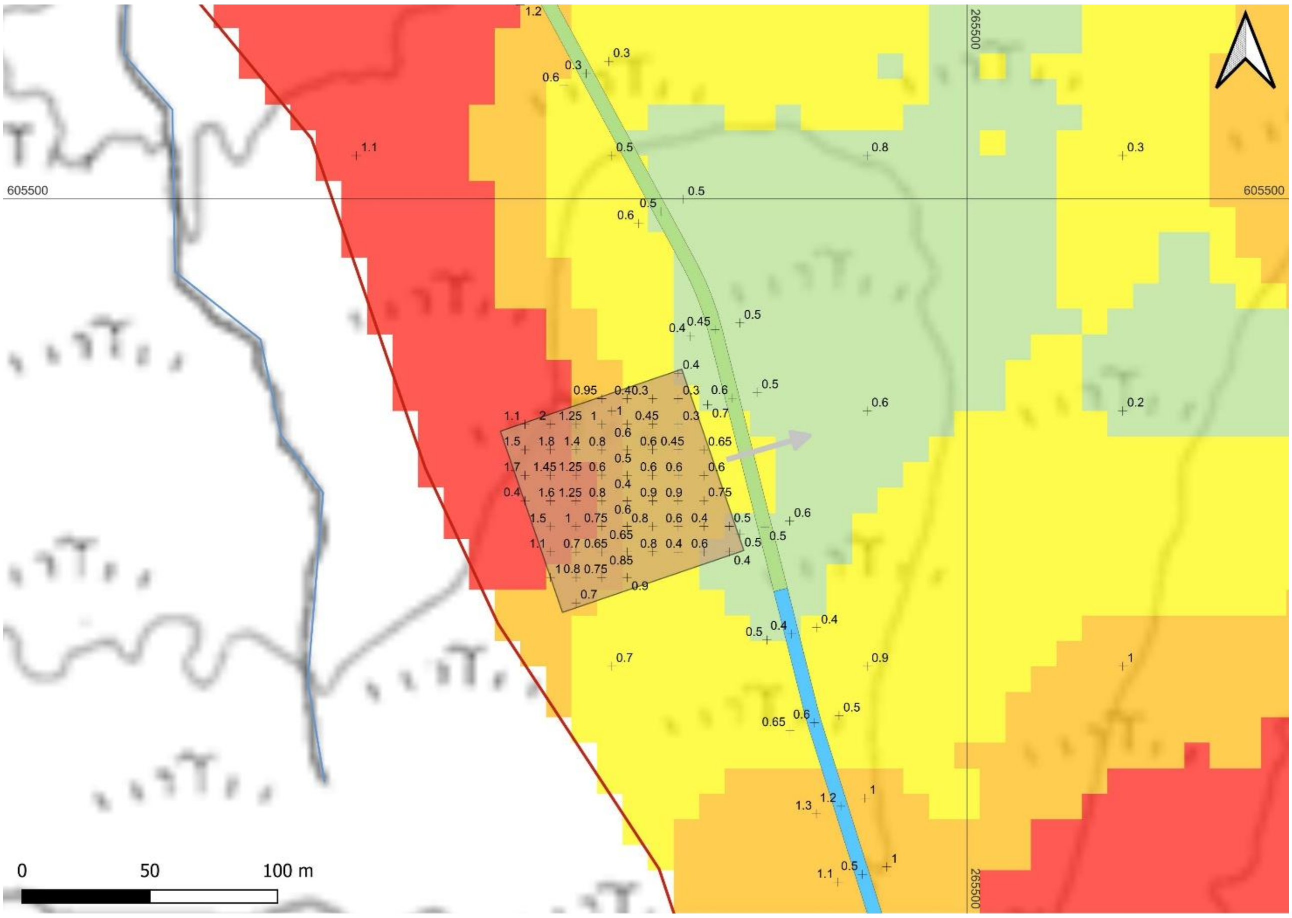
Satellite Construction Compound 1 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding across the compound position so care should be taken when stockpiling peat around the temporary construction compound to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
	1	3	Peat Depth (Mean = 0.80m)	3	3+2 * (3) = 15

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Satellite Construction Compound 2			Slope Angle (3°)	1	(Medium)
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



Satellite Construction Compound 2 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The overall risk ranking is 'Medium' due to the proximity to the watercourse and increased peat depths (up to 1.80 m) to the west. A micrositing of the construction compound to the northeast to the other side of the proposed access track would reduce the overall risk to 'Negligible' by moving it to shallow peat and beyond the watercourse buffer.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Access Constructio	1	1	Peat Depth (Mean = 0m)	1	Negligible (No Peat)
			Slope Angle (4°)	3	
			FoS	1	

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
n Compound			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

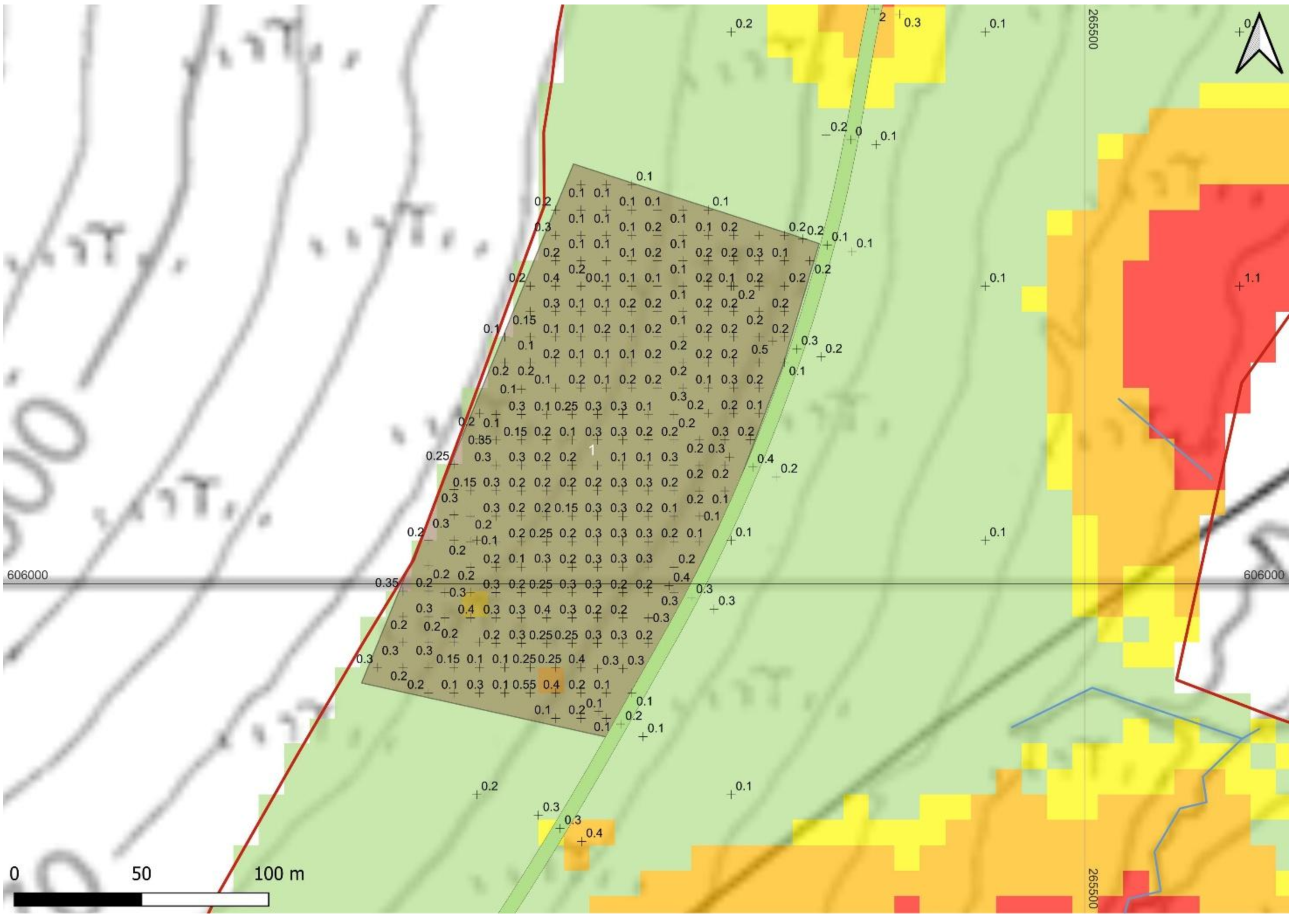
Access Construction Compound – Bing Satellite Imagery 1:1250 Scale

Location Specific Mitigation:

This compound is located on an agricultural field. Satellite imagery shows that it has clearly been used for agricultural purposes and there is no peat in the location. Therefore, the risk of peat slide is negligible.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Borrow Pit 1 (Blackcraig Hill)	1	1	Peat Depth (Mean = 0.20m)	1	No Peat (Negligible)
			Slope Angle (12°)	5	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

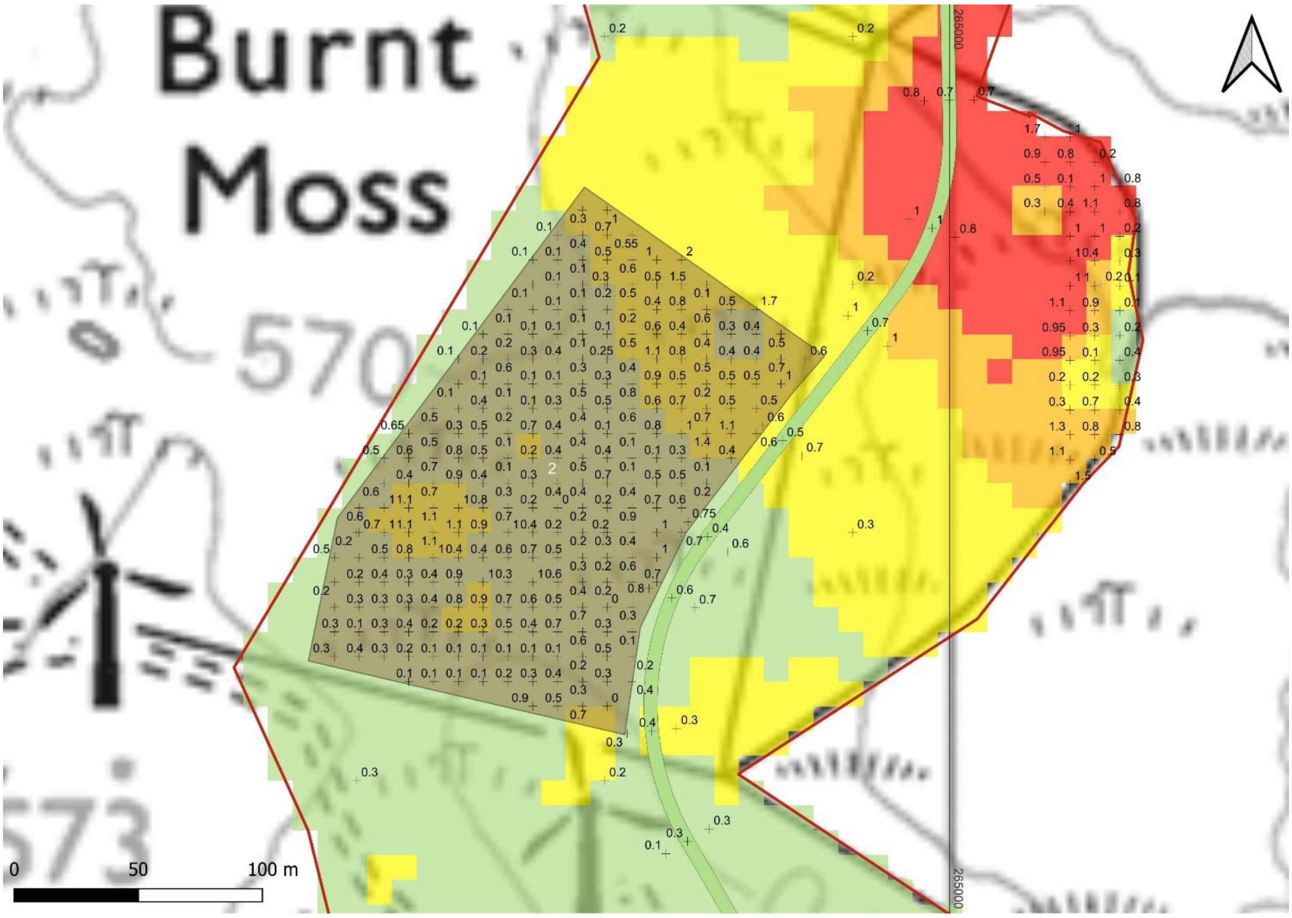


Borrow Pit 1 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The slope angle is conducive for peat sliding so care should be taken when stockpiling where the shallow peat is located to avoid steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Borrow Pit 2 (Burnt Moss)	1	1	Peat Depth (Mean = 0.46m)	1	2 (Negligible)
			Slope Angle (3°)	1	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

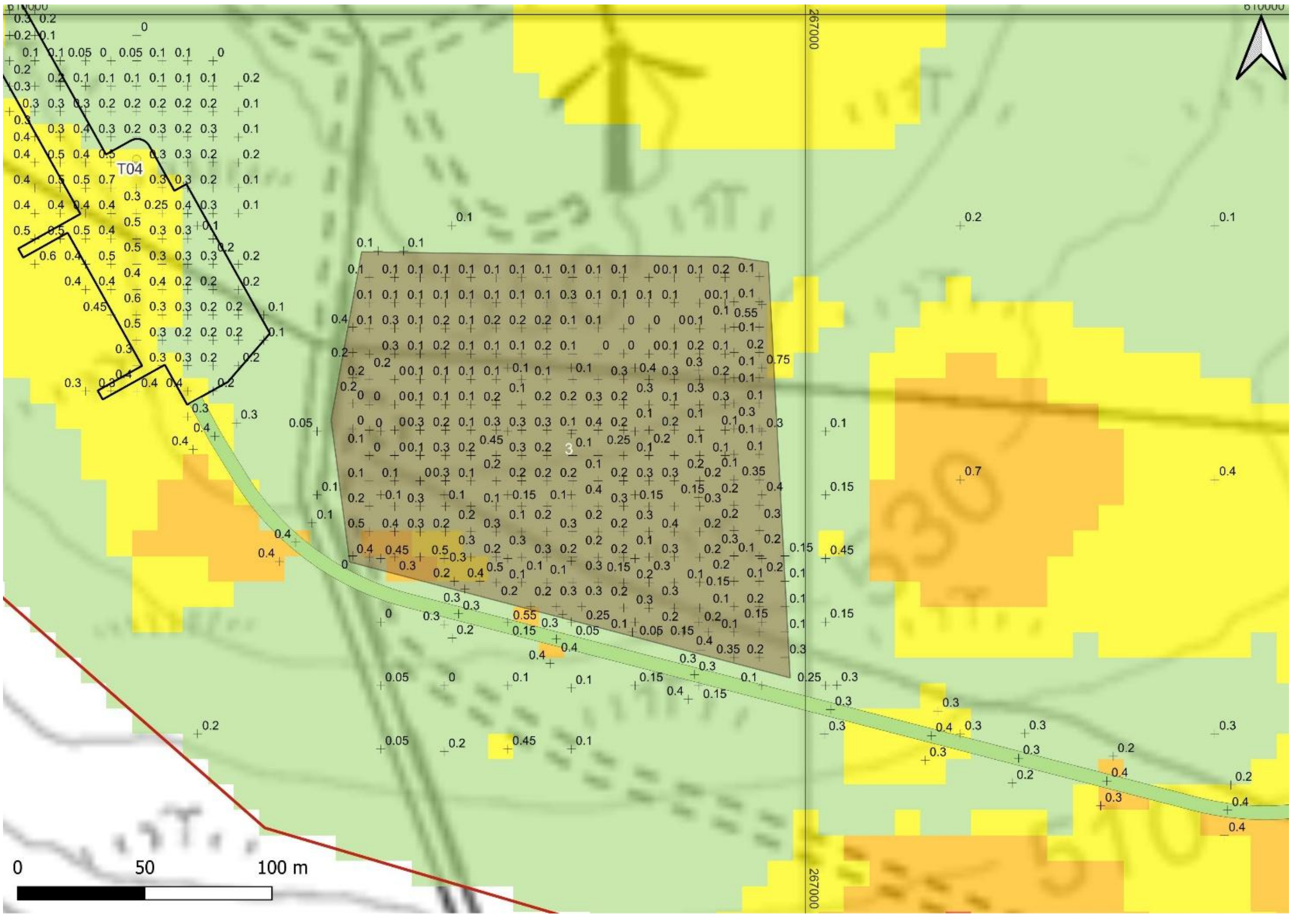


Borrow Pit 2 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Care should be taken when stockpiling during the construction process around this borrow pit location due to the steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Borrow Pit 3 (West of T04)	1	1	Peat Depth (Mean = 0.18m)	1	No Peat (Negligible)
			Slope Angle (3°)	1	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	

