Scottish & Southern Electricity Networks
TRANSMISSION

TEM-NET-ENV-XXX

Environmental

Preliminary Peat Landslide Hazard and Risk Assessment

Project Name – Cambushinnie 400kV Substation

Project Code – LT520 (60721943)

April 2025

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1 Introduction

1.1 General

AECOM Limited (AECOM) have been appointed by SSEN Transmission (the Applicant) to produce a Preliminary Peat Landslide Hazard and Risk Assessment (PLHRA) with respect to the following Proposed Developments:

- Proposed Cambushinnie 400 kV substation – Consent will be sought under by the applicant under the Town and Countryside
- Overhead line tie overhead Line (OHL) tie-in from the Cambushinnie 400kV substation to the existing Beauly Denny OHL, – Consent will be sought by the applicant under section 37 of the Electricity Act;
- A new haul road that bypasses the need to route construction traffic through Braco village, the applicant will progress this under a separate Planning Application.

This PLHRA has been prepared as an overarching document covering the proposed Cambushinnie 400kV substation and OHL tie-in listed above (for the purposes of this document the 'project' is defined as the proposed Cambushinnie substation and the OHL tie-in). The proposed haul road is not considered as part of this document as the areas crossed are not recorded as a peatland habitat and negligible peat, if any, is anticipated.

The Proposed Developments are required to enable connections to meet the Electricity System Operators (ESO) Pathway to 2030 Holistic Network Design (HND); which identified the requirement to reinforce the onshore corridors between Beauly and Peterhead, Beauly and Spittal in Caithness, and an offshore subsea cable between Spittal and Peterhead as well as the need to upgrade the 275kV Beauly-Denny circuit. In December 2022, the Office of Gas and Electricity Markets (Ofgem), approved the need for the upgrade of the existing Beauly-Denny 275kV circuit as part of the (Accelerated Strategic Transmission Investment) ASTI framework as a Great Britain wide programme of investments. Ofgem's decision approved all SSEN Transmission's Pathway to 2030 projects, which includes the Proposed Developments. The Proposed Developments, alongside several other major network upgrades planned in the north of Scotland, is therefore part of a Great Britain wide programme of works that are required to meet UK and Scottish Government energy targets.

This document has been prepared to inform the planning authority Perth and Kinross Council (PKC) and Energy Consents Units (ECU) to confirm the initial infrastructure design phase of the Proposed Developments.

The Project as defined for the purposes of this PLHRA will comprise the following:

- Temporary construction compound (including a temporary potable water borehole for welfare during construction, with expected volume extracted of less than 10m3 per day) and laydown area;
- Substation platform of approximately 410 m x 220 m with associated earthworks;
- Two 400/132kV transformers, a new 400kV double busbar and ancillary equipment;
- A new control building (approximately 24 m x 49 m) with a maximum height of 7 m above the finished surface level;
- Existing access track upgrades between the B8033 and existing Braco West Substation;
- Construction of new access track from the existing Braco West Substation to the proposed Cambushinnie substation platform;
- Upgrades to the existing Cambushinnie Hill track;

- Construction of new access track from the northwestern edge of the proposed Cambushinnie substation platform to the Sustainable Drainage System (SUDS) basin;
- Permanent drainage systems including a SUDS basin;
- One permanent borehole for site water supply located on approach to the main access gate of the proposed Cambushinnie substation (expected volume extracted of less than 10m3 per day);
- Landscaping and biodiversity enhancements; and
- Palisade perimeter fence of maximum height of 4 m above the finished surface level
- Overhead Line (OHL) tie ins from the proposed substation to the existing Beauly-Denny OHL;
    - Temporary OHL diversion including two temporary towers;
    - New permanent tower to allow tie-in.

The Project will comprise upgrades to the existing access track from the B8033 to existing Braco West substation as shown in **Figure 1**, **Appendix A Figures**. However, for the purposes of this Preliminary PLHRA, the Project Site ('the Site) only includes the area shown in **Figure 2**, **Appendix A Figures**. The upgrades to the existing access track are minor with proposals typically comprising widening of the existing track. Peat is also only anticipated to be present towards the western extent of the existing access track, although no ground investigation data is available along the existing access track. For this preliminary assessment the peat landslide risk along the existing access track is considered to be negligible, although this will be revisited as part of the Final PLHRA carried out post-consent, on design maturity and further information becoming available. For the purposes of this preliminary assessment, no further information on the existing access track has been provided.

1.2 Assessment Team

The assessment works were undertaken by a team of engineering geologists and geotechnical engineers all of whom have previous experience in undertaking peat assessments.

The team was led by a Chartered Engineering Geologist with over 28 years industry experience and in particular within the renewables energy sector. He has managed and assessed geotechnical risks and undertaken geohazard assessments within peatland environments and with a previous employer (Halcrow Group Ltd) also undertook the checkers role on many PLHRA reports on behalf of the ECU.

The site walkovers and site works (i.e. peat probing & peat coring) have been undertaken by various teams and personnel including engineering geologists, geotechnical engineers and a ground investigation contractor all of which have experience in working and assessing peatland environments.

1.3 Site Location and Description

The Project Site is located just to the west and southwest of the existing Braco West Substation, on the southern facing slopes of Feddal Hill approximately 4.0 km west of the village of Braco, within Perth & Kinross. The National Grid Reference (NGR) to the approximate centre of the Project area is NN 79267 08941. Note for the purposes of this PLHRA, 'the Site' refers to the location as shown on **Figure 2**, **Appendix A Figures** and does not include the existing access track which is to be upgraded from the B8033 to the existing Braco West Substation.

The Site is within land used for commercial forestry. Recent site visits observed much of the Site contained felled trees which had been recently replanted although towards the western and southern boundaries mature and semi-mature trees were still present. Within the zone of mature trees in the western extent of the Site, wind-blown fallen trees are also present. Mature and semi-mature trees were also noted just out-with the east and southeast boundaries of the Site, as well as young trees being present immediately to the northwest of the northwestern boundary. Within the northwest of the Site the northeast – southwest trending Beauly to Denny overhead electrical line is present.

1.4 Assessed Areas

Where assessment of the existing access track is considered to be required, this will be undertaken as part of a Final PLHRA which shall be undertaken post consent as part of the detailed design process, after full development of the proposals and inclusive of any new information or investigations that become available.

Peat restoration and reuse areas are proposed within the Site. The preliminary proposals for peat reuse are split into three areas: dressing of slopes and verges (relating to the proposed substation platform earthworks, new access track and SUDS basin), specific peatland restoration areas and peatland restoration through reinstatement of natural drainage conditions. A peat management plan (PMP)[1] has been produced for the Project to accompany the EA. The PMP should be referred to for further details on the actual peat reuse and restoration proposed.

The dressing of slopes and verges is not anticipated to create a significant peat landslide risk, as the size/thickness of these are likely to be minimal and controlled by the Designer to ensure stability. As such, this Preliminary PLHRA does not assess the potential peat landslide risk posed by reuse of the peat in dressing of slopes and verges.

At the peatland restoration areas, it is proposed to deposit peat in these areas essentially increasing the overall peat thickness. As part of the proposals, earthwork bunds are proposed within each restoration area to act as both a roadway to deposit the peat and also to provide some support for the displaced peat. At present the plans for the restoration areas are indicative and require geotechnical design to ensure they meet the required stability. As a detailed geotechnical design of the peatland restoration area is still to be undertaken and this will in-effect ensure stability of these areas, this Preliminary PLHRA does not assess the potential peat landslide risk posed by the specific restoration areas. The effects of constructing these restoration areas as relates to the surrounding peat is, however, indicatively assessed.

For the peatland restoration through reinstatement of natural drainage conditions, the proposals indicate this will be undertaken through infilling of both drainage ditches and furrows within the Site. Over time this should increase the groundwater level present within the Site, although until the groundwater level stabilises will likely result in less stable peat conditions. At present it is assumed all areas of the Site, outwith the proposed works and other restoration areas, will have drainage ditches and furrows infilled. However, the exact locations where this is feasible is not yet determined, as a detailed survey of the Site is required. As the exact details and locations of the infilling is still to be determined, as well as the phasing of these works in relation to the construction of the Project, this Preliminary PLHRA does not assess the potential peat landslide risk posed by the reinstatement of the natural drainage conditions.

[1] AECOM on behalf of SSEN Transmission (2025) Stage 1 Peat Management Plan, Cambushinnie 400kV Substation, LT520, April 2025

1.5 Scope of Report

The scope of this report comprises a summary of the methodology used for the Preliminary PLHRA; a review and assessment of the baseline conditions based on available geological, hydrogeological and topographic information for the Site; an estimate of the geotechnical hazards and risks associated with peat slides during and post construction; a qualitative risk assessment in relation to the peat encountered; a summary and discussion of potential mitigation and control measures to reduce the risk caused by the presence of peat; and present any conclusions and recommendations which can be drawn from the information and assessments undertaken as part of this preliminary PLHRA.

Available information includes:

- Digital topographic datasets showing the slope angles within the Site;
- Historic OS Mapping and Aerial photography;
- Geological datasets showing the published superficial and solid geology;
- Geo-environmental Desk Study produced by SSEN Transmission[2];
- AECOM Geo-Environmental Desk Study[3]
- Information collected during walkover surveys;
- Peat depths recorded by peat probing surveys and peat depths and composition recorded by peat coring; and
- Ground investigation information[4] from intrusive works undertaken within the Site.

This PLHRA was conducted in general accordance with the guidance provided in Peat Landslide Hazard and Risk Assessments – Best Practice Guide for Proposed Electricity Generation Developments[5]. The guidance follows a staged approach methodology in relation to the peat stability risk as follows:

- Preliminary Assessment;
- Hazard and Risk Rating;
- Stability Analysis (if required); and
- Detailed Quantitative Risk Assessment (if required).

As part of this PLHRA a qualitative hazard and risk ranking review was undertaken in accordance with the published guidance[5].

The layout of the Project has been frozen for the purposes of the planning application and given the stage of the project, the design has not yet reached maturity. . As such, intrusive investigations have been undertaken to inform the layout and planning stage design of the Project with peat depths estimated through widespread peat probing and more targeted exploratory holes. As the Project is at the planning stage, a quantitative slope stability analysis to estimate Factors of Safety and a quantitative hazard and risk assessment have therefore not been undertaken. To

[2] Scottish and Southern Electricity Network (2023). *LT520 – Braco West Substation, Geo-Environmental Desk Study.* Doc Ref. LT520-BRCW-GDS-CIV-001, Rev. 1.0, October 2023.

[3] AECOM Ltd (AECOM) (2024). *LT520 Cambushinnie 400kV Substation, Geo-Environmental Desk Study,* Report No. 60721943, July 2024.

[4] Igne Ltd (2024). *Braco West Sites 2 & 3, Report on Ground Investigation*. Contract No. 26555, Report Issue: Draft, January 2024.

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

support the detailed design of the Project, post consent, the Principal Contractor may undertake further peat surveys and investigative works, although at this stage these have not been confirmed.

The reuse of peat is proposed as part of the Project. However, this Preliminary PLHRA does not take into account the peat reuse or restoration areas (as discussed in **Section 1.4**), although it is acknowledged the areas of reuse or restoration may impact on the overall peat stability both of the existing deposits and of the placed peat.

Development of this PLHRA will require to be undertaken, post-consent, considering the final design of the Project (inclusive of the peat reuse and restoration areas) and considering any new further information (e.g. investigation data, survey data, etc.) becoming available. This PLHRA is therefore preliminary.

1.6 Limitations

AECOM does not warrant or guarantee to any party in any way the completeness or accuracy of the documentary information submitted by third parties during the course of this study. Any assessment(s), interpretation(s), conclusion(s) or opinion(s) contained herein is or are made by AECOM in good faith based on information available at the time of compilation of the report and are made for the sole and exclusive use of the Applicant.

AECOM accepts no liability towards third parties for decisions made by any such based on information or statements contained herein. Third parties making use of any information or statement of any kind whatsoever presented or contained within this report or attachments hereto do so at their own risk.

Where peat depth has been determined through peat probing, it should be noted that due to the nature of the probing and as no sample is recovered during the advancement of the probe, the peat depth recorded is only an estimate based on the judgement of the probe operator. More intrusive ground investigation techniques, where samples are recovered, is required to more accurately determine the peat depth and truth the probed depths. The intrusive records available for the Site have been reviewed against the probed depths to verify the probed results. However, the intrusive investigation does not cover the full probed areas and as such the peat depth where no intrusive investigation is in the near vicinity continues to be an estimate, as noted early in this paragraph.

Peat probing has been undertaken across much of the Site to cover the proposed infrastructure and restoration areas. However, the whole of the Site and proposed infrastructure could not be probed due to wind fallen trees or dense woodland. Where the peat probe data has been interpolated out to the boundary of the Site from points which are not within 10 m of the boundary, this was undertaken using estimation and professional judgement. There is therefore the potential for the peat to be different in thickness than predicted, which may increase or decrease the predicted peat slide assessed hazard. Further investigation is proposed as part of the design development and as such data gaps are anticipated to be filled as a result, during future reporting. Where data gaps remain, these shall be discussed and assessed further as part of the final PLHRA undertaken post-consent and following design maturity.

Ground surveys indicate likely conditions but investigate only a relatively small volume of the ground in relation to the size of the Site and can only provide a general indication of site conditions. The comments made and recommendations given in this report are based on AECOM's understanding of the ground conditions at the time of the preparation of this report. There may be exceptional ground conditions on the Site which have not been disclosed, and which have therefore not been taken into account in this report.

The assessment of the peat slide hazard is based on the effect the proposed works could have on the surrounding peat in its current condition, situation and thickness. Where reference is made to peat restoration areas in the assessment section, this relates to how these works may affect the stability of peat that is currently present surrounding the area, during the restoration works. No allowance has been made to account for the proposed change in peat thickness or the potential change in hydrology or peat condition within the restoration areas. The detailed design of the restoration areas will consider and assess the stability of the peat mass as a whole both during and following deposition. During the detailed design process any mitigation measures required to reduce the likelihood or exposure of a peat slide occurring as a result of the peat restoration areas will be included. The findings of the detailed design will then be included in the Final PLHRA, post-consent and following design maturity.

2 Methodology

2.1 Desk Top Review

An initial desk top review was undertaken, comprising the review and analysis of available information from sources as detailed below:

- British Geological Survey (BGS)[6] for geology and hydrogeology;
- National Ground Subsidence – Landslide information as provided within the Groundsure Report obtained contained within Appendix C of the AECOM Geo-Environmental Desk Study[3];
- Scotland's Soils[7] for soil coverage;
- Centre for Ecology and Hydrology (CEH), National River Flow Archive (NRFA)[8] for flows and rainfall;
- SEPA[9] for river basin management plans, groundwater classification, groundwater vulnerability, water quality and hydrogeology;
- Historic OS maps (available within Appendix C of the AECOM Geo-Environmental Desk Study[3]) and Aerial Photography[10]; and
- Digital Terrain Model (DTM) for topography.

The initial desk top review was carried out by AECOM with full details provided in the Geo-Environmental Desk Study Report undertaken for the Project[3]. A summary of the information relevant to this PLHRA Report can be found in the 'Baseline Environment' in **Section 0** of this report.

