Bingally 400/132kV Substation and 400kV OHL Tie In

Preliminary Peat Landslide Hazard and Risk Assessment

SSEN Transmission

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1. Introduction

1.1 General

Scottish & Southern Energy Transmission (SSEN Transmission) (the ‘Applicant’) is proposing to develop a substation and associated overhead line tie-in at the proposed Bingally substation in the vicinity of the village of Tomich, in the Highlands of Scotland. Bingally 400 /132 kV Substation (the ‘Proposed Development’) is planned to comprise the new substation platform and associated infrastructure to allow access, construction and link into the exitsing electricty transmission network.

AECOM Ltd (AECOM) has been commissioned to carry out a preliminary Peat Landslide Hazard and Risk Assessment (PLHRA) to confirm the initial infrastructure design phase.

An Environmental Appraisal (EA) is being prepared in conjunction with this PLHRA on behalf of the Applicant for the Proposed Development and may be referred to at various points within this report.

1.2 Assessment Team

The assessment works were undertaken by a team of AECOM engineering geologists and geotechnical engineers based in Edinburgh all of whom have previous experience in working on projects in a peat environment and specifically in undertaking peat assessments for PLHRAs.

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.

The site walkovers and site works (i.e. peat probing) have been undertaken by various AECOM personnel involved in the production of the EA including hydrogeologists, geoenviromental consultants, ecologists and external ground investigation Contractors all of which have experience in working and assessing peatland environments.

1.3 Site Location and Description

The location and details of the Proposed Development site are shown on **Figures 1 and 2**, in **Appendix A** within the red line boundary. For the purposes of this document, the Proposed Development can be split into 2 distinct areas: the main works area and the access track. The substation, overhead line (OHL) tie-in and associated infrastructure are all located within the main works area. The access track extends from the A831 south to the main works and comprises both upgrades of existing sections of track and new construction.

The main works area is located approximately 2.5km south of Tomich at approximate National Grid Reference (NGR) NH 30371 24232. The main works area is located with clear-felled commercial forestry with surface vegetation in the form of heathland observed with very localised juvenile trees present sporadically throughout the area. Existing drainage channels associated with the forestry land use were noted within the area although these were generally obscured and overgrown. The existing forestry access track is present in the west and south of the area with a drainage channel running alongside the track.

The access track extends from the main works area in the south (approximate NGR: NH 30397 24625) to the A831 in the north, approximately 1km east of the village of Cannich (approximate NGR: NH 35141 31677). The proposed access track is approximately 9.5km in length and comprises upgrade of approximately 3.6km of existing forestry track and construction of approximately 5.9km of new access track. Where present, the existing access track was observed to be orientated northeast – southwest and to be of unbound construction comprising of compacted stone with a drainage channel typically running alongside. The existing access track is recorded to extend from around the proposed substation, to approximately 5.0km north of the proposed substation. Over its length the proposed access track does not follow the alignment of the existing access track throughout. The proposed access track variously runs through areas of managed forestry plantation and open heathland throughout its length. Several culverted watercourses are also crossed by the access track at various points along its length.

Within the main works area and running adjacent to the proposed access track is the existing north – south trending Beauly – Denny overhead line.

The Proposed Development is located within hilly terrain with the topography varying throughout although in general the topography falls from east to west.

1.4 Proposed Peat Reuse & Restoration Areas

Peat reuse and restoration areas are proposed as part of the Proposed Development within the Site, however, these are currently being considered further and assessed as part of the design development. These areas will result in peat deposition generated by the construction of the Proposed Development within the Site which will, in areas, result in the increase of overall peat thickness beyond that currently present. Peat reuse and restoration works may also result in the change of condition in the peat until conditions stabilise. As the peat reuse and restoration within the Site are still being developed, these will be assessed as part of the detailed design stage and have therefore not been considered as part of this PLHRA. The assessment undertaken on the peat reuse and restoration areas in relation to the peat stability as a result of increased thickness will be presented as part of the detailed PLHRA, post-consent following design maturity and any further information becoming available.

The assessment also does not consider the peat contained within temporary peat storage areas during the construction period as these should be covered by temporary works design.

1.5 Proposed Infrastructure

The Proposed Development layout is shown on **Figures 1a** to **1c,** in **Appendix A**.

The Proposed Development will comprise the following:

- Substation platform with associated earthworks;
  - Installation of 400 / 132kV transformers, new 400 / 132kV double busbars, 400 / 132kV future bays and ancillary equipment;
  - A new control building;
- OHL tie ins from the new substation to the existing Beauly-Denny OHL;
  - Temporary OHL diversion;
- New tower and gantries to allow tie-in;Upgrade of existing access track, and the construction of a new section, connecting the A831 to the new substation;
- Temporary compounds (for laydown/stockpile areas, material processing and offices and welfare);
- Borrow Pit;
- Permanent drainage systems; and
  - Inclusive of new SuDS basins to manage surface water runoff from the Proposed Development;
- Landscaping mitigation and biodiversity enhancement, including peatland restoration areas.

1.6 Scope of Report

The scope of this report comprises the following;

- A summary of the methodology used for the preliminary PLHRA;
- A review and assessment of the baseline conditions emanating from 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

- 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;
- Aerial photography;
- Geological datasets showing the published superficial and solid geology;
- Geotechnical and Geo-environmental Desk Studies produced by AECOM [AECOM, 2025a & b];
- Information collected during walkover surveys (see **Section 4.1**);
- Peat depths recorded by peat probing surveys (see **Section 2.4**);
- Ground investigation information [Igne, 2024] from intrusive works undertaken within the Site; and
- Ground information as presented within Jacobs Ground Investigation Report for the Proposed Development (Jacobs, 2024).

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 [Scottish Government, 2017]. 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 [Scottish Government, 2017].

At present, the Proposed Development is still in the design stage with only the outline scheme developed. As such, initial intrusive investigations have been undertaken, as summarised in **Section 2.4**, with peat depths estimated through widespread peat probing and coring with more targetted exploratory holes (trial pits and boreholes) within the main works area. A quantitative slope stability analysis to estimate Factors of Safety and a quantitative hazard and risk assessment have therefore not been undertaken. This will be undertaken during the detailed design stage.

The reuse of peat is proposed as part of the Proposed Development. At this stage the reuse of the peat within areas of the Site has only been partially developed with further areas currently being considered. As such, this preliminary PLHRA does not take into account the peat reuse areas, although it is acknowlegded the areas of reuse or restoration may impact on the overall peat stability both of the existing deposits and of the placed peat. The stabiltiy of peat reuse areas will be assessed as part of the detailed design process with the assessment presented within the Detailed PLHRA completed, post-consent.

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

1.7 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 instrusive investigation does not cover the full probed areas, specifically the access track, 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.

Where the peat probe data has been interpolated out from the nearest points, this was undertaken using estimation and 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. More probing and investigation is proposed to inform the detailed design and as such data gaps are anticipated to be filled as a result and shall be discussed and assessed further as part of the Detailed 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.

2. Methodology

2.1 Desktop Review

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

- British Geological Survey (BGS) for geology, geological related hazards and hydrogeology;
- Scotland's Soils for soil coverage;
- Centre for Ecology and Hydrology (CEH), National River Flow Archive (NRFA) (www.ceh.ac.uk/data/nrfa) for flows and rainfall;
- SEPA (www.sepa.org.uk) for river basin management plans, groundwater classification, groundwater vulnerability, water quality and hydrogeology;
- Aerial Photography; and
- Ordnance Survey maps and Digital Terrain Model (DTM) for topography.

Groundsure Reports providing key information (such as geology, historic maping, mining, etc.) for the Proposed Development were also obtained and used as part of the desktop review undertaken. This report is provided as Appendix C of AECOMs Geotechnical and Geo-Environmental Desk Study Reports [AECOM, 2025a & b].

The initial desktop review was carried out by AECOM with full details provided in the Geotechnical and Geo-Environmental Desk Study Reports undertaken for the Proposed Development [AECOM, 2025a & b]. A summary of the information relevant to this PLHRA Report can be found in the 'Baseline Environment' in **Section 3** of this report.

2.2 Assessment Approach

A single stage assessment of the peat slide Hazard Ranking has been completed for the Proposed Development. 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 6** 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.

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 [Scottish Government, 2017];
- SEPA Regulatory Guidance – Developments on Peat and Off-site Uses of Peat [SEPA, 2017];
- Floating Roads on Peat [Scottish Natural Heritage (SNH) & Forestry Commission Scotland (FCS), 2010];
- Constructed Track in the Scottish Uplands [SNH, 2015];
- Good Practice during Wind Farm Construction [Nature Scot Guidance, 2024];
- Guidance on Developments on Peatland, Peatland Survey [Scottish Government, SNH & SEPA, 2017]; and
- Developments on Peatland: Guidance on the assessment of peat volumes, reuse of excavated peat and the minimisation of waste [SR & SEPA, 2012].

2.4 Summary of Surveys

The following surveys have been undertaken for the Proposed Development:

- Initial phase of ground investigation covering both intrusive exploratory holes and peat probing was undertaken by Igne from November 2023 to January 2024 to cover the proposed substation site;
- Further peat depth probing and peat coring was undertaken by BAM Ritchies in May to July 2024 to cover the proposed access track, OHL and further infrastructure locations at the proposed substation location; and
- A site walkover was conducted by AECOM in May 2024 to verify the desktop survey findings and inform the EA process.

The peat probing locations undertaken across both investigations are shown on **Figures 7a** to **7e,** in **Appendix A**. **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 **Figures 3a** to **3c,** in **Appendix A**.

2.5 Site Infrastructure Design

The peat depth assessment identified that peat depths ranging from 0.0m to 1.0m, cover the majority of the Proposed Development, with areas where peat depths were recorded up to 3.0m and isolated locations where recorded peat depths were >3.0m also identified within and surrounding the proposed substation. Significant deposits of deep peat >5.0m in depth were identified to the northeast of the proposed substation location, outwith areas of proposed infrastructure.

