TECHNICAL APPENDIX 10.3 PEAT LANDSLIDE HAZARD RISK ASSESSMENT

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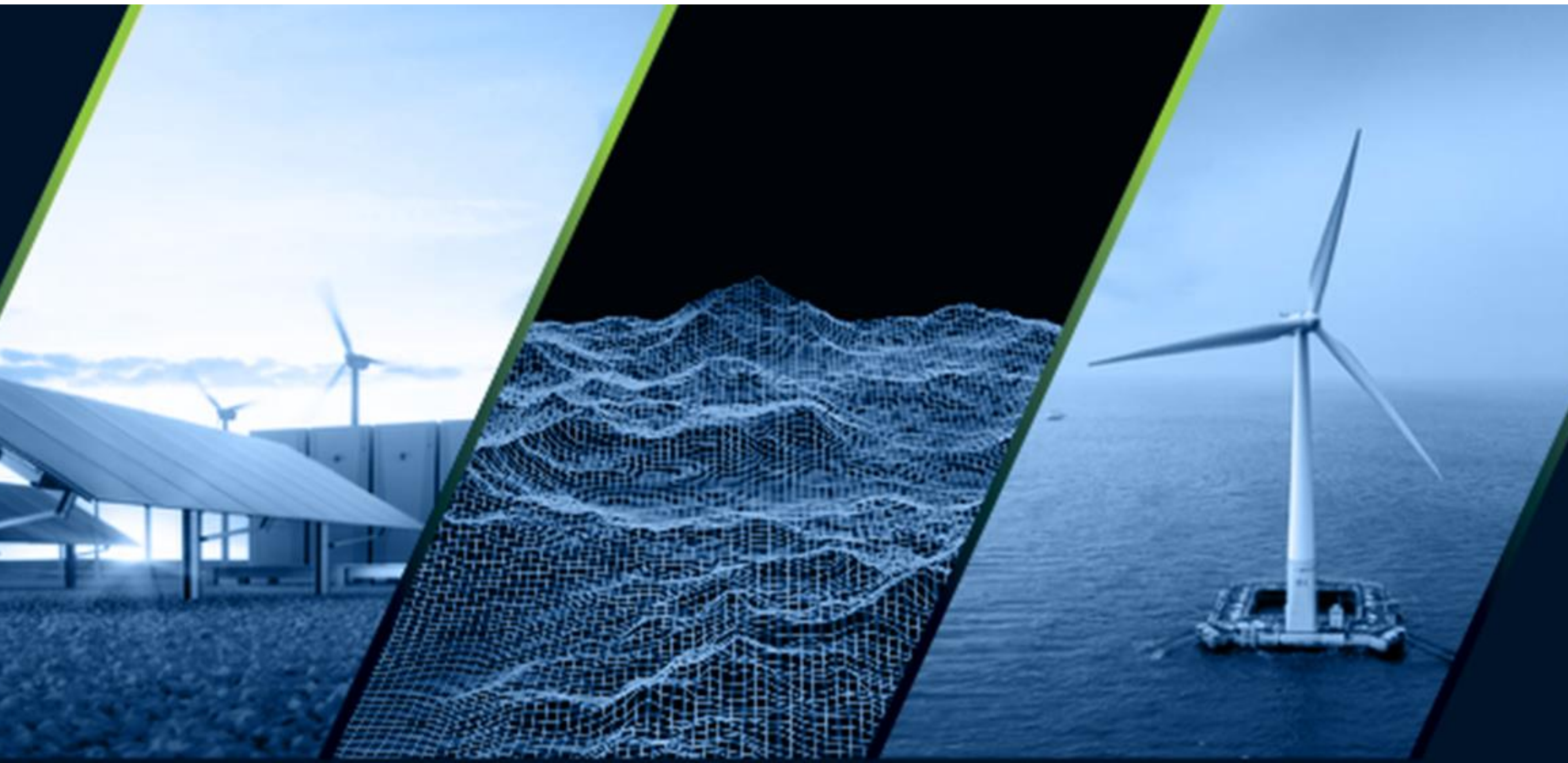

Lewis Hub (AC Substation & HVDC Converter Station) TA10.3 - Peat Landslide Hazard and Risk Assessment

Client	:	SSEN Transmission
Document No.	:	OWC-042605-001-REP002-B
Client Doc. No.	:	N/A
Document Status:	:	Issue

Document Notes

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Information

Project Name:	Lewis Hub
Document Title:	TA10.3 - Peat Landslide Hazard and Risk Assessment
Client Name:	SSEN Transmission PLC
Document No.:	OWC-042605-001-REP002-B
Document Status:	Issue
Contracted Entity:	OWC

Document History

Rev	Date	Authored	Reviewed	Approved	Notes
A	2024-12-03	AM	RH	AM	Draft for internal review
B	2025-01-20	AM	RH, OD, KC, MR	AM	Second draft
C	2025-02-03	AM	RH, OD, KC, MR, LC	AM	Issue

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1 Introduction

1.1 Background

Scottish and Southern Electricity Networks Transmission plc (SSEN Transmission, “the Applicant”) are seeking Planning Permission in Principle (PPiP) for construction of the “Lewis Hub” HVDC Convertor Station and associated 132 kV and 400 kV AC Substation works (hereafter “the Proposed Development”) near Stornoway on the Isle of Lewis.