2.2 Assessment Approach

A single stage assessment of the peat slide Hazard Ranking has been completed for the Project. The Hazard Ranking is based on the output from Geographic Information Systems (GIS) software using a multi-criteria analysis. The outputs generated from the GIS assessment can be overly conservative in areas and therefore a review of the Hazard Rankings is also undertaken. This review considers the factors contributing to the peat landslide hazard in more detail and rationalises whether the Hazard Ranking can be reduced. The assessment of the Hazard Rankings inclusive of the review and any reduction considered appropriate is presented in **Section 0** of this PLHRA.

The outputs from the assessment of the Hazard Rankings form the basis of the overall PLHRA outcome and to whether any mitigation measures are required.

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[6] British Geological Survey (2024). *Hydrogeological Maps.* [Online] [accessed September 2024] available from: Hydrogeological maps | British Geological Survey (BGS)

[7] NatureScot (2024). *Scotland's Soils Maps.* [Online] [accessed September 2024] available from: https://map.environment.gov.scot/Soil_maps/?layer=1

[8] Centre for Ecology and Hydrology (2024). *National River Flow Archive* [Online] [accessed September 2024] available from Data | National River Flow Archive

[9] Scottish Environmental Protection Association (2024). [Online] [accessed September 2024] available from: Water | Scottish Environment Protection Agency (SEPA)

[10] Google (2024). *Google Earth Pro, Imagery courtesy of Airbus.* [Online] [Accessed August 2024] available from: earth.google.com/static/multi-threaded/versions/10.59.0.2/index.html?

2.3 Good Practice Guidance

The following good practice guidance was used to inform this appendix:

- Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments[5];
- SEPA Regulatory Guidance – Developments on Peat and Off-site Uses of Peat[11];
- Floating Roads on Peat[12];
- Constructed Track in the Scottish Uplands[13];
- Good Practice during Wind Farm Construction[14];
- Guidance on Developments on Peatland, Peatland Survey[15]; and
- Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste[16].

2.4 Summary of Surveys

The following surveys have been undertaken for the Project:

- Initial phase of ground investigation covering both intrusive exploratory holes and peat probing was undertaken by Igne in November and December 2023;
- Additional peat probing undertaken by AECOM in March 2024;
- A site walkover was conducted by AECOM in May 2024; and,
- Supplementary peat probing and peat coring undertaken by AECOM in December 2024.

The peat probing locations from the Igne and AECOM peat probing surveys, are shown on **Figure 7**, **Appendix A Figures**. **Section 4** provides further details on the surveys undertaken and their findings. Other features as observed during the walkover survey and investigative works are shown on **Figure 3**, **Appendix A Figures**.

2.5 Site Infrastructure Design

The peat depth assessment identified that peat depths ranging from absent to 1.0m cover the majority of the Site, with localised areas where peat depths were recorded up to 3.0m and isolated locations where recorded peat depths were >3.0m also identified. Significant deposits of peat >2.0m in depth were identified along the northwestern boundary of the Site and to the northwest of the Site. Generally, the Site infrastructure was located out-with this deeper peat area with only the temporary overhead line diversion extending into the vicinity.

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[11] Scottish Environment Protection Agency (SEPA) (2017). *SEPA Regulatory Guidance – Developments on Peat and Off-site Uses of Waste Peat*, SEPA Guidance, WST-G-052. Version 1., May 2017

[12] Scottish Natural Heritage and Forestry Commission Scotland (SNH & FCS) (2010). *Floating Roads on Peat, A Report into Good Practice in Design, Construction and Use of Floating Roads on Peat with particular reference to Wind Farm Developments in Scotland*, August 2010.

[13] Scottish Natural Heritage (SNH) (2015). *Constructed Tracks in the Scottish Uplands*, 2nd Edition, September 2015.

[14] Scottish Renewables (SR), Scottish Natural Heritage (SNH), Scottish Environment Protection Agency (SEPA), Forestry Commission Scotland (FCS), Historic Environment Scotland (HES), Marine Scotland Science (MSS) and AECoW (SR, et al) (2019). *Good Practice during Wind Farm Construction*, 4th Edition, 2019.

[15] Scottish Government, Scottish Natural Heritage, SEPA (2017). Peatland Survey. Guidance on Developments on Peatland

[16] Scottish Renewables (SR) and Scottish Environment Protection Agency (SEPA) (SR & SEPA) (2012). *Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste*, Version 1, January 2012.

It is acknowledged that there are very localised areas where peat >2.0m is recorded underlying the Project, however, it was not possible to design the layout to avoid these completely considering the engineering constraints of the Project. Where deposits >2.0m in depth are recorded underlying the Project, further consideration as to how these may affect the Project and how the removal of the deposits can be minimised is being considered.

3 Baseline Environment

3.1 Topography and Slope Analysis

An Ordnance Survey 5m DTM file was obtained for the Site. This file was used to produce the contour data as shown on **Figure 4**, **Appendix A Figures**. A summary of the elevation data is also presented below.

The topographic data obtained indicates the Site is located on the southern facing slopes of Feddal Hill. Within the area the land generally slopes southwards from approximately 260mAOD in the northwestern corner to approximately 200mAOD in the southwestern and continues to fall southwards out with the boundary of the Site.

The 5m DTM was used to create a slope assessment of the Site with this shown on **Figure 4**, **Appendix A Figures**. A review of this figure shows that the Site has slope gradients typically up to 10° with a very localised area with up to 15° slope gradient towards the southern boundary of the Site. Generally, the slope gradients in the northern half of the Site are recorded up to 5°.

3.2 Historical OS Mapping and Aerial Photography Review

Historic OS mapping was obtained for the Site as part of the Groundsure Report obtained for the Desk Study and is included as Appendix C of the AECOM Geo-Environmental Desk Study[3]. Review of the earliest available map from 1862 identified the Site was generally undeveloped open moorland, with several access tracks present within and water courses present in the southwestern corner. The Site use generally remained unchanged until around 2001 when forestry plantation was then recorded across the Site. By 2010 the existing access track within the Site was recorded, and by 2024 the Site was shown in its present-day layout and land use.

Historic aerial imagery for the Site was obtained through the time slider feature of Google Earth[10]. The earliest available aerial photograph with good resolution was from 2005 and recorded that the Site was within a conifer plantation with mature unfelled trees present throughout. The existing Braco West substation had not been constructed, however, the existing access track leading to the Braco West substation from the B8033 was in its present alignment. By 2015 much of the conifers within the Site had been felled, although many still remained particularly within the southeast and southwest, and the Braco West substation appears to be under construction with the northeast – southwest trending Beauly to Denny overhead electrical line also under construction. The access track located within the northwest of the Site was present presumably to facilitate the construction of the Beauly to Denny overhead line as part of the Braco West substation's development. By 2017 construction of the Braco West substation had been completed, as was the Beauly to Denny overhead line to the west of the existing substation. An additional branch of access track was present within the south and southwest of the Site with all the existing tracks within the Site now in their present alignment. By the most recent aerial photography available from 2021, the plantation within and surrounding the Site was in its present state of felling/replanting.

No obvious evidence of peat instability features were noted from review of the available historic and current OS mapping or aerial photography.

3.3 Current Land Use

The current land use of the Site was assessed based on recent ordnance survey mapping and aerial imagery available through Bing Maps[17] and through consultations with the Applicant.

The Site is dedicated forestry plantation (coniferous wood) with the majority of the Site having been recently felled and replanted. Firebreaks and ridings are present, and aerial imagery clearly shows drainage channels and forestry planting ploughs throughout the Site. Within the northeast of the Site is the existing Braco West Substation and running within the Site in the northern half is the existing northeast – southwest trending Beauly to Denny overhead electrical line. Within the northern half of the Site is also a northeast – southwest trending access track, with a spur off this access track also noted trending northwest – southeast and present within the southwest of the Site. Both access tracks extend out-with the Site. Towards the southern boundary of the Site, the source of two watercourses is shown. What appears to be watercourses or drainage channels are also recorded within the northeast of the Site towards the existing Braco West Substation.

3.4 Geology and Soils

Superficial Geology (Drift Deposits)

A review of the British Geological Survey (BGS) Onshore GeoIndex Viewer[18] indicates the Site to predominantly underlain, from surface, by peat. Glacial till is recorded from surface within the south of the Site. Towards the eastern extent of the Site, an area where no superficial deposits are recorded is indicated by the BGS suggesting that bedrock is close to surface in that area. Given the potential presence of shallow bedrock adjacent to the Site, this may indicate that locally peat is directly overlying bedrock, which is likely to be weathered. Where not directly overlying bedrock, the peat is anticipated to be underlain by glacial till. The extents and location of the recorded superficial deposits across the Site are shown on **Figure 5**, **Appendix A Figures**.

Although not recorded by the BGS, as watercourses are recorded within the south of the Site, there is potential for alluvial deposits to be present in the immediate vicinity of these watercourses. Again, although not recorded by the BGS made ground is also anticipated within the Site associated with the existing developments (e.g. access track, substation, overhead line, etc.).

[17] Microsoft (2024). *Bing Maps,* available: https://www.bing.com/maps/, [Online] [accessed August 2024]

[18] British Geological Survey (BGS) (2024) *Onshore Geoindex.* [Online] available: https://mapapps2.bgs.ac.uk/geoindex/home.html, [accessed August 2024]

The BGS provide the following descriptions of the recorded and possible superficial deposits:

- Glacial Till – the BGS do not provide a description of this deposits, however, it is anticipated to consist of a variable proportion of clay, silt, sand and gravel with cobbles and boulders.
- Peat – "partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps."
- Alluvium – general term for clay, silt, sand and gravel deposited by a river, stream or other running water body. The deposit is typically described as "soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel."
- Made Ground – the BGS do not provide a description of made ground, however, this is likely to be highly variable in its composition, dependant on its source and may contain anthropogenic material.

The information obtained from the BGS was supplemented through review of the National Soil Map of Scotland Viewer[19]. This source identified the following:

- The Site is predominately underlain by Balrownie soils consisting of peaty gleyed podzols. This soil is recorded as being derived mainly from sandstones of Lower Old Red Sandstone age, which are often water-modified. The soils are recorded as being formed on undulating uplands with gentle and strong slopes which are non-rocky.
- Locally within the northwestern corner of the Site and extending further north and west out with the Site, the mapping indicates organic soils consisting of dystrophic blanket peat are present. These soils are recorded as being formed in the uplands and northern lowlands on both gentle and strong slopes.

Review of the Carbon and Peatland 2016 Map layer of the National Soil Map of Scotland Interactive Map Viewer[19] was also undertaken. This source indicated that the Site is predominately underlain by Class 4 carbon and peatland soils. Locally in the northern half of the Site, Class 5 carbon and peatland soils are also recorded.

The 2016 Carbon and Peatland map provides further details on the classifications recorded as follows:

- Class 4 – Predominately mineral soils where some peat soil may be encountered. The areas are unlikely to be associated with peatland habitats or wet and acidic type soils. The area is also unlikely to contain carbon-rich soils.
- Class 5 – Recorded as a peat soil, where the soil information takes precedence over the vegetation data. No peatland habitat is recorded within the area; however, the soils are likely to be carbon-rich and contain deep peat. Bare soils may also be present within the area.

Based on the information reviewed, it is noted that peat deposits are likely to be present throughout the Site.

Taking cognisance of the available information, the substrate is likely to vary between glacial till and bedrock (likely weathered). Intrusive ground investigation has been undertaken and so the composition of the substrate underlying the Site can be better estimated through this. Discussion on the substrate underlying the peat within the Site is provided in **Sections 4.2** and **6.5** of this report.

[19] Scotland's Soils (2024). *National Soil Map of Scotland*, [Online] available: https://map.environment.gov.scot/Soil_maps/?layer=1#, [Accessed: August 2024].

A review of the landslide layer of the BGS Geoindex was undertaken as part of the superficial geology review, which indicated the BGS do not hold records of any landslides having occurred within or in close vicinity to the Site.

The potential for landslides is also identified as part of the natural ground subsidence assessment included as part of the Groundsure Report included within Appendix C of the AECOM Geo-Environmental Desk Study[3]. This source identified the Hazard rating in relation to landslides within the Site as 'Very Low'. This is defined as 'Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered.'

Solid Geology (Bedrock)

A review of the BGS Onshore GeoIndex Viewer indicates the Site to be underlain by sandstone of the Teith Sandstone Formation. Surrounding the Site to the south, east and northeast, rock comprising mudstone and siltstone of the Cromlix Mudstone Formation is recorded. Both the Teith Sandstone Formation and Cromlix Mudstone Formation are part of the Stratmore Group. The extents and location of the recorded solid geology across the Site is shown on **Figure 6**, **Appendix A Figures**.

The BGS provide the following descriptions of the recorded solid geology:

- Teith Sandstone Formation – recorded to be of sedimentary rock type. Described as "reddish-brown, grey, purple and brown, cross-bedded sandstone, locally interbedded with siltstone and mudstone intercalations, conglomerate members and interbeds are common in the Highland Border area."
- Cromlix Mudstone Formation – recorded to be of sedimentary rock type. Described as "characteristically soft, bright red to dull brownish-red, maroon or purplish-brown, with green reduction spots in the north-eastern Midland Valley, generally massive but often thinly laminated, poorly-sorted, fine-grained silty sandstones, sandy siltstones, siltstones and mudstones, which lithologies may be locally interbedded with thin lenses of medium to coarse-grained pebbly sandstone."

Structural Geology

A review of the BGS Onshore GeoIndex Viewer indicates no faults are present within the Site. An inferred fault is recorded to be present approximately 30m south of the Site, orientated approximately east – west.

Surrounding and locally recorded within the south of the Site, a series of typically eastward trending glacial meltwater channels are shown. These channels may contain deposits of outwash gravels formed during glacial retreat.

The locations of the fault and glacial meltwater channels are shown on **Figure 6**, **Appendix A Figures**.

3.5 Mining and Quarrying

Coal Mining

The Coal Authority Interactive Map Viewer[20] indicates the Site is not within Coal Mining Reporting Area. Furthermore, there are no areas within the Site which fall within the Development High Risk Area designation and there are no mine entries recorded within 500m of the boundary of the Site.

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[20] Coal Authority (CA) (2024). *Interactive Map,* [Online] available: https://datamine-cauk.hub.arcgis.com/. [Accessed: August 2024].

Quarrying

Review of the Groundsure Report for the Site as contained within Appendix C of AECOMs Geo-Environmental Desk Study indicates no quarrying activities are recorded within 100m of the Site. This is confirmed through the review of the available historic OS mapping and aerial imagery for the Site.

A review of the Mine Plans Extents layer of the BGS Geoindex was also undertaken. Plans are shown to cover the entire Site. However, do not show underground mining at a depth shallow enough that will affect the Site.

The Active Mines and Quarries layer of the BGS Geoindex also indicates no active mines or quarries are present within or in the immediate surroundings of the Site.