It is acknowledged that there are localised channels where peat >2.0m has accumulated as shown in **Figure 7a** to 7e , however, it was not possible to design the layout to avoid these completely.

3. Baseline Environment

3.1 Topography and Slope Analysis

An Ordnance Survey 5m DTM file was obtained for the Proposed Development. This file was used to produce the contour data as shown on **Figures 4a** to **4c** within **Appendix A**. A brief summary of the elevation data is also presented below.

The topographic data obtained indicates the Site generally slopes down to the northwest. At the main works area the data indicates a fall from approximately 380m above ordnance datum (AOD) in the east to approximately 285m AOD in the west. Across the OHL line the topography is shown to fall from approximately 335m AOD at the southern extent to approximately 285m AOD at the northern extent.

The topographic data indicates that the existing access track typically falls from southeast to northwest as well was from south to north. Towards the main works area the access track is at a level of approximately 300m AOD which falls to approximately 90m AOD by the A831.

The 5m DTM was used to create a slope assessment of the Site with this shown on **Figures 4a** to **4c,** in **Appendix A**.

3.2 Historic OS Mapping and Aerial Photography Review

Historic OS mapping was obtained for the Proposed Development as part of the Groundsure Report obtained for the Desk Studies and is included as Appendix C of the AECOM Geotechnical and Geo-Environmental Desk Studies [AECOM, 2025a & b]. Review of the earliest availble map from 1872 identified the Site was generally undeveloped mainly agricultural land with localised areas of forestry. By 1971 further presumably commercial forestry was recorded particularly within the south of the Site. The mapping up to 1971 also identifies the former alignment of the OHL within the southwest of the Site with access tracks presumably for the forestry indicated within the centre and south of the Site. Also recorded within the south of the site were ponds and a disused gravel pit. From the 1971 mapping to present day no significant or extensive changes were noted within the Site. Typically only new access tracks, OHL, slight changes to the forestry extent and localised pits/quarries were recorded.

A review of aerial photographs relating to the Proposed Development was undertaken using the historical aerial imagery time slider of Google Earth . The earliest available aerial photograph from 1985 was of poor resolution, however, it appeared to record the Proposed Development to be predominately heathland with localised areas of forestry. The next map with good quality resolution was from 2006 which indicated the old alignment of the OHL which was present just to the west of the present-day Beauly – Denny OHL within the Proposed Development. The image from 2006 also indicated extensive forestry in what appears to be a conifer plantation in the main works area which extends to the east of the Proposed Development. The next available photograph which showed any change was from 2016, which showed felling of most of the forestry within the main works area. The OHL that was present had been upgraded to the now present-day Beauly – Denny OHL in its current alignment, with the old OHL appearing to have been demolished. The existing access track within the Proposed Development that runs from the village of Fasnakyle past the proposed substation is now also present. It is assumed the existing access track was constructed for the installation of the present-day Beauly – Denny OHL alignment. Approximately 3.80km northeast of the proposed substation a presumed borrow pit is shown, which is assumed to have been formed for the extraction of aggregate for use in the construction of the existing access track. No further significant development was noted through the images reviewed up to the most recent from 2024.

No obvious evidence of peat instability features where 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 [Microsoft, 2024] and through consultations with the Applicant.

The main works area comprises commercial forestry with all of the Proposed Development clear-felled and grown over with vegetation. Sporadic juvenile trees are also present within the main works area. In relation to the southern half of the OHL, the land generally comprises of open heathland.

The proposed access track variously runs through areas of managed forestry plantation and open heathland throughout its length. Several watercourses are also crossed by the access track at various points along its length. What appears to be an historic borrow pit is noted from aerial imagery immediately adjacent to the proposed access track, with this thought to have been formed as part of the construction of the existing track.

Within the main works area and running alongside much of the proposed access track is the existing north – south trending Beauly – Denny Overhead Electricity Line.

3.4 Geology and Soils

3.4.1 Superficial Geology (Drift Deposits)

A review of the BGS Onshore GeoIndex Viewer [BGS, 2024] indicates the majority of the Proposed Development to be underlain by either glacial till or areas where no superficial deposits are recorded, indicating bedrock is at or near ground level. Pockets of peat are frequently recorded throughout the Proposed Development typically in the lower lying areas, in northeast – southwest trending channels. Locally within the southeast associated with the southern half of the OHL line and within the northern extent of the Site the glacial till is recorded as hummocky (mound). The extents and location of the recorded superficial deposits across the Site are shown on **Figures 5a** to **5c,** in **Appendix A**.

Although not recorded by the BGS, as watercourses are recorded within 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, overhead line, etc.).

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.
- Hummocky (Moundy) Glacial Till – similar in composition to the glacial till, however, described as more granular comprising of sand and gravel in larger constituents.
- 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 [Scotland’s Soils, 2024]. This source identified the main works area to be predominately underlain by peaty gleys with dystrophic semi-confined peat. Locally, to the northwest and southwest of the main works area, humus-iron podzols with peaty gleyed podzols are recorded. The proposed OHL is also recorded to be underlain by peaty gleys with dystrophic semi-confined peat in the northern half and southern extent of the works area; and humus-iron podzols with peaty gleyed podzols in the southern half and northern extent of the works area. In relation to the access track, this is recorded to be predominantly underlain by humus-iron podzols with peaty gleyed podzols throughout. Locally towards the middle of the route, the access track is recorded to be underlain by peaty gleyed podzols. The northern extent of the access track is also locally underlain by mineral alluvial soils with peaty alluvial soils and the southern extent towards the substation underlain by peaty gleys with dystrophic semi-confined peat.

Review of the Carbon and Peatland 2016 Map layer of the National Soil Map of Scotland Interactive Map Viewer [Scotland's Soils, 2024] was also undertaken. This source indicated that the main works area is predominately underlain by Class 5 carbon and peatland soils. Locally, within the southwestern extent of the main works area Class 0 deposits are recorded and to the north of the main works area two small pockets of Class 1 carbon and peatland soils are recorded.

The 2016 Carbon and Peatland Map layer indicates that the proposed OHL is underlain by Class 5 soils in the northern half and Class 0 soils in the southern half. Locally in the southern extent of the OHL Class 1 soils are recorded, with these also recorded just to the east of the OHL as noted for the main works area above. Class 0 soils are also recorded within the northern extent of the OHL.

For the access track, the 2016 Carbon and Peatland Map layer indicates this is predominately underlain by Class 0 soils. Locally towards the centre of the access track route, an area of Class 2 Carbon and Peatland soils are recorded. An area of Class 1 soils is also recorded to the east of the access track, within the red line boundary for the Proposed Development but not underlying the proposed access track alignment.

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

- Class 0 – Generally mineral soils where peatland habitats are not typically found.
- Class 1 – Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value.
- Class 2 – Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential.
- 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 in areas 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 0** and **6.5** of this report.

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 lanslides having occurred within or in close vicinity to the Site.

3.4.2 Solid Geology (Bedrock)

A review of the BGS Onshore GeoIndex Viewer [BGS, 2024] indicates the Site to be predominately underlain by the Tarvie Psammite Formation. Locally on the Site boundary within the north of the Site, an area of the Tarvie Psammite Formation is recorded to comprise of both Psammite and Semipelite. Also locally on the Site Boundary, approximately 1.8km northeast of the proposed substation a small deposit of the Glen Moriston Vein Complex is recorded. The extents and location of the recorded solid geology across the Site is shown on **Figure 6,** in **Appendix A**.

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

- Tarvie Psammite Formation – recorded to be of metamorphic rock type. Described as "predominantly psammite, thin-bedded, siliceous to micaceous. Local, thin semipelite beds are muscovite-rich and locally migmatitic. Large quartzite lenses occur, in particular near the base." As noted above, the formation is locally recorded to comprise of Psammite and Semipelite within a small area in the north of the Site on the Site boundary.

- Glen Moriston Vein Complex – recorded to be of igneous rock type. Described as “microgranite and trace leucogranite and pegmatite.”

3.4.3 Structural Geology

A review of the BGS Onshore GeoIndex Viewer [BGS, 2024] indicates no faults are present within the Site.

Locally throughout the Site, typically northeast – southwest trending glacial meltwater channels and glacial flutes are recorded.

3.5 Mining and Quarrying

3.5.1 Coal Mining

The Coal Authority Interactive Map Viewer [CA, 2024] 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 Site boundary.

3.5.2 Quarrying

Review of the Groundsure Report for the Site as contained within Appendix C of AECOMs Geotechnical and Geo-Environmental Desk Studies [AECOM, 2025] indicates four quarries and pits in the vicinity of the Proposed Development. All of which have a ceased status. This is confirmed through the review of the available historic OS mapping and aerial imagery for the Site. An additional borrow pit is noted from review of the aerial imagery, immediately adjacent to the proposed access track approximately 3.8km north of the proposed substation. The borrow pit is assumed to have been formed for construction of the existing access track.

The Active Mines and Quarries layer of the BGS Geoindex [BGS, 2024] indicated mines and quarries within and in the vicinity of the Site as indicated within the Groundsure Report. These mines and quarries were recorded with a ceased status.

A review of the Mine Plans Extents layer of the BGS Geoindex [BGS, 2024] was also undertaken. Plans are shown to cover the entire Site, however, these are recorded to be for hydroelectric developments and are not considered to affect the Site.

3.6 Hydrogeology

An estimation of the groundwater producitivity of the superficial deposits recorded within the Site was made using the guidance contained within the BGS Aquifer Producitivty Report [BGS, 2015]. 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 [BGS, 2024], provides information on the solid geology aquifer productivity. This indicates that the Loch Eli Group, of which all rock formations recorded within the Site belong too, is a low productive aquifer. The BGS describe this aquifer as having “small amounts of groundwater in near surface weathered zone and secondary fractures”.