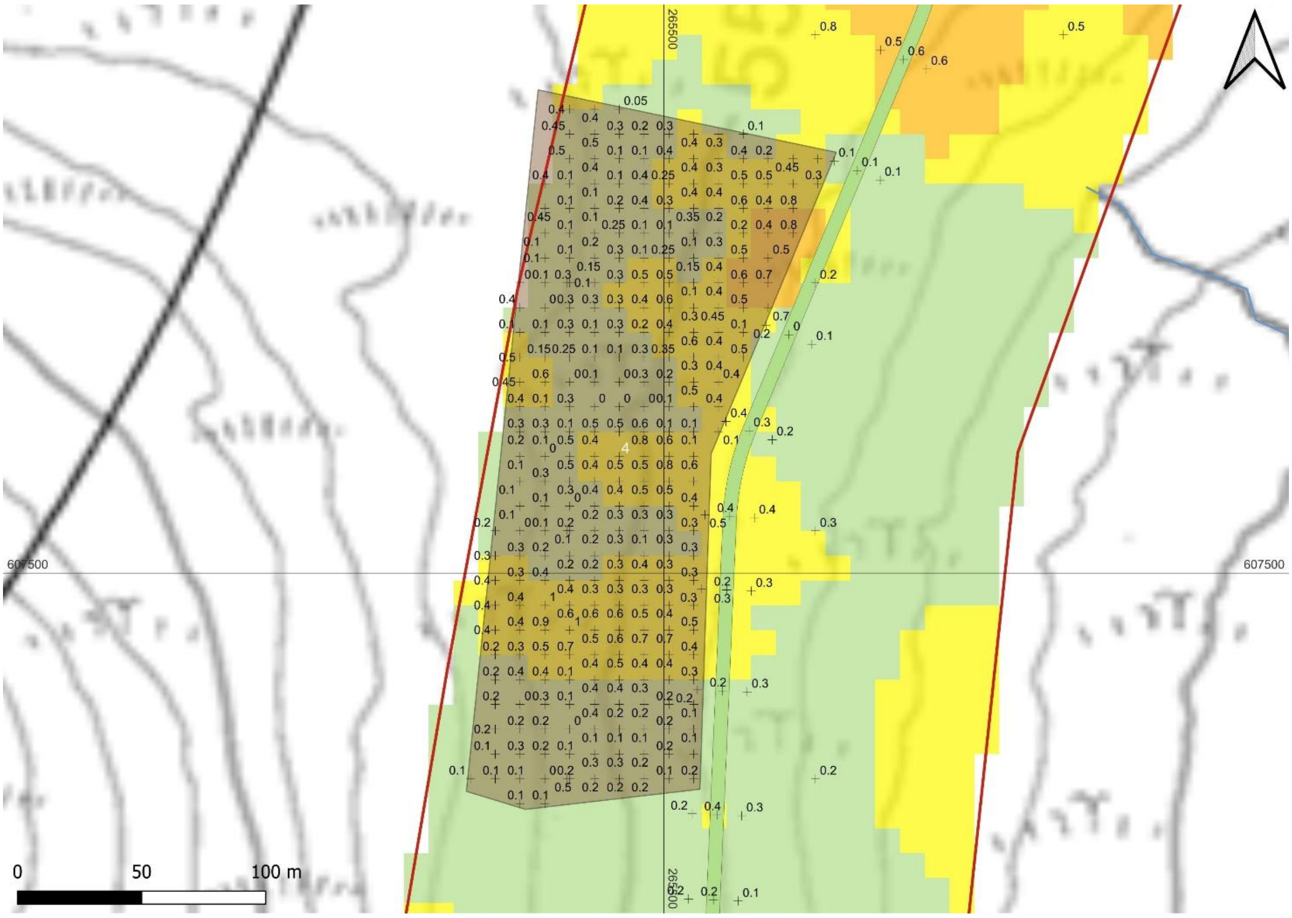


Borrow Pit 3 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

There is a small area of 'Medium' risk in the southwestern corner of the borrow pit due to a small patch of peat and steeper gradient. Care should be taken here in particular when stockpiling during the construction process around this borrow pit location due to the steeper gradients.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Borrow Pit 4 (South of Quintin Knowe)	1	1	Peat Depth (Mean = 0.30m)	1	5+2 = 7 (Low)
			Slope Angle (13°)	5	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



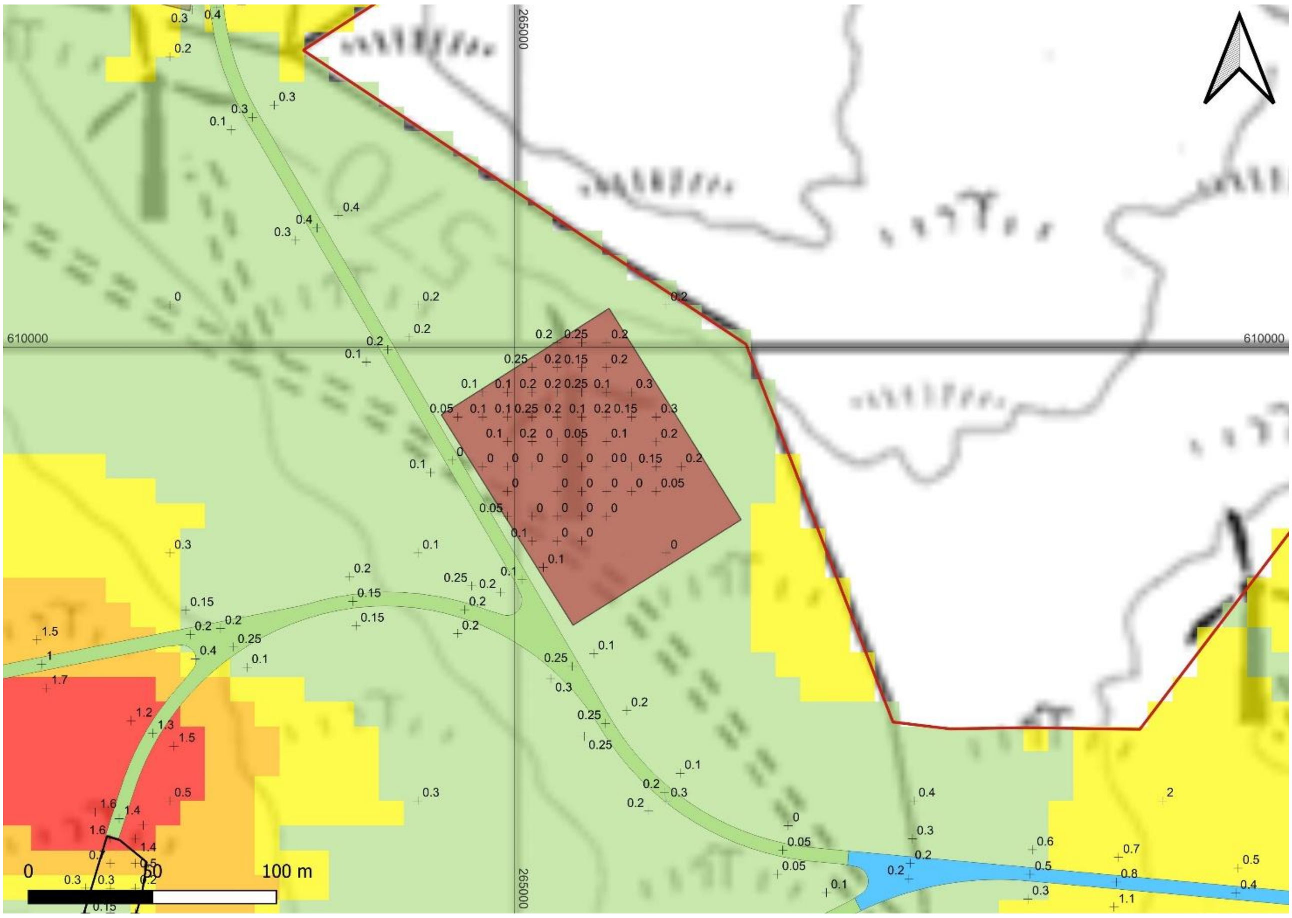
Borrow Pit 4 – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

The northeastern area of the borrow pit is within the 100 – 150 m watercourse buffer so special mitigation measures should be implemented to avoid contamination to the watercourse to the northeast such as limiting stockpiles, drainage ditching and silt fencing.

Care should also be taken when stockpiling during the construction process where there are steeper gradients in particular the central and southern areas of the borrow pit.

Location	Development Infrastructure	Environmental	Contributary Factors (Probability/Exposure)		Risk Ranking
Substation Building	1	1	Peat Depth (Mean = 0.17m)	1	No Peat (Negligible)
			Slope Angle (8°)	3	
			FoS	1	
			Peat cracking / infiltration	1	
			Groundwater Flow	1	
			Hydrology	1	
			Previous Instability	1	
			Land Management	2	



Substation Building – OS Mapping 1:25,000 – 1:1250 Scale

Location Specific Mitigation:

Care should be taken when stockpiling during the construction process around this substation location due to the steeper gradients.

6.1. Turbine Bases and Ancillary Infrastructure

Table 6.2 below summarises the risk assessment outcome and hazard ranking assignments for each turbine and infrastructure location. The principal contributory factors and impact scales used to derive these assignments are also stated.

Table 6.2: Risk Assessment Outcome and Hazard Ranking

Turbine / Infrastructure ID	Risk Ranking Baseline	Principal Contributory Factors in Risk Assessment	Risk Ranking and Targeted Mitigation and Best Practice Construction
T01	Low	Peat depth, slope angle	Low
T02	Low	Slope angle, proximity to watercourse	Low
T03	Low	Peat depth, slope angle	Low
T04	Negligible (No Peat)	Slope angle, proximity to watercourse	Negligible (No Peat)
T05	High	Peat depth, slope angle, proximity to watercourse	Low

Turbine / Infrastructure ID	Risk Ranking Baseline	Principal Contributary Factors in Risk Assessment	Risk Ranking and Targeted Mitigation and Best Practice Construction
T06	Low	Slope angle, proximity to watercourse	Low
T07	Negligible (No Peat)	Slope angle	Negligible (No Peat)
T08	Medium	Proximity to watercourse, slope angle	Low
T09	Low	Peat depth, slope angle	Low
T10	Low	Slope angle	Negligible
T11	High	Peat depth, slope angle, proximity to watercourse	Low
T12	Negligible (No Peat)	Slope angle, proximity to watercourse	Negligible (No Peat)
T13	Negligible (No Peat)	Slope angle, proximity to watercourse	Negligible (No Peat)
T14	Low	Slope angle, proximity to watercourse	Low
T15	Low	Slope angle, proximity to watercourse	Low
T16	Low	Slope angle, proximity to watercourse	Low
T17	Low	Peat depth, slope angle	Low
T18	Low	Slope angle, proximity to watercourse	Low
T19	Negligible	-	Negligible
T20	Negligible (No Peat)	Proximity to watercourse, slope angle	Negligible (No Peat)
T21	Low	Slope angle, peat depth	Low
T22	Low	Slope angle, proximity to watercourse	Low
T23	Negligible (No Peat)	Slope angle	Negligible (No Peat)
Blade Laydown Area	Negligible (No Peat)	Proximity to watercourse	Negligible (No Peat)
Main Construction Compound	Negligible (No Peat)	Slope angle, proximity to watercourse	Negligible (No Peat)
Satellite Construction Compound 1	Low	Slope angle	Negligible

Turbine / Infrastructure ID	Risk Ranking Baseline	Principal Contributary Factors in Risk Assessment	Risk Ranking and Targeted Mitigation and Best Practice Construction
Satellite Construction Compound 2	Medium	Peat depth, proximity to watercourse	Negligible
Borrow Pit 1	Negligible (No Peat)	Slope angle	Negligible
Borrow Pit 2	Negligible	-	Negligible
Borrow Pit 3	Negligible (No Peat)	-	Negligible
Borrow Pit 4	Low	Slope angle, proximity to watercourse	Low
Substation Building	Negligible (No Peat)	Slope angle	Negligible (No Peat)

Source: Natural Power

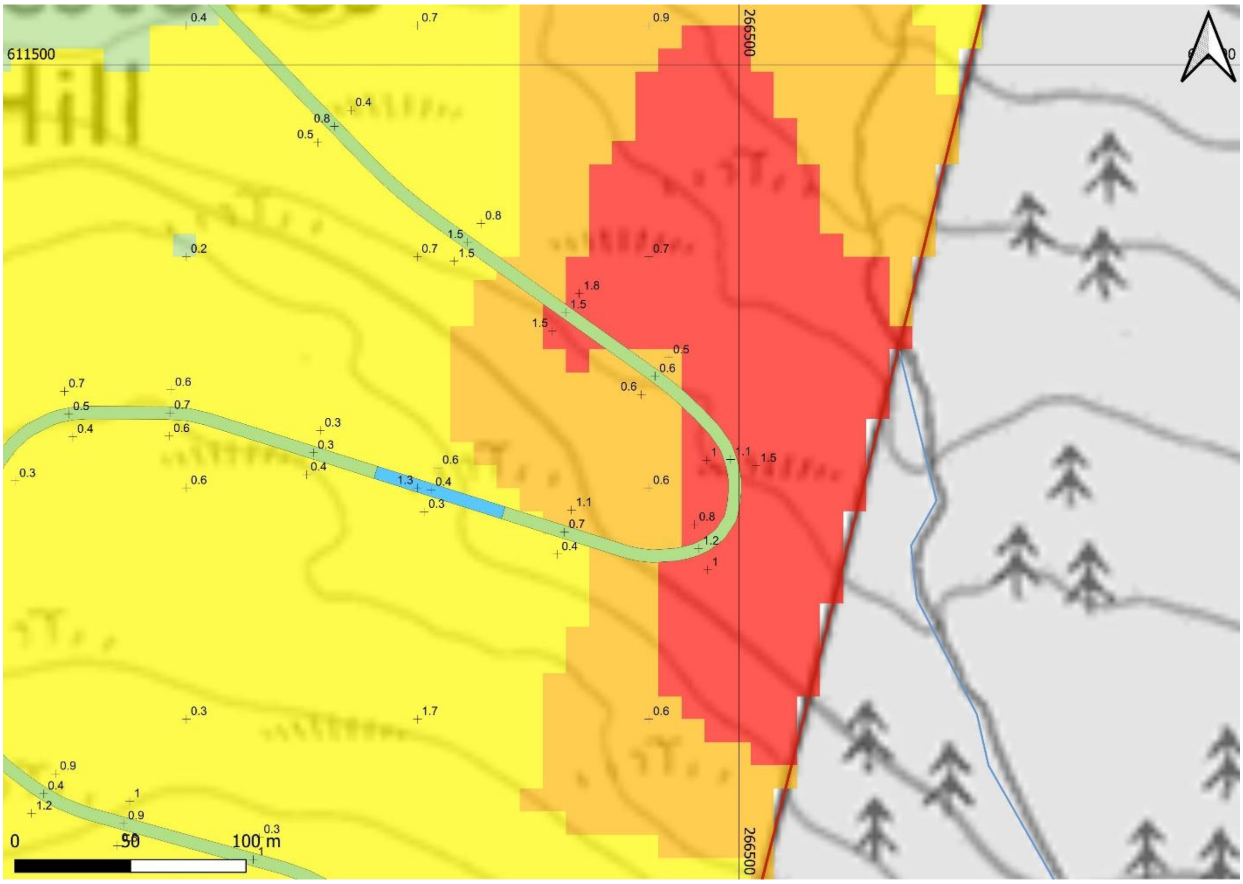
The risk assessment reflects the probability of peat material entering the surface water course and being entrained to an offsite receptor without any mitigation. The wider geomorphological assessment and evidence from recorded peat depths would indicate that a large-scale translational mass movement of peat deposits is very unlikely.

6.2. Access Tracks

In addition to the turbine bases the sections of track have also been reviewed across the Site. The areas of track with the deepest peat are between junction to T08 to east of T07, between T18 and T20 and north of T09 hardstanding towards T22.

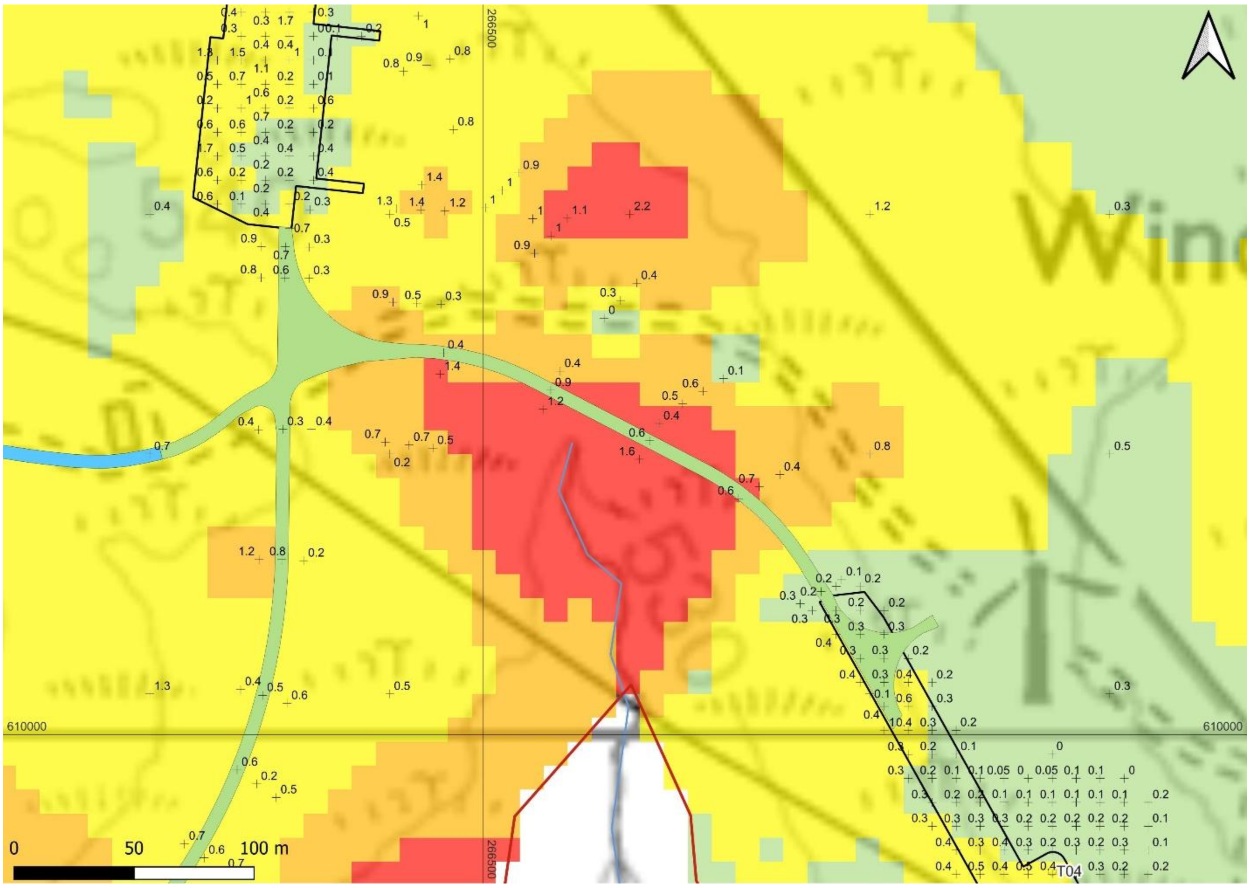
Table 6.3 below highlights discrete track sections which indicate elevate risk of peat instability and therefore will require targeted mitigation to ensure peat slides can be prevented and risk reduced to the low category. The table uses the track sections previously outlined in Section 3.2. Sections of access track have also been reviewed across the site. The highest risk areas are where track alignments cross areas of deeper peat, watercourses and the steep slopes around the watercourse if peat is present.