3.6 Hydrogeology

An estimation of the groundwater productivity of the superficial deposits recorded within the Site was made using the guidance contained within the BGS Aquifer Productivity Report. The following aquifer productivity estimations were therefore made:

- Glacial Till – typically regarded as having a very low to low permeability and so are generally classed as not a significant aquifer;
- Alluvium – can have a varying permeability ranging from high to very low depending on the parent material making up the deposit. If the deposits are dominated by sand and gravel, then the deposits can be considered as a moderate to high productivity aquifer with potential yields from 1 to >10l/s. If the deposits are dominated by clay or silt, then they are likely to be classified as not a significant aquifer.
- Peat – peat is not covered within the guidance document; however, it is typically considered to have a relatively low permeability. Given this the peat is considered to not be a significant aquifer.

Review of the Hydrogeology 1:625,000 scale layer of the BGS Geoindex, provides information on the solid geology aquifer productivity. This indicates that the Strathmore Group, of which all rock formations recorded within the Site belong too, is a moderately productive aquifer. The BGS describe this as a "Sandstones, in places flaggy, with siltstones, mudstones and conglomerates and interbedded lavas locally yield up to 12l/s in parts of Strathmore."

3.7 Hydrology

The recorded hydrology for the Site, as recorded by OS mapping, is shown on **Figure 7**, **Appendix A, Figures**.

The majority of the Site appears to be drained by the two unnamed watercourses in the south. Both watercourses typically flow to the south and drain into the Crocket Burn at around Altersie, approximately 620m south southeast of the Site. The northeastern corner of the Site contains recorded watercourses which are assumed to be drainage channels associated with the existing Braco West substation. This drainage channel is locally assumed to drain the northeastern extent of the Site and is recorded to flow to the north, draining into the Bullie Burn approximately 200m north of the Site.

Given the land use of the Site is commercial forestry, it is known and anticipated that several drainage ditches and channels are present within the Site with these generally assumed to drain into the two recorded watercourses in the south of the Site.

One main river catchment is recorded within the Site; the Allan Water. The Crocket Burn and Bullie Burn, to which all watercourses and drainage ditches within the Site are anticipated to drain, eventually flow into the Allan Water, which is present at its closest point, approximately 3.1km southeast of the Site.

Review of SEPA's water classification hub[21] indicates no watercourses within the Site have been Classified by SEPA. However, the Bullie Burn located to the north of the Site and the Muckle Burn, where the Crocket Burn drains into to the south of the Site, have been classified by SEPA. Both of these have been classified with an overall status of 'Good'. As the watercourses within the Site and the Crocket Burn have not been classified by SEPA, it is assumed these have the same overall status classification as the Bullie Burn and Muckle Burn (i.e. overall status of 'Good').

Review of the National River Flow Archive (NFRA) shows no flow gauges are present for the watercourses located within the Site or for the watercourses to which the onsite ones flow into.

3.8 Climate

The rainfall data for the site is obtained through review of the catchment information tab relating to specific measurement gauges along watercourses, available from the National River Flow Archive (NRFLA) search data page[22]. This source indicated two gauging stations are located within 10km of the Site as follows:

- Located on the Allan Water at Kinbuck, approximately 3.2km south of the Site; and
- Located on the River Teith at Bridge of Teith Doune, approximately 10.0km southwest of the Site.

Table 3-1 shows the annual average rainfall recorded from each of these gauging stations.

Table 3-1 NRFA Rainfall Data

Catchment	NGR	Gauge ID	Station Level (AOD m)	Period of Record	Annual Average Rainfall (mm)
Allan Water at Kinbuck	NN 792053	18001	92.99	1961 – 1990	1384
River Teith at Bridge of Teith, Doune	NN 725011	18003	14.84	1961 – 1990	2001

3.9 Flooding

Flooding information relevant to the Site has been obtained as part of the Groundsure Report contained in Appendix C of the AECOM Geo-Environmental Desk Study. This source record negligible risk of river and coastal flooding within the Site. Very localised small areas of surface

[21] Scottish Environment Protection Agency (SEPA) (2024). *Water Classification Hub*. [Online] available: https://www.sepa.org.uk/data-visualisation/water-classification-hub/, [Accessed: August 2024].
[22] National River Flow Archive (NFRA) (2024). *River Flow Data Search,* [Online] Available: https://nrfa.ceh.ac.uk/data/search, [Accessed August 2024].

water flooding are recorded within the Site with the highest risk being a 1 in 30-year rainfall event causing flooding of greater than 1.0m in depth.

The Groundsure Report indicates a negligible risk of groundwater flooding associated with the peat deposits recorded within the Site and a low risk associated with the glacial till recorded within the Site. See **Figure 5**, **Appendix A Figures** for the BGS recorded locations of these superficial deposits within the Site.

3.10 Geomorphology

The geomorphology of the Site is dominated by the topography and resulting drainage pattern. The topography of the Site is dominated by the southern facing slopes of Feddal Hill. Generally, the northern extent of the Site is flat because of being towards the crest of Feddal Hill with the topography then sloping generally to the south at slope gradients typically up to 10°. Drainage patterns are therefore typically trending to the south.

The flatter and less steep ground within the northern half of the Site are likely to represent wetter areas that are more likely to contain deeper peat accumulations. This is confirmed through the BGS recorded locations and extents of peat (see **Figure 5**, **Appendix A Figures**) as well as during the site walkovers (see **Section 4.1**). Along the steeper slopes within the south of the Site less thick peat accumulations and extents are anticipated, with the BGS recording glacial till from surface within the south of the Site (see **Figure 5**, **Appendix A Figures**).

4 Sources of Peat During Construction

4.1 Walkover Survey

Three site walkover surveys were undertaken within the Site to inform this report as follows:

- By AECOM in March 2024 as part of the additional peat probing undertaken;
- By AECOM in May 2024; and
- By AECOM in December 2024 as part of the supplementary peat probing undertaken.

Generally, the site walkover agreed with the features as identified in the 'Current Land Use' Section of this PLHRA (**Section 3.3**). The Site was found to be covered by commercial coniferous forestry with the woodland present varying in maturity. An access track was present within the north of the Site along with the existing overhead electricity line leading into the existing Braco West Substation in the northeastern corner of the Site. The existing watercourses as identified in **Section 3.7** were not observed as part of the walkovers, however, drainage channels, some of which were deep (i.e. >1.0m in depth), were observed throughout the Site. Observations made on the batters of the drainage channels showed both areas of deep peat (>1.0m in depth) and more shallow peat (approximately 0.5m in thickness) with these observations typically agreeing with the probing discussed in the next section of this report. The peat observed within the Site was noted as being likely disturbed as part of the felling and replanting process of the commercial forestry operations. The maturity of the woodland in the Site was typically observed as recently felled and replanted with young trees, although there were areas of mature trees in the western extent of the Site, with semimature trees in the south and southwest of the Site.

Ground conditions across the Site were noted to vary. Within the north of the Site where the land was flatter and where deeper peat deposits are anticipated; the ground conditions were noted as softer and wetter underfoot. This would suggest that peat is present and may indicate deeper deposits. Along the steeper topography in the south of the Site the underfoot conditions were noted as being firmer and drier potentially indicating the absence or thinner peat deposits being present. No evidence of peat landslide or peat cracking were noted during any of the Site walkovers.

There were no peat instability features observed during the Site surveys. Fallen trees were noted as part of the Site walkovers, within the west of the Site associated with the mature woodland. Observations suggested that the tree root systems were fairly shallow within the superficial and that, where observed, at least a peaty topsoil was present with deeper peat deposits possible.

Observations made in relation to the maturity of woodland and saturated ground conditions of the Site are shown on **Figure 3**, **Appendix A Figures** of this report.

Watercourses/Ponds

As highlighted above, the watercourses recorded from the Desk Study within the Site were not observed as part of the Site walkovers. Numerous drainage channels were observed within the Site associated with the forestry works, however, minimal water and no perceptible flow was observed in these. The drainage channels observed are not included as part of the OS mapping on **Figure 7**, **Appendix A Figures** of this report.

4.2 Peat Investigations

Multiple peat investigations were undertaken across the Site to ensure adequate coverage for use in the planning stage design. Note where peat investigations were undertaken, these were scoped taking cognisance of the Peatland Survey Guidance[16].

Initial Ground Investigation (2023)

An initial phase of ground investigation was undertaken by Igne in November and December 2023. The investigation included 4795 peat probes, 17 no. boreholes and 20 no. trial pits. The results of the investigation are included within Igne's Factual Report[4]. **Figure 10** within **Appendix A Figures** shows the locations of the boreholes and trial pits undertaken by Igne.

The peat probing was undertaken across two possible locations for the Project, the proposed Site and a location just to the north of the proposed Site. The peat probes were undertaken to give an initial understanding of the peat extent and depth across the possible Site locations to allow selection of the Site with the thinnest peat deposits. The peat probing undertaken was at approximate 10m centres across the possible substation platform locations. Estimated peat depths from this survey ranged from absent to 7.0m.

The intrusive investigation (i.e. trial pits and boreholes) were typically undertaken within the Site to allow outline design of the Project to be undertaken. The peat encountered within the exploratory holes varied between 0.2m (BH14 New & TP13 New) to 2.0m (BH13) in thickness with the thickness of peat generally greater towards the northwestern boundary of the Site. Generally, the peat depths encountered were <1.0m in thickness and were locally recorded to be absent with the average thickness calculated at approximately 0.8m. The intrusive investigation results were reviewed against the peat probe data, with these generally showing agreement in peat depth. The peat deposits across the Site, as reported in Igne's Factual Report, are typically recorded to fall into two different types, as follows:

- soft dark brown spongy amorphous peat locally with cobbles and pieces of wood; and
- soft dark brown spongy pseudo-fibrous peat locally with pieces of wood.

Within BH13 where the deepest peat deposits were recorded a very soft plastic amorphous peat was recorded underlying the soft spongy amorphous peat at a depth of 1.2 m. Note, however, BH13 is situated just outwith the Site boundary to the west. No discernible trends were noted in relation to the spread of amorphous or pseudo-fibrous peat across the Site, and the acrotelm or catotelm was not identified.

SLR Consulting Limited produced a Ground Investigation Report (GIR) for the Project[23] which includes description on the peat findings and an engineering assessment. Generally, SLRs interpretation of the peat depths and extents agreed with the text provided in the paragraph immediately above. However, SLR note that although amorphous peat has been recorded within exploratory holes at several locations, they considered this to be more pseudo-fibrous in nature.

The substrate across the Site was recorded to vary between course-grained deposits typically of gravelly sand or sand & gravel, and fine-grained deposits typically of clay. The coarse-grained deposits were generally recorded within the southwest of the Site and the fine-grained deposits were generally recorded within the northeast of the Site.

[23] SLR Consulting Limited (2024) Braco West ASTI 400kV Substation, Ground Investigation Report, SLR Project No. 422.064790.00001, Revision: Final, 21 May 2024

Additional Peat Probing (2024)

Additional peat probing within the Site was undertaken by AECOM in March 2024. The additional probing was undertaken to cover areas of the Project which were not included as part of the initial probing. The probing was undertaken at 10m spacing throughout the proposed infrastructure not already covered to gain understanding of the peat depth.

In total 847 probes were proposed as part of the additional probing exercise, however, only 442 probes were able to be undertaken. This was due to windblown and the risk of windblown trees restricting access for the proposed probe locations in the southwest of the Site and dense forestry restricting access for probing in the south of the Site. **Figure 7**, **Appendix A Figures** presents the results of all of the probing undertaken and illustrates the probes which could not be completed.

Estimated peat depths from the additional probing ranged from absent to 3.7m, although the majority of probes recorded estimated peat depths <1.0m.A Technical Note providing full details on the additional probing undertaken by AECOM in March 2024 is provided as **Appendix B Peat Investigation Technical Notes.**

Supplementary Peat Probing and Peat Coring (2024)

A supplementary phase of peat depth probing was undertaken by AECOM in December 2024 and included 7 no. peat cores to identify composition of the peat deposits present. The supplementary probing was undertaken in 3 separate areas across the Site, targeting areas not previously probed. Note that 1280 probes were initially proposed for the supplementary peat investigation works, however, this was reduced to 683 as reasoned in the following text. In the area in the southeast of the main works area, the probing was based on an original 10m grid, however, after initial probing the peat depths encountered were typically estimated to be <1.0m in thickness and as such the density of probes was reduced to typical 10m spacing in the northeast – southwest orientation and 20m spacing in the southeast – northwest orientation. The grid was increased back to a 10m grid where deposits >1.0m were identified. In the area of the proposed OHL tie-in works, a typical 10m probing grid was undertaken across the proposed OHL tower and working platform locations. The last area probed was to the immediate east of the main works area and south of the existing Braco West Substation. The probing was undertaken here to gain understanding of the peat depths adjacent to the main works area and was undertaken in a typical 20m grid. Probing in this area was reduced from that initially proposed due to the presence of an underground 33kV cable and due to the presence of dense forestry in the east of the area. **Figure 7**, **Appendix A Figures** presents the results of all of the probing undertaken and illustrates the probes which could not be completed.

Estimated peat depths from the supplementary probing ranged from absent to 2.4m, although the majority of probes recorded estimated peat depths <1.0m with many indicating peat depths <0.5m.

As part of the peat investigation works undertaken, peat coring using a Russian Corer was also carried out. The cores were taken adjacent to trial pits previously undertaken in order to obtain samples for laboratory testing and to build on the peat description which had previously been omitted. The 7 no. peat cores were taken at locations corresponding to trial pits (TP's 01, 03, 04, 09, 10, 11 & 13) undertaken by Igne as part of the Initial Ground Investigation to provide further detailed descriptions on the composition of peat present within the Site. **Figure 10 in Appendix A Figures** provides the location of the Igne exploratory hole locations for reference. The peat depths encountered as part of the coring ranged from 0.25m to 1.0m. Descriptions of the peat encountered were typically recorded as soft dark brown to brown fibrous to pseudo fibrous peat locally with occasional pieces of wood.

The Von Post Humification Scale[24] was used as part of the logging of the peat cores recovered, whereby the peat is classified in accordance with its degree of humification (decomposition) between H1 and H10, with H1 being completely undecomposed and H10 being completely decomposed. The peat was also classified in accordance with its moisture content using a scale of B1 to B5, with B1 as dry peat up to B5 which is very high moisture content. The peat recovered from the coring was recorded in the range H4 (slight decomposition) to H5 (moderate decomposition) / B2 (low moisture content), although locally moisture contents of B1 (dry) and B3 (moderate) were also recorded. Geotechnical laboratory testing was undertaken on core samples recovered during the peat coring exercise. These typically indicated water contents ranging from 486% to 822% and organic matter content (OMC) ranging from 59.1% to 71.7%. Given the high OMC, generally ≥60%, the peat present onsite would typically meet the minimum OMC required as per NatureScot's Guidance[25] of 60% to be considered a peat. However, there were two locations corresponding to TP03 & TP13, where lower OMCs were recorded; 9.7% and 14.7%, respectively. At TP13 this means the peat likely falls more into a peaty topsoil. Whereas, at TP03 the depth of the test was towards the base of peat layer (0.42m – 0.60m) and may indicate the peat is shallower here coming into a more organic mineral soil at this depth. The descriptions of the peat recovered from the AECOM peat coring typically indicate the peat is more fibrous or pseudo-fibrous in nature rather the amorphous recorded by Igne, therefore agreeing with SLR's Consultants assessment that the peat present within the Site is generally more fibrous in content than recorded by Igne.