3.7 Hydrology

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

The majority of the main works area appears to be drained by three watercourses which are all tributaries of the Abhainn Deabhag; one in the south (unnamed), one in the north (Allt á Bhuachaille) and one in the east (unnamed). The watercourses in the south and north of the main works areas underly proposed infrastructure, whereas the eastern watercourse runs in the immediate vicinity of the borrow pit. The southern most watercourse flows typically flows to the west draining into the Allt an Rathain just outwith the Site, which ultimately drains into the Abhainn Deabhag approximately 1.2km west of the Site. The northern watercourse typically flows to the northwest and ultimately drains into the Abhainn Deabhag approximately 1.35km northwest of the Site. The eastern most watercourse typically flows to the northwest draining into the Allt á Choire Bhudhe within the Site approximately 820m northeast of the proposed substation. This watercourse then continues to flow to the northwest within the Site passing under the proposed access track before leaving the Site and eventually draining into the Abhainn Deabhag approximately 1.3km east of the Site.

Along the proposed access track, frequent (typically minor) watercourses are crossed, with all generally flowing to the northeast into the Abhainn Deabhag or the River Affric (to which the Abhainn Deabhag drains into at around Fasnakyle) which becomes the River Glass within Cannich. The River Glass is present within the Site at its northern extent, however, the proposed access track is located approximately 130m south of the river at its closest point.

Given the land use in some 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 watercourses in the vicinity. The state of the drainage dicthes in the main works area is thought to be degraded as a result of the felling operations and as they appear to have been overgrown. There is also the drainage ditch which runs along the existing access track within the Site which was observed during site walkovers and appeared to be in working condition.

Scotland's Environment Interactive Map Viewer [Scotland's Environment, 2024] indicated the main river catchment within the Site is the River Beauly. All watercourses and drainage ditches within the Site are anticipated to drain, eventually into the River Glass which drains into the River Beauly approximately 10.5km north of the Site .

Review of SEPA's water classification hub [SEPA, 2024a] indicates none of the minor watercourses within the Site have been classified by SEPA. However, the River Glass within the northern extent of the Site and the River Affric which is present to the west of the Site and to which the Abhainn Deabhag and many other watercourses within the Site are assumed to drain, have been classified by SEPA as Abhainn Deabhag (ID 20235). Both watercourses have been classified with an overall status of 'Good'. As the minor watercourses within the Site have not been classified by SEPA, it is assumed these have the same overall status classification as the River Glass and Abhainn Deabhag (i.e. overall status of 'Good').

Review of the National River Flow Archive (NFRA) [NFRA, 2024] shows flow gauges are present for the River Glass within the northern extent of the Site and for the River Affric to which the Abhainn Deabhag and many of the watercourses within the Site drain. **Table 3-1** shows the average flow recorded from each of these gauging stations. The flows indicate that the River Glass has generally high flows. Both of the downstream distances to the flow guages from the Site are noted in **Section 3.8** below.

Table 3-1. NRFA River Flow Data

Catchment	NGR	Gauge ID	Period of Record	Annual Flow (m^3/s)
Glass at Fasnakyle	NH 31500 28700	5004	1991 – 2021	4.894
Glass at Kerrow Wood	NH 35400 32000	5003	1989 – 2021	31.525

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 NFRA search data page [NRFA, 2024]. This source indicated three gauging stations are located surrounding the Site as follows:

- River Glass at Kerrow Wood, approximately 550m northeast of the Site;

- River Glass at Fasnakyle, approximately 720m west of the Site; and
- River Enrick at White Bridge, approximately 4.7km east of the Site.

Table 3-2 shows the annual average rainfall recorded from each of these gauging stations. The annual average of rainfall in Scotland was 1487 mm[1] for 2024, therefore the records shown for Glass at Fasnakyle and Glass at Kerrow Wood show that there tends to be higher than average rainfall in this area. While Enrick at White Bridge has an average rainfall level.

Table 3-2. NRFA Rainfall Data

Catchment	NGR	Gauge ID	Period of Record	Annual Average Rainfall (mm)
Glass at Fasnakyle	NH 31500 28700	5004	1961 – 1990	2249
Glass at Kerrow Wood	NH 35400 32000	5003	1961 – 1990	2209
Enrick at White Bridge	NH 39100 30100	6012	1961 – 1990	1331

3.9 Flooding

The SEPA Flood Maps for planning website [SEPA, 2024b] to assess potential flood risks at the Site, which are summarised below:

- River Flooding – The Site is not in an area of designated flood risk from river flooding, suggesting that the flood risk is <0.1% chance. An area to the immediate southeast of the Site, in the area of Loch a' Ghreidlein is shown as a high risk from river flooding. The Groundsure Reports (contained in Appendix C of AECOM Geotechnical and Geoenvironmental Desk Studies) shows some sporadic areas within the south and north of the Site to be at highest risk from river flooding of 1 in 30-year return period, these represent small areas immediately surrounding existing surface water features. Additionally, some areas in the centre and within 50m centre of the Site are shown as highest risks of 1 in 100-year return period.
- Coastal Flooding - The Site is not at risk of coastal flooding. This is also confirmed by the Groundsure Reports obtained for the Site.
- Surface Water Flooding – SEPA flood mapping indicates areas across the Site to be of low to high risk from surface water flooding. This is also confirmed by the Groundsure Reports, which describes the surface water flooding at highest risk of 1 in 30-year return period within the south, centre and north of the site, and within 50m distance from these. The highest risk areas appear to be located in topographical low points and surrounding existing small surface water features.
- Groundwater Flooding – The Groundsure Reports indicate that the Site lies predominantly within an area of negligible risk of flooding from groundwater. A small section within the north of the Site lies in an area of moderate risk from groundwater flooding and a small area in the south of the Site relating to the OHL lies in an area of low risk. SEPA does not provide information on groundwater flooding risk.

The above does not constitute a formal flood risk assessment, just a collation of the available information relating to the topic. A separate Flood Risk Assessment for both the substation and access track has been submitted as part of the accompanying planning application.

3.10 Geomorphology

The geomorphology of the Site is dominated by the topography and resulting drainage pattern. The topography of the main works is generally flatter than that to the east and west, which is indicated to be steep, possibly indicating a plateau at the Site. The drainage patterns are likely to follow that of the general topography within land typically sloping towards the northwest. The generally flatter and less steep ground within the majority of the main works is likely to represent wetter areas that are more likely to contain conditions suitable for the development of deeper peat accumulations. This BGS records more localised channels of peat through this area

[1] Met Office Hadley Centre HadUKP Data Download

(see **Figure 5,** in **Appendix A**), with the peat probing undertaken (dicussed in **Section 4.0** of this Report), typically confirming this interpretation.

Along the proposed access track, the topography is typically steeper and so generally would not be anticipated to be suitable for the development of deeper peat deposits, with shallow bedrock or glacial till typically recorded by the BGS. Localised areas of flatter ground are recorded along the proposed access track, which roughly coincide with the peat deposits as recorded by the BGS (see **Figure 5,** in **Appendix A**). The results of the peat probing typically agree with this interpretation with deep peat deposits only locally recorded in areas of flatter topography.

4. Site Surveys

4.1 Walkover Surveys

Two site walkover surveys were undertaken within the Site:

- By Jacobs in November 2023 to inform the ground investigation undertaken; and
- By AECOM in May 2024 to inform the EA process.

Generally, the site walkover agreed with the features as identified in the ‘Site Location and Description’ and ‘Current Land Use’ Sections of this PLHRA (**Sections 1.3** & **0**, respectively). The main works area was found to to be covered by open ground with heathland present at surface and sporadic juvenile trees noted. The forestry was noted to have been clear-felled with undulating ground present as a result. The existing access tracks were noted within the area to the west and south. No peat exposures were observed within the main works area. Localised areas of standing water and very soft underfoot conditions were frequently encountered suggesting that soft peat deposits are present within the area. Bedrock exposures were noted in the west of the area indicating the presence of shallow bedrock. Drainage ditches were identified typically along former firebreaks generally following the topography, from east to west. The existing Beauly – Denny OHL was observed in the west of the Site with this typically trending north – south.

Along the proposed access track, the land was typically recorded to be a mix of open heathland and forestry with the existing access track partially present. No peat exposures were noted along the route of the proposed access track. Rock exposures were noted locally along the alignment of the proposed access track indicating the presence of shallow bedrock. The existing Beauly – Denny OHL was also observed running alongside the proposed access track.

Ground conditions were noted to vary within the Site, with both firmer and drier ground typically encountered on the steeper slopes and very soft and wet conditions encountered on the flatter ground in localised areas. This would suggest deeper peat is present within the flatter lying ground. Although not observed during the site walkovers, the peat within the areas of forestry is likely disturbed as a result of the commercial forestry operations. No evidence of peat landslide or peat cracking were noted during any of the site walkovers.

4.1.1 Watercourses / Ponds

Some of the watercourses as identified within **Section 3.7** of this report were observed as part of the site walkovers undertaken. As there are numerous watercourses recorded to be present within the Site these are not all recorded within the text of this PLHRA, with reference to the Figures in **Appendix A** highlighted for locations of these. Drainage channels/ditches were observed within the Site associated with the forestry works, however, these were highly obscured by surface vegetation and the felling operations. The drainage channels observed are not included as part of the OS mapping on the Figures within **Appendix A** of this report.

4.1.2 Existing Access Tracks

An existing unbound access track is present within the west and south of the Site and with their alignments as shown on the OS Basemap of **Figures 7a** to **7e,** in **Appendix A**. The access tracks were noted to be constructed of granular aggregate (predominately of gravel sized fractions), with the source of this gravel thought to be from borrow pits constructed within the Site. The access track was noted to be in a reasonable condition with no obvious signs of significant surface settlement or failures noted.

4.2 Igne Ground Investigation

An initial phase of ground investigation was undertaken by Igne from November 2023 to January 2024. The investigation included 6,270 peat probes, 25 no. boreholes & 38 no. trial pits. The results of the investigation are included within Igne’s Factual Report [Igne, 2024] and summarised in AECOM’s Geotechnical and Geo-environmental Desk Study for the proposed substation and access track [AECOM, 2025a].