Table 6.3: Track Sections

Track Element
Track Section 1: Access track from Whitestones Hill to Black Hill

Contributors to elevated peat slide risk: • Proximity to watercourse to east • Slope angles – 7-18° • Peat depth –0.4-1.8 m
Specific Mitigation: The following mitigation is therefore required along this track section in order to reduce the risk from high and medium to low: • No stockpiling or surcharging of the peat along areas of medium to high risk on this section. • Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation. • A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 3: South T03 hardstanding to T04 hardstanding



Contributors to elevated peat slide risk:

- Slope angle – 3-10 °
- Peat depth – 0.4 – 1.6 m

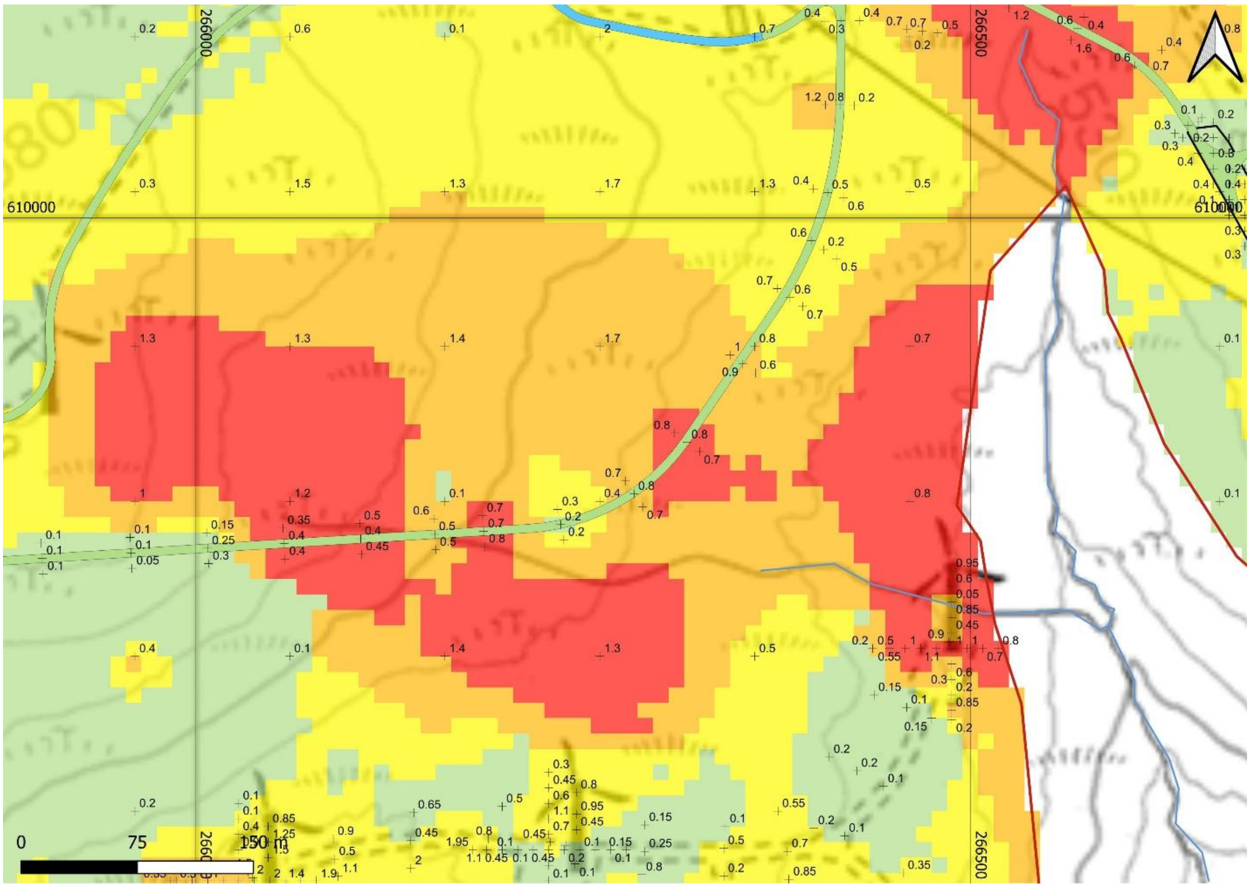
Specific Mitigation:

The following mitigation is therefore required along this track section in order to reduce the risk from medium and high to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 4: Junction to T05 to track southeast of CC1



- Slope angle – 2-13 °

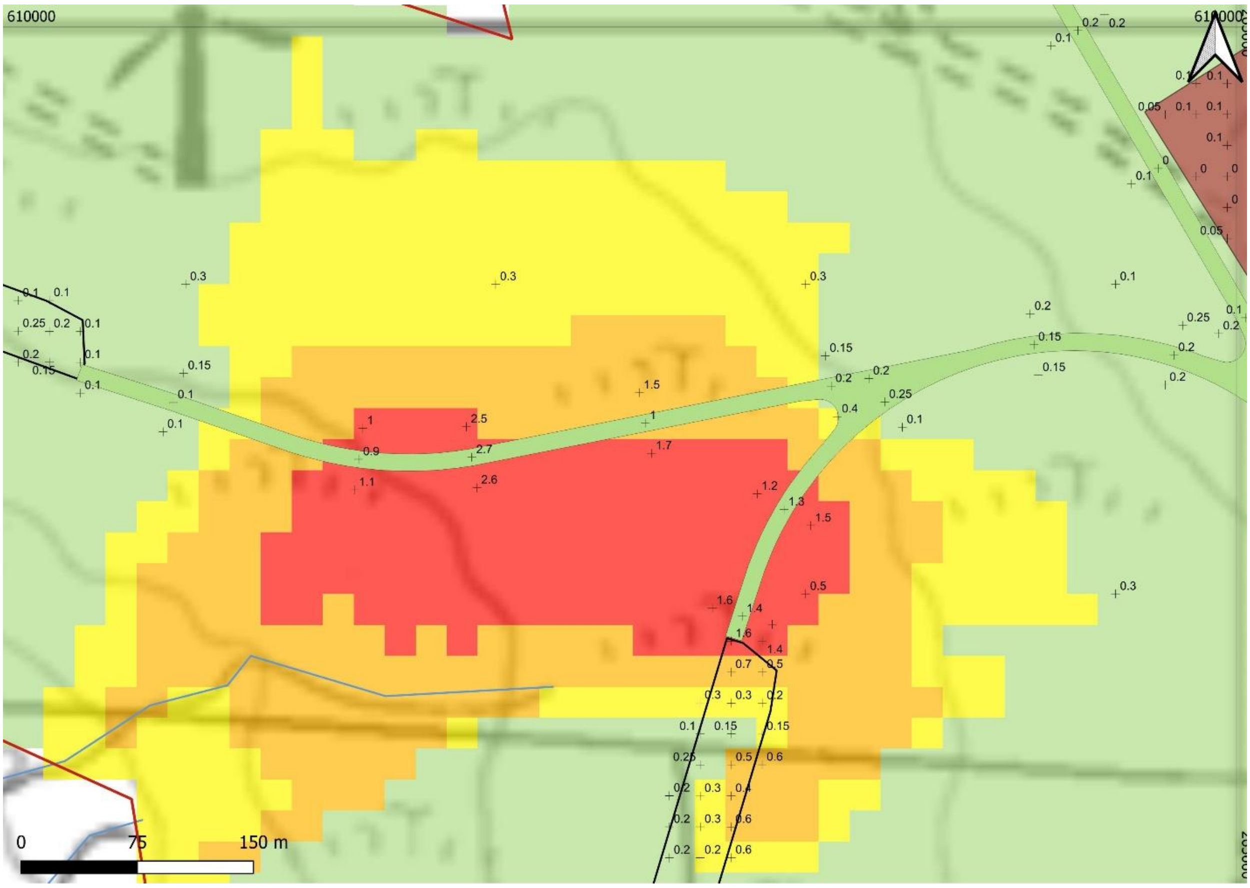
Peat depth – 0.3 – 1.2 m

The following mitigation is therefore required along this track section in order to reduce the risk from medium and high to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 6: Junction to T08 to east of T07 hardstanding



Contributors to elevated peat slide risk:

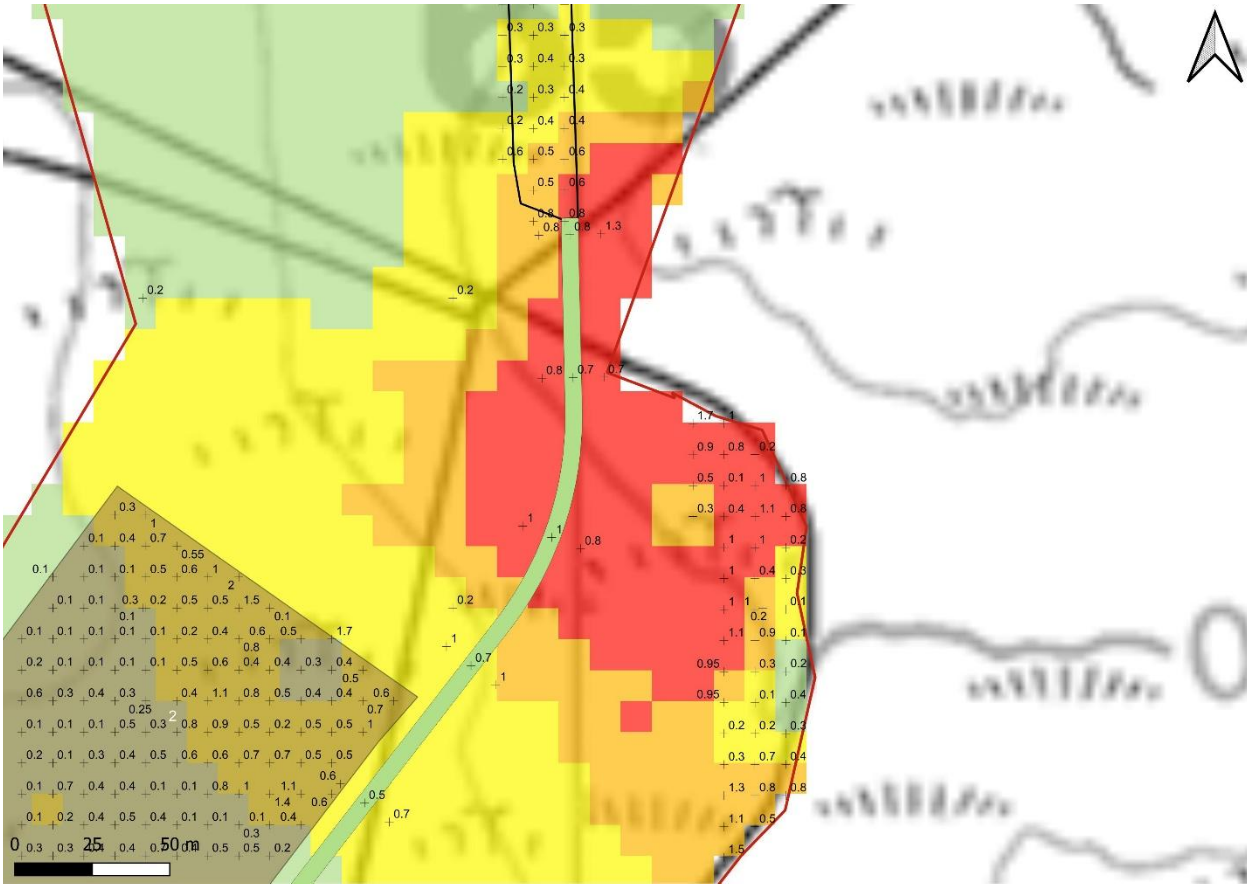
- Proximity to watercourses
- Slope angle – 3-8 °
- Peat depth – 0 – 2.7 m.

Specific Mitigation:

The following mitigation is therefore required along this track section in order to reduce the risk from medium and high to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element
Track Section 7: Northwest of Substation to T06 hardstanding



Contributors to elevated peat slide risk:

- Proximity to watercourse to east
- Slope angle – 6 - 14°
- Peat depth – 0.7 – 1.3m

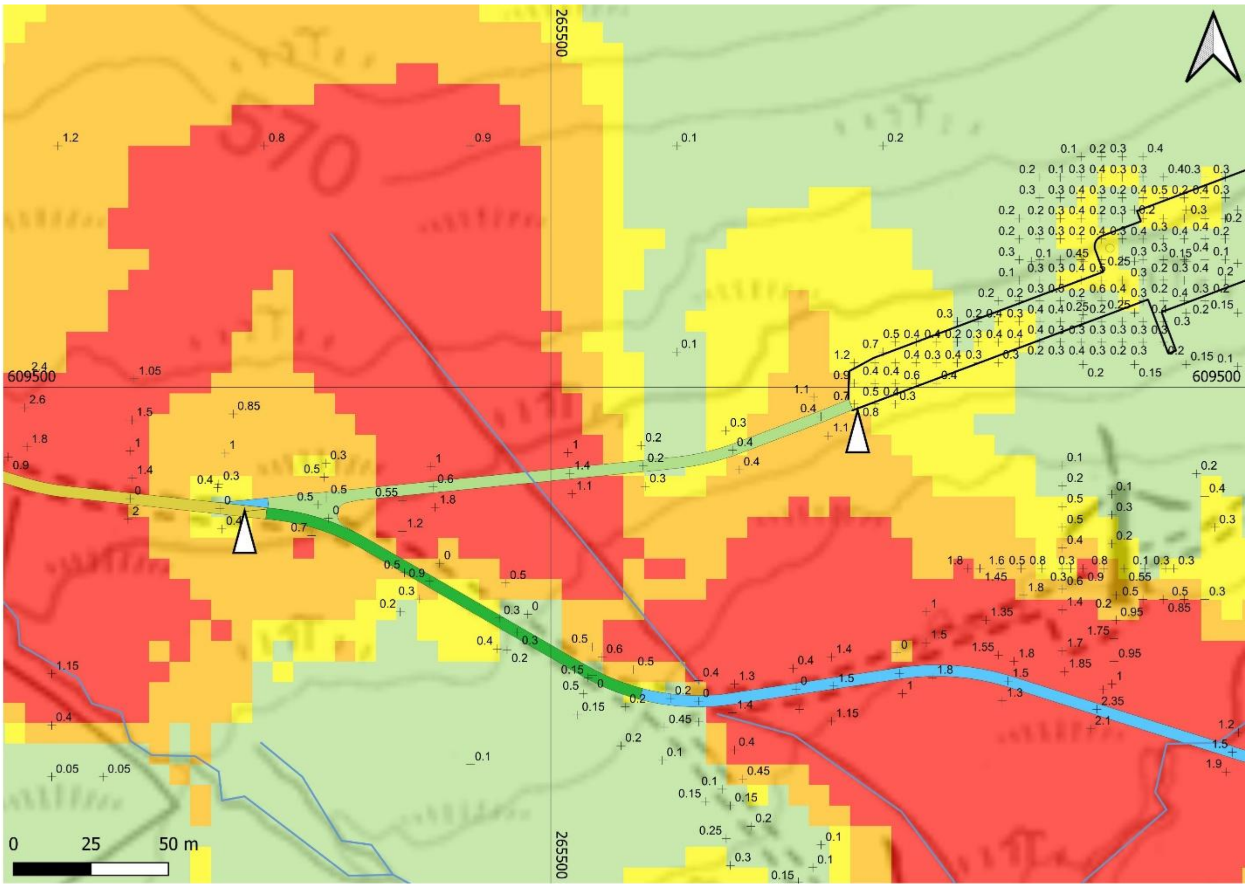
Specific Mitigation:

The following mitigation is therefore required along the track section showing medium to high risk in order to reduce this to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 8: West of T16 to existing track junction



Contributors to elevated peat slide risk:

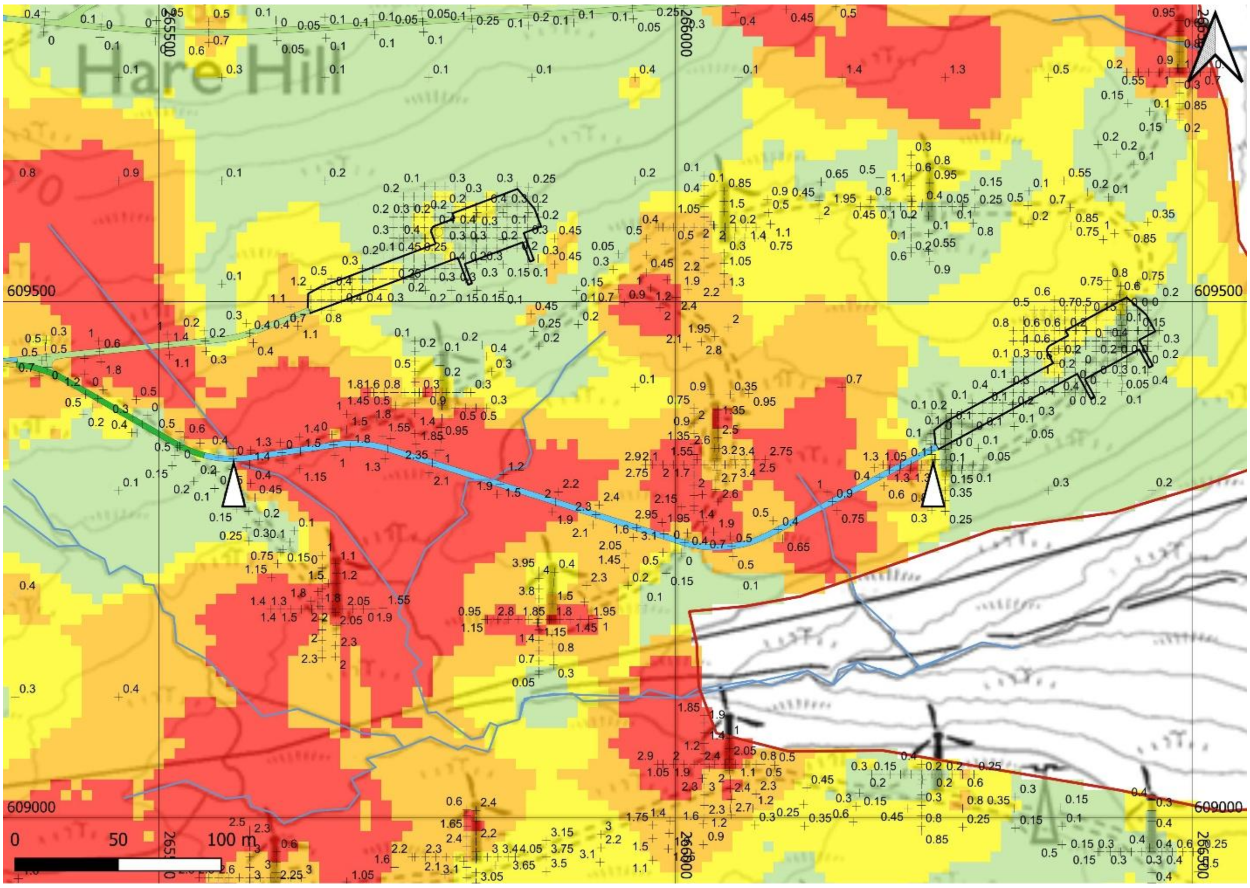
- Proximity to watercourse / watercrossing
- Slope angle – 2-10°
- Peat depth – 0 – 2.4 m