The substrate was recorded in 5 no. of the cores taken and was typically described as a very sandy silty gravel, grading to a silty sand and gravel in one location.

A Technical Note providing full details on the supplementary probing undertaken by AECOM in December 2024 is provided as **Appendix B Peat Investigation Technical Notes**.

Peat Probing Summary

In total, 5920 probes were carried out for the Project. **Figure 7**, **Appendix A Figures** shows the locations of the peat probes undertaken across all surveys and indicates the estimated depth of peat encountered. **Figure 8**, **Appendix A Figures** then uses the results of the peat probes and their locations to create a peat depth interpolation plan for the Site. Note the peat depth interpolation was undertaken using the Inverse Distance Weighting methodology. It should be noted that there are areas of the Site where no peat probing has been carried out within 50m. In these areas the peat depth has been estimated based on the general peat depth from the nearby probes and by assuming a peat depth across the areas. It is acknowledged that peat depths may be greater than estimated in these areas, however, for this preliminary assessment the estimation is considered suitable. A final PLHRA will be required post-consent, following design maturity, where it is anticipated the Site will be clear felled and probed in full to allow informed peat depth thicknesses to be known throughout.

In general, the results of the peat probing within the Site indicate peat depths ranging from absent to 1.0m, with localised areas indicating peat depths up to 3.7m in the northern extent of the Site

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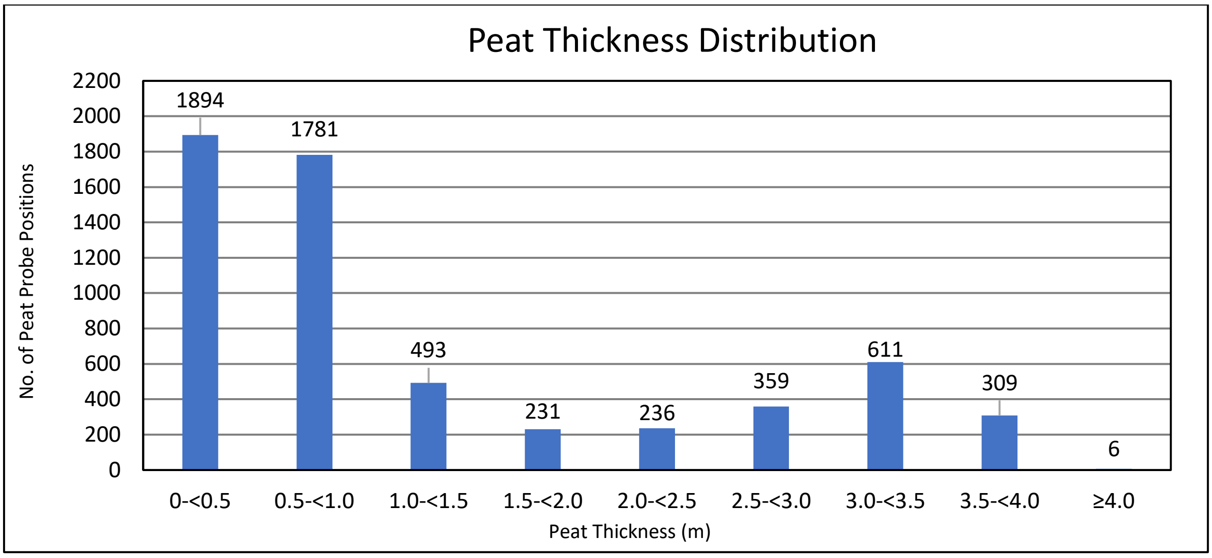
[24] Von Post, L. (1924) Das genetische System der organogenen Bildungen Schwedens, Comite International de Pedologie. IV Commission. No. 22., 1924.

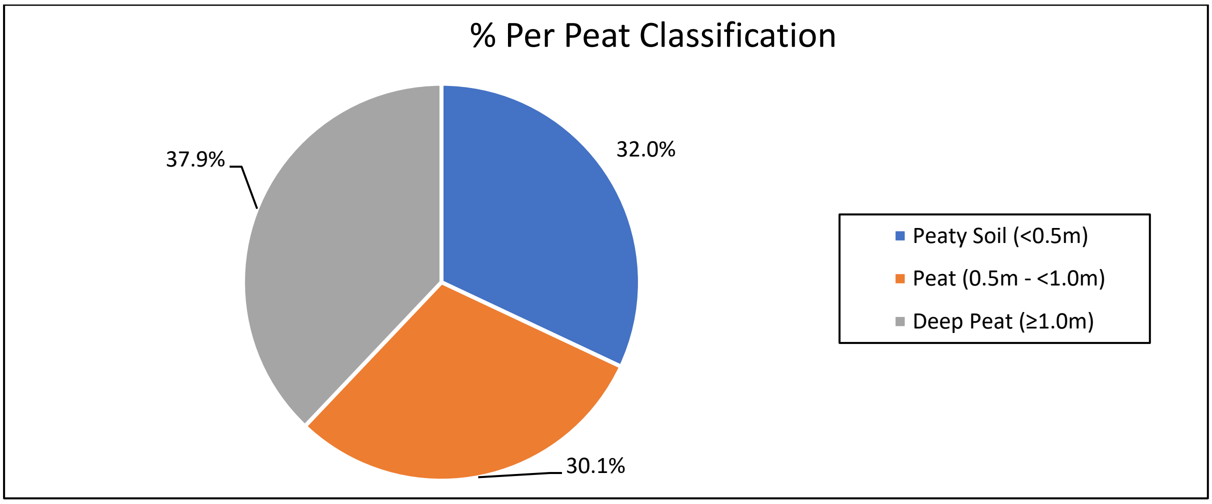
[25] NatureScot (2023) Advising on peatland, carbon-rich soils and priority peatland habitats in development management. Available at: https://www.nature.scot/doc/advising-peatland-carbon-rich-soils-and-priority-peatland-habitats-development-management [accessed December 2024]

and localised areas of up to 3.0m in the south of the Site, with very isolated probes also indicating peat depths >5.0m within the Site.

Plot 1 and **Plot 2** below, present the distribution of peat probes against the thickness range recorded.



Plot 1 - Peat Thickness Distribution



Plot 2 - Percentage Per Peat Classification

When considering both the IGNE and AECOM peat probe surveys undertaken, 2245 of the probes (~37.9% of the 5920 no. total probes) indicate deep peat >1.0m in thickness. Peat deposits between 0.5m and <1.0m thick were recorded in 1781 no. of the probes (~30.1% of the 5920 no. total probes, and peaty soil <0.5m thick were recorded in 1894 no. of the probes (~32.0% of the 5920 no. total probes).

In relation to the Site, the deep peat deposits were typically located out with the boundary of the Site to the northwest, as shown on **Figure 7**, **Appendix A Figures** and underlying the alternate possible substation location considered during the Site selection process. Peat and peaty soil deposits were generally encountered throughout the Site with no particular trend noted. Localised areas of deep peat deposits were identified within the Site typically along the northwestern boundary, within the southwest and towards the western extent. The deep peat deposits were typically recorded up to a depth of 3.5m, however, very localised probes encountered deeper deposits with the maximum being >5.0m within the Site. The areas of deeper peat generally agree with the understood geomorphology of the Site with the deeper peat deposits generally encountered in areas of flatter lying ground.

5 Site Based Excavation & Management Assessment

5.1 General Information on Peat

The BGS describe peat as a "partially decomposed mass of semi-carbonized vegetation which has grown under waterlogged, anaerobic conditions, usually in bogs or swamps."

Peat is characterised as generally having an extremely high-water content, high organic content, low bulk and dry densities, low shear strength and very high compressibility[26]. The Scottish Government guidance document[15] provides further information on the characteristics of peat indicating that dry peat is typically 90 – 95% organic matter and that it has special hydrological properties with water contents of around 90%.

Peat deposits are split into two layers an upper acrotelm and a lower catotelm. The acrotelm is typically <0.6m deep and is where there is a living root system which helps to loosely bind the plant remains together with a normal level of water table fluctuations also within the layer. The catotelm is a more decomposed layer which is below the water table level and is waterlogged. The position of the water table therefore controls the level of acrotelm and catotelm deposits which therefore control the stability of the peat deposits. For the purposes of this assessment, it has been estimated that the simple accepted assumption of the upper 0.3 m peat thickness being acrotelm and the rest of the peat thickness being catotelm.

BS 5930[27] provides a means for describing peat in the field in the form fibrous peat, pseudo-fibrous peat and amorphous peat. Fibrous peat is described as having clearly recognisable plant remains with the deposits also retaining some tensile strength. Pseudo-fibrous peat is described as a mixture of plant fibres and amorphous peat paste. Amorphous peat is described as having no recognisable plant remains with the deposits also having a 'mushy' consistency. The degree of decomposition of the peat can be further estimated in the field by applying the von Post Scale of humification[27] which ranges from H1 (no decomposition) to H10 (totally decomposed).

The Scottish Government Guidance document[5] records three different naming conventions depending on the depth of the peat deposits. These are listed as follows:

- Peaty Soil – a peat or surface organic soil with a depth of <0.5m;
- Peat – a peat of >0.5m but ≤1.0m depth and which has an organic matter content of >60%; and
- Deep Peat – a peat that is >1.0m depth.

The Scottish Government Guidance document also identifies three different types of peat deposits; raised bog, blanket bog and fen bog. The Wildlife Trust records that a raised bog is formed of deep peat which can be several metres higher than the surrounding ground level and covered with a surface layer of vegetation[28]. Generally, raised bogs are significantly wetter than the surrounding land and are fed almost entirely by rainwater. The Wildlife Trust[29] records that a blanket bog is generally an upland habitat with peat that has accumulated to a depth of at least 0.5m, typically on flat or gently sloping land where drainage is poor, and the peat is predominately fed by

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[26] O'Kelly, B.C. (2017). *Measurement, interpretation and recommended use of laboratory strength properties of fibrous peat, Geotechnical Research*. Volume 4 Issue GR3, ICE Publishing, October 2017

[27] British Standards Institute (BSI) (2020). *Code of practice for ground investigations, BS 5930:2015 + A1:2020*. BSI Standards Limited, May 2020.

[28] Wildlife Trust (2024a). *Raised Bog,* [Online] available: https://www.wildlifetrusts.org/habitats/wetlands/raised-bog, [Accessed August 2024].

[29] Wildlife Trust (2024b). *Blanket Bog*, available: https://www.wildlifetrusts.org/habitats/wetlands/blanket-bog, [Accessed August 2024].

rainwater. The International Peat Society[30] records fen peatlands as being located in depressions which have strong connections with groundwater that have been in contact with mineral bedrock or soil.

Peat accumulations are typically thickest in reasonably flat lying areas or topographic hollows where surface and groundwater drainage are often concentrated and thins as the local slope angle increases. On steep slopes the conditions are generally considered too steep for thick peat to form, although some peat may be present.

5.2 Factors Controlling Peat Instability

The Scottish Government Guidance document indicates that peat instability can manifest in a number of ways, which generally fall into two categories: minor instability and major instability. Minor instability are features which may be warning signs of major instability or possibly just simply represent a response to the land against drainage and gravity (e.g. creep). Localised and small tension cracks, tears in the acrotelm, compression ridges or bulges and thrusts in the peat deposits represent some features which represent minor instability. Major instability comprises an actual peat landslide which can vary in form and scale.

The Scottish Government Guidance document records that peat instability can be caused by a number of factors which can be split into two groups: preparatory factors and triggering factors. Preparatory factors increase the susceptibility of peat to become unstable (i.e. fail) without necessarily causing a peat landslide. As such, preparatory factors can influence peat stability over a long period of time. Triggering factors have an immediate or rapid effect on the peat changing its stability from stable to unstable. As such, triggering factors can be considered as being the cause of failure.

The main preparatory factors, which reduce the overall stability of peat include:

- Increase in the mass of peat (e.g. through vertical accumulation of peat, increase in water content and through afforestation within the peat);
- Reduction in shear strength of the peat or substrate through physical changes in its structure (e.g. creep or vertical fracturing), chemical or physical weathering or by clay dispersal in the substrate;
- Loss of surface vegetation (e.g. through burning, pollution or through deforestation) causing reduction in tensile strength;
- Increased buoyancy of the peat through increase in sub-surface water or wetting of desiccated areas; and
- Afforestation, which will reduce the water content of the peat body and increase the likelihood in the formation of desiccation cracks which are likely to be infiltrated by rainfall.

Triggering factors can be split into two types; natural events and man-made. Triggering factors covering the two types include:

- Natural Events:
  - High intensity and prolonged rainfall, in particular following a dry period, or melting of snow / ice causing a short-term high pore-water pressure at pre-existing or potential rupture surfaces;
  - Earthquakes causing rapid ground acceleration;
  - Erosion at the toe of a peat slope, reducing support to the upslope peat mass; and
  - Increased loading on the peat mass (e.g. through previous peat landslide debris).

[30] International Peat Society (2024). *Types of Peatland.* available: https://peatlands.org/peatlands/types-of-peatlands/, accessed August 2024.

- Man-made Events:
    - Alteration of hydrological regime by changing natural drainage paths;
    - Rapid ground accelerations caused by works (e.g. through blasting or vibrations of plant);
    - Extraction of peat at toe of slope, reducing support to the upslope peat mass;
    - Increased loading on the peat by plant, structures or overburden;
    - Earthworks including excavating, filling, stockpiling and embankment of material; and
    - Ground subsidence associated with mining.

While peat failures are often considered to originate in thick or extensive accumulations, it should be noted that instability can still occur in areas of limited peat thickness. The nature of the peat and the interface between the separate layers can also influence its stability. The plane of failure can be located at the interface between the upper, periodically saturated acrotelm layer and the underlying permanently saturated catotelm layer. The plane of failure can also be located at the interface between the peat and the underlying substrate.

Failure can occur due to heavy or prolonged rainfall or due to melting snow or ice which can cause short-term high pore-water pressure along pre-existing or potential rupture surface (e.g. between the substrate and the peat) and can increase the mass of the peat accumulation. This can be exacerbated by drying out of the peat (in summer months for example) leading to the formation of desiccation cracks which can in turn fill with water during rainfall resulting in a short-term increase in pore-water pressure and potentially cause failure. The influence of rainfall on potential peat failure is considered to be heavily dependent on the natural drainage regime within the peat. It should be noted that peat failures often occur after heavy rainfall events after the peat slope has been conditioned to fail after other processes. Given the effect of global warming and the anticipated greater frequency of extreme weather conditions, including more intense storms with heavy rainfall, the rainfall trigger of peat instability may be of more significant concern in the future.

Peat extraction can generate new drainage pathways, leading to a concentration of surface and / or groundwater flow and subsequently result in either increased erosion or concentration of water within localised areas of the accumulation, which can potentially increase the instability of the peat mass. Extraction or erosion can also have the effect of releasing the confining pressures acting on the peat, which can lead to the development of tension cracks in adjacent peat accumulations as a result of the loss in lateral support. Extraction or erosion of the peat mass at the toe of a slope also reduces the support to the upslope material which can result in peat slope failure.

Loading of peat causes an increase in the shear stress applied to the peat mass and can also generate the formation of tension cracks through compression and bulging of underlying or adjacent peat soils. In the case where tension cracks are formed, depending on the topography, the strength of the peat may be dramatically reduced and due to the alteration in loading, rainfall may not be required to initiate a failure.