The peat probing was undertaken across two possible locations for the proposed substation, the proposed Site and a location to the northeast of the proposed Site. The peat probes were undertaken to give an understanding of the peat extent and depth across the possible Site locations to inform the site selection process and to allow detailed design as relates to the peat. The peat probing results aided in informing the selection of the site with the site that possess a lesser volume of peat and less impact on the Class 1 peatland selected. The peat probing undertaken was at approximate 10m centres across the possible substation platform locations. Estimated peat depths from this survey typically ranged from 0.0m to 2.0m thickness, although local areas of deeper peat were recorded within the area of the GI up to a maximum of 7.82m bgl.

The intrusive investigation (i.e. trial pits and boreholes) were typically undertaken within the Site to allow design of the proposed substation and associated works. The peat was encountered from surface to a maximum depth of 3.50m (BH28) within 13 boreholes and in all trial pits, with the exception of TP16 and TP27 where topsoil was encountered. The intrusive investigation results were reviewed against the peat probe data, with these generally showing agreement in peat depth. Where observed in exploratory holes, the peat was generally described as dark brown slightly sandy plastic amorphous locally spongey fibrous peat. The Von Post Humification Scale was used to log the peat 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. In general, the peat encountered as part of the ground investigation was recorded in the range of H4 to H5 / B1 to B2, although humification of up to H8 as well as moisture contents of up to B3 was locally recorded underlying proposed infrastructure such as the proposed substation platform, Temporary Compound 1 and Temporary Compound 4. Geotechnical laboratory testing was undertaken on 17 samples of the peat which indicated a water content ranging between 105% and 1353% with an average value of 521% and an organic matter content ranging between 13% and 24% with an average value of 19.2%. Included within Appendix A of Jacobs GIR [Jacobs, 2024] are geological longitudinal sections at three locations across the main works area, with the predicted platform level shown.

The substrate across the area where peat probing was undertaken was recorded to typically comprise granular glacial deposits of sand and/or gravel. Locally the peat was recorded to be underlain directly of bedrock, although in these cases the bedrock was considered to be weathered.

4.3 BAM Ritchies Peat Investigation

Additional peat probing within the Site was undertaken by BAM Ritchies in May to July 2024. The additional probing was undertaken to cover areas of the proposed access track, OHL and any infrastructure which were not included within the initial probing by Igne as part of Ground Investigation. The spacing of the probing varied depending on location with a 25m grid typically undertaken adjacent to the proposed access track extending to 50m with distance from the track. For the OHL infrastructure, a 10m grid was typically undertaken at each proposed tower location, working area and access track to the towers. For the proposed borrow pit location a 25m grid was typically undertaken.

In total 3,361 probes were undertaken as part of the additional probing exercise. Estimated peat depths from the additional probing ranged from 0.0m to 4.5m, although the majority of probes recorded estimated peat depths <1.0m.

In addition to the peat probing, BAM also undertook 60 peat cores using a Russian Corer. Full details of the probing and peat coring undertaken is presented in Fairhurst's GI Summary Note dated 2024 [Fairhurst, 2024]. The locations of the cores undertaken are as shown on Drawings within Fairhurst's Summary Note, with 5 present within and in close proximity to the proposed borrow pit area and the rest spread across the length of the proposed access track. Of the 60 Russian Cores taken, all but 11 encountered peat. The majority of cores where no peat was encountered were located towards the northern extent of the proposed access track, although further cores where no peat was encountered are also located locally throughout the proposed access track alignment. Where peat was encountered the depths encountered through the Russian Coring typically agreed with the peat depths as estimated through the peat probing undertaken.

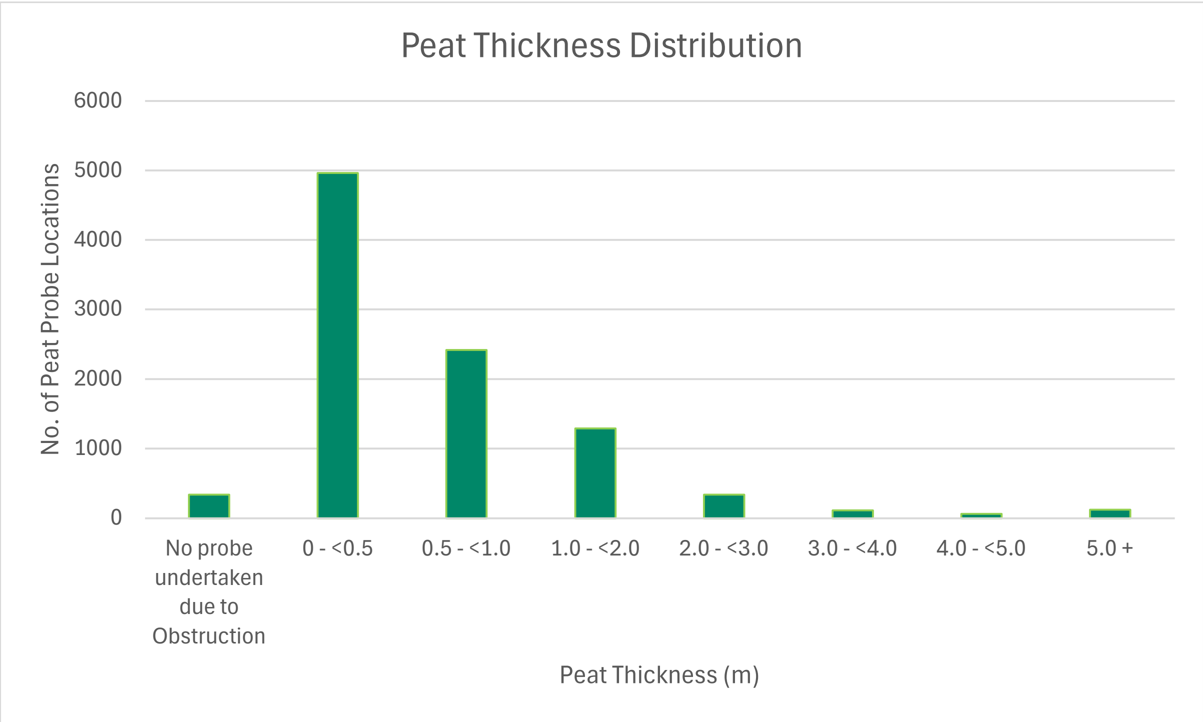
Where peat was encountered within the Russian Core positions, typically two distinct layers were encountered; an upper more fibrous layer and a lower more amorphous layer. The upper layer is likely to represent the acrotelmic layer of the peat, with this typically recorded from ground level to between 0.10m and 1.25m bgl. The upper layer is generally described as spongy to firm brown to dark brown fibrous PEAT with many fine roots. In relation to the Von Post Humification Scale the upper layer was typically recorded in the range H2 (insignificant decomposition) to H4 (slight decomposition), locally H1 (no noticeable decomposition) or H5 (moderate decomposition), with a moisture content of B1 (dry) to B2 (low), locally B3 (moderate). The lower more amorphous layer of peat is likely to represent the catotelmic layer of the peat, with this generally recorded underlying the actotelm to the base of the core location, at the interface with the substrate. The lower peat layer is typically described as spongy to firm, locally plastic, dark brown becoming black clayey pseudo-fibrous PEAT with a deeper deposit also frequently recorded underlying the pseudo-fibrous peat, typically comprising firm to plastic dark brown to black amorphous PEAT. In relation to the Von Post Humification Scale, the lower peat layer was typically recorded to range from H5 (moderate decomposition) to H7 (strong decomposition) becoming H8 (very strong decomposition) or H9 (nearly complete decomposition) with depth, with a moisture content of B2 (low) to B3 (moderate), locally B4 (high) or B5 (very high). No testing was carried out on the peat recovered from the BAM Ritchies peat investigation.

4.4 Peat Probing Summary

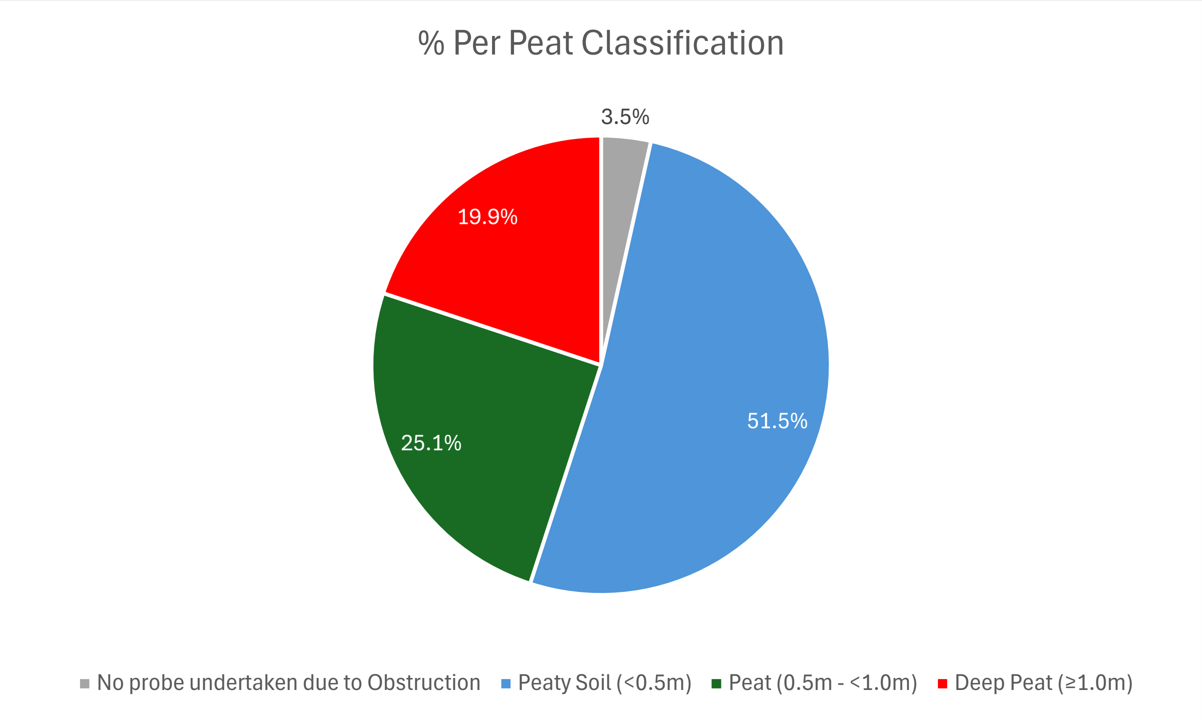
In total, 9,631 probes were carried out for the Proposed Development. **Figures 7a** to **7e,** in **Appendix A,** shows the locations of the peat probes undertaken across both surveys and indicates the estimated depth of peat encountered. **Figures 8a** to **8e,** in **Appendix A,** then uses the results of the peat probes and their locations to create a peat depth interpolation plan for the Site using the Inverse Distance Weighting (IDW) metholodgy. Forthe assessment, in these areas the peat depth has been estimated based the depth of the nearest probes. 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 detailed PLHRA will be required post-consent, following design maturity, where further probing may be undertaken to inform and as required by the detailed design.