Specific Mitigation:

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained;
- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element
Track Section 9: West T17 to existing track junction



Contributors to elevated peat slide risk:

- Proximity to watercourse / watercrossings
- Slope angle – 8-27°
- Peat depth – 0 – 3.1m

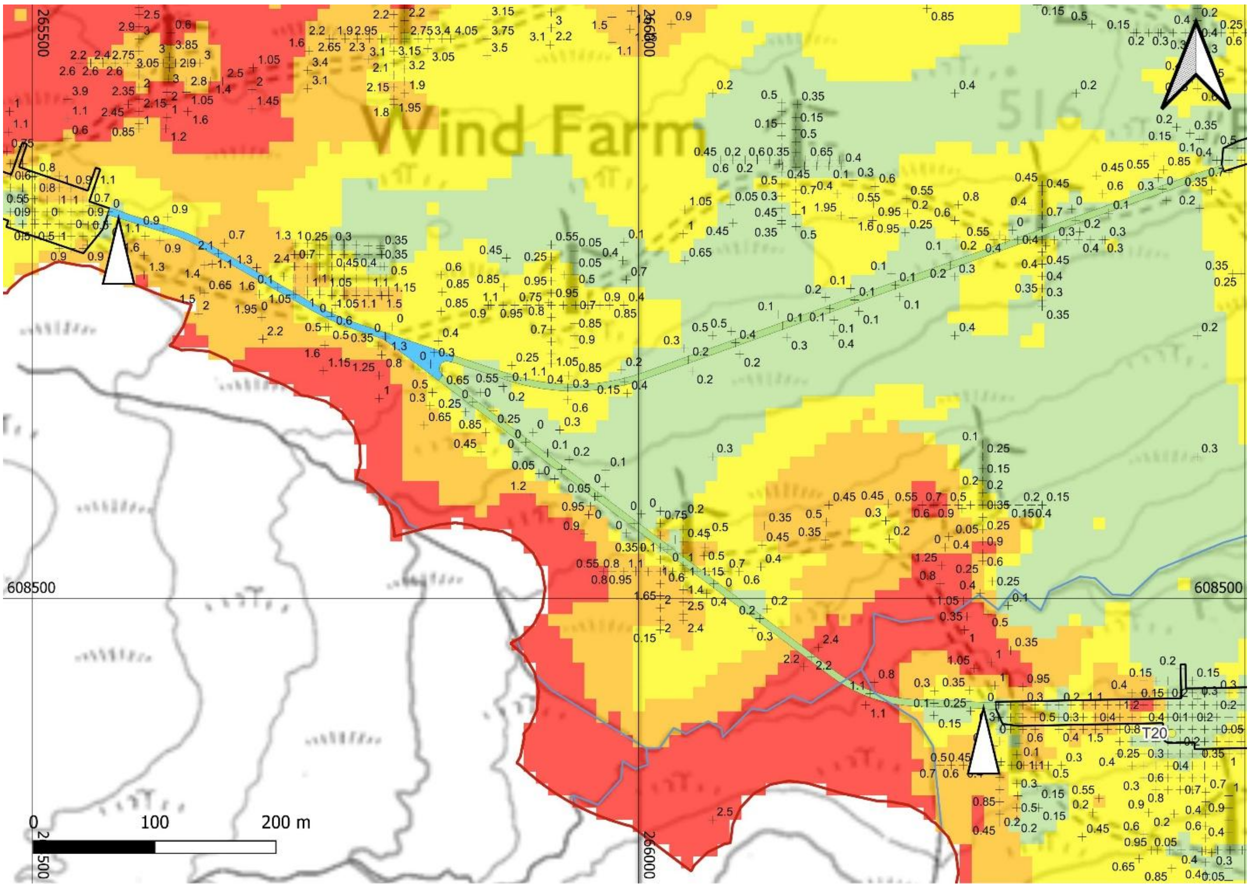
Specific Mitigation:

The following mitigation is therefore required along the track section showing medium to high risk in order to reduce this to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained;
- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 10: East of T18 to west T20 hardstanding



Contributors to elevated peat slide risk:

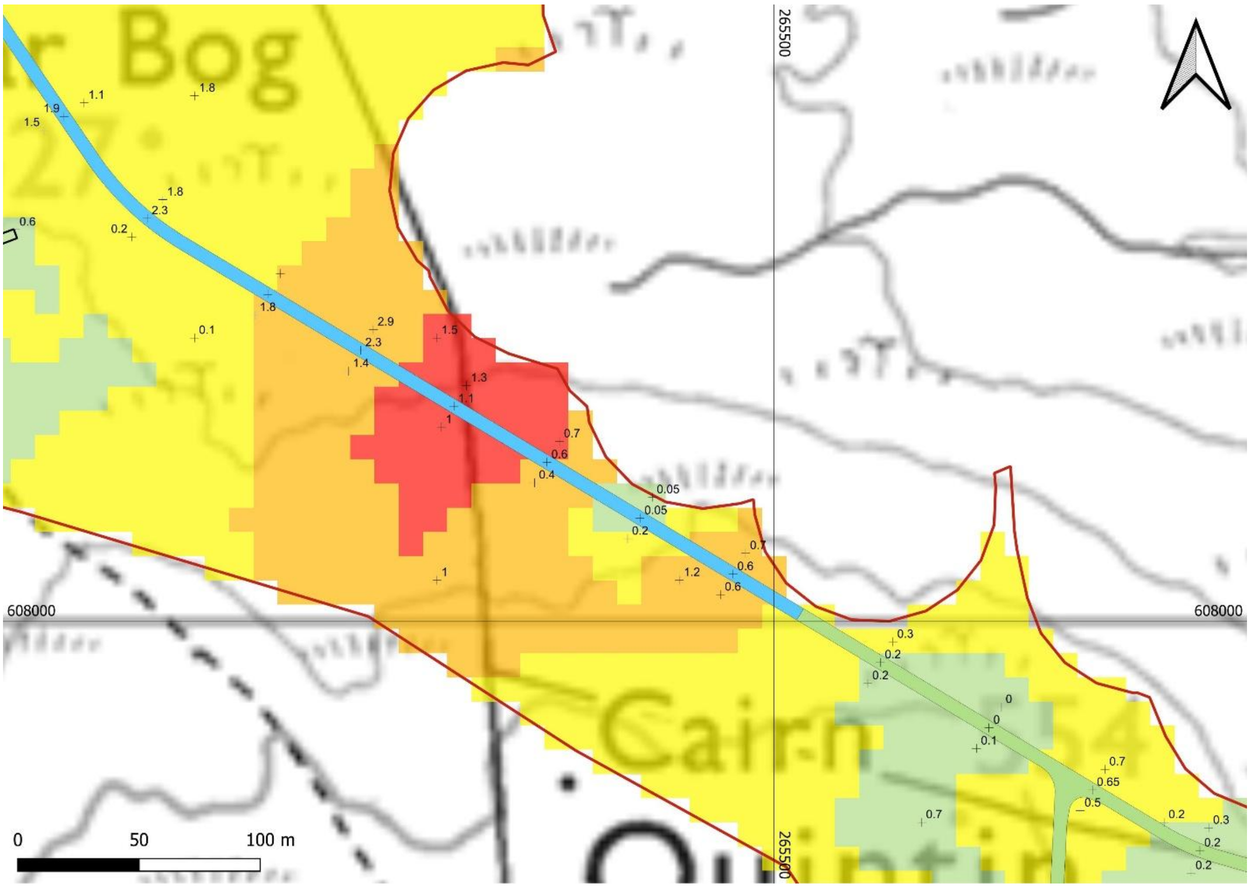
- Proximity to watercourse / watercrossing
- Slope angle –1-10 °
- Peat depth – 0-2.40 m

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained;
- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 11: North of T09 hardstanding to Quintin Knowe/T22 junction



Contributors to elevated peat slide risk:

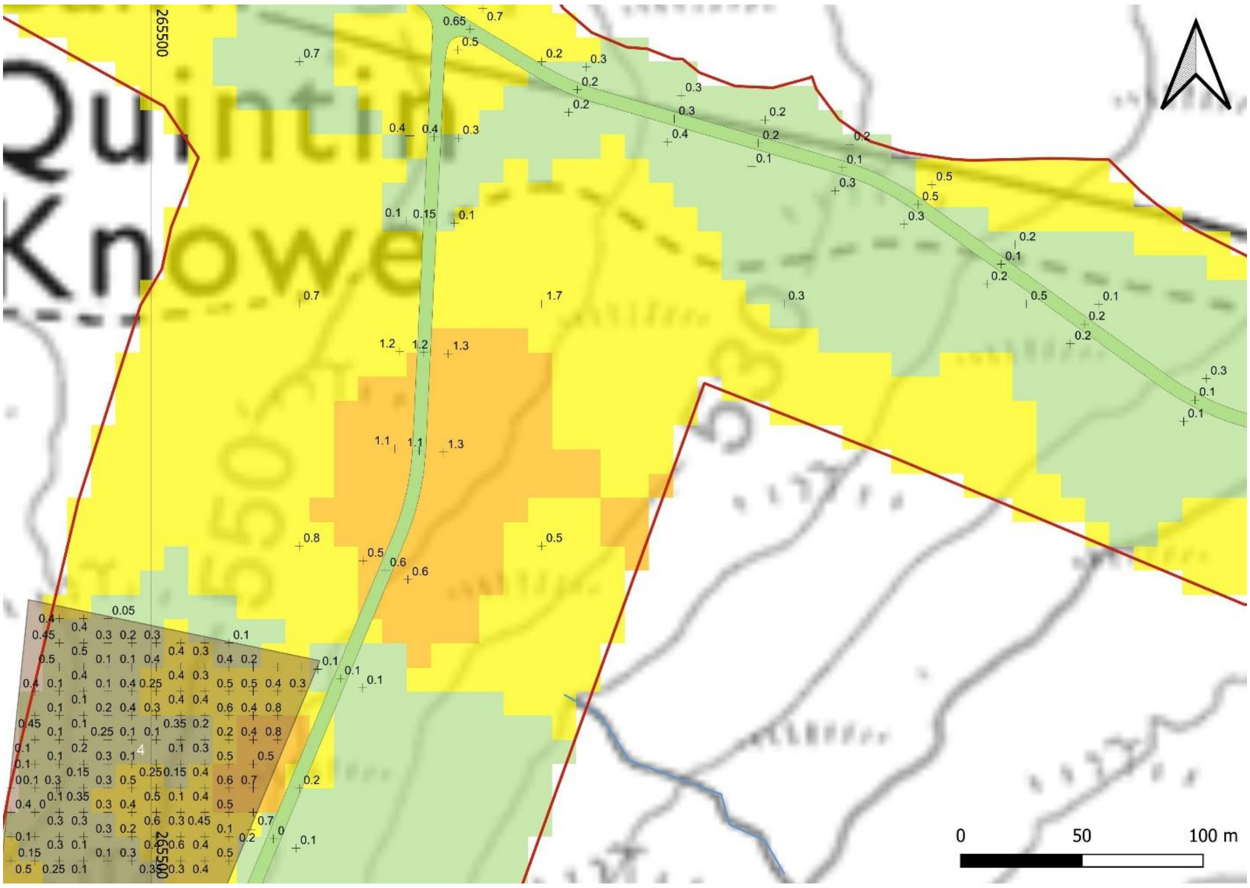
- Proximity to watercourse to northeast
- Slope angle – 0-8°
- Peat depth – 0-2.90 m

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 12: Quintin Knowe/T22 junction to BP4



Contributors to elevated peat slide risk:

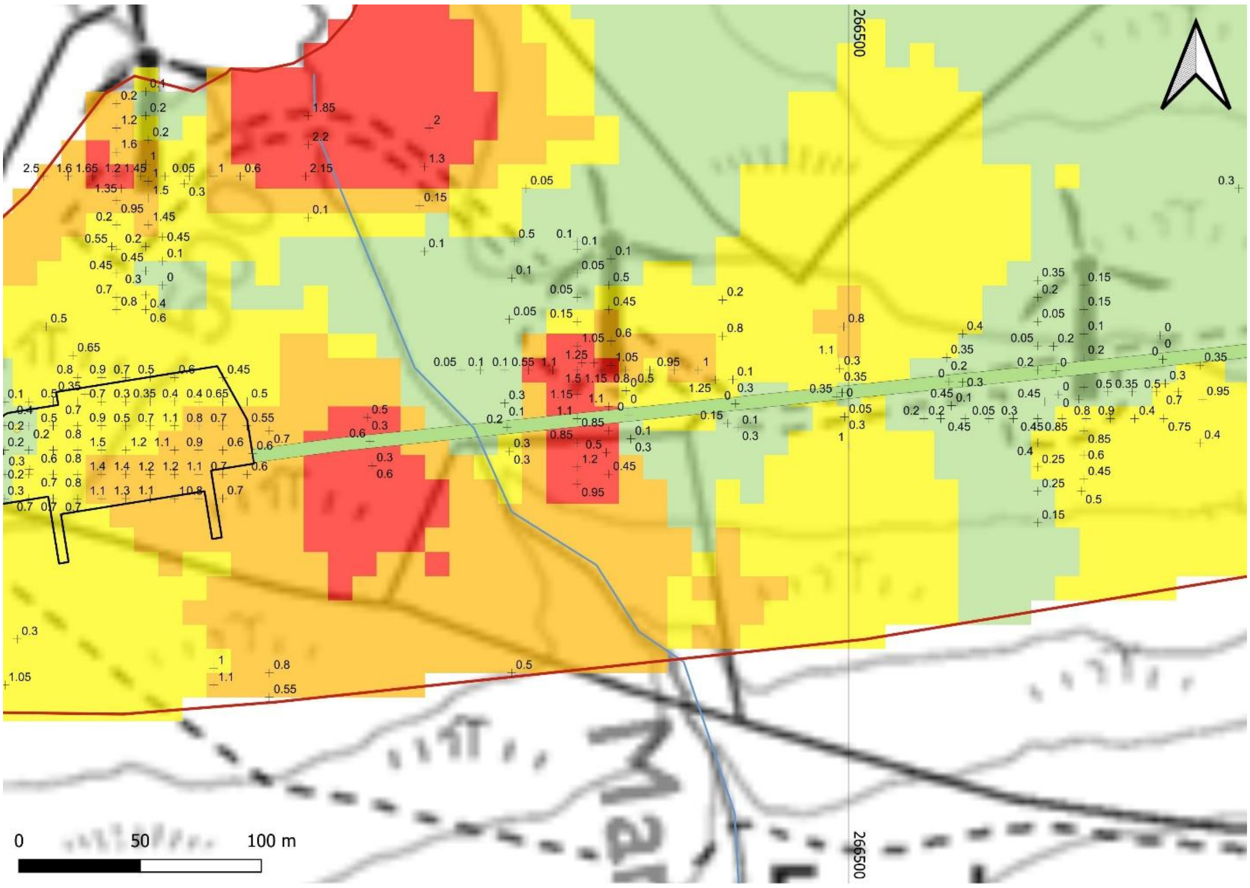
- Proximity to watercourse to east
- Slope angle –5-7 °
- Peat depth – 0.5-1.3 m

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element

Track Section 13: East of T22 to east of watercourse

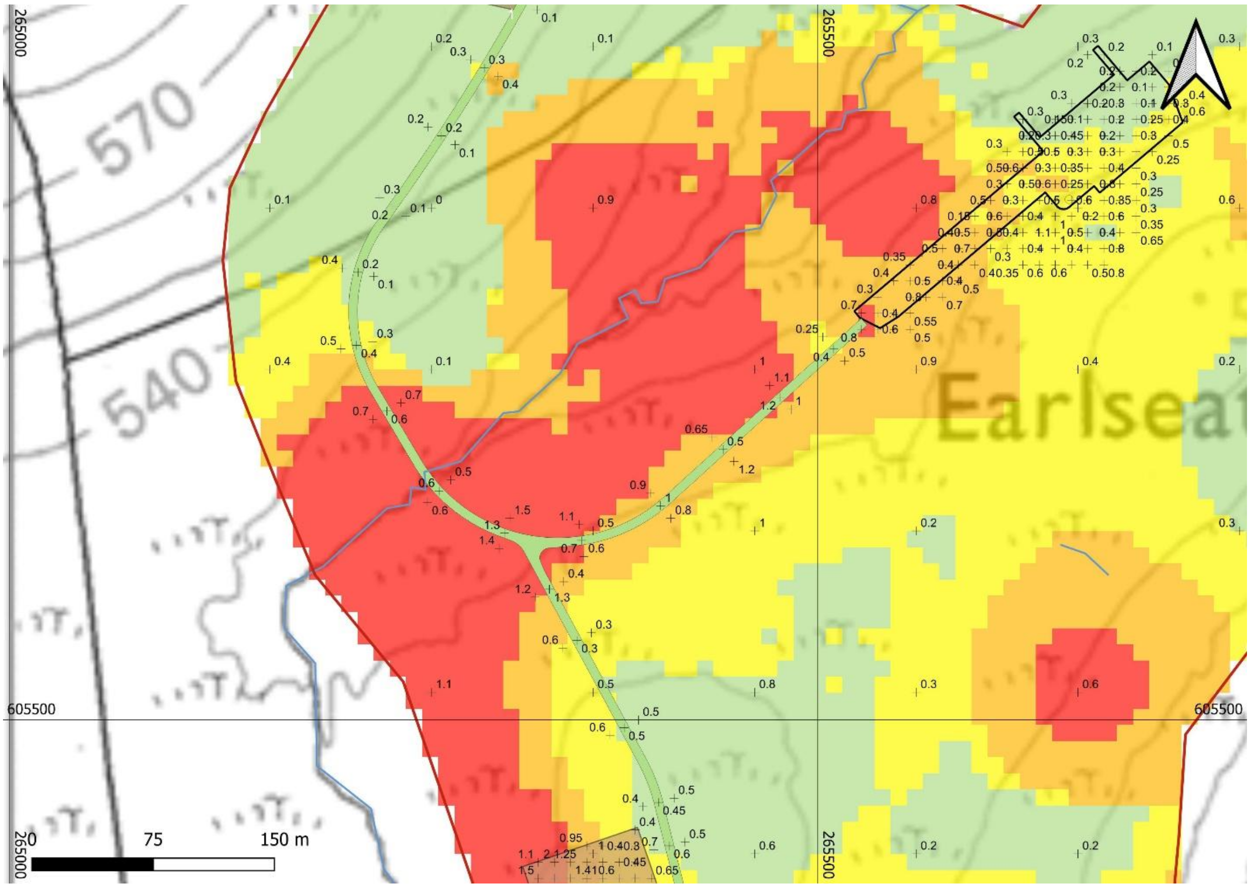


Contributors to elevated peat slide risk:

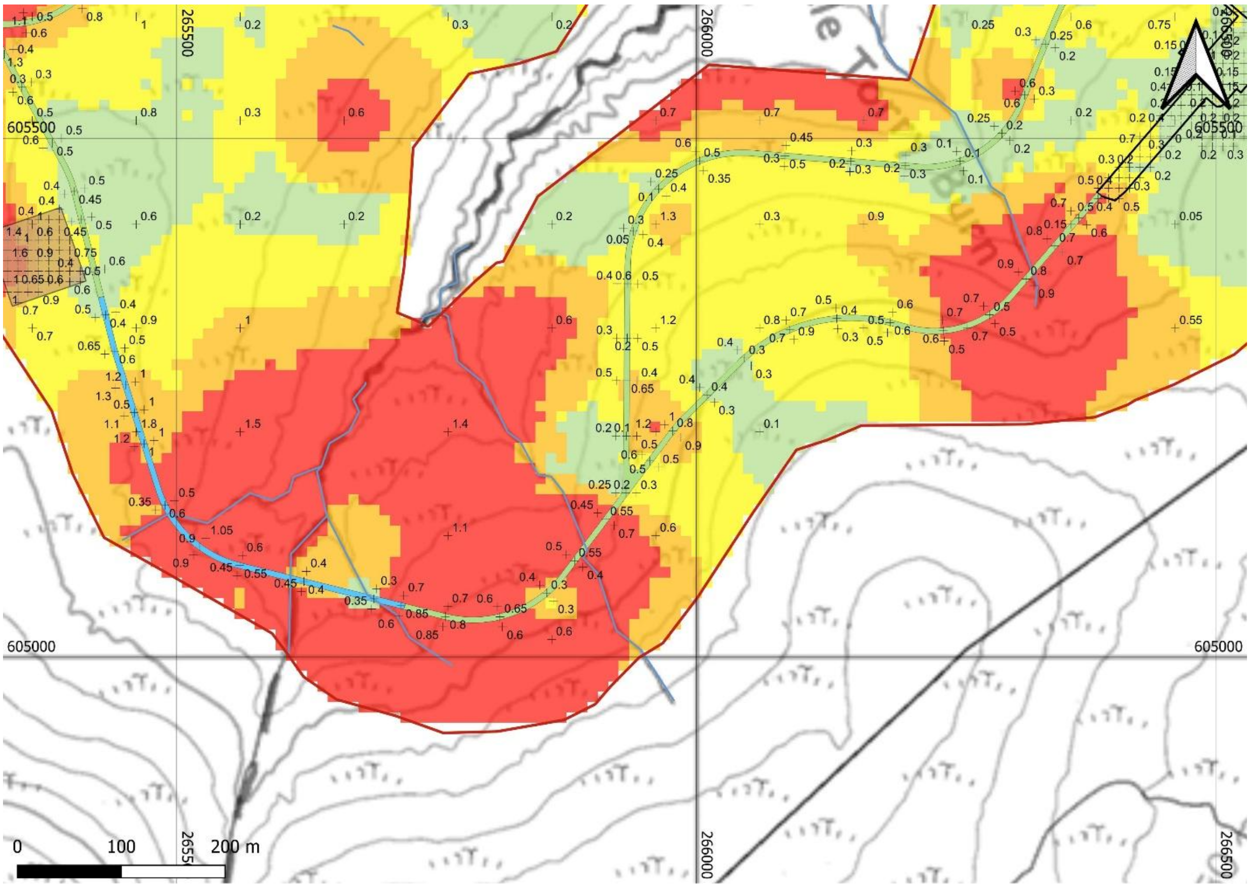
- Proximity to watercourse / watercrossing
- Slope angle – 1-9°
- Peat depth – 0.1-1.2 m

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained;
- No stockpiling or surcharging of the peat along areas of medium to high risk on this section.
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

Track Element
Track Section 14: Southwest of T11 to south of Satellite CC2

Contributors to elevated peat slide risk: • Proximity to watercourse / watercrossing • Slope angle – 5-13° • Peat depth – 0.3-1.5 m
The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low: • Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained; • No stockpiling or surcharging of the peat along areas of medium to high risk on this section • Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation. • A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

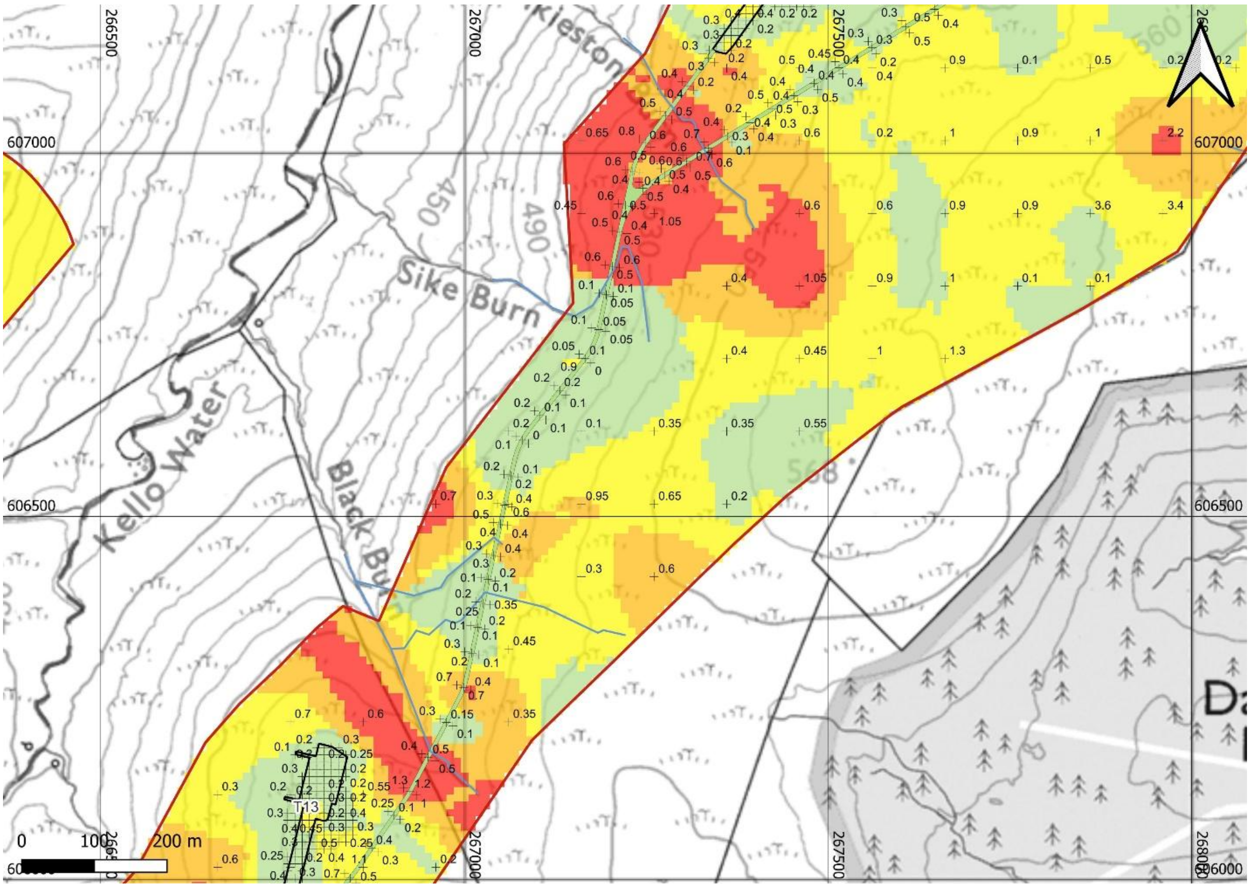
Track Element
Track Section 15: Southwest of Satellite CC2 to southwest T12



Contributors to elevated peat slide risk:

- Proximity to watercourses/ watercrossings
- Slope angle – 5-24°
- Peat depth – 0.3-1.3 m

Track Element
Track Section 16: Black Burn to Pikieston Burn (south of T14)

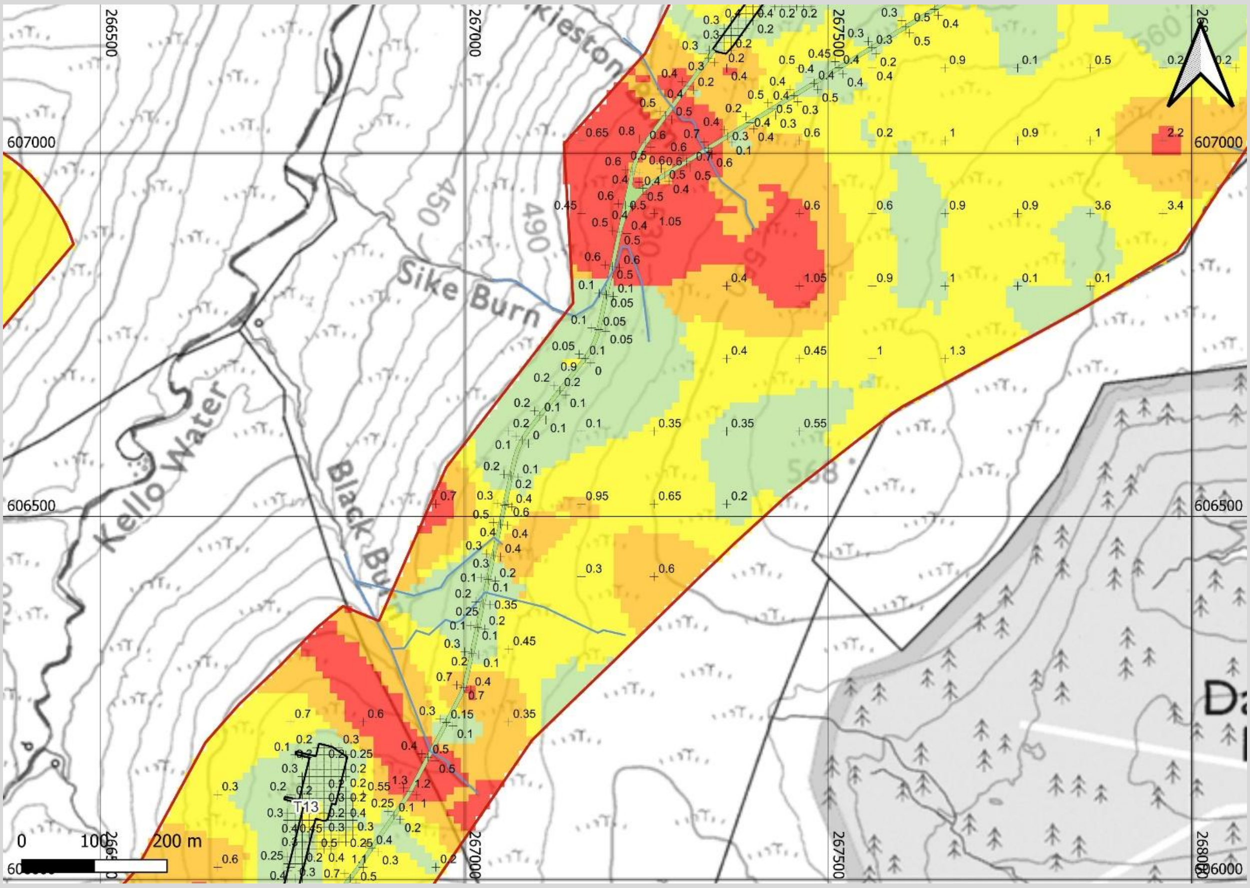


Contributors to elevated peat slide risk:

- Proximity to watercourse to east
- Slope angle – 6-24°
- Peat depth – 0.1-1.3m

Track Element

Track Section 17: South of Satellite CC1 to north BP1



Contributors to elevated peat slide risk:

- Proximity to watercourses / watercrossings
- Slope angle – 7-26°
- Peat depth – 0.2-2 m

The following mitigation is therefore required along the track section showing medium and high risk in order to reduce this to low:

- Cross track drainage which prevents any ponding or build-up of groundwater pressure within the peat upslope or beneath the access infrastructure. Where possible existing drainage systems should be utilised and maintained;
- No stockpiling or surcharging of the peat along areas of medium to high risk on this section
- Where detail design proves floating access, track is safe to use, this should be the preferred method of track construction to reduce the impact on peatland by avoiding excavation.
- A system of ongoing monitoring throughout the construction phase should be in effect to monitor any movement in the peat. A rapid reaction strategy should be development to ensure measures can be deployed to protect the watercourse in the event of any movement. This may include installation of downslope retaining systems to prevent peat material entering the watercourse.

6.3. Peat Slide Pathways

The assessment considers environmental receptors (main watercourses) to be the primary focus of the risk assessment. Minor or ephemeral watercourses have been assessed to have the potential to transport material to offsite receptors. Where relevant onsite proposed infrastructure has been assessed.

Notwithstanding the point above, this report examines the terrain and the potential evolution of any triggered peat slide event. The determination has been that entrained peat flows would primarily be channelled along the main watercourse's downslope of proposed infrastructure, these locations are highlighted by the black arrows on the Peat Slide Pathways Map in Figure 6.1. The pathways shown indicate the directions where peat flows would travel into main watercourses or waterbodies, they do not indicate risk of instability. The main offsite receptors are the River Nith to the north, the Kello Water to the northeast and the Afton Water to the west from which the main waterbodies within the proposed Development drain into.

Source: Natural Power

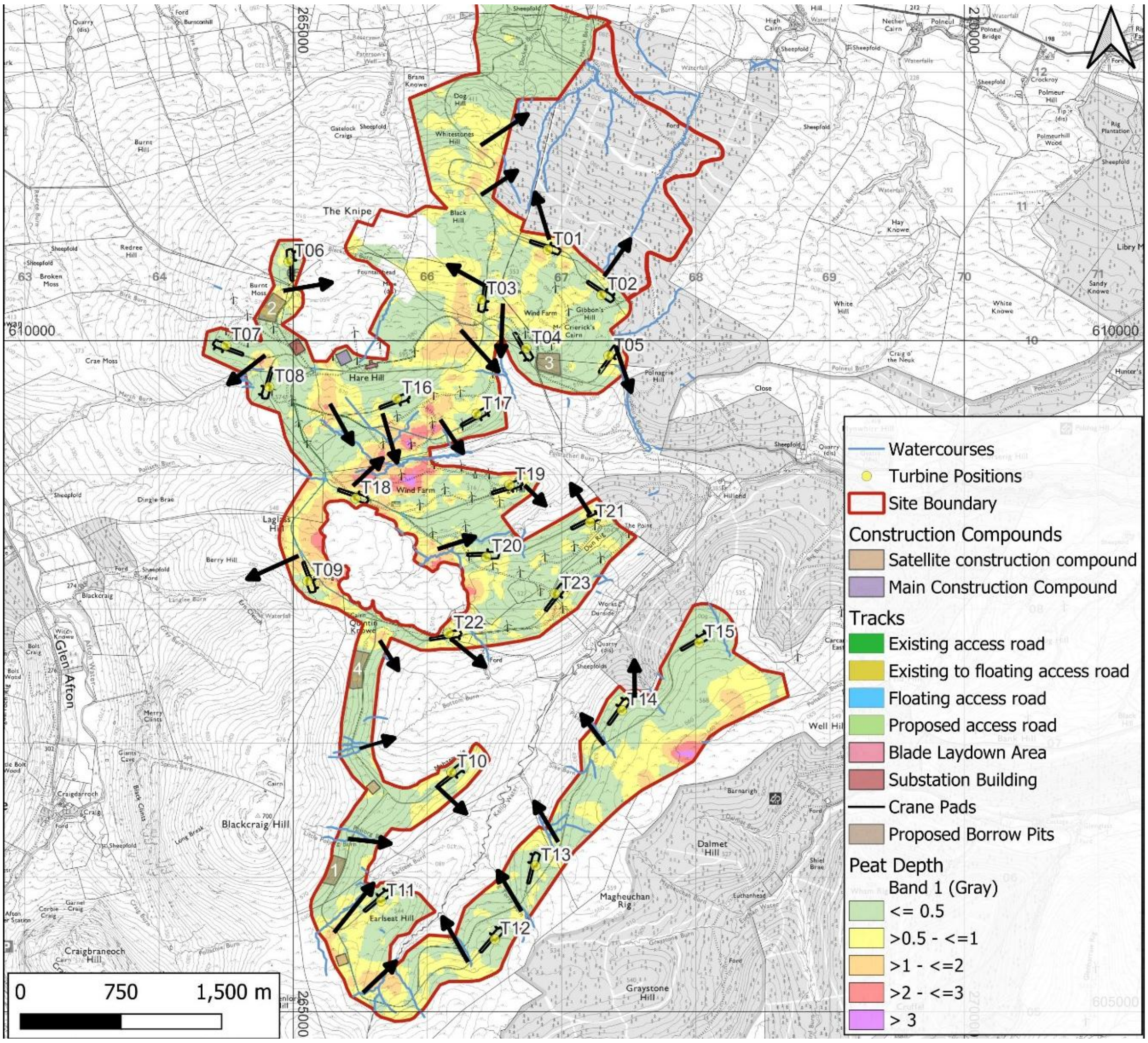


Figure 6.1: Peat Slide Pathways (black arrows show flow direction) and indicative peat depth

The risk of run out and significant damage to the wider hydrological environmental is deemed low, providing the relevant control measures outlined in his report are implemented at the site.

6.4. Preliminary Geotechnical Risk Register

The preliminary risk register for development wide hazards is listed in Table 6.3 below. Key control measures for the hazards have also been identified. A geotechnical risk register should be utilised on an individual turbine basis throughout the construction phase and amended accordingly as new information is received.