Ground subsidence associated with the collapse of shallow underground workings and / or abandoned mine shafts may trigger localised peat slumps. Peat failures initiated by mining subsidence could be expected to typically involve peat slumping in towards the area affected by subsidence and their scale would be dependent on a number of factors including the depth of the peat deposits, the nature of the local hydrological regime and the topography of the surrounding area.

Rapid ground accelerations caused by either man-made vibrations or earthquakes increases the shear stresses within the peat mass and may trigger a peat landslide.

Tree felling (even where affected areas are subsequently re-planted) and permanent deforestation can impact upon the hydrogeological regime of the peatland area through reduced groundwater extraction and altered drainage pathways. This can lead to increased peat erosion and focused drainage and short-terms high pore-water pressures within pre-existing or potential rupture surfaces in the peat accumulation, both of which can increase the risk of peat failure. Also, removal of trees can remove the potentially stabilising root systems, which can reduce the tensile strength of the peat mass.

Alteration of the hydrological regime can have long-term and far-reaching effects on the stability of peat accumulations. Alteration by diverting or blocking either man-made or natural surface drainage pathways or the proposed construction of new ditches can transport and concentrate water into areas which can cause potential peat instability.

Within peat accumulations, groundwater will generally flow more readily within the upper acrotelm layer relative to the underlying less permeable catotelm. Excavations within peat will influence existing drainage paths and local permeability. The construction of the Project will potentially generate an area of hydrological sensitivity due to the free draining nature of the construction stone.

It should be noted that peat is a natural feature which under the correct conditions will grow. It is likely that, on sloping ground and where the peat has been growing, there will be a time when the stabilising forces (e.g. internal strength of the peat and the interface with the underlying substrate) will be outweighed by the unstabilising forces (e.g. weight of the peat mass) and the peat accumulation will fail.

5.3 Peat Failures

Areas that have experienced historic peat instability are more likely to experience future instability issues during and post construction. It is therefore essential to identify and record any signs of past instability (e.g. cracking of the peat surface, any debris from past failures, peat creep, etc) as part of any peat instability assessment.

Peat failures can occur on gentle slopes, just as on steeper slopes, depending on the loading, drainage conditions and the condition of the peat structure. Changes in gradient, including the subsurface gradient of underlying strata, can also contribute to peat failure due to the potential short term excess pore-water pressures they can create within both concave and convex slope profiles and the gravitational effects on the peat mass.

Types of Peat Failure

Table 2.1 of the Scottish Government Guidance document identifies a number of different types of peat failures, as follows:

- Bog Bursts – failure of a raised bog which involves the emergence of liquid basal peat followed by the settlement of the previously overlying residual peat. Typically recorded to occur on slopes with gradients between 2° and 5° with a typical peat thickness of between 2 and 5m;
- Bog Flow – failure of a blanket bog which involves the emergence of highly humified (decomposed) basal peat from a clearly defined source followed by the settlement of the previously overlying residual peat. Typically recorded to occur on slopes with gradients between 2° and 5° with a typical peat thickness of between 2 and 5m;
- Bog Slide – failure of blanket bog involving the sliding of the peat along a shearing surface within the peat mass. Typically recorded to occur on slopes with gradients between 5° and 8° with a typical peat thickness of between 1 and 3m;
- Peat Slide – failure of blanket bog involving sliding of entire peat mass on a shearing surface at the peat / substrate interface leading to a transitional type failure. Typically estimated to occur on slopes with gradients between 5° and 8° with a typical peat thickness of between 1 and 3;
- Peaty Debris Slide – Transitional failure in which the shearing surface is entirely located within the substrate. The covering layer of peat is part of the failure; however, the peat is only considered to be a secondary influence on the failure. Typically recorded to occur on slopes with gradients between 4.55° and 32° with a typical peat thickness of <1.5m; and
- Peat Flow – any other failure not covered by one of the above, in any other peat deposit (e.g. fen, basin bog, etc) and by any other failure mechanism.

6 Peat Landslide Hazard and Risk Assessment

6.1 General

Due to the presence of peat accumulations across the Site, a preliminary PLHRA was carried out to assess the risks posed by such soils to the Project.

Peat slides can represent a significant hazard and can occur during the construction, operation and decommissioning phases of a development. The nature of electricity generation developments in Scotland often situates them in areas where peat moorland is typically found, and it is inevitable that some alteration of the local hydrological regime of a site will occur due to the design and construction practices of such a development.

It is widely considered that development in areas of peat accumulation can have an effect on the stability of these soft soils through alteration of the drainage regime, alteration of loadings (both temporary loads during construction and final working loads), alteration of land use (e.g. removal of surface vegetation) and alteration of the topography. Any proposed development within such an area requires a PLHRA to characterise the site, identify issues and develop the required construction mitigation measures to reduce the risk of a failure occurring within the peat.

The key considerations of this assessment are that:

- Existing, historical or potential areas of instability are identified; and
- The Project, including construction works, does not result in an unacceptable risk of peat failure.

6.2 Triggering and Preparatory Factors Relevant to the Project

The following provides a summary of the relevant triggering and preparatory factors which relate to the Project:

- Rainfall is not a controllable factor. However, the assessment considers the potential effects of heavy rainfall at the Site;
- Peat loading, and peat extraction are potential hazards. However, both can be mitigated through particular working methodologies (to be identified in the site-specific construction methodology documents to be prepared by the Contractor prior to construction);
- The topography of the Site is characterised by relatively elevated and sloping terrain and the assessment should take cognisance of the combined topography and peat thickness;
- The creation of new drainage paths may lead to the potential channelling and ponding of run-off in areas of the Site, posing a potential hazard. This hazard can be minimised through the adoption of particular working methodologies (to be confirmed in site-specific construction methodology documents);
- The creation of rapid ground acceleration through plant and construction methods. This hazard can be reduced through the adoption of particular working methodologies and practices (to be confirmed in site-specific construction methodology documents); and
- The removal of surface vegetation (i.e. through tree felling and vegetation clearance). This hazard can be reduced by only removing vegetation where required to complete the Project.

Working methodologies / mitigation measures referred to above are discussed further in the **Mitigation Measures Section** of this report.

6.3 Consequences of Peat Failure

A key part of the risk assessment process is to identify the potential scale of peat failure should it occur and identify the receptors of the consequences. For the Site, the key potential sensitive receptors of peat failure are the following:

- The Project (e.g. new substation, proposed access track, damage to existing and proposed overhead lines, SUDS Basin, etc.);
- Existing development (e.g. existing Braco West Substation, access track, etc.)
- Site workers and plant (risk of injury / death or damage to plant);
- Wildlife (disruption or destruction of habitat);
- Watercourses and aquatic fauna;
- Site drainage (blocked drains / ditches leading to localised flooding / erosion); and
- Visual amenity (scarring of landscape).

6.4 Qualitative Risk Assessment

This preliminary PLHRA consists of a qualitative assessment based on an examination of available topographical maps and aerial photography, a digital terrain model, observations made during site visits, an assessment of peat probing and initial ground investigation results and engineering judgement.

The Qualitative Risk Assessment ('Hazard Ranking') was undertaken by identifying the factors that can cause landslide events and estimating the impact of such events on the Project. The Hazard Ranking has been undertaken in accordance with the Scottish Government Guidance[5].

The Hazard Ranking was calculated using the following equation (Eq. 3 from the Scottish Government Guidance):

Hazard Ranking = Hazard x Exposure

The terms Hazard is defined in this case as "the likelihood of the peat landslide event occurring." The term Exposure is defined in this case as "the impact and consequences that the event may have" or its "adverse consequences."

The Hazard scale used in this assessment is shown in **Table 6-1**, which is based on the scale recommended in Table 5.1 of the Scottish Government Guidance.

Table 6-1 Peat Landslide Hazard Ranges over the Lifetime of the Project

Peat Landslide Hazard Scale	Likelihood	Probability of Occurrence
5	Almost certain	> 1 in 3
4	Probable	1 in 10 – 1 in 3
3	Likely	1 in 10^2 – 1 in 10
2	Unlikely	1 in 10^7 – 1 in 10^2
1	Negligible	< 1 in 10^7

The Exposure scale used in this assessment is shown in **Table 6-2,** which is based on the scale recommended in Table 5.2 of the Scottish Government Guidance.

Table 6-2 Peat Landslide Exposure Ranges over the Lifetime of the Project Peat Landslide Exposure Ranges over the Lifetime of the Project

Peat Landslide Exposure Scale	Exposure	Impact as % damage to (or loss) of receptor	Example Consequences
5	Extremely high	> 100% of the asset	Loss of life or serious injury, major pollution incident, complete destruction of property or infrastructure or public road, major loss of habitat.
4	Very high	10% – 100%	Minor or non-serious injury, significant damage to property, significant pollution incident or significant loss of habitat.
3	High	4% – 10%	Minor pollution incident, minor damage to property or temporary closure of infrastructure, destruction of access track locally, significant delay to construction, localised loss of habitat.
2	Low	1% – 4%	Temporary closure of forest roads, minor delay to construction.
1	Very low	< 1% of the asset	Minor remediation of infrastructure or habitat.

Once all areas within the Site have been assigned a peat landslide Hazard and degree of Exposure, a Hazard Ranking can be estimated for the Project. The indicative Hazard Ranking used in this assessment are shown in **Table 6-3**, which is based on the scale recommended in Table 5.3 of the Scottish Government Guidance.

Table 6-2 Indicative Hazard Levels

Peat landslide Hazard	Peat Landslide Exposure				
	Extremely High	Very High	High	Low	Very Low
Almost Certain	High	High	Moderate	Moderate	Low
Probable	High	Moderate	Moderate	Low	Negligible
Likely	Moderate	Moderate	Low	Low	Negligible
Unlikely	Low	Low	Low	Negligible	Negligible
Negligible	Low	Negligible	Negligible	Negligible	Negligible

Where the Hazard Ranking for a zone is moderate or high, avoidance or specification of mitigation measures would normally be the only means by which project infrastructure could be considered acceptable within that zone at the Site.

The need for further investigation or specification of mitigation measures should be a function of the Hazard Rankings present on the Site. The Hazard Rankings and suggested actions used in this assessment are shown in **Table 6-4**, which is based on the scale recommended in Table 5.4 of the Scottish Government Guidance.

Table 6-3 Hazard Ranking and Suggested Actions

Hazard Ranking	Action suggested for each zone
High	Avoid project development at these locations
Moderate	Project should not proceed unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to low or negligible.
Low	Project may proceed pending further investigation to refine assessment and mitigate hazard through relocated or re-design at these locations.
Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

6.5 Estimating the Hazard

To estimate the peatland landslide Hazard, the inputs used have been based on the major factors that can affect slope stability at the site, namely: slope angle, peat thickness, evidence of peat instability, substrate present within the Site, presence of forestry and hydrology. The selection of the ranges for ranking of these inputs was based on a literature review, site evidence and engineering judgment. A discussion on the rankings chosen for each of the main factors listed is given in the following sections.

Slope Angle

Gravity is the primary driving force of all landslides and as such, slope angle is a significant factor in controlling the stability of peat soils.

Boylan, et al., 2008[31], recorded although peat is known to have failed on relatively gentle sloping land, with the majority of failures occurring on ground sloping between 4° and 8°, this is likely to correspond to these slope angles being favourable to significant peat accumulation, and therefore more closely linked to the thickness of peat.

Shallower sloping ground is considered to have a reduced likelihood of failure, since there is less gravitational force to facilitate instability. As such, gentle slopes are not considered to be as susceptible to failure as steeper slopes.

As a result, assigned rankings relating to slope angle vary between 0.5 (where slopes are almost flat) and 5 (where steep slopes are present), as presented in **Table 6-4**.

Table 6-4 Slope Angle Ranking (Ranking Factor 1)

Slope Angle (°)	Ranking
0 – 2	0.5

[31] Boylan. N., Jennings. P., and Long. M (Boylan, et al.) (2008). *Peat Slope Failure in Ireland, Quarterly Journal of Engineering Geology and Hydrogeology,* V. 41, No. 1, p. 93-108, February 2008.

< 2 – 5	1
< 5 – 10	2
<10 – 15	3
<15 – 20	4
≥ 20	5

Refer to **Figure 4, Appendix A Figures** for the topography across the Site.

Peat Thickness

Mills, A.J, 2002[32], reports that peat slides most frequently occur in peat accumulations between 0.5m and 1.5m in thickness, while bog bursts commonly occur in peat ranging between 1.0m and 5.0m in depth. Warburton, et al., 2004[33], defined peat slides as "slab-like, shallow translational failures with a shear failure mechanism operating at, or just below, the peat and underlying substrate interface". Mills, A.J, 2002[37], defined bog bursts as "involving large quantities of water and peat debris that flows downslope…usually associated with raised bogs" following bursting of peat in a near-liquid state through tears in the surface layers, possibly as a result of a build-up of hydrostatic pressures within the peat.

Peat failure may be facilitated through the development of weak layers within the peat mass which may either form naturally or by 'hydrological factors. Peat has a natural anisotropic strength due to the process by which it is formed. In particular, the nature of the interface between the distinct layers within a peat mass is defined by hydrology. These distinct layers are:

- An upper vegetative mat consisting of the living vegetation of herbaceous plants, grasses and mosses;
- The acrotelm, which is the surface layer of an active peat forming mire; and
- The catotelm, which is the lower layer of an active peat forming mire.

The JNCC, 2011[34], considered that the nature of the boundary between the acrotelm and catotelm, and between the catotelm and the underlying substrate (e.g. mineral soil, weathered rock) influence the strength of the peat mass.

Peat stratification and thickness are associated with one another. This is because thin deposits of peat are unlikely to have a catotelm and may mainly be composed of a vegetative mat and acrotelm. As such, with inherent strength because of a more fibrous morphology, peat thicknesses of less than 0.5m are not reported to fail catastrophically. However, thicker deposits are more likely to contain weaker layers or bands of pseudo fibrous / amorphous peat, which are more likely to fail.

For the purposes of this assessment, peat thickness has been ranked between 0.5 and 4. The ranking increases with depth; increasing values relate to more onerous conditions and reflect the tendency for 'weaker' peat to be present as thickness increases, in addition to the presence of a greater disturbing force as a consequence of the increasing thickness. The ranking adopted for peat thickness is given in

Table 6-5.

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32 Mills, A.J. (2002). *Peat Slides: Morphology Mechanisms and Recovery*, Submitted for the degree of Doctor of Philosophy, University of Durham.

33 Warburton, J., Holden, J. and Mills, A.J. (2004). *Hydrological Controls of Superficial Mass Movements in Peat*. Earth Science Reviews 67 139 - 156.

34 Joint Nature Conservation Committee (JNCC) (2011). *Towards an Assessment of the State of UK Peatlands,* JNCC Report No. 445.

Table 6-5 Peat Thickness Ranking (Ranking Factor 2)

Peat Thickness (m)	Ranking
≤ 0.5	0.5
>0.5 - 1.0	1
>1.0 - 2.0	2
>2.0 - 3.0	3
> 3.0	4

Refer to **Figure 8**, **Appendix A Figures** for the peat depths across the Site.