In general, the results of the peat probing indicate peat depths ranging from 0.0m to 1.0m, with localised channels indicating peat depths up to 3.0m and very isolated areas indicating peat up to 5.0m. Areas of significant deep peat extent typically >5.0m are recorded within the Site to the northeast of the proposed substation. However, it should be noted this area is outwith areas of proposed infrastructure. Where shallow bedrock or boulders, trees or access tracks were encountered, no probe was undertaken at this location.

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 investigations, 337 probes (~3.5% of the 9,631 no. total probes) were not undertaken due to the presence of obstructions at surface (e.g. trees, boulders, access track, etc.). Peaty soil <0.5m thick were recorded in 4,961 no. of the probes (~51.5% of the 9,631 no. total probes) and peat deposits between 0.5m and <1.0m thick were recorded in 2,415 no. of the probes (~25.1% of the 9,631 no. total probes). Deep peat >1.0m in thickness was recorded in 1,918 no. of the probes (~19.9% of the 9,631 no. total probes).

In relation to the Proposed Development, the peat deposits recorded are typically <1.0m in thickness. However, it is acknowledged that deep peat deposits (>1.0m in thickness) are present. These deeper deposits are aligned from northeast to southwest within the proposed substation footprint as well as being present more locally underlying each other proposed piece of infrastructure. The deep deposits underlying the Proposed Development are typically up to 3.0m in depth with very localised areas up to 4.0m underlying the proposed substation footprint, temporary office & welfare compound and Temporary Compound 3/borrow pit. Very isolated areas of peat up to 5.0m thick are also recorded underlying the southern corner of Temporary Compound 3/borrow pit.

5. Peat Stability

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." [BGS, 2024].

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 [O'Kelly, 2017]. The Scottish Government guidance document [Scottish Government, 2017] 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 fluctations also within the layer. The catotelm is a more decomposed layer which is below the water table level and is waterlogged [O'Kelly, 2017]. The position of the water table therefore controls the level of acrotelm and catotelm deposits which therefore control the stability of the peat deposits.

BS 5930 [BSI, 2020] 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 recognisible plant remains with the deposits also retaining some tensile strength. Pseudo-fibrous peat is described as a mixture of plant fibres and amorphous peat. 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 which ranges from H1 (no decomposition) to H10 (totally decomposed) [Von Post, 1924].

The Scottish Government Guidance document [Scottish Government, 2017] 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 [Scottish Government, 2017] also identifies three different types of peat deposits; rasied bog, blanket bog and fen bog. The Wildlife Trust [Wildlife Trust, 2021a] 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. Generally, raised bogs are significantly wetter than the surrounding land and are fed almost entirely by rainwater. The Wildlife Trust [Wildlife Trust, 2024b] 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 gentlely sloping land where drainage is poor, and the peat is predominately fed by rainwater. The International Peat Society [International Peat Society, 2021] 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 is 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 [Scottish Government, 2017] 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 [Scottish Government, 2017] 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 accummulation 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).
- Man-made Events:
  - Alteration of hyrdological 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 Development 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 a wind farm 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 instabilty issues during and post construction. It is therefore essential to identify and record any signs of past instability (e.g. cracking of the peat suface, 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.

5.3.1 Types of Peat Failure

Table 2.1 of the Scottish Government Guidance document [Scottish Government, 2017] 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 2m 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 2m 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 1m and 3m;
- 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 Proposed Development.

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 Proposed Development, including construction works, does not result in an unacceptable risk of peat failure.

6.2 Triggering and Preparatory Factors Relevant to the Proposed Development

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

- 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 (
- 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
- 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 (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 Proposed Development.

Working methodologies / mitigation measures referred to above willl be presented in detail in the site specific construction methodology documents prepared in the Construction Phase PMP and CEMP and 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 considered to be the following:

- The Proposed Development (e.g. new substation, new / upgrades to existing access track, existing and temporary overhead lines, SuDS Basins, etc.);

- Existing private and public infrastructure;
- 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);
- Archaeology; 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, digital terrain model, observations made during site visits, an assessment of peat probing results 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 Proposed Development. The Hazard Ranking has been undertaken in accordance with the Scottish Government Guidance [Scottish Government, 2017].

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 Proposed Development

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 Proposed Development

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, destruction of property or infrastructure or public road, major loss of habitat.
4	Very high	10% – 100%	Minor or non-serious injury, minor damage to property or temporary closure of infrastructure, significant pollution incident or significant loss of habitat.
3	High	4% – 10%	Minor pollution incident, 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 Level can be estimated for the Proposed Development. The indicative Hazard Levels 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 6-3. Indicative Hazard Levels

Peat landslide probability or likelihood	Adverse consequence				
	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 Level 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 risk level present on the Site. The Hazard Levels 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 6-4. Hazard Level and Suggested Actions

Risk Level	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 level of 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.

6.5.1 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.

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 [Boylan, et al., 2008].

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 6-5**.

Table 6-5. Slope Angle Ranking (Ranking Factor 1)

Slope Angle (°)	Ranking
0 – 2	0.5
< 2 – 5	1
< 5 – 10	2
<10 – 15	3
<15 – 20	4
≥ 20	5

Please refer to **Figure 4,** in **Appendix A,** for the topography across the Site.

6.5.2 Peat Thickness

Mills, A.J (2002) 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. Peat slides are defined as “slab-like, shallow translational failures with a shear failure mechanism operating at, or just below, the peat and underlying substrate interface” [Warburton, et al., 2004]. Bog bursts “involve 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.” [Mills, 2002]

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.

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 [JNCC, 2011].

Peat stratification and thickness are associated with one another. This is due to the fact that thin deposits of peat are unlikely to have a catotelmic layer and may mainly be composed of a vegetative mat and acrotelm. As such, with inherent strength as a consequence 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 0.5m and 4m. 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 6-6**.

Table 6-6. 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

Please refer to **Figures 7a** to **7e** & **8a** to **8e**, in **Appendix A**, for the peat depths across the Site.

6.5.3 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 feastures 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 6-7**.

Table 6-7. 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

6.5.4 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 extent 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 comparitvely 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 6-8. Substrate Ranking (Ranking 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**, the GI typically indicated the Site was underlain by granular glacial deposits substrate. Locally, weathered rock was recorded directly underlying the peat, however, the rock was indicated to be weathered comprising sand and gravel. Based on the GI available the entire Site has been assessed as having a coarse-grained substrate. It is acknowledged that the current GI undertaken does not cover the whole Site, however, the BGS record similar deposits throughout and therefore for this preliminary assessment is considered suitable. Further GI will be undertaken by the Principal Contarctor prior to construction and will be included in the detailed PLHRA, where considered required, post consent.

6.5.5 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. 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 [Wilson & Hegarty, 1993]. This process initially affects the structure and hydrology of the upper acrotelmic layer of peat. Drains were noted to have been created 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 obsured 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 is highly likely to 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 6-9. Presence of Forestry Ranking (Ranking of 5)

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

Please refer to **Figures 3a** to **3c** for the presence of forestry across the Site.

6.5.6 Hydrology

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 [Carling, 1986].

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 [JNCC, 2011]. 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.

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.

Table 6-10. 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

Generally the Site walkover surveys identified drainage ditches associated with forestry within the main works area, however, these were not considered to be in good working order with branches and vegetation present within. The Site walkovers identified very soft and wet ground locally throughout the Site. As such, the full Site has been assessed as boggy or saturated ground.

6.5.7 Weightings

The factors affecting peat instability are not considered to contribute equally and as such, weightings have been applied based on AECOM's 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 slope 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.

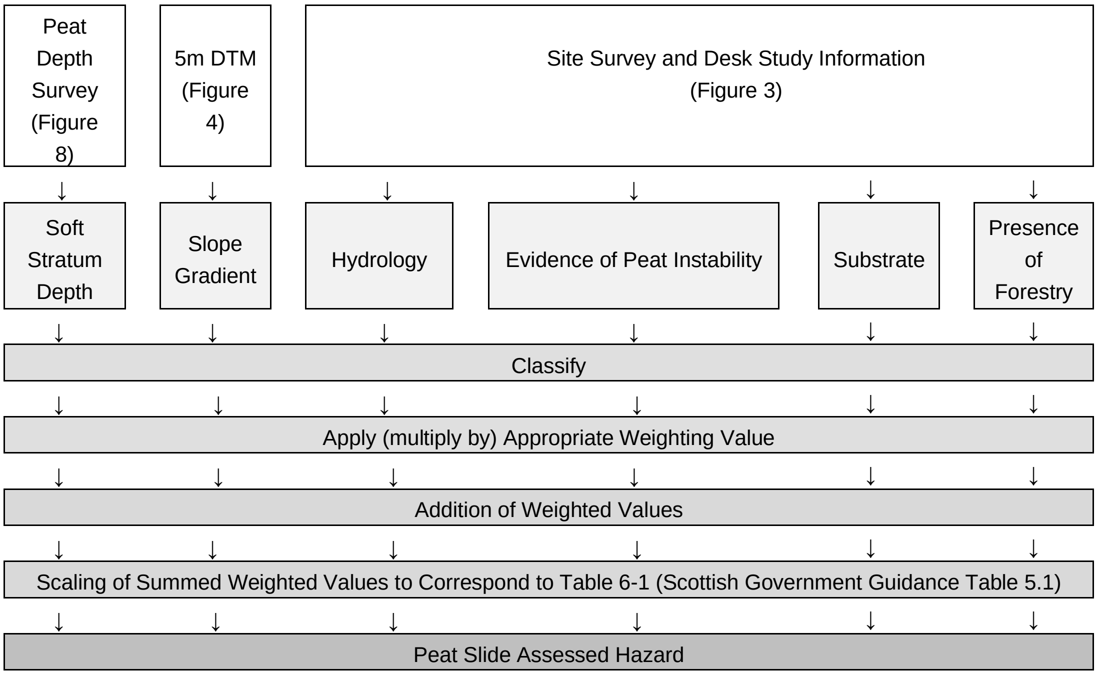
Finally, the hydrology of the peat is also considered to contribute to its stability. However, due to the extent of the forestry across the Site, hydrology is considered to be less influential. This is because the hydrology is closely related to the drainage network throughout the forestry and this factor 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 6-11**.