Table 6.3: Preliminary Geotechnical Risk Register

Hazard	Cause	Location	Consequence
Peat Landslide / Bog Burst / Peat Flow	High rainfall, and increased surface water infiltration leading to build up of pore water pressure	**T01, T03, T05, T09, T11, T17, T21, CC5, track sections 1, 3 and 6-17.**	Instability of peat deposits and underlying superficial deposits around earthworks. Contamination of natural watercourses and damage to hydrological systems. Harm to personnel and damage to plant / equipment. Destruction of built infrastructure.
Mitigation	Due consideration given to prevailing ground and weather condition when scheduling construction works. I.e. avoid opening new excavation during heavy precipitation and ensure sufficient drainage measures are in place to support construction activities. Ensure a contingency is in place to concentrate on more suitable construction activities during wet weather. The drainage design should be such that its construction is in sequence with providing necessary drainage to new areas of excavation and construction in advance of works. I.e. ensure cut-off ditches are in place prior to opening new excavation. The drainage design should as far as practicable preserve the natural hydrological regime and should not inundate areas with run-off which were previously not subjected to such effects. Monitoring weather forecast with site specific weather station. Monitoring (visual) regular site inspection to detect early indications of ground movement (tension cracks, groundwater issues).		
Peat Landslide / Bog Burst / Peat Flow	Concentrated loads placed at the top of slope system or on marginally stable peat deposits	**T01, T03, T05, T09, T11, T17, T21, CC5, track sections 1, 3 and 6-17.**	Contamination of natural watercourses and damage to hydrological systems. Rapid ground movement and mobilisation of material down slope of construction operations; Harm to personnel, plant and equipment. Destruction of temporary or permanent construction works.
Mitigation	At these locations, robust and strict controls on the phasing and pace of construction must be in place. This would be most effectively managed through the CMS. Plant operatives should be briefed in detail regarding the side-casting and stockpiling of materials. Higher risk areas particularly at T05 and T11 should be demarked by high visibility ticker tape or similar as a warning not to stockpile any materials in the deeper peat and steeper areas. Ensure the peat depth contour mapping is available and has a high visibility during construction. A programme of frequent inspections should be implemented during excavation and access track construction works. This should be carried out by suitably experienced and qualified personnel. Where stockpiles are placed in suitable areas, these should be closely monitored through the use of high accuracy GPS level and visual survey.		
Peat Landslide / Bog Burst / Peat Flow	Increased subsurface groundwater flow and 'piping' failure beneath natural peat deposits, temporary and permanent earthworks	**T01, T03, T05, T09, T11, T17, T21, CC5, track sections 1, 3 and 6-17.**	Localised instability associated with temporary and permanent earthworks. Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment.
Mitigation	Ensure geotechnical design prevents blockages of groundwater flow. This may be achieved through the use of free draining fills and ensuring temporary and permanent earthworks do not cause the build-up of groundwater pressures. A programme of geotechnical inspections should be implemented throughout construction phase. Ensuring focus extends beyond immediate areas of construction, both up-slope and down-slope to detect any unforeseen effects on stability.		
Bearing Capacity Failure (Peat Surface)	Increased loading of low shear strength deep peat deposits	**T01, T03, T05, T09, T18, T20, T22, CC5,**	Localised instability and settlement associated with temporary and permanent earthworks.

Hazard	Cause	Location	Consequence
		track sections 1, 3 and 6-17.	Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment. Contamination of natural watercourses and damage to hydrological systems from peat material mobilised down slope;
Mitigation	Due consideration given to the prevailing ground and weather conditions when scheduling site works. Ensure detailed peat depth contour plan to be used in construction planning and design. Use of appropriate plant machinery (low ground pressure and long reach to avoid over loading peat deposits). A programme of geotechnical inspections will be implemented during excavation works. Geotechnical monitoring post-construction.		
Peat Failure	Mass movement of temporary storage mounds and bunds	**T01, T03, T05, T09, T11, T17, T21, CC5, track sections 1, 3 and 6-17.**	Localised instability and settlement associated with temporary and permanent earthworks. Triggering of mass movement of peat material down slope causing harm to personnel, plant and equipment.
Mitigation	Storage site selection and stockpile design by a suitably qualified and experienced geotechnical engineer. Routine maintenance and inspection of peat storage mounds.		
Creep, long term settlement of structures	Tracks or hardstand founded on peat and/or poor or variable foundation soils	**T01, T03, T05, T09, T11, T17, T21, CC5, track sections 1, 3 and 6-17.**	Ongoing settlement and damage of infrastructure, e.g. damage to access track running surface.
Mitigation	Contingency of routine maintenance of infrastructure and drainage elements to ensure longer term issues do not cause a build-up of effects leading to higher level consequences e.g. larger scale instability.		

Source: Natural Power

Conclusions

The peat depths across the Site are variable, with the proposed infrastructure layout avoiding the deepest areas of peat. None of the turbines are within significant peat deposits that have the potential for peat sliding.

The following construction related factors to peat slide are highlighted for consideration:

- Movement can occur following over-loading of peat slopes, e.g. by placement of fill, stockpiling and end-tipping directly onto peat slopes;
- Suitability of drainage measures and the prevailing groundwater conditions are also key factors to consider during construction. Increasing pore water pressures within peat deposits decreases the stability of a slope;
- In extreme events, peat can act as a viscous fluid and travel over very shallow slopes. The re-working or excessive handling of peat can reduce the shear strength to residual levels and hence lead to 'liquid' peat behaviour;
- The rate of construction can have a major influence on the stability of peat land environments. Rapid loading and limited time for excess pore pressure dissipation can also decrease the stability state of peat slopes;
- Excavation across a side slope, a convex slope / break in slope can induce peat failure;
- Therefore, the most significant but highly unlikely impact is death or injury to site personnel. More likely is damage of the environment and disruption to the proposed infrastructure leading to time and cost impacts.

It should be noted that where peat probes indicate shallow depths 0 to 0.30 m that the deposits are likely to be composed of a topsoil and mineral subsoil, thus the risk of peat sliding is none.

The mean un-drained shear strength determined across the Development is (23 kPa). This indicates peat of low shear strength. A conservative characteristic value of 10kPa has been used in the slope stability modelling (representing the minimum recorded value).

The risk ranking produced in this report are a combination of the overall likelihood with the potential environmental/impact effect of a peat instability event. With increased proximity to watercourses exposure of such an event is vastly increased as watercourses act as a sensitive off-site receptor and can carry peat debris to further offsite receptors. In addition, where relevant the position of proposed internal site infrastructure and assets has been considered.

The initial risk rankings are based on the risk of peat failure occurring without appropriate mitigation and control measures in place during construction. It should be highlighted that through geotechnical risk management, strict construction management and implementation of relevant control measures, this shall reduce the risk of peat failure across the development to residual low levels.

The risk assessment should be reviewed prior to construction and further refined following intrusive ground investigation and detailed infrastructure design.

7. Recommendations

The peat slide risk assessment cites key control measures which are required to ensure the risk of peat slide remains at residual (low) levels. However, there should be wider consideration of these measures across all areas of the proposed Development which may be influenced by the proposed construction. This is critical where infrastructure may impact terrain and slope conditions beyond the proposed working areas.

- Location specific mitigation has been described within Table 6.1. This includes restrictions on peat storage and stockpiling during the construction process, floating access track and drainage outfall design. Recommendation is made for potential micro-siting post-consent that would reduce the environmental risk rating several turbine positions, this is as follows:

  - Micrositing T05 50 m to the south;
  - Micrositing T06 20 m to the west;
  - Micrositing T08 50 m to the east;
  - Micrositing T11 50 m to the southeast;
  - Micrositing T18 40 m to the southeast;
  - Micrositing T20 10 m to the south;
  - Micrositing T22 50 m micrositing to the west;
  - Micrositing of Satellite Construction Compound 2 northeast to other side of the proposed new track.
- A detailed intrusive ground investigation would be carried out (post-consent) and as part of the pre-construction phase of development. This investigation would seek to further characterise the peat deposits with emphasis on, in-situ shear strength testing and targeted undisturbed sampling and laboratory testing. All peat samples recovered should be classified in accordance with the Von Post system, (Hobbs, 1986) and current British and Eurocode standards for site investigation. Further investigation of the peat sub-soil interface would also be carried out;
- Groundwater level information would be collated as part of any future ground investigation;
- The results of a detailed ground investigation should be assessed with respect to refining the peat stability assessment at infrastructure locations where peat slide risk is elevated. All pertinent control measures and mitigation measures should be revised, and their implementation supervised following the results of the ground investigation and construction design phase of works;
- Continued assessment and monitoring throughout the construction phase of works and at suitable intervals post construction should be implemented to ensure the control measures are suitable and are providing adequate mitigation against peat instability;
- Construction practices should be managed through the Construction Method Statement (CMS) and within the wider context of the Construction Environmental Management Plan (CEMP). The CMS should be prepared by the appointed principal contractor and reviewed by a suitably experienced geotechnical engineer who has read and understood this report. The following general recommendations are provided in line with the, Good practice during wind farm construction, (2019) guidance:
  - Avoid peat arisings being placed as local concentrated loads on peat slopes without first establishing the stability condition of the ground and slope system. Stockpiling on areas of deep peat and in close proximity to steep slopes should be avoided.
  - Avoidance of uncontrolled and concentrated surface water discharge onto peat slopes as this may act as contributory factor to failure. All water discharged from excavations during construction phase should be directed away from all areas identified as susceptible to peat failure and should managed by a suitably designed site drainage management plan.
  - All excavations where required should be adequately supported to prevent collapse and the destabilising peat deposits adjacent to excavations.

- A system of daily reporting should be established during construction and utilised to monitor the geotechnical performance of slopes including peat, sub-soil and bedrock. This should be implemented and undertaken by a suitable experienced and qualified geotechnical engineer. Post construction this monitoring procedure should be curtailed to allow for annual or ad-hoc inspection as required.

7.1. Floating Track Construction

MacCulloch, (2006) advises that a ‘floating’ type road construction which leaves the peat deposits in situ may be advantageous with respect to preventing peat failure. This method of construction has a lower impact on the internal groundwater flow within the peat land. However, there are cases where groundwater flow within the peat can be detrimentally affected. The following control measures should be implemented as part of the design and construction of ‘floating’ access track:

- Prevent the rupture of vegetation surface of the peat by avoiding the use of large sharp rock fill;
- Prevent the overloading and subsequent shearing of the peat throughout construction and use of the ‘floating’ track;
- Monitoring of the long-term settlement of the ‘floating’ track is necessary to predict the effects of reducing permeability within the peat and hence increasing groundwater pressures beneath the track construction. Through ongoing monitoring additional drainage relief measures can be implemented when conditions for peat failure are predicted;
- Do not position ‘floating’ access track on or adjacent to convex side slopes.

An additional control on the construction and use of ‘floating’ track is through the strict management of construction traffic loading. This may involve the timing between heavy traffic to be staggered to prevent the effect of cyclic loading over short time periods reducing the shear strength of the peat. In order to assess the maximum loading rate or timing between heavy construction traffic it may be necessary to monitor the vertical deformation of the ‘floating’ track sections following loading and recording the time taken for recovery of vertical deformation. The use of simple settlement plates and survey pegs can be used to achieve this. The frequency of trafficking for heavy loads must then be timed to allow deformation of the ‘floating’ road to recover its deformation.

MacCulloch (2006) generally advises that in order to prevent injury or an environmental incident, it is important that there is a robust procedure in place should it become apparent that a peat failure is imminent.

7.2. Cut/Fill Track Construction

Across the main area of Development not affected by deep peat; the construction of proposed access tracks should be considered by excavation and replacement method, MacCulloch, (2006). Excavated peat is removed and targeted for suitable re-use. Aggregate would be used to form the subgrade and running surface of the track.

For ‘Cut/Fill’ track construction the risk of peat failure is therefore focussed on the peat deposits adjacent to the access track, and the placement of peat arisings. In these areas the following control measures are listed by MacCulloch, (2006):

- Careful excavation of peat deposits by appropriate machine excavator to limit localised peat failures which can occur on the edge of the track excavation. This is in order to prevent a minor failure triggering retrogressive peat failure affecting a larger area of peat adjacent to the track;
- Temporary drainage systems followed by establishment of a permanent drainage network. Silt traps and small retaining structures may be required especially in proximity to water crossings to prevent siltation and blockage of watercourses;
- Ongoing monitoring and on demand maintenance when silt traps require emptying and temporary drainage reinstated if blocking occurs. This will assist in maintaining hydrology baseline conditions;
- The permanent drainage system must direct surface water flow away from the ‘cut’ track to prevent peat failure within the track bunds.

7.3. General Earthworks

It has been identified that there is a requirement for the excavation of peat soils and superficial deposits during construction of the wind farm. Initially the vegetated peat layer and any topsoil should be stripped and temporarily stockpiled away from areas of deep peat and instability risk. The design of this stockpile must be agreed by a suitably qualified geotechnical engineer. When working in areas of deep peat (i.e. >0.5m) no peat or overburden should be stored on such deposits as this may lead to instability. The following options for peat storage may be considered:

- Dedicated peat storage areas designed under the advisement of a suitable qualified geotechnical engineer and conform to up-to-date regulations and waste directives.
- Re-use of peat in dressing-off of batters on access tracks, finishing of cable trenching works, the landscaping of turbine bases. Peat must be re-used to ensure stability and its long terms sustainability i.e. the prevention of drying of desiccation.
- Excavated glacial till and weathered rock may be used as backfill to turbine bases should material be deemed geotechnically suitable. All related works must be carried out in accordance with an agreed CEMP and conform to site restoration plans.
- For in-situ and undisturbed peat; site vehicle movements must be minimised across such areas, throughout construction and post construction. Observation and monitoring for settlement, deformation, or signs of failure along access tracks and critical working areas must be implemented. This may be achieved with a network of settlement plates and survey markers which can be periodically re-surveyed, and any differential movements identified. It is recommended that all earthworks are designed in accordance with current national standards. Such measures would be focused on zones of deep peat and areas at elevated peat slide risk.

The following risk mitigation is recommended with regards to peat storage:

- Storage site selection and stockpile design would be undertaken by a suitably qualified and experienced engineer;
- Temporary storage of peat in a single dedicated area shall be avoided;
- Peat storage on areas of low / negligible peat slide risk only;
- Peat storage height shall not exceed 0.5m without dedicated stability assessment; and
- Routine maintenance and inspection of peat storage areas would be undertaken.

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9. Glossary

Table 9.9.1: Scientific Terms used within this Peat Slide Risk Assesement

Term	Definition
Acrotelm	The thin aerobic zone at the surface of the mire usually fibrous and containing the majoring of groundwater flow through the peat mass, underlain by the thick anaerobic zone called the catotelm, usually a higher degree of humification and lower shear strength.
Bog Burst / Flow	Failure of a raised bog (i.e. bog peat) involving the break-out and evacuation of (semi-) liquid basal peat. A flow is formed of highly humified basal peat from a clearly defined source area.
Bulk Density	The normal in situ density of a soil, i.e. its mass divided by its volume.
Catotelm	see acrotelm.
Consolidation	The process by which a soil decreases in volume.
Construction Method Statement	(CMS), a detailed written description of how a particular construction activity will be carried out safely and in an environmentally compliant manner.
Diamicton	Glacially derived soil which is poorly sorted and contains soil particles ranging in size from clay to boulders.
Geographical Information System (GIS)	Form of technology capable of capturing, storing, retrieving, editing, analysing, comparing and displaying spatial environmental information.
Geo-hazard	Geological hazard, either natural or man-made, which threatens either humans or the environment in which they live.
Geo-membrane	Non-porous sheet that has a very low permeability (in engineering terms impermeable) usually formed of polyethylene.
Geo-textiles	Man-made fabrics, generally made from plastics but also may be made from natural materials, used in construction.
Groundwater	Water located beneath the ground surface in soil pore spaces and in the fractures of rock formations.
Ground Investigation	Specialist intrusive phase of site investigation with associated monitoring, testing and reporting to a national standard.
Hagg	Natural gully or weathering structure in surface of peat mass.
Hazard	Something with a potential for adverse consequences / harm.
Humification	The process of decomposition of a peat soil.
Hydrological regime	The statistical pattern of a river’s constantly varying flow rate.
Mitigation	The limitation of undesirable effects / impact of a particular event.
Mitigation Measures	Actions in place to limit the undesirable effects / impact of a particular event.
Peat Slide	Failure of a blanket bog involving sliding of intact peat and the mineral substrate material or immediately above the contact with the underlying mineral soil substrate.
Peat 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.
Permeability	The rate at which water and air moves through a soil.
Pore water	The water filling the voids between grains of soil