Evidence of Peat Instability

Evidence of previous or incipient peat instability may provide an indication that conditions at that location are favourable to peat instability and therefore the area may be prone to further instability. As such, it is considered that areas with evidence of peat instability will have a higher risk of failure than areas where no stability issues have been identified.

For the purposes of this assessment, where no peat instability is identified through the desk study or site visit, a ranking of 0 is applied. Where localised small-scale failures or instability features are identified, a ranking of 1 is used and where more widespread or large-scale failures are identified, a ranking of 2 is applied, as indicated in **Table 6-6**.

Table 6-6 Signs of Relic Failure Ranking (Ranking Factor 3)

Signs of Relic Failure in Vicinity	Ranking
Absent	0
Localised evidence of instability	1
Widespread evidence of instability	2

Substrate

As noted in the Peat thickness section above, it is considered that the nature of the boundary between the acrotelm and catotelm, and between the catotelm and the underlying substrate (e.g. mineral soil, weathered rock) influence the strength of the peat mass. The nature of the substrate can therefore play a part in the level of stability of a peat mass.

Where fine-grained deposits (e.g. clay or silt) are present at the interface, there is likely to be weathering and softening of the clay due to the peat likely being saturated, with poor or non-existent vertical drainage paths. This will result in a reduction of the undrained shear strength or effective shear strength parameters of the fine-grained deposits. This means failure could occur within the peat mass itself, at the interface with the fine-grained deposit or within the fine-grained deposit.

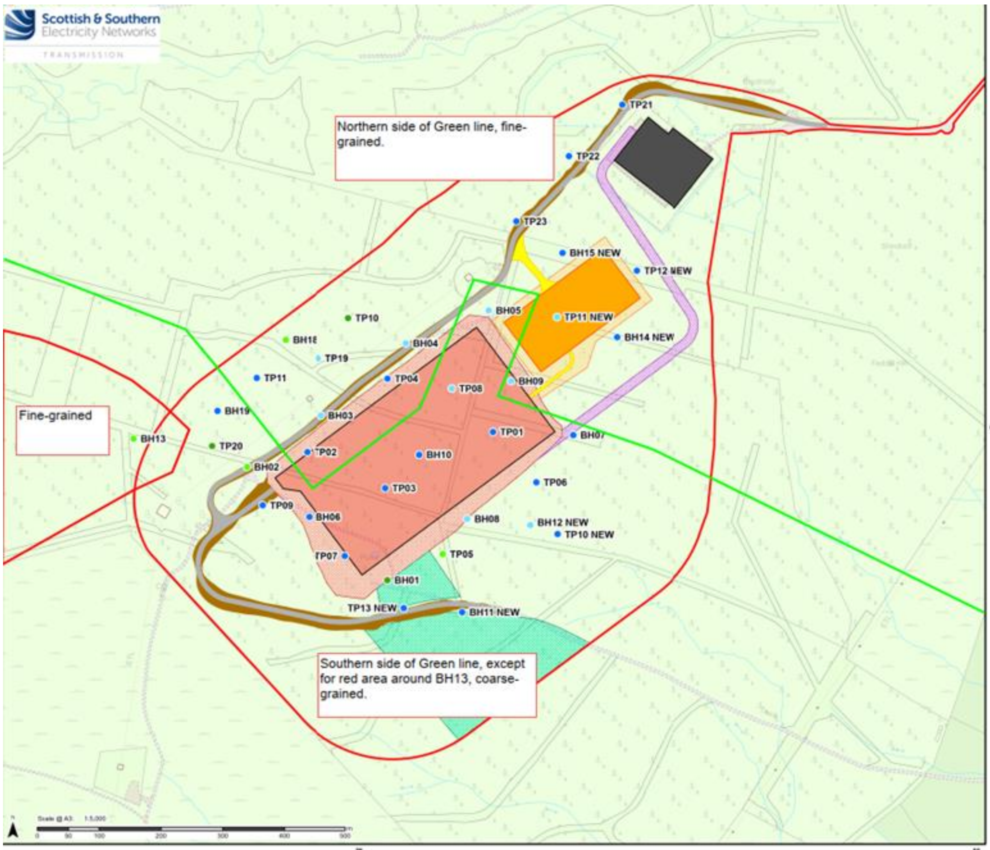
Where coarse-grained deposits (e.g. sand, sand & gravel or gravel) are present at the interface, the effective shear strength parameters are likely to be comparatively high compared to the fine-grained deposits. Where coarse-grained deposits are present failure is likely to occur in the peat mass itself.

Rock provides a high strength substrate, where encountered, however, the rock surface may be smooth and as such can provide a weak interface with the peat. Failure of the peat may therefore occur within the peat mass itself or at the interface with the rock. For the purposes of this preliminary assessment any rock interface has been given a higher risk rating similar to that of the fine-grained interface. **Table 6-8** presents the ranking for the possible substrates which can be encountered at the Site.

Table 6-7 Substrate Ranking (Ranking Factor 4)

Substrate	Ranking
Coarse-grained (fine to coarse sand, sand & gravel, Gravel)	1
Fine-grained (silt or clay) & very clayey/silty fine to medium sand	2
Rock	2

The selection of the substrate present underlying the Site is based on the initial investigation undertaken by Igne. As highlighted in **Section 4.2** a mixture of fine-grained and coarse-grained deposits were encountered across the Site. The location where the substrate was encountered was taken into consideration and the Site split to take account of the substrate material encountered, as shown on **Insert 6-1** below.



Insert 6-1 Substrate Distribution across the Site

Presence of Forestry

The process of afforestation and subsequent deforestation can have significant effects on the structure and hydrological properties of peat soils, which may in turn result in an increased risk of peat failure.

During the planting operations, a series of drains are generally cut into the peat soil across the area to be afforested. Wilson & Hegarty, 1993[35], These drains are typically between 0.4m and 0.6m deep and are cut perpendicular to the surface contours to allow drainage of the soils to fall away from the plantation. This process initially affects the structure and hydrology of the upper acrotelmic layer of peat. Drains were noted to have been installed within the forestry in the Site, as described, during the site walkover surveys undertaken.

Over the years and decades following initial planting, drying out and degradation of the peat adjacent to the furrows results in their widening. As the trees mature and their canopies grow, an increase in the capacity of the trees to intercept rainfall and for evapotranspiration to occur, results in further drying of the peat. Dry summers can also exacerbate the drying effects on the peat, with water uptake by root systems replacing drainage as the main cause of peat drying, resulting in the water table falling below the base of the furrows and causing cracking to extend deeper into the catotelmic layer. Eventually, the drying effects can cause the peat to crack, with the cracks typically following the lines of drains / furrows. No cracks were noted within the peat on-site during the site walkover surveys. However, the peat surface was typically obscured by vegetation and so cracks may have been present.

As the plantation matures, the peat is subject to progressive loading from the growing trees and the water table generally decreases in level. Over the lifetime of the forest, drainage ditches can become blocked due to the trees shedding their needles / leaves, ground vegetation cover infiltrating them and soils washing into them causing them to 'silt up'. This can prevent water draining away as intended and can cause a short-term high pore-water pressure build-up following periods of heavy rainfall. During the site walkover surveys, the drainage channels were generally noted to be free from debris.

As such, the process of afforestation can have a negative effect on the stability of peat.

Following deforestation, peat loading from the trees is largely removed and there is typically a rise in the water table. However, with the reintroduction of a higher water table level, a short-term increase of pore-water pressure may be established within the peat mass. Deforestation is considered to have a negative effect on peat stability but is considered less of a concern than when recently forested due to the overall reduction of peat loading.

Based on the above discussion, the following ranking for the presence of forestry is considered appropriate, as shown in **Table 6-9.**

Table 6-8 Presence of Forestry Ranking (Ranking Factor 5)

[35] Wilson, P. & Hegarty, C. (1993). *Morphology and Causes of Recent Peat Slides on Skerry Hill, Co. Antrim, Northern Ireland*. Earth Surface Processes and Landforms, Vol. 18, pp. 593 - 601.

Presence of Forestry in the Area	Ranking
Absent	0
Recently deforested / afforested	1
Present	2

Please refer to **Figure 3, Appendix A Figures** for the presence of forestry across the Site.

Hydrology

Carling, 1986[36], highlighted an increase in pore-water pressures generated by intense rainfall is a significant potential 'triggering mechanism' for peat slides. However, prolonged periods of heavy rainfall are not necessarily related to instability. Both the distribution and intensity of precipitation have a complex influence on the mass movement of peat.

In many cases of peat failures, a relatively dry period has been followed by intense rainfall. Although intense rainfall appears to be an important factor, it is important to recognise that the occurrence of an extreme event does not necessarily directly result in peat instability; this being a function of many factors and a combination of climatic preparatory events. For the purpose of this assessment, rainfall has been considered to be a constant for the entire site.

It has been noted that peat slides have been initiated along natural drainage lines or in association with artificial drainage[34]. Blocking of existing drainage paths could create a buoyancy effect which may reduce the strength of the peat or cause liquefaction due to raised pore-water pressures at the base of the peat.

Poorly drained areas (such as boggy ground with few / no drainage channels) are considered to be more susceptible to instability due to higher groundwater tables than well-drained areas.

Where drainage ditches become blocked with vegetation for example, water can build up in them allowing pore-water pressures to develop and exceed critical levels during or immediately following intense rainfall.

Generally, the site walkover surveys identified the drainage within the Site was well drained with a good drainage system in working order, however, locally boggy or saturated ground was also encountered.

The parameter for hydrology has been given a ranking value of between 0.5 and 2 as shown in **Table 6-10.**

Increasing values relate to relatively poorer drainage conditions that are considered likely to increase the probability of instability occurring.

[36] Carling, P (1986). *Peat Slides in Teesdale and Weardale, Northern Pennines, July 1983: Description and Failure Mechanisms. Earth Surface Processes and Landforms.* Vol. 11, pp. 193 - 206.

Table 6-9 Hydrology Ranking (Ranking Factor 6)

Hydrology description	Ranking
Well drained with a good drainage system in working order	0.5
Boggy or saturated ground	1
Blocked drainage paths	2

Please refer to **Figure 3, Appendix A Figures** for the location of the boggy or saturated ground within the Site.

Weightings

The factors affecting peat instability are not considered to contribute equally and as such, weightings have been applied based on AECOMs understanding of the Site and experience of assessing peat slide risk.

For example, as slope angle is considered to represent one of the main driving forces for peat instability, a weighting of 6 has been assigned to the factor to capture its importance in the mobility of peat. Likewise, evidence of peat instability is considered to be equally influential, as if the conditions in areas have resulted in failures in the past, similar failures could initiate in the future and therefore a weighting of 6 has also been assigned to this factor.

Peat depth is also considered to play a significant role in the stability of peat. As the thickness of peat increases, so does the weight of the peat, which could result in the activation of a slip plane. Also, due to the anisotropic nature and highly variable structure of peat, the thicker the deposits are, the more likely they are to have a greater number of weaker zones throughout its profile affecting the overall stability of the peat mass. This factor is, however, considered less influential to peat instability than the slope angle and evidence of peat instability and has therefore been given a lower weighting value of 4.

The type of substrate present within the Site can be significant as relates to the peat landslide risk. The presence of fine-grained or rock substrate can mean there is multiple potential failure zones and hence more chance of a peat landslide. The peat thickness can play an important role as to the increased risk of peat instability depending on the substrate present. This factor is, however, considered less influential than peat thickness and has therefore been given a lower weighting value of 3.

Forestry plays a significant role on the peat stability within the Site due to its extensive coverage. The planting process will likely have caused damage to the structure of the upper peat layer, additional loading on the peat from the weight of the trees and degradation of the peat by their drying out all of which can result in an increased risk of peat instability. However, this is not considered to be as significant a factor as peat thickness, slope angle and evidence of peat instability and has therefore been assigned a weighting value of 3.

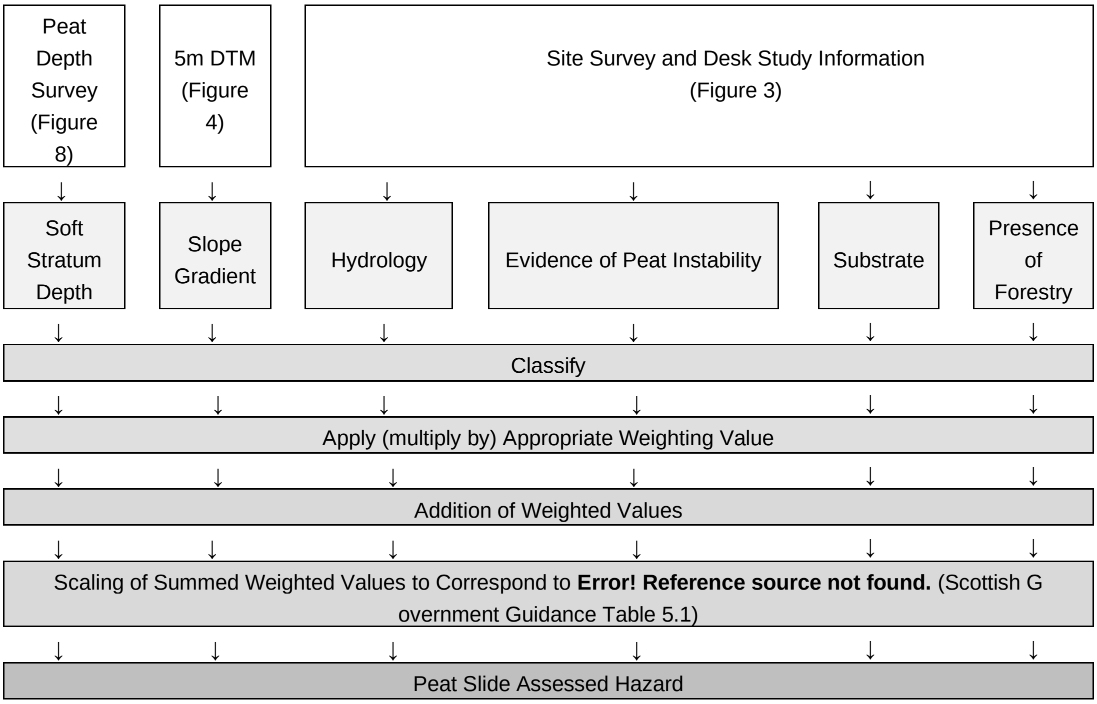
Finally, the hydrology of the peat is also considered to contribute to its stability. However, due to the extent of the forestry across the Site, hydrology is considered to be less influential. This is because the hydrology is closely related to the drainage network throughout the forestry and this factor is therefore linked to and largely covered under the weighting applied to the forestry. However, it is still important to consider this factor, and as such it has been assigned a weighting value of 2.

The weightings assigned to each of the parameters are summarised in **Table 6-10.**

Table 6-10 Weighting Values for Each Parameter

Parameter	Ranking Factor	Weighting
Slope Angle	1	6
Signs of Relic Failure	2	6
Peat Thickness	3	4
Substrate	4	3
Forestry	5	3
Hydrology	6	2

To estimate the level of hazard across the Site and produce the Peat Slide Assessed Hazard (PSAH) plan, the classification and weighting was carried out in Geographic Information Systems (GIS) software using a multi-criteria analysis. The processed used is illustrated in **Insert 6-2**.