Table 6-11. Weighting Values for Each Parameter

Layer	Ranking Factor	Weighting
Slope Angle	1	6
Peat Thickness	2	4
Signs of Relic Failure	3	6
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 6-1**.



Insert 6-1. GIS Multi-Criteria Analysis for the PSAH Plan

The scaling of the Weighted Totals corresponds to **Table 6-1** (and the Scottish Government Guidance Table 5.1) and is shown in **Table 6-12**, below.

Table 6-12. 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 **Figures 9a** to **9e,** in **Appendix A,** 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) and very isolated areas being assessed as ‘Probable’ (4) .

6.6.1 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 (i.e. sensitive habitats), 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 (e.g. 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), the following Exposure ratings have been applied;

- 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); and
- 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 Proposed Development, the following was taken into account. Generally, where access tracks, compounds, overhead lines, and drainage systems are proposed, the impact is considered to be '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 Proposed Development (Exposure rating of 3 – i.e. significant delay to construction and increase in total cost.).

Table 6-13 presents the qualitative assessment undertaken for the Site in a tabular format for each individual infrastructure component. Column 2 of the **Table 6-13** is to be cross-referenced with **Table 6-1** and refers to the peat slide Hazard value assigned to the infrastructure component (see **Figures 9a** to **9e,** in **Appendix A**). The peat slide Hazard may be assessed to be reduced during the evaulation 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 Proposed Development is most likely to affect the peat stability.

Column 3 of **Table 6-13** presents the assessed Exposure (see **Table 6-2**) relating to the individual proposed infrastructure components and any existing infrastructure (i.e. existing forestry tracks).

Column 4 of **Table 6-13** presents the assessed Exposure (see **Table 6-2**) relating to the environmental receptors.

Column 5 of **Table 6-13** is to be cross-referenced with **Table 6-3** 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 6-13** expresses the worst-case Hazard Ranking value as one of the four terms, which are shown in **Table 6-4**. 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 relatistic worst-case combination between the two inputs would be.

Table 6-13. Qualitative Assessment of Peat Landslide Hazard, Exposure and Hazard Ranking

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
See Figure 9 for reference of infrastructure locations and assessed peat slide Hazard						
Proposed new substation (and associated earthworks)	2	3	1	6	Low	Area of 'Likely' peat slide Hazard underlying and within 50m of the proposed new substation, however, this is to be removed as part of the earthworks and so can be neglected. Worst case peat slide Hazard within 50m of the proposed substation is therefore 'Unlikely'. Considering the infrastructure, the proposed substation has the higher Exposure Rating of 'High', which has been carried forward for the assessment. The rest of infrastructure both existing and proposed has a 'Low' Exposure Rating. No environmentally significant designation recorded within the footprint of or in close vicinity (< 50m) to the proposed new substation and no watercourse recorded within 50m or downslope of the proposed substation in the near vicinity. Therefore environmental exposure of 'very low' considered suitable.
Proposed Access Track from the A831	4	3	3	12	Moderate	Typically the proposed access track is indicated with a peat land Hazard of 'Negligible' or 'Unlikely', however, large areas of 'Likely' and isolated areas of 'Probable' are also indicated within the near vicinity of the proposed access track. Typically, a peat landslide in this area would impact on the access track and , potentially sections of the existing OHL (which runs parallel with the track along much of its alignment) or the north most SuDS basin within the southern extent of the alignment . As such, these would generally result in an Infrastructure Exposure rating of 'Low'. However, as the OHL is key infrastructure and a peat slide could potentially impact on one of the towers, the rating has been increased to 'High'. This could have been assessed as 'Very High' however, the towers are set back sufficiently from any works associated with the formation of the track. Also, towards the northern extent of the proposed access track, a peat slide could affect the A831 and as such, the rating has been increased to 'High'. This rating could have been higher, however, the peat thickness within this northern extent is estimated as <0.5m throughout and as such a significant volume of peat is not anticipated to be able to fall onto the road. In relation to the Hazard Ranking relating to the Infrastructure the combination of 'Negligible' or 'Unlikely' peat slide would typically result in a 'Negligible'

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
						Hazard Ranking when combined with the Infrastructure Exposure of the proposed access track itself. This Hazard Ranking can be applied to the majority of the access track. Where 'Likely' or 'Probable' peat slide Hazards are identified along the proposed access track, the combination of this with the proposed access track Infrastructure Exposure would result in a 'Low' Hazard Ranking. The area of 'Moderate' Hazard Ranking therefore only affects OHL towers in areas where the 'Likely ' or 'Probable' peat slide hazard combines with the 'High' Infrastructure Exposure and within the northern extent of the proposed access track where it joins to the A831. The proposed access track is recorded to cross and be within 50m of watercourses.The Environmental Exposure is therefore assessed as being 'High'. In the vicinity of the watercourses the peat slide Hazard ranges from 'Negligible' to 'Probable'. This gives Hazard Rankings ranging from 'Negligible' to 'Moderate'. Typically the watercourses are within peat slide Hazard areas of 'Unlikely' or 'Likely' giving a typical Hazard Ranking of 'Low' along the proposed access track when crossing or within the vicinity of watercourses. Locally, particularly within the northern half of the route, 'Moderate' peat slide Hazards are recorded adjacent to the watercourses and the proposed access track giving the 'Moderate' Hazard Ranking.
Southern Realigned Access Track	2	3	3	6	Low	Area of 'Unlikely' peat slide Hazard within 50m of the realigned access track. The worst-case infrastructure Exposure relates to the proposed substation which is downslope of the access track.Therefore the infrastructure Exposure has been rated as 'High'. A watercourse is crossed by the access track and is present just to the south of access track. Enviromental Exposure is therefore rated at as 'High'.
Western Realigned Access Track	3	2	1	6	Low	Highest peat slide Hazard within 50m of the realigned access track is 'Likely'. The worst-case infrastructure Exposure relates to the access track itself, the OHL diversion and the existing OHL in the north of the route which is downslope of the access track. The infrastructure Exposure has therefore been rated as 'Low'. No environmentally significant designation recorded within or in close vicinity to the proposed access track and no watercourse recorded within 50m. Enviromental Exposure is therefore rated at its lowest at 'very low'.

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
Northern SuDS Basin	2	2	2	4	Negligible	Highest peat slide Hazard within 50m of the basin is 'Unlikely'. The proposed SuDS Basin is downslope of the proposed substation and therefore any peat slide caused by the basin is not considered to affect it. The worst-case Infrastructure Exposure relates to the basin itself, access track and OHL, which are assessed to have an Exposure of 'Low'. No environmentally significant designations recorded within or in close vicinity to the SuDS Basin. A watercourse is located within the vicinity of and downslope of the basin, however, >50m from this. A worst-case Environmental Exposure of 'Low' is therefore considered suitable.
Southern SuDS Basin	2	2	2	4	Negligible	Highest peat slide Hazard within 50m of the basin is 'Unlikely'. The proposed SuDS Basin is parallel on the slope with the proposed substation and therefore any peat slide caused by the basin is not considered to affect it. The worst-case Infrastructure Exposure relates to the basin itself, access track and OHL, which are assessed to have an Exposure of 'Low'. A watercourse is recorded within 50m of the basin, however, is parallel on the slope and is not downslope. A peat landslide caused by the basin is therefore considered to have a reduced Exposure than what would normally be applied, with a 'Low' Environmental Exposure considered suitable.
Temporary Working Areas around Existing OHL Pylons where works are proposed	3 (1)	2	1 (2)	6	Low	Three of the working areas typically have a 'Negligible' peat slide Hazard, with two (the northern most) indicated with a 'Likely' peat slide Hazard within 50m. The second most northenly tower is located within an area where the peat will be excavated as part of the substation platform construction. As such, the likely peat slide Hazard associated with this areas can be considered to be negligible. The assessed worst-case Infrastructure Exposure for the working areas around the existing towers relates to the towers themselves and the proposed/existing access tracks. The proposed substation is upslope of the working areas and so assumed not to be affected by a peat slide caused by the working areas. As such, an Infrastructure Exposure of 'Low' has been used. Generally the existing OHL towers where works are to be undertaken do not have environmentally significant designation recorded within or in close

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
						vicinity and do not have watercourses recorded within 50m. A watercourse is located within the vicinity of and downslope of the second most southernly tower, however, >50m from the towers working area. Generally the Environmental Exposure has been assessed to be 'Very Low', however, at the second most southernly tower this has been assessed as 'Low'. The combination of this higher Environmental Exposure and the peat slide hazard at and in the vicinity of the tower (Negligible) gives a Hazard Ranking of 'Negligible'. The worst-case Hazard Ranking of 'Low' is therefore associated with the 'Likely' peat slide Hazard in the vicinity of the two northern most towers where works are proposed and the Infrastructure Exposure relating to these.
Temporary OHL Diversion Pylons	2	2	2	4	Negligible	The two temporary towers associated with the OHL diversion are typically within areas assessed with a worst-case peat slide Hazard within 50m of 'Unlikley'. The southern most tower does have a very small area of 'Likely' peat slide Hazard within 50m, however, given its size and the general peat slide Hazard in its surroundings this is not considered representative and has therefore been omittedfrom this assessment. The worst-case Infrastructure Exposure relates to the temporary towers and associated working areas as well as the proposed and existing access tracks which are upslope. Therefore the infrastructure Exposure has been rated as 'low'. No environmentally significant designations recorded within or in close vicinity to the temporary OHL towers. A watercourse is located within the vicinity of and downslope of the southern most temporary tower, however, >50m from this tower. A worst-case Environmental Exposure of 'Low' is therefore considered suitable.
Temporary Offices & Welfare Compound	3	2	2	6	Low	Highest peat slide Hazard within 50m of proposed compound is 'Likely'. Peat slide Hazard of 'Likely' is present underlying the area also, however, this is antipicated to be removed as part of the construction process and so can be neglected. The proposed substation is upslope of the proposed compound and so is not considered to be affected by a peat slide casued by it. The worst-case infrastructure Exposure therefore relates to the proposed compound itself as well as the proposed access track. As such, the the infrastructure Exposure has been rated as 'Low'.