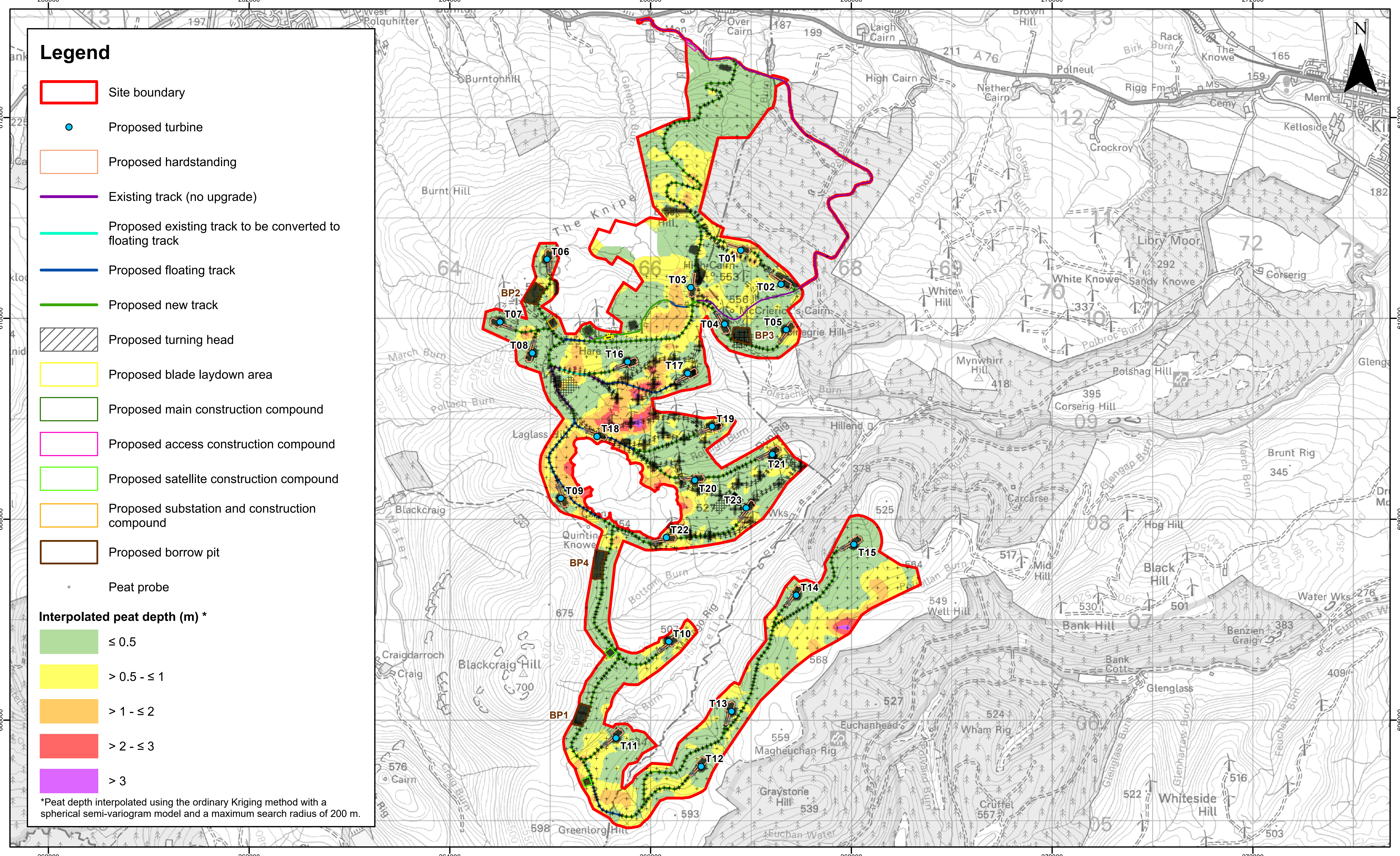
Term	Definition
Primary consolidation	The process by which a soil decreases in volume through the expulsion of internal pore water
Overland flow	Water passing rapidly over or through the surface layer of soil.
Peat	A largely organic substrate formed of partially decomposed plant material
Precipitation	Deposition of moisture including dew, hail, rain, sleet and snow.
Risk	The combination of the probability of an event and the magnitude of its consequences
Residual Risk	The risk remaining after mitigation measures have been undertaken.
Rockhead	The upper surface of rock mass beneath the superficial soil cover.
Runoff	Surface runoff is the flow of water over the surface that can result due to the surrounding soils lacking the capacity to infiltrate further water or due to the surface water flowing off infrastructure such as access tracks and hardstands.
Secondary Consolidation	The compression of a soil that takes place after primary consolidation due to creep, compression of organic matter etc.
Sedimentation	The tendency for particles in suspension to settle out of the fluid in which they are entrained.
Site Investigation	The overall process of discovery of information concerning a site, the appraisal of data, assessment and reporting. Can include desk, non-intrusive and intrusive investigation.
Shear strength	The maximum shear stress which a material can withstand without rupture/ failure
Shear vane	In situ test using a x4 blade steel vane pushed into the ground and rotated to provide an indication to the undrained shear strength of a soil.
Superficial Deposits	Young, sediments and soil deposits occurring at the surface.
Surcharge	An additional mass of material or load applied to an existing soil or structure
Topography	The physical features of a geographical area.
Undisturbed Sample	A sample of soil whose condition is sufficiently close to the actual condition of the soil in situ to be used to approximate the properties of the soil in the ground.
Water resources	The supply of groundwater and surface water in a given area.

Source: Natural Power

Appendices

A. Maps

- Figure A.1 Interpolated Peat Depth
- Figure A.2 Slope Angle
- Figure A.3 Environmental impact Zonation Map
- Figure A.4 Peat Slide Risk Ranking
- Figure A.5 Factor of Safety



ScottishPower Renewables

Rev	Date	By	Comment
C	30/10/25	DM	Third Issue.
B	09/05/25	DM	Second Issue.
A	27/03/25	DM	First Issue.

1:35,000 Scale @ A3

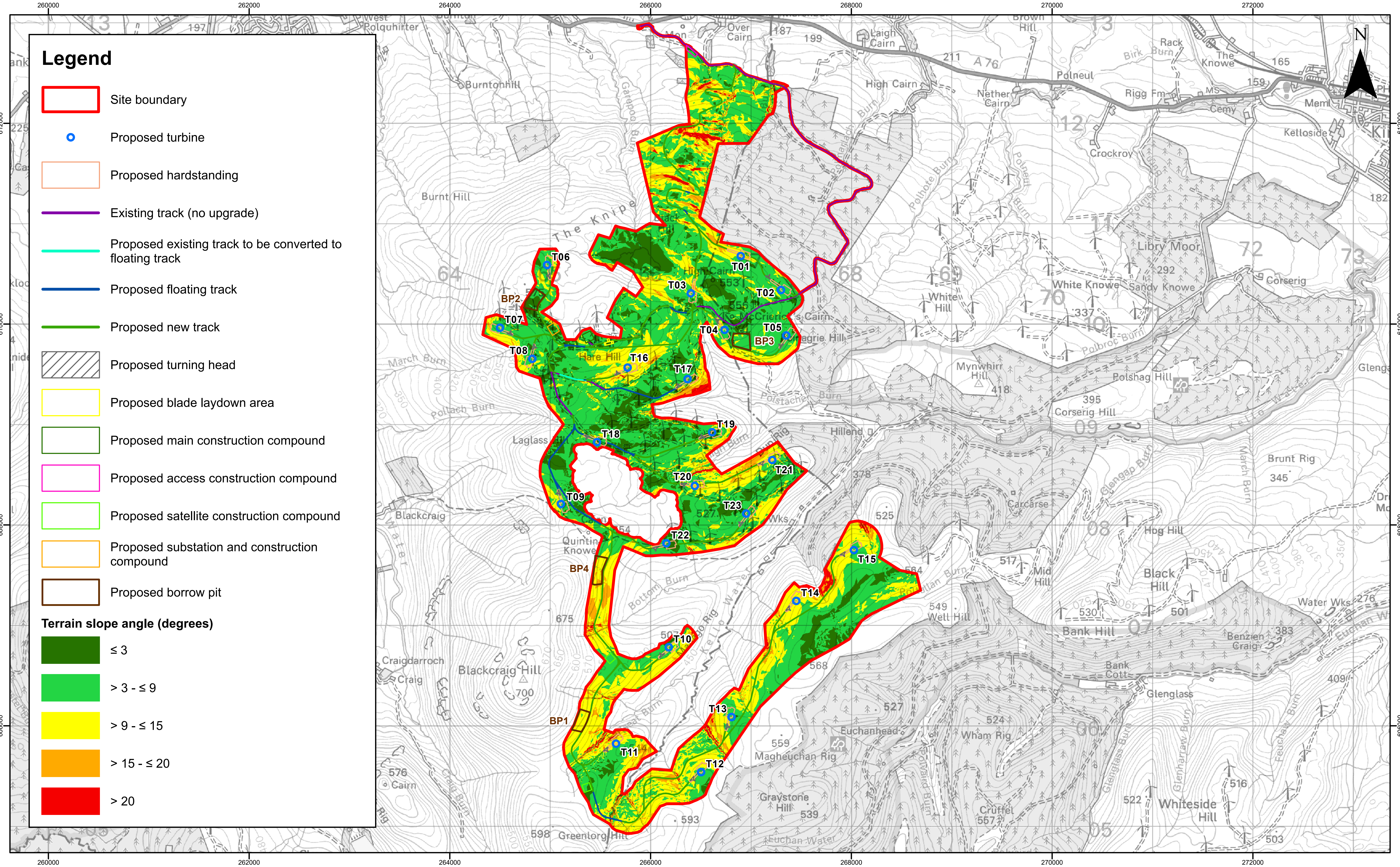
0 1 2 Km

Hare Hill Windfarm Repowering and Extension

Interpolated Peat Depth

Drg No	GB200665_M_069
Rev	C
Date	30/10/25
Figure	A9.1

Datum: OSGB36
Projection: OS BNG



Rev	Date	By	Comment
C	31/10/25	DM	Third Issue.
B	09/05/25	DM	Second Issue.
A	21/03/25	DM	First Issue.

1:35,000
Scale @ A3

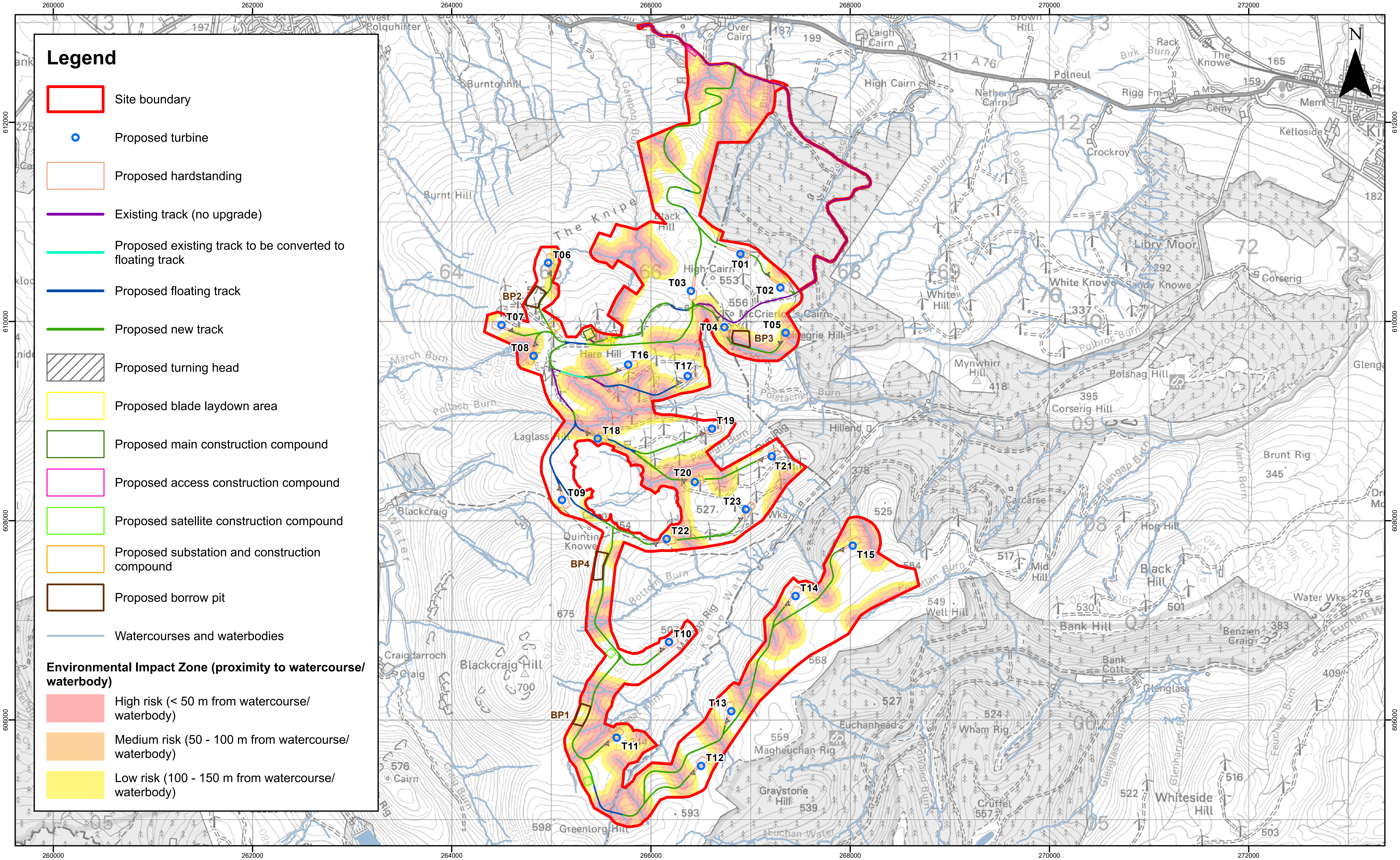
0 1 2 Km

Hare Hill Windfarm Repowering and Extension

Terrain Slope Angle

Drg No	GB200665_M_070
Rev	C
Date	31/10/25
Figure	A.2

Datum: OSGB36
Projection: OS BNG



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C	31/10/25	DM	Third Issue.
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A	21/03/25	DM	First Issue.

1:35,000 Scale @ A3

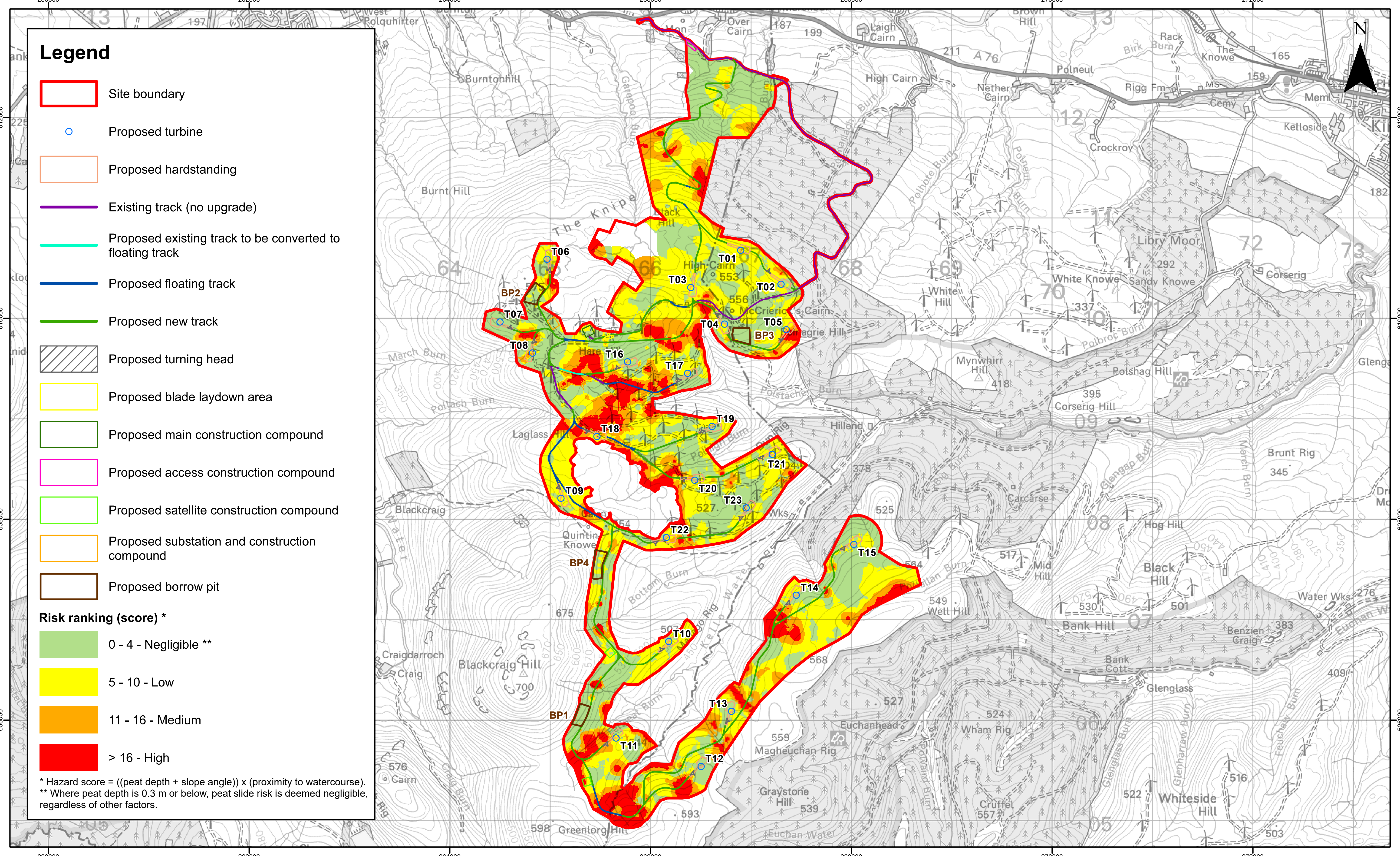
0 1 2 Km

Hare Hill Windfarm Repowering and Extension

Environmental Impact Zonation

Drg No	GB200665_M_071
Rev	C
Date	31/10/25
Figure	A.3

Datum: OSGB36
Projection: OS BNG



Rev	Date	By	Comment
C	31/10/25	DM	Third Issue.
B	09/05/25	DM	Second Issue.
A	21/03/25	DM	First Issue.

ScottishPower Renewables

1:35,000
Scale @ A3

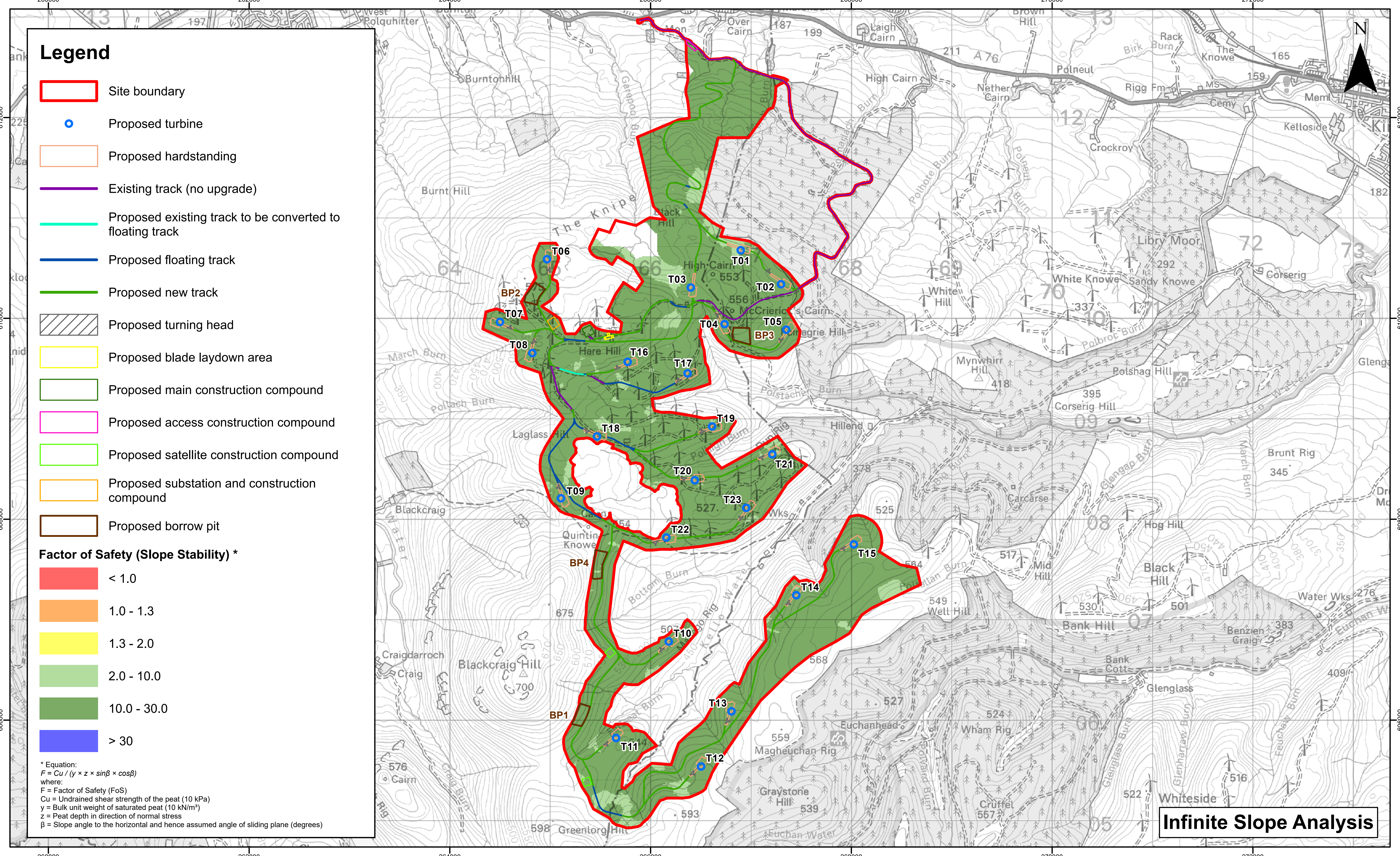
0 1 2 Km

Hare Hill Windfarm Repowering and Extension

Peat Slide Risk Ranking

Drg No	GB200665_M_072
Rev	C
Date	31/10/25
Figure	A.4

Datum: OSGB36
Projection: OS BNG



Rev	Date	By	Comment
C	31/10/25	DM	Third Issue.
B	09/05/25	DM	Second Issue.
A	21/03/25	DM	First Issue.