Insert 6-2 GIS Multi-Criteria Analysis

The scaling of the Weighted Totals corresponds to **Table 6-1** (and the Scottish Government Guidance Table 5.1) and is shown in below.

Table 6-11 Weighted Total vs Scale

Weighted Total	Scale	Likelihood	Probability of Occurrence
> 50	5	Almost certain	> 1 in 3
41 – 50	4	Probable	1 in 10 – 1 in 3
31 – 40	3	Likely	1 in 10^2 – 1 in 10
21 – 30	2	Unlikely	1 in 10^7 – 1 in 10^2
< 20	1	Negligible	< 1 in 10^7

6.6 Peat Slide Assessed Hazard Plan

The assessed potential peat slide Hazard is presented in **Figure 9**, **Appendix A - Figures** and indicates that the potential peat slide Hazard across the Site is generally assessed to be 'Negligible' (1) or 'Unlikely' (2) with only minor areas assessed as being 'Likely' (3).

The majority of the proposed infrastructure, including the main substation and compound area, is located in areas assessed as 'Negligible' or 'Unlikely' potential peat slide Hazard. Small local areas of "Likely" peat slide Hazard are noted in the vicinity of the proposed access track to the west, proposed temporary overhead line diversion to the north and south of the proposed substation platform area.

Estimating the Exposure

Following assessment of the potential peat slide Hazard, the potential impact and the consequences (i.e. Exposure) of a peat landslide has been assessed for both environmental exposure and infrastructure exposure.

The Exposure of a peat slide to the environmental receptors (e.g. watercourses, designated sites, ecologically important areas, etc) are based on the likely environmental impact resulting from a peat slide.

When considering the potential impact of a peat failure, the presence of any existing structures or infrastructure (e.g. forestry tracks etc.), future development (i.e. proposed infrastructure) and / or sensitive receptors (e.g. watercourses, designated sites, etc.) are taken into account.

When considering the baseline condition (i.e. the Site prior to construction), where no receptors are present the impact is typically considered to be 'very low' (i.e. Exposure rating of 1). Where existing forestry tracks are present and no change is proposed along these, an impact of 'very low' is also considered sufficient, due to the potential impact as a percentage of the total project cost likely to be less than 1% (i.e. Exposure rating of 1). Where the existing overhead line is present the exposure is raised to 'low' (i.e. Exposure rating of 2 – e.g. minor temporary closure of access roads or overhead line, minor delay to construction). The exposure is then raised to 'high' when in the vicinity of the existing Braco West substation (i.e. Exposure rating of 3 – e.g. minor damage to property or temporary closure of infrastructure). Where infrastructure is located within 50m of a watercourse, the impact is rated at 'high' (i.e. Exposure rating of 3 – minor pollution incident may occur).

When considering the potential impact, a peat failure during construction could have on the Project, the following was considered. Generally, where access tracks, compounds, overhead lines, and drainage systems are proposed, the impact is 'very low' or 'low' (i.e. Exposure rating of 1 or 2 – e.g. minor remediation of infrastructure or temporary closure of access roads, minor delay to construction). At the location of the proposed new substation an impact of 'high' is considered appropriate due to the increased impact on the cost of the Project (Exposure rating of 3 – i.e. significant delay to construction and increase in total cost). At the locations of the proposed peatland restoration areas an impact of 'low' is considered appropriate as depending on the phasing of the proposed peat deposition, any upslope or downslope failure is likely to cause instability of the recently placed peat and cause further damage to the restoration area (i.e. Exposure rating of 2 – e.g. minor remediation or minor delay to construction).

Table 6-12 presents the qualitative assessment undertaken for the Site in a tabular format for each individual infrastructure component. Column 2 of the **Table 6-12** is to be cross-referenced with **Table 6-1** and refers to the peat slide Hazard value assigned to the infrastructure component (see **Figure 9, Appendix A Figures**). The peat slide Hazard may be assessed to be reduced during the evaluation process based on engineering judgement. Where any reduction has taken place, this will be discussed in the text within the table. It should be noted that the peat slide assessed Hazard includes a 50m buffer around each infrastructure component, as within this buffer zone is where it is considered the Project is most likely to affect the peat stability.

Column 3 of **Table 6-12** presents the assessed Exposure (see **Table 6-2** Peat Landslide Exposure Ranges over the Lifetime of the Project Peat Landslide Exposure Ranges over the Lifetime of the Project) relating to the individual proposed infrastructure components and any existing infrastructure (i.e. existing forestry tracks). Column 4 of **Table 6-12** presents the assessed Exposure (see **Table 6-2** Peat Landslide Exposure Ranges over the Lifetime of the Project Peat Landslide Exposure Ranges over the Lifetime of the Project) relating to the environmental receptors.

Column 5 of **Table 6-12** is to be cross-referenced with **Table 6-2** and **Table 6-4,** and gives the worst-case Hazard Ranking (i.e. Hazard Ranking = Hazard Scale x Exposure Scale), whereby the value given in Column 2 (the Hazard) is multiplied by the higher value of the two Exposure ratings given in Columns 3 and 4 and expressed as a number.

Column 6 of **Table 6-12** expresses the worst-case Hazard Ranking value as one of the four terms, which are shown in **Table 6-3.** When considering the worst-case Hazard this is considering what the worst-case combination of peat slide assess Hazard and infrastructure/environmental Exposure is. I.e. the worst-case peat slide Hazard may not interact with the worst-case infrastructure/ environmental Exposure, and so the score chosen rationalises what the realistic worst-case combination between the two inputs would be.

Table 6-12 Qualitative Assessment of Peat Landslide Hazard, Exposure and Hazard Ranking

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
See Figure 9, Appendix A - Figures for reference of infrastructure locations and assessed peat slide Hazard						
Proposed new substation (and associated earthworks)	3	2	2	6	Low	Area of 'Likely' peat slide Hazard underlying and within 50m of the proposed new substation. The areas of 'likely' peat slide Hazard underlying the proposed substation and associated earthworks will be removed during the construction process, as the peat will be stripped and competent strata founded upon. Outwith the proposed substation itself, although areas of 'likely' peat slide Hazard are encountered within 50m these are located downslope or parallel with the proposed new substation and as such, are not considered to significantly adversely affect the proposed substation itself as the flow of peat would typically be away from the substation. The existing access track and proposed access track may be affected and therefore an Infrastructure Exposure rating of 'low' is considered suitable. No existing environmentally significant designation recorded within or in close vicinity to the proposed new substation and no watercourse recorded within 50m. Watercourse located downslope of proposed new substation 'likely' peat slide assessed Hazard and both South Restoration Area 1 & South Restoration Area 2 are present downslope of the 'likely' peat slide assessed Hazard also. Therefore, environmental exposure of 'low' considered suitable.
Proposed access track (and associated earthworks)	3 (2)	2 (3)	3	9 (6)	Low	Area of 'Likely' peat slide Hazard underlying and within 50m of the proposed access track. The worst-case Infrastructure Exposure relates to the existing and proposed substations with an Exposure rating of 'High' applied. No 'likely' peat slide Hazard is within 50m of the proposed access track and upslope in the vicinity of the proposed new substation, and as such these two aspects would not interact with each other. An area of 'likely' peat slide Hazard is recorded underlying and immediately adjacent to the proposed track in vicinity of the existing Braco West substation. However, it is considered the majority of the 'likely' peat slide hazard would be removed as part of the works, as almost all the 'likely' peat slide Hazard is underlying the proposed access

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						track and would be excavated to allow its installation. The very small area of 'likely' peat slide Hazard left outwith the footprint of the access track after excavation, is downslope of the existing substation and so would not flow toward it. As such, the peat slide Hazard that would interact with the worst case Infrastructure Exposure is therefore considered to be 'unlikely' peat slide Hazard as shown with the ratings presented in brackets. The combination of worst-case Infrastructure Exposure and associated peat slide Hazard would give a Hazard Ranking of 'Low' as identified by the ranking in brackets. Out-with the existing and proposed substations areas of 'likely' peat slide Hazard within 50m of the proposed access track are present towards the eastern extent of the access track on the Site boundary and in the west of the Site. In these areas, taking into account the topography of the Site, the infrastructure which is likely to be affected would be the proposed access track itself, and the SUDS Basin. Therefore, an Infrastructure Exposure rating of 'low' is considered suitable. This combination, as shown by the ratings outwith the brackets (except for the Hazard Ranking column), would give a Hazard Ranking of 'Low'. No environmentally significant designation recorded within or in close vicinity to the proposed access track and no watercourse recorded within 50m. However, the area of 'likely' peat slide Hazard in the east is within 50m of a watercourse, therefore meaning a worst-case environmental exposure of 'high' is applied. In relation to the west of the Site watercourses are located downslope of the proposed access track 'likely' peat slide Hazard, as well as the West Restoration Area and the South Restoration Area 2. Therefore, an environmental exposure of 'low' considered suitable for this western section.

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						Considering the worst-case peat slide Hazard of 'likely' would interact with the worst-case Environmental Exposure of 'high', this combination would give a Hazard Ranking of 'Low'.
Proposed Temporary Overhead Line Diversion (inclusive of existing towers which the temporary OHL will tie-in to)	2 (3)	3 (2)	1 (2)	6	Low	Area of 'likely' peat slide Hazard are within 50m of the proposed temporary overhead line towers and working areas. The majority of the areas are very small and may be related to pixilation limitations related to the assessment with how the 5m DTM file is interpolated into a surface, as these areas typically appear to relate to a single pixilation of the assessment. In these cases, the 'likely' peat slide Hazard have been discounted as considering the surrounding peat slide Hazard these would not appear representative. The peat slide Hazard associated with the OHL would therefore typically be 'unlikely'. However, at the western extent of the temporary OHL where it ties into an existing tower, areas of 'likely' peat slide Hazard are present within 50m which are not discounted and are taken into account in the assessment. The worst-case infrastructure Exposure relates to the proposed substation, which is downslope of the proposed temporary overhead line. Therefore, the infrastructure Exposure has been rated as 'high'. The 'likely' peat slide Hazard would not interact with the proposed substation as the substation is upslope or parallel in the slope to these higher Hazard areas. Instead, the highest peat slide Hazard interacting with the proposed substation as a result of the OHL would be 'unlikely'. The highest infrastructure Exposure that would interact with the 'likely' peat slide Hazard would be the proposed access track and OHL towers themselves. In these cases the infrastructure Exposure has been assessed as 'low' as shown by the numbering within the brackets. When considering either combination of peat slide Hazard and Infrastructure Exposure presented above, the assessed Hazard Ranking is 'Low'.

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						No environmentally significant designation recorded within or in close vicinity to the proposed temporary OHL and no watercourse recorded within 50m. However, the West Restoration Area is downslope of 'the likely' peat slide Hazard identified in the vicinity of the western extent of the temporary OHL. Environmental Exposure is therefore rated at 'low' for this western extent (as shown by numbering in the brackets) and 'very low' for the rest of the OHL alignment.
Proposed Temporary Access Tracks for Temporary OHL	2	3	1	6	Low	Highest peat slide Hazard within 50m of proposed temporary access tracks is 'unlikely'. The worst-case infrastructure Exposure relates to the proposed substation, which is downslope of the proposed temporary access tracks. Therefore, the infrastructure Exposure has been rated as 'high'. No environmentally significant designation recorded within or in close vicinity to the proposed temporary access track and no watercourse recorded within 50m. Environmental Exposure therefore rated at its lowest at 'very low'.
Proposed Overhead Line Tie-ins (relating to the proposed new permanent tower and the existing towers to the immediate	2	3	1	6	Low	Highest peat slide Hazard within 50m of proposed tie-in is 'unlikely'. The worst-case infrastructure Exposure relates to the proposed substation, which is downslope of the proposed OHL tie-in works, and existing OHL line were works are proposed. Therefore, the infrastructure Exposure has been rated as 'high'. No environmentally significant designation recorded within or in close vicinity to the proposed OHL tie-in and no watercourse

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
east and west)						recorded within 50m. Environmental Exposure therefore rated at its lowest at 'very low'.
Proposed Drainage System SUDs basin, related clearance and South Restoration Area 2	2 (3)	2	3 (2)	6	Low	Area of 'likely' peat slide Hazard within 50m of proposed SUDs basin to the north. However, this has been covered by the proposed access track assessment and so is neglected for the proposed SUDS basin. Two other small areas of 'Likely' peat slide Hazard also noted, one within the proposed SUDS basin and the other to the south of proposed SUDS basin within the clearance area and to the south of South Restoration 2 area. The majority of the 'likely' peat slide within the SUDS basin is likely to be removed as part of its construction as the peat would be stripped from the basin. The remnants of this 'likely' peat slide Hazard would then be very small and not considered representative of the peat slide Hazard considering the surroundings. This 'likely' peat slide Hazard has therefore been discounted from the assessment. This leaves the only 'likely' peat slide Hazard taken into consideration within the assessment as the area located to the south of South Restoration Area 2. Elsewhere across the majority of the rest of the area within 50m the peat slide Hazard is assessed to be 'unlikely'. The worst-case infrastructure Exposure relates to the proposed access track which is to the north of the proposed SUDS basin and the basin itself. Therefore, the infrastructure Exposure has been rated as 'low'. This Infrastructure Exposure would not interact with the 'Likely' peat slide Hazard considered as this is downslope. Instead, the Infrastructure Exposure would interact with an 'unlikely' peat slide Hazard. No environmentally significant designation recorded within or in close vicinity to the proposed SUDS basin. A watercourse is

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						located within 50m of the proposed clearance area for the SUDs basin to the east and therefore the worst-case environmental exposure of 'high' is considered suitable. The South Restoration Area 2 is also located to the south of the SUDS basin and so outwith the influence zone of the watercourse, an environmental exposure of 'low' could also be applied. In relation to the Exposure of the watercourse ('high') and the South Restoration Area 2 ('low'), the 'likely' peat slide Hazard would not interact with these as it is located downslope. Instead, the 'unlikely' peat slide Hazard would interact with these. In relation to the 'likely' peat slide Hazard to the south of the restoration area this would interact with a watercourse which is located downslope but greater than 50m from the area. The Exposure would therefore be rated as 'low'. The combination of the 'likely' peat slide Hazard with the 'low' environmental Exposure would give a Hazard Ranking of 'Low' as shown by the ratings in brackets.
Proposed Construction / Contractors Compound (inclusive of temporary access tracks)	1	3	2	3	Negligible	Highest peat slide Hazard within 50m of proposed construction / contractors' compound is 'negligible'. The worst-case infrastructure Exposure relates to the proposed new substation, which is downslope of the proposed construction / contractor's compound. Therefore, the infrastructure Exposure has been rated as 'high'. No environmentally significant designation recorded within or in close vicinity to the proposed construction / contractors' compound and no watercourse recorded within 50m. Watercourse and South Restoration Area 2 located downslope of proposed construction / contractors' compound. Therefore, an environmental exposure of 'low' is considered suitable.