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
						No environmentally significant designation recorded within or in close vicinity to the proposed compound and no watercourse recorded within 50m. A watercourse is located downslope of proposed compound, however, >50m from this and therefore an Environmental Exposure of 'Low' is considered suitable.
Temporary Compound 1	3	2	2	6	Low	Within and immediately adjacent to Area 1 the peat slide Hazard is estimated as 'Negligible' or 'Unlikely'. However, an area of 'Likely' peat slide Hazard is located within 50m of Area 1. A peat slide casued by the compound is not anticipated to affect the proposed substation. A peat slide is antipcated to affect the compound itself, the access track, or the temporary offices and welfare compound. As such, the Infrastructure Exposure is estimated as 'Low'. No environmentally significant designation recorded within or in close vicinity to the compound and no watercourse recorded within 50m. A watercourse is located downslope of the proposed compound, however, >50m from this and therefore an Environmental Exposure of 'Low' is considered suitable.
Temporary Compound 2	2	3	1	6	Low	Within and immediately adjacent to the proposed compound the peat slide Hazard is estimated as 'Negligible'. However, areas of 'Unlikely' peat slide Hazard are located within 50m of the proposed compound. The proposed substation is downslope of the proposed compound and as such may be affected by a peat slide from the compound. As such, a worst-case Infrastructure Exposure of 'High' is estimated. No environmentally significant designation recorded within or in close vicinity to the proposed compound and no watercourse recorded within 50m. Enviromental Exposure therefore rated at its lowest at 'very low'.
Temporary Compound 3 / Borrow Pit	3 (2)	2 (3)	3	6	Low	Generally the peat slide Hazard within and immediately adjacent to this area is estimated as 'Negligible' or 'Unlikely', however, areas of 'Likely' peat slide Hazard are present on the southern boundary of the area. Very small areas of 'Probable' peat slide Hazard are also indicated, however, given their size these are not considered representative of the wider peat slide Hazard with this higher Hazard therefore neglected.

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
						The worst-case Infrastructure Exposure relates to the proposed substation which is downslope of the area. This is estimated with an Infrastructure Exposure of ‘High’. However, given the distance between the ‘Likely’ peat slide Hazard and the proposed substation, these are not antipcated to interact and so have not been combined together to estimate the Hazard Ranking. For the worst-case Infrastructure Exposure ‘High’ (shown in brackets) this is combined with a reduced and more representative peat slide Hazard of ‘Unlikely’ (shown in brackets) to give a ‘Low’ Hazard Ranking. The ‘Likely’ peat slide Hazard is anticipated to affect the proposed temporary compound and access tracks which have an Infrastructure Exposure of ‘Low’. This gives an estimated Hazard Ranking of ‘Low’. A watercourse is located just to the east and upslope of the area. The worst-case Environmental Exposure is therefore ‘High’. A peat slide downslope of the watercourse would not signifcantly affect the watercourse. As such, the ‘Likely’ peat slide Hazard would not be combined with the ‘High’ Environmental Exposure as the ‘Likely’ peat slide Hazard within 50m of the area, which may be affected by works and cause a peat slide, is downslope of the watercourse. Instead the ‘Unlikely’ peat slide Hazard upslope of teh area and the watercourse, which could be affected by the works and cause a peat slide, should be combined with the ‘High’ Environmental Exposure. This would give a worst-case Hazard Ranking of ‘Low’.
Temporary Compound 4	2	3	3	6	Low	Highest peat slide Hazard within 50m of the area is ‘Unlikely’. The proposed compound is immediately adjacent to the proposed substation. During construction a peat slide from the compound affecting the proposed substation is unlikely as both areas will be stripped of peat. A peat slide associated with the proposed compound, once reinstated following completion of its use, affecting the proposed substation may occur and therefore the worst-case Infrastructure Expoure is ‘High’. A watercourse is recorded immediately to the south of the proposec compound. A ‘High’ Environmental Exposure is therefore considered suitable.
Temporary Compound 5 (inclusive of access track leading to the compound)	4 (2)	1 (2)	3	12 (4)	Moderate (Low)	Highest peat slide Hazard within 50m of temporary compound is ‘Probable’. Peat slide Hazard of ‘Likely’ is also present downslope and within 50m of the Temporary Compound and associated access track to the north. Both the ‘Probable’ and ‘Likely’ peat slide Hazards are downslope of Proposed Infrastructure and so a peat slide from these areas would not affect the

Column 1 Area	Column 2 Assessed Hazard (Worst Case)	Column 3 Assessed Infrastructure Exposure	Column 4 Assessed Environmental Exposure	Column 5 Worst-Case Hazard Ranking	Column 6 Worst-Case Hazard Ranking	Column 7 Comment
						Proposed Infrastructure itself. Furthemore there is no existing infrastructure downslope of these higher peat slide hazard areas that would be considered to be affected. As such, the lowest Infrastructure Exposure of 'Very Low' has been applied to interact with the highest peat slide Hazard of 'Probable'. In relation to the worst-case infrastructure exposure, this relates to the Temporary Compound itself. However, no areas of 'Probable' or 'Likely' peat slide Hazard are upslope within 50m of the proposed Temporary Compound. As such, the worst case peat alside Hazard considered to interact with the Temporary Compound is 'unlikely'. This assessment is as shown in the brackets, adjacent. No environmentally significant designation recorded within or in close vicinity to the proposed Temporary Compound. Watercourses are recorded within 50m of the Temporary Compound and associated access track, giving a worst-case environmental exposure of 'High'. The 'High' environmental exposure would interact with the worst-case peat slide Hazard of 'Probable', giving a worst case Hazard Ranking of 'Moderate'.

The qualititative assessment has identified that the majority (9 No.) of the proposed infrastructure aspects are located within ‘Low’ Hazard Ranking areas, with 2 No. located wihtin a ‘Moderate’ Hazard Ranking area. The remaining 3 No. of the proposed infrastructure aspects are located in ‘Negligible’ Hazard Ranking areas.

7. Mitigation Measures

7.1 General

Construction activites (e.g. excavation, drainage, etc.) are known to have a potential destabilising effect on peat deposits. The design of the Proposed Development 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 affects on the peat and its habitat.

As part of the Proposed Development, a Construction and Environment Management Plan (CEMP) and Construction Management Statement (CMS) should be prepared 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 Proposed Development to inform the detailed design. The GI information will also be used to update the PLHRA, following the Scottish Government Guidance [Scottish Government, 2017].

7.2 Mitigation Measures

Mitigation measures and good practice procedures are ultimately the responsibility of the Principal Contractor. That being said, 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
- 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 downslope 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 and also to minimise the extent and duration that excavations are left open;
- Where excavated tracks are constructed, the peat and any soft soils should be removed and replaced with granular material placed in layers and compacted;
- Construction staff should be made aware of peat slide indicators and emergency procedures;
- Where previously unidentified areas of peat instability concern or sensitive receptors are identified, undertake micrositing of infrastructure to avoid areas or minimise impacts;
- Emergency procedures should include steps to be taken on detection of an incipient peat slide or of the event occurring; and
- Adoption of good practice measures for forestry clearance activities.

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 [Scottish Government, 2017], discussion of mitigation measures relevant to each potential peat landslide hazard identified is required.

A more detailed PLHRA will be required for the Proposed Development at design maturity post-consent, which includes the findings of further intrusive works to characterise the peat further. 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, may require additional engineering measures. Infrastructure with a 'Moderate' Hazard Ranking will require additional engineering measures. These 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. If applicable, re-routing surface (flushes/gullies) and subsurface (pipes) drainage around critical areas will also help control surface water.
    - Catch Fences – these should be installed down slope of areas of potential risk and are used to slow or halt run out from a landslide. These would typically be constructed into the peat substrate.

  – Catch Ditches – these should be installed down slope of areas of potential risk and like catch wall fences are used to slow or halt run out. These would typically be constructed in non-peat material.
  – Monitoring of slope and peat stability – both in the vicinity and down slope of turbine / track areas during construction by suitably experienced and qualified personnel.

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

Construction Management – as part of the final CMS will include but is 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 detailed in **Table 6-13**, there are various areas that have a potential ‘Low’ or ‘Moderate’ Hazard Ranking. Once the Final PLHRA, inclusive of further ground investigation information and a more quantitative risk assessment, has been undertaken then **Table 7-1** sets out targeted preliminary worst-case mitigation measures that could be used for each of these areas within the Proposed Development.