ScottishPower Renewables

1:35,000
Scale @ A3

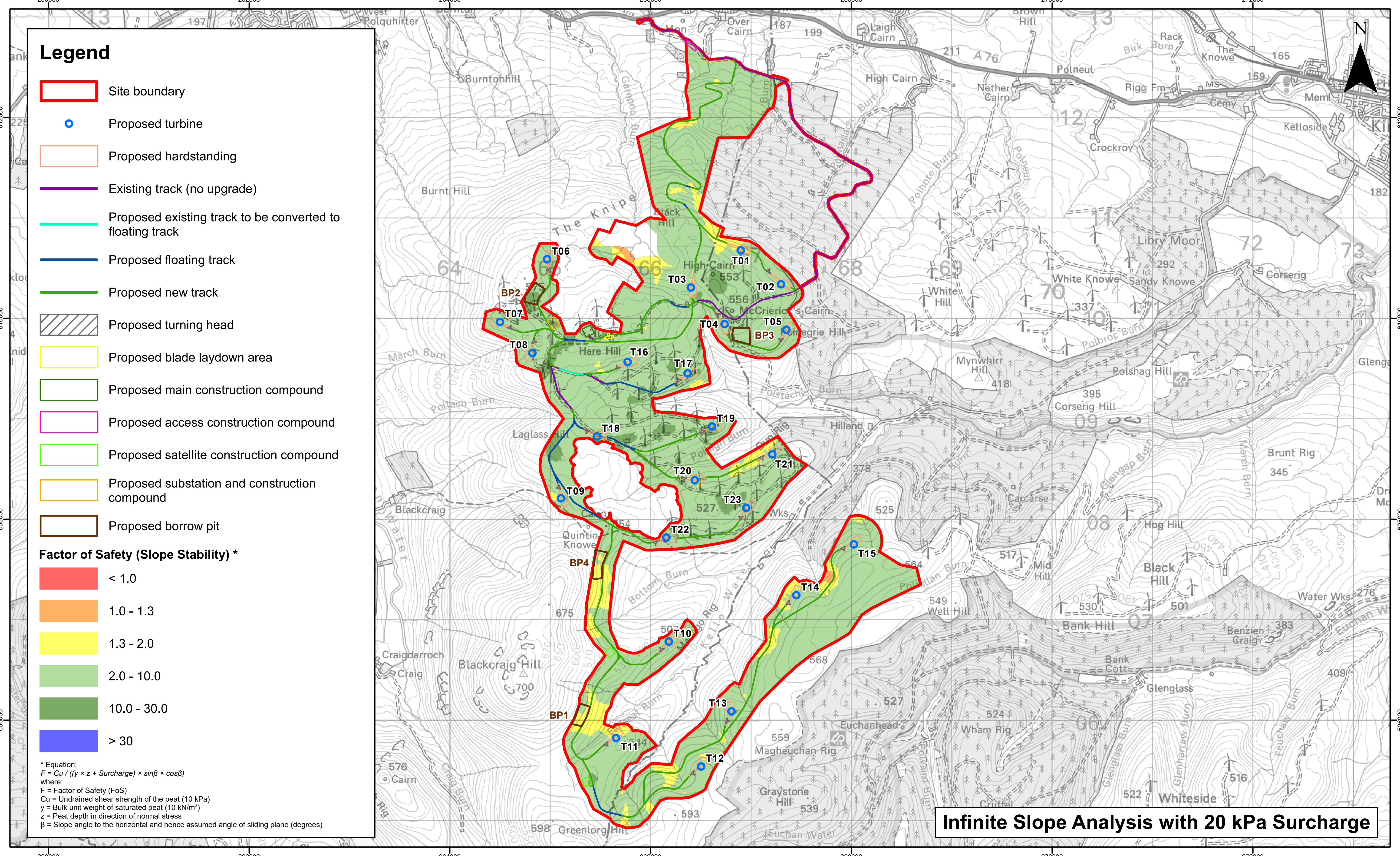
0 1 2 Km

Hare Hill Windfarm Repowering and Extension

Factor of Safety (Slope Stability)

Drg No	GB200665_M_073
Rev	C
Date	31/10/25
Figure	A.5

Datum: OSGB36
Projection: OS BNG



ScottishPower Renewables	C	31/10/25	DM	Third Issue.	1:35,000 Scale @ A3	Hare Hill Windfarm Repowering and Extension
	B	09/05/25	DM	Second Issue.	0 1 2 Km	Factor of Safety (Slope Stability)
	A	21/03/25	DM	First Issue.		
	Rev	Date	By	Comment		

Drg No	GB200665_M_073	
Rev	C	Datum: OSGB36
Date	31/10/25	Projection: OS BNG
Figure	A.5	

B. Peat Cores, Hand Shear Vane and Lab Testing Results

B.1. Peat Cores

Peat Core Descriptions – Harehill Windfarm Repowering				
Location ID	Top Depth	Bottom Depth	Log	Sample
T01 (266897E, 610677N)	0.00	0.40	Very soft dark brown pseudofibrous PEAT (H6/B2)	Y
T03 (266400E, 610306N)	0.25 0.70 1.25	0.70 1.25 1.80	Very soft brown fibrous PEAT (H4/B3) Soft dark brown pseudofibrous PEAT (H6/B2) Soft dark brown pseudofibrous PEAT (H6/B2)	Y
T07 (264499E, 609964N)	0.00	0.40	Soft brown spongey fibrous PEAT (H4/B2)	Y
T10 (266180E, 606782N)	0.00	0.70	Soft brown spongey fibrous PEAT (H4/B3)	Y
T11 (265655E, 605822N)	0.00	0.60	Soft brown spongey fibrous PEAT (H3/B2)	Y
T13 (266806E, 606087N)	0.00	0.30	Very soft brown spongey fibrous PEAT (H4/B3)	Y
T14 (267451E, 607243N)	0.00	0.40	Very soft dark brown spongey fibrous PEAT (H4/B3)	Y
T15 (268025E, 607750N)	0.00	0.60	Soft brown spongey fibrous PEAT (H3/B2)	Y

Peat Core Descriptions – Harehill Windfarm Repowering				
Location ID	**Top Depth**	**Bottom Depth**	**Log**	**Sample**
T19 (266612E, 608924N)	0.00	0.60	Firm brown spongey fibrous PEAT (H4/B2)	Y
500m West of T01 (270116E, 609044N)	0.00	0.30	Very soft brown spongey fibrous PEAT (H4/B3)	Y
100m NE of CC1 (267351E, 609887N)	0.00	0.50	Soft brown spongey fibrous PEAT (H3/B2)	Y

B.2. Hand Shear Vane Results

Project Name:	Harehill Windfarm Repower	
Project ID :	18476UKC	
HSV Results	Corrected Hand Shear Vane Results	
Location	Depth	Peak Undrained Shear (kPa)
T01	0.3	18
T02	0.4	12
T03	1.7	26
T04	0.3	30
T05	0.7	26
T06	0.30	21
T08	0.35	29
T11	0.55	19
T13	0.28	26
T15	0.37	22
T16	0.35	21
T18	0.32	24
T19	0.35	25

B.3. Laboratory Results

Certificate of Analysis

Certificate Number	25-07310-1	*Issued:*	14-Apr-25
Client	MATTest Ltd. 10 Queenslie Point 120 Stepps Road Glasgow G33 3NQ		
Our Reference	25-07310-1		
Client Reference ~	25/353		
Order No ~	MATSC7029		
Contract Title ~	Hare Hill Power		
Description	10 Soil samples.		
Date Received	03-Apr-25		
Date Started	03-Apr-25		
Date Completed	14-Apr-25		
Test Procedures	Identified by prefix DETSn (details on request).		
Notes	**This report supersedes 25-07310; Sample info updated at client request** Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.		

Approved By

Reyhan Irfan
Operations Manager

2139

Normec DETS Limited
Unit 2, Park Road Industrial Estate South, Consett, Co Durham, DH8 5PY
Tel: 01207 582333 • email: info@dets.co.uk • normecdets.com

Summary of Chemical Analysis
Soil Samples

Our Ref 25-07310-1
Client Ref ~ 25/353
Contract Title ~ Hare Hill Power

				Deviating	Deviating	Deviating	Deviating	Deviating	Deviating	Deviating	Deviating	Deviating	Deviating
			Lab No	2488816	2488817	2488818	2488820	2488821	2488822	2488823	2488824	2488825	2488826
			Sample ID ~	T1 *	T2	T3 *	T5	T12	T14	T17	T18	T19	T21
			Depth ~	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00	0.00-1.00
			Other ID ~										
			Sample Type ~	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL
			Sampling Date ~	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
			Sampling Time ~	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s	n/s
Test	**Method**	**LOD**	**Units**										
Inorganics													
Loss on Ignition at 440oC	DETSC 2003#	0.01	%			87		47			93	79	94
Carbon, Total	DETSC 2084*	0.5	%	32	27	43	34	25	51	52	39	46	51
Organic matter	DETSC 2002#	0.1	%	22	16	> 25	25	> 25	23	21	> 25	> 25	> 25

*Sample location superseded - See T01 and T03 in Lab Sheet 25-23479

Information in Support of the Analytical Results

Our Ref 25-07310-1
Client Ref ~ 25/353
Contract ~ Hare Hill Power

Containers Received & Deviating Samples

Lab No	Sample ID ~	Date Sampled ~	Containers Received	Holding time exceeded for tests	Incorrect container for tests
2488816	T1* 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488817	T2 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488818	T3* 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Loss on Ignition (730 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488820	T5 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488821	T12 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Loss on Ignition (730 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488822	T14 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488823	T17 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488824	T18 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Loss on Ignition (730 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488825	T19 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Loss on Ignition (730 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	
2488826	T21 0.00-1.00 SOIL		PT 1L	Sample date not supplied, Carbon, Total (14 days), Loss on Ignition (730 days), Organic Matter (Manual) (28 days), Total Carbon (730 days)	

Key: P-Plastic T-Tub

Normec DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

*Sample location superseded - See T01 and T03 in
Lab Sheet 25-23479

Information in Support of the Analytical Results

Our Ref 25-07310-1
Client Ref ~ 25/353
Contract ~ Hare Hill Power

Soil Analysis Notes

Inorganic soil analysis was carried out on a dried sample, crushed to pass a 250µm sieve
Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Key:

~ Sample details are provided by the client and can affect the validity of the results
***** -not accredited.
# -MCERTS (accreditation only applies if report carries the MCERTS logo).
$ -subcontracted.
n/s -not supplied.
I/S -insufficient sample.
U/S -unsuitable sample.
t/f -to follow.
nd -not detected.

End of Report

Certificate of Analysis

Certificate Number	25-23479	*Issued:*	20-Oct-25
Client	MATTest Ltd. 10 Queenslie Point 120 Stepps Road Glasgow G33 3NQ		

Our Reference	25-23479
Client Reference ~	25/1054
Order No ~	MATSC7644
Contract Title ~	Hare Hill Wind Farm Repowering
Description	2 Soil samples.
Date Received	10-Oct-25
Date Started	10-Oct-25
Date Completed	20-Oct-25
Test Procedures	Identified by prefix DETSn (details on request).
Notes	Opinions and interpretations are outside the laboratory's scope of ISO 17025 accreditation. This certificate is issued in accordance with the accreditation requirements of the United Kingdom Accreditation Service. The results reported herein relate only to the material supplied to the laboratory. This certificate shall not be reproduced except in full, without the prior written approval of the laboratory.

Approved By

Louise Cook
Contracts Manager

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Summary of Chemical Analysis
Soil Samples

Our Ref 25-23479
Client Ref ~ 25/1054
Contract Title ~ Hare Hill Wind Farm Repowering

			Lab No	2581317	2581318
			Sample ID ~	T01-D1	T03-D1
			Depth ~	0.00-0.40	1.25-1.80
			Other ID ~	D1	D1
			Sample Type ~	D	D
			Sampling Date ~	23/09/2025	23/09/2025
			Sampling Time ~	n/s	n/s
Test	**Method**	**LOD**	**Units**		
Inorganics					
Total Organic Carbon	DETSC 2084#	0.5	%	52	46
Organic matter	DETSC 2002#	0.1	%	0.4	0.3

Information in Support of the Analytical Results

Our Ref 25-23479
Client Ref ~ 25/1054
Contract ~ Hare Hill Wind Farm Repowering

Containers Received & Deviating Samples

Lab No	Sample ID ~	Date Sampled ~	Containers Received	Holding time exceeded for tests	Incorrect container for tests
2581317	T01-D1 0.00-0.40 SOIL	23/09/25	PT 1L		
2581318	T03-D1 1.25-1.80 SOIL	23/09/25	PT 1L		

Key: P-Plastic T-Tub
Normec DETS cannot be held responsible for the integrity of samples received whereby the laboratory did not undertake the sampling. In this instance samples received may be deviating. Deviating Sample criteria are based on British and International standards and laboratory trials in conjunction with the UKAS note 'Guidance on Deviating Samples'. All samples received are listed above. However, those samples that have additional comments in relation to hold time, inappropriate containers etc are deviating due to the reasons stated. This means that the analysis is accredited where applicable, but results may be compromised due to sample deviations. If no sampled date (soils) or date+time (waters) has been supplied then samples are deviating. However, if you are able to supply a sampled date (and time for waters) this will prevent samples being reported as deviating where specific hold times are not exceeded and where the container supplied is suitable.

Soil Analysis Notes

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Organic soil analysis was carried out on an 'as received' sample. Organics results are corrected for moisture and expressed on a dry weight basis.
The Loss on Drying, used to express organics analysis on an air dried basis, is carried out at a temperature of 28°C +/-2°C.

Disposal

From the issue date of this test certificate, samples will be held for the following times prior to disposal :-
Soils - 1 month, Liquids - 2 weeks, Asbestos (test portion) - 6 months

Key:
~ Sample details are provided by the client and can affect the validity of the results
***** -not accredited.
# -MCERTS (accreditation only applies if report carries the MCERTS logo).
$ -subcontracted.
n/s -not supplied.
I/S -insufficient sample.
U/S -unsuitable sample.
t/f -to follow.
nd -not detected.

End of Report Ver 25.10.01

MATtest Limited
materials testing & consultancy

10 Queenslie Point
Queenslie Industrial Estate
120 Stepps Road
Glasgow
G33 3NQ

Tel: 0141 774 4032

email: info@mattest.org
Website: www.mattest.org

LABORATORY TEST CERTIFICATE

Certificate No :	**25/1054 - 01-1**
To :	**Evelin Erős**
Client :	**Natural Power Consultants** The Green House Forrest Estate Dalry Castle Douglas **DG7 3XS**

LABORATORY TESTING OF SOIL

Introduction

We refer to samples taken from Hare Hill Wind Farm Repowering and delivered to our laboratory on 07th October 2025.

Material & Source

Sample Reference	:	See Report Plates
Sampled By	:	Client
Sampling Certificate	:	Not Supplied
Location	:	See Report Plates
Description	:	See Page 2
Date Sampled	:	Not Supplied
Date Tested	:	07th October 2025 Onwards
Source	:	19514UK - Hare Hill Wind Farm Repowering

Test Results

As Detailed On Page 2 to Page 4 inclusive

Comments

The results contained in this report relate to the sample(s) as received
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
All remaining samples for this project will be disposed of 28 days after issue of this test certificate

Remarks

Approved for Issue

T McLelland (Director)

Date 22/10/2025

UKAS TESTING
2643

TRIAL PIT	SAMPLE	DEPTH (m)	SAMPLE DESCRIPTION
T01	T01-D1	0.00-0.40	Brown PEAT. (Von Post Classification - H4)
T03	T03-D1	1.25-1.80	Brown PEAT. (Von Post Classification - H5)

SUMMARY OF SAMPLE DESCRIPTIONS

TRIAL PIT	SAMPLE	DEPTH (m)	WATER CONTENT (%)
T01	T01-D1	0.00-0.40	572
T03	T03-D1	1.25-1.80	822

BS EN ISO 17892-1 : 2014 + A1 : 2022
BS 1377-2 : 2022

SUMMARY OF WATER CONTENT TEST RESULTS

MATtest Limited
materials testing & consultancy

TRIAL PIT	SAMPLE	DEPTH (m)	WATER CONTENT (%)	BULK DENSITY (Mg/m^3)	DRY DENSITY (Mg/m^3)
T01	T01-D1	0.00-0.40	572	1.00	0.15
T03	T03-D1	1.25-1.80	822	1.07	0.12

BS EN ISO 17892-2 : 2014 : 5.1 - Linear Measurement Method
BS 1377 - 2 : 2022

SUMMARY OF WATER CONTENT AND BULK DENSITY TEST RESULTS

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For full details on our ISO and other certifications, please visit our website.