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Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
West Restoration Area	2 (3)	2 (1)	2 (1)	4 (3)	Negligible	Highest peat slide Hazard within 50m of proposed West Restoration Area is 'likely'. However, much of the 'likely' peat slide Hazard will be removed as part of the construction process due to the peat being stripped from the footprint of the access tracks and substation and the 'likely' peat slide Hazard underlying the restoration area being made stable/mitigated against as part of the geotechnical design of the restoration area undertaken during the detailed design process post-consent. The 'likely' peat slide Hazards between the access track and restoration area, are contained by the access track (where peat has been stripped below) and the restoration area (which will be designed to be stable) meaning these are unlikely to affect any receptor in a significant manner and as such have been discounted from the assessment. This would leave the only 'likely' peat slide Hazard which is considered as part of the assessment to the west of the restoration area. Ouwith the 'likely' peat slide the predominant peat slide Hazard within 50m of the restoration area is 'unlikely'. Although the proposed substation is immediately adjacent to the restoration, it is upslope, and any peat landslide is not anticipated to affect it. As such, the worst-case infrastructure ranking is considered to be the proposed access track surrounding the restoration area. Therefore, an environmental exposure of 'low' considered suitable. The access track would not interact with the 'likely' peat slide Hazard due to the peat being stripped as part of the construction, therefore removing the hazard, or the 'likely' peat slide Hazard being made stable through the geotechnical design of the restoration area. As such, the worst-case Infrastructure would interact with the 'unlikely' peat slide Hazard. The 'likely' peat slide Hazard considered as part of the assessment is not upslope within 500m of an infrastructure receptor and as such the

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						Infrastructure Exposure rating interacting with this peat slide Hazard is considered to be the lowest of 'very low'. This assessment is shown in the rating in brackets. No environmentally significant designation recorded within or in close vicinity to the restoration area and no watercourse recorded within 50m. A watercourse is located downslope of the proposed restoration area, and the restoration area is considered an environmental receptor itself. Therefore, an environmental exposure of 'low' is considered suitable. The 'likely' peat slide Hazard would not interact with the restoration area as this is located upslope and no watercourse or environmental designation is located within 500m downslope. As such, the environmental Exposure interacting with the 'likely' peat slide Hazard has been assessed at its lowest of 'very low'. This assessment is shown in the rating in brackets.
South Restoration Area 1 and associated Earth Mounding	3 (2)	2	2 (3)	6	Low	Highest peat slide Hazard within 50m of the area is 'likely', although the majority is 'unlikely'. The worst-case infrastructure Exposure relates to the proposed access track and SUDS Basin, which is downslope of the proposed area to its west. Therefore, the infrastructure Exposure has been rated as 'low'. No environmentally significant designation recorded within or in close vicinity to the proposed area. A watercourse is present underlying and to the south of the area. An area of 'likely' peat slide hazard is present within 50m of the watercourse; however, the 'likely' hazard is underlying the earth mound and so would likely be removed as part of the construction works as the peat would be stripped from its footprint. The watercourse at this location is also underlying the earth mound and so is

Area	Assessed Hazard (Worst Case)	Assessed Infrastructure Exposure	Assessed Environmental Exposure	Worst-Case Hazard Ranking	Worst-Case Hazard Ranking	Comment
						likely to be diverted or buried. The 'likely' peat slide hazard is therefore not considered to interact with the worst-case Environmental Exposure of the watercourse ('high'). An 'unlikely' peat slide hazard would interact with the watercourse as noted in the numbers in the brackets. Outwith the watercourse, the environmental Exposure would relate to the peat restoration area itself which has an exposure ranking of 'low' and would interact with the areas of 'likely' peat slide hazard.

7 Mitigation Measures

7.1 General

Construction activities (e.g. excavation, drainage, etc.) are known to have a potential destabilising effect on peat deposits. The design of the Project should consider the weak and susceptible nature of peat.

Although no historic peat instability has been noted within the Site, appropriate good practice and, where required, mitigation measures should be used to minimise the destabilising effects on the peat and its habitat.

As part of the Project, Construction and Environment Management Plans (CEMPs) should be prepared for each of the Proposed Developments, incorporating good practice measures for the construction of electricity generating schemes in peatland environments. These documents will continue to be updated through pre-construction and construction in accordance with good practice guidance, of which a non-exhaustive list is provided in **Section 2.3**.

It should be noted that further Ground Investigation (GI) will be carried out prior to construction of the Project to inform the detailed design to design maturity. The GI information will also be used to update the PLHRA, following the Scottish Government Guidance[5] [15].

7.2 Mitigation Measures

Mitigation measures and good practice procedures are ultimately the responsibility of the Principal Contractor. During the construction phase, the following list may be considered but not limited to:

- Maintaining and updating a Geotechnical Risk Register throughout the works;
- Provision of a Geotechnical specialist on-site during the construction phase to undertake advance inspection, carry out regular monitoring and provide advice when required;
- Supervision of construction work by suitably qualified and experienced personnel;
- Identification of areas of deep peat, physical demarcation of such areas and instruction to site personnel to avoid these areas or minimise activities in these locations, where practical;
- Identification of approved areas for stockpiling of any excavated rock or soils including peat;
- Side-casting of material during construction only in appropriate areas identified following risk assessment and agreed with all relevant parties (Environmental Clerk of Works / Geotechnical Clerk of Works, SEPA, NatureScot etc.);
- Avoid placing excavated material or other forms of loading on breaks of slope or other potentially unstable slopes;
- Any excavations in peat should be risk assessed, and measures adopted to minimise the risk of failure within excavation side slopes and surrounding materials;
- Excavation on side slopes within peat should be as shallow an angle as possible and care should be taken to stabilise sides;
- Upslope drainage ditches should be included on all earthworks which are constructed through side-long ground;
- The camber of the access track should be such as to encourage surface water drainage to the upslope drainage ditch;
- The construction plant should minimise the extent and duration of open excavations and bare ground;

- Earthmoving activities should be restricted during and immediately after heavy and prolonged rainfall events;
- Establish / re-establish vegetation as soon as possible to improve slope stability and provide sediment transport control;
- Design and construction of a suitable drainage system for tracks and hardstanding's that does not significantly affect the hydrological regime of the peat and would require minimal maintenance;
- Include measures to ensure drainage systems (including existing) are well maintained, including identification of sensitive drainage areas;
- Prevent artificial drainage from concentrated flows onto slopes or into excavations;
- Where deep peat excavations require dewatering, discharges of the pumped water will require to be controlled in a manner which does not adversely affect habitats on-site (due to potential silt content etc.) and does not lead to the creation of saturated, and hence very soft, areas of peat;
- Design of appropriate sediment control measures including the use of silt traps / barriers where necessary and cut-off ditches in particular at appropriate locations along site tracks and earthworks;
- Identification of drainage areas and areas of run-off which could potentially be affected by the development and appropriate stand-off distances established;
- Monitoring of slope and peat stability both in the vicinity and down slope of infrastructure (both existing and proposed) during construction by suitably experienced and qualified personnel;
- Appropriate track construction methods to take cognisance of local topography, peat thickness and peat features (such as peat pipes, slumps, hags, etc.);
- Development of working methodologies that ensure that any exposed peat is protected to limit the potential for degradation, erosion or failure of the accumulation;
- Where excavated tracks are constructed, the peat and any soft soils should be removed and replaced with granular material placed in layers and compacted;
- Where floating tracks are constructed, a suitable geogrid and separator geotextile (where required) should be laid over the existing ground surface with graded stone (nominally 75mm down) placed over this in layers and compacted. However, a geotextile specialist should be sought regarding this;
- Any floating track design should take into account the properties of the peat soils at the Site;
- Construction staff should be made aware of peat slide indicators and emergency procedures; and
- Emergency procedures should include steps to be taken on detection of an incipient peat slide or of the event occurring.

Many of the measures provided above serve both to mitigate and reduce the likelihood of a peat slide occurring, as well as being good construction practice.

In line with the Peat Landslide Hazard and Risk Assessments, Best Practice Guide for Proposed Electricity Generation Developments[37], discussion of mitigation measures relevant to each potential peat landslide hazard identified is required.

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

A final PLHRA will be required for the Project at design maturity post-consent, which includes the findings of further intrusive works to characterise the peat further, which targets more sensitive areas and that provides peat data (e.g. extents & depths throughout the Site). Preliminary mitigation measures are recommended as follows:

- Infrastructure with a 'Negligible' Hazard Ranking – ground conditions in these areas may be considered acceptable provided that all infrastructure and access roads are constructed in line with good practice guidelines which will be set out in the CMS / CEMP. However, even in negligible areas, additional intrusive works should be undertaken to assist in the overall characterisation of the peat, as well as for monitoring for signs of potential instability.
- Infrastructure with a 'Low' Hazard Ranking, will require additional peat thickness and characteristic information by intrusive investigation and engineering measures may be required and should be considered during the ground investigation, detailed design and construction to minimise risks of triggering a peat landslide in the short term (during construction) or long term (during operation and decommissioning) such as:
    - Installation of drainage - Installation of targeted drainage would aim to isolate the areas of peat from upslope surface water. Specific consideration should be given to those areas identified with 'likely' peat slide hazard. If applicable, re-routing surface (flushes/gullies) and subsurface (pipes) drainage around critical areas will also help control surface water. Drainage measures need to be carefully planned to minimise any negative impacts.
    - Monitoring of water levels within existing watercourses and groundwater levels throughout the Site during construction.
    - Monitoring of slope and peat stability both in the vicinity and down slope of proposed infrastructure and restoration areas during construction and at regular intervals post construction, especially after extreme rainfall or snow events, by suitably experienced and qualified personnel.

It is considered that such engineering measures would only be used in localised areas where a particular hazard could not be avoided or reduced, and which could not be dealt with adequately by other measures (such as engineered out during the detailed design process). A more detailed peat stability assessment and quantitative PLHRA is required (post consent) following further ground investigation and detailed design to design maturity.

Construction Management – as part of the final CEMP will include but are not limited to:

- Specific work method statements to monitor compliance of activities in susceptible areas.
- Reviewing the weather forecast to prevent working in areas of peat during or immediately following heavy rainfall.
- Construction plant should be operated from the areas already constructed where practicable. Should there be no alternative to plant accessing areas of peat, low ground pressure equipment should be used.
- Spoil disposal areas (both peat and mineral soils) should be located where the risk of erosion, mass movement and water quality deterioration are minimal.
- Continual monitoring of groundwater and ground movement should be maintained.
- Drainage Measures – the installation of drainage measures such as soakaways and gullies (surface water) and pipes (subsurface water) can be used to re-route upslope surface water and groundwater around potential critical areas.
- Localised Slope Re-profiling – this measure would only be recommended where environmental costs have been outweighed by the reduction in the Hazard Ranking.

As noted, peat reuse and restoration areas are proposed as part of the works, and these have been indicatively described as part of this PLHRA, although not assessed. Although the peat reuse and restoration areas may increase the risk of peat instability in those areas, design and construction techniques to mitigate against the instability of the areas for reuse or restoration will be developed as part of the detailed design.

7.3 Potential Peat Slide Indicators

During the site works (i.e. GI works or Construction works), site staff should be made aware of the slope failure indicators, how to recognise them and the importance and mechanism for reporting these. They should also receive training and instruction in emergency procedures in the event of a peat slide. This will minimise the impact should a peat slide occur.

There are a number of recognised indicators for slope failures, and these can also indicate the potential of a peat slide event. The factors below are particularly applicable to low velocity events:

- The development of tension cracks across the slope or in semi-circular patterns showing progressive development;
- Boggy ground or new springs appearing at the base of slopes;
- Sudden reactivation / drying up of spring lines, drainage channels or streams;
- Creep and bulging of ground;
- Displacement and leaning of trees, fence posts, dykes, etc.; and
- Breaking of underground services.

8 Conclusions and Recommendations

8.1 Conclusions

The general approach to the infrastructure design has been to design the Project to avoid areas of deep peat deposits (i.e. >1.0m thickness) wherever possible.

As indicated in **Figure 9**, **Appendix A - Figures** the peat slide assessed Hazard for the Site is generally assessed to be either 'Negligible' or 'Unlikely'. However, some of the infrastructure components and environmental receptors for the Project are located in or within 50m of an area with a peat slide Hazard of 'Likely'.

From the qualitative assessment (**Table 6-12**) of the construction components within the Site, the proposed infrastructure was assessed with 22% being classed with a Hazard Ranking of 'Negligible' and 78% with a Hazard Ranking of 'Low'.

All of the proposed infrastructure is located in areas assessed as having a Hazard Ranking of 'Low' or 'Negligible', meaning that the project can proceed as long as further investigation and design to refine the assessment and mitigate the hazard is undertaken. It should be noted that even after this preliminary PLHRA, the Hazard Ranking is considered to be relatively conservative given the approach undertaken. As such, it is considered that following a quantitative assessment, which incorporates further detailed GI data and further details on the design and construction, the Hazard Rankings will reduce.

As components were assessed with a 'Low', AECOM have outlined mitigation measures (**Section 7.2**) that could be implemented to reduce the Hazard and Exposure. The decision on whether further analysis is undertaken and/or the selection and details on the mitigation measures used shall be determined by the Principal Contractor of the Project. A further update to the PLHRA shall be carried out for the Project by the Principal Contractor, using additional information collected during the additional ground investigation, post consent, and considering further details on the design of the scheme after this reaches design maturity. As part of the update to the PLHRA, it is considered that the Hazard Ranking at several locations will be reduced following the provision of further information and a more detailed qualitative assessment.

As highlighted the Project will include the reuse and restoration of peat in some form as part of the works. The extent of reuse /restoration has been indicatively described and shown, although this is still in the design and development stage and as such has not been assessed. It is acknowledged that this reuse/restoration of the peat may increase the peat instability risk on the Site, however, as part of the development and detailed design of these areas, the Designer will ensure and prove stability whether that be through engineered solutions within the areas or through the implementation of mitigation measures. As such, this should reduce the likelihood of a peat slide as a result of the reuse/restoration and/or reduce its exposure to acceptable levels, if not prevented all together. The final PLHRA shall consider the effect that the reuse and restoration areas have on the peat stability within the Site and present the detailed design of these areas as relates to the peat stability and how instability has been prevented, reduced or mitigated, if not proven to be stable.

The Principal Contractor will be required to produce a Construction and Environment Management Plan (CEMP)for the construction of the Project. This should include the results of any updated PLHRA, considering the detailed procedures and methods intended to be used by the Principal Contractor to minimise any environmental impact, including the risk of any peat slide events.

8.2 Recommendations

Any further ground investigation should specifically target the areas within the Site where no or minimal investigation was previously undertaken (e.g. at the proposed peat restoration areas). Investigation should also be undertaken along the existing access track which is proposed to be upgraded.

The ground investigation shall also allow for the collection of additional information on peat thickness and characteristic properties (including laboratory testing of samples as set out in the Best Practice Guidance[9]), and the installation and monitoring of groundwater wells to estimate groundwater level throughout the Site, so that the Final PLHRA can determine whether the extent of these areas can be reduced and allow for the detailed targeting of any mitigation measure required.

The ground investigation shall also allow and provide further information for the production of a detailed and fully justified quantitative assessment of the peat slide hazard, if considered required.

Following clear-felling of the remaining trees, the peat probing should be completed in these areas to reduce the estimation required, relating to peat depth and extent, as part of the final PLHRA.

Appendix A Figures

Appendix B Peat Investigation Technical Notes