Table 7-1. Targeted Mitigation for Each Development Area Identified with 'Low' or 'Moderate' Hazard Ranking

Area	Worst-Case Hazard Ranking	Comment
Proposed New Substation (and associated earthworks)	Low	**Installation of drainage** – Installation of targetted drainage on the upslope sides (east) of the proposed substation would aim to isolate the areas of peat from upslope surface water. 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. **Catch wall fences** – Installation of catch wall fences to the east of the proposed substation. Installing on these sides would help reduce and/or halt any landslide event towards the proposed substation from upslope. These fences will need to be engineered in such a way that they are adequately founded into the bedrock and should be inspected periodically and, if required, debris removed. **Catch ditches** – A softer engineering approach to catch wall fences are catch ditches. These could be installed as a first line of defence, in the east in front of the catch wall fence, if there is space. **Monitoring** – The slope / peat to the east could be monitored for any movement during construction, reinstatement and following completion of the works.
Proposed Access Track from the A831	Moderate	**Installation of drainage** – Installation of targetted drainage around the upslope and downslope sides of the access tracks would aim to isolate the areas of peat of 'Likely' and 'Probable' peat slide Hazard from upslope surface water. 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. **Catch wall fences** – Installation of catch wall fences around watercourses and on the southern side of the A831. Installing these would help reduce and/or halt any landslide event towards the watercourses and the A831. These fences will need to be engineered in such a way that they are adequately founded into the bedrock and should be inspected periodically and, if required, debris removed. **Catch ditches** – Installation of catch ditches in front of the catch wall fences to act as a first line of defence. Catch ditches could also be installed on the upslope side of the access track where 'Likely' or 'Probable' peat slide Hazard are indicated. **Monitoring** – the slopes / peat around the access track could be monitored for any movement during the construction works and after significant rainfall events.
Southern Realigned Access Track	Low	Mitigation around the proposed substation covered by 'Proposed New Substation' mitigation measure above, which includes as a result of this access track. **Installation of drainage** – Installation of targetted drainage on the upslope side of the access track and around the watercourse would aim to isolate the areas of peat from upslope surface water. 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. **Catch wall fences and catch ditches** – Installation of catch wall fences and catch ditches on the upslope side of the watercourse crossed and in the near vicinity to help reduce and/or halt any landslide event from reaching watercourse These would need to be considered in tandem with any catch wall fences and ditches being considered for the proposed material processing area and southern SuDS basin. **Monitoring** – The slope / peat surrounding the watercourse could be monitored for any movement during construction and following reinstatement of the material processing area.
Western Realigned Access Track	Low	**Installation of drainage** – Installation of targetted drainage on the downslope side of the access track at the northern most tower where works are proposed would aim to isolate the areas of 'Likely' peat slide Hazard from upslope surface

Area	Worst-Case Hazard Ranking	Comment
		water. 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. **Catch ditches** – Installation of catch ditches on the downslope side of the access track, upslope of the northern most tower where works are proposed to help reduce and/or halt any landslide event from reaching the tower. **Monitoring** – The slope / peat to the west and northwest of the proposed realigned access track where 'Likely' peat slide Hazard is indicated could be monitored for any movement during the construction.
Temporary Working Areas around Existing OHL Towers	Low	The mitigation measures recommended for the working areas and towers, generally relate to the northern most tower and working area as the others have an acceptable Hazard Ranking. The mitigation measures recommended for this tower is included within the Western Realigned Access Track migitation measures above, as both cover this tower.
Temporary Offices & Welfare Compound	Low	**Installation of drainage** – Installation of targetted drainage to the north of the area upslope of the 'Likely' peat slide Hazard would aim to isolate the area of 'Likely' peat slide Hazard from upslope surface water and from this mobilising into a peat failure. 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** – The slope / peat to the north of the area where 'Likely' peat slide Hazard is indicated could be monitored for any movement during the construction.
Temporary Compound 1	Low	The risk associated with this area relates to the 'Likely' peat slide Hazard to the northwest within 50m. The recommended mitigation for this area is as described for the Temporary Offices & Welfare Compound.
Temporary Compound 2	Low	**Installation of drainage** – Installation of targetted drainage on the upslope side of the area would aim to isolate the areas of 'Unlikely' peat slide Hazard and the reinstated peat in the area following construction from upslope surface water. 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. **Catch wall fences –** Installation of catch wall fences just upslope of the proposed substation of the eastern side. Installing these would help reduce and/or halt any landslide event towards the proposed substation from the upslope side. These fences will need to be engineered in such a way that they are adequately founded into the bedrock and should be inspected periodically and, if required, debris removed. **Catch ditches** – A softer engineering approach to catch wall fences are catch ditches. These could be installed as a first line of defence, in the east in front of the catch wall fence, if there is space. **Monitoring** – The slope / peat to the east and within the area following reinstatement could be monitored for any movement during construction and following reinstatement of the area.
Temporary Compound 3 & Borrow Pit	Low	**Installation of drainage** – Installation of targetted drainage on the southern side of the area and watercourse further south would aim to isolate the areas of 'Likely' peat slide Hazard from upslope surface water. 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. **Catch wall fences –** Installation of catch wall fences upslope of the watercourse in the south. Installing these would help reduce and/or halt any landslide event towards the watercourse from the upslope side. These fences will need to be

Area	Worst-Case Hazard Ranking	Comment
		engineered in such a way that they are adequately founded into the bedrock and should be inspected periodically and, if required, debris removed. **Catch ditches** – A softer engineering approach to catch wall fences are catch ditches. These could be installed as a first line of defence, in the south in front of the catch wall fence, if there is space. Catch ditches could also be installed on the southern side of the area, to halt or reduce a peat landslide event resulting from the 'Likely' peat slide Hazard in the south from entering into the area. **Monitoring** – The slope / peat to the south and within the area following reinstatement could be monitored for any movement during construction and following reinstatement of the area.
Temporary Compound 4	Low	**Installation of drainage** – Installation of targetted drainage around the compound once reinstated following completion of the works would aim to isolate the reinstated peat from upslope surface water and from this mobilising into a peat failure affecting the newly constructed substation. 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** – The peat reinstated within the compound could be monitored for any movement following reinstatement and any significant rainfall event.
Temporary Compound 5 (inclusive of access track leading to it)	Moderate	**Installation of drainage** – Installation of targetted drainage around the upslope side of the 'Probable' and 'Likely' peat sldie Hazard in the vicinity of the access track into the Temporary Compound and on the downslodpe side of the Temporart Compound itself would aim to isolate the areas of peat of 'Likely' and 'Probable' peat slide Hazard from upslope surface water. 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. **Catch wall fences** – Installation of catch wall fences around the watercourse crossed by the access track into the Temporary Compound. Installing these would help reduce and/or halt any landslide event towards the watercourse. These fences will need to be engineered in such a way that they are adequately founded into the bedrock and should be inspected periodically and, if required, debris removed. **Catch ditches** – Installation of catch ditches in front of the catch wall fences to act as a first line of defence, as well as on the upslope side of the watercourse to the south of the proposed Temporary Compound. **Monitoring** – the slopes / peat around the Temporary Compound and associated access track could be monitored for any movement during the construction works and after significant rainfall events.

As noted areas where peat will be reused or restored are currently being developed and are in the design stage. Although these areas will likely increase the risk of peat instability at the Site, design and construction techniques to mitigate against the instability of the areas for reuse or restoration will be developed. Where these areas are within areas where Hazard Ranking is assessed to be Low or Moderate, the measures used to design and construct these may superseed the measures highlighted above as they will be embedded within the reuse/restoration design and would aim to reduce the peat instability risk.

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 Proposed Development to avoid areas of deep peat deposits (i.e. >1.0m thickness) wherever possible.

As indicated in **Figure 9,** in **Appendix A,** the PSAH for the Site is generally assessed to be either 'Negligible' or 'Unlikely'. However, some of the infrastructure components of the Proposed Development are located in or within 50m of an area with a peat slide Hazard of 'Likely' with more isolated areas located in or within 50m of areas with a 'Moderate' peat slide Hazard.

From the qualitative assessment (**Table 6-13**) of the construction components within the Site, the proposed infrastructure was assessed with 21% being classed with a Hazard Ranking of 'Negiligible', 65% with a Hazard Ranking of 'Low' and 14% with a Hazard Ranking of 'Moderate'.

The majority of the proposed infrastructure is located in areas assessed as having a Hazard Ranking of 'Low', meaning that the project can proceed as long as further investigation 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 incoporates further more detailed GI data and further details on the design and construction, the Hazard Rankings will reduce.

As components were assessed with a 'Low' or 'Moderate' Hazard Ranking, AECOM have outlined targetted worst-case mitigation measures (**Table 7-1**) that could be implemented to reduce the Hazard and Exposure. A detailed Final PLHRA shall be carried out for the Proposed Development 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 Final PLHRA, it is considered that the Hazard Ranking at several locations will be reduced following the provision of further information and a more detailed quantitative assessment.

As highlighted the Proposed Development will include the reuse of peat in some form as part of the works. The extent of reuse/restoration is still in the design and development stage and as such has not been included as part of this PLHRA. It is acknowledged that this reuse/restoration of the peat may increase the peat instability risk on the Site, however, it is difficult to quantify this without knowing the full details on the design of these areas. The design of the reuse/restoration areas may also reduce the peat instability risk through engineering measures installed to contain the peat. This may reduce the Hazard Ranking currently asigned to certain areas. As such, the Final PLHRA shall consider the effect that these areas have on the peat stability within the Site considering the further investigative information obtained and the detailed design.

The Principal Contractor will be required to produce a CMS for the construction of the Proposed Development. This should include the results of the Final PLHRA, which will be a further development of this preliminary PLHRA. The Final PLHRA will provide 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 Proposed Development which were assessed as being 'Low' or 'Moderate' Hazard Rankings or where no investigation was previously undertaken (e.g. along the proposed access track).

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 [Scottish Government, 2017]), so that the Final PLHRA can determine whether the extent of these areas can be reduced and allow for the detailed targetting of any mitigation measure required.

The ground investigation shall also allow for the production of a quantitative assessment of the peat slide hazard, if considered required. However, the ground investigation should not be limited to said areas and information on the peat should be collected across the Site to allow for the peat to be better characterised.

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Appendix A – Figures

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