The site is in two distinct geographical areas. The eastern area, referred to in this document as ‘Arnish Moor’ comprises the Proposed Development and lies approximately 2 km to the southwest of Stornoway. The Arnish Moor site is approximately 1.3 km^2 (c. 130 ha) in area, bordered to the west by the A859 road connecting Stornoway with the south of Lewis, to the south by the Creed Park recycling centre and to the east by the Arnish road connecting Stornoway to port installations within Stornoway Bay. The western area, referred to as ‘Creed North’ is a restoration area within which material excavated from Arnish Moor is proposed to be used to placed to restore peat removed by historical cutting. The Creed North area is c. 1.6 km^2.

Plate 1.1 provides an overview of the Proposed Development extent, superimposed on satellite imagery of the Site.

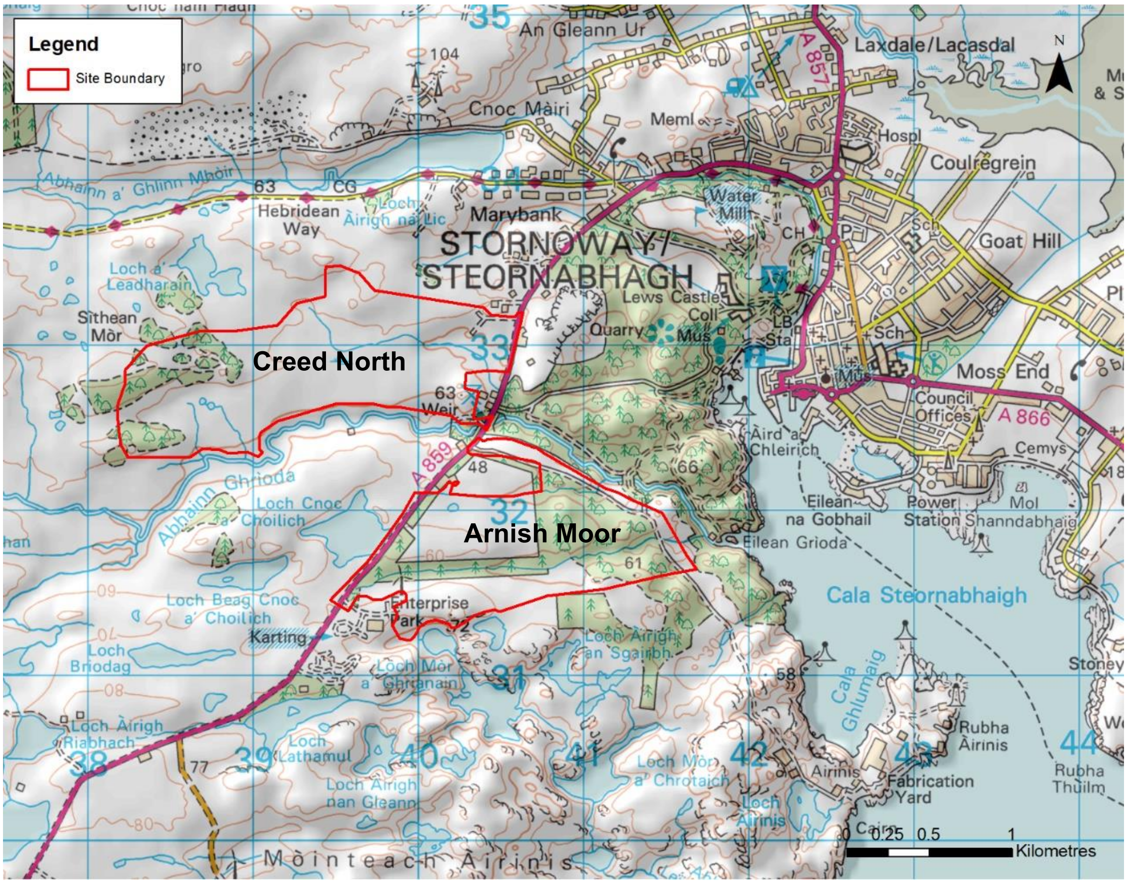


Plate 1.1 Location of the Proposed Development

A High Voltage Direct Current (HVDC) Convertor Station, in turn comprised of:

- Two main converter buildings housing transformers, converters, dynamic brake system and DC hall;
- Service and control building between the converter buildings;
- Two AC Hall and Filter Equipment buildings; and
- A number of smaller auxiliary buildings (diesel generator, spares building, etc).

A joint 132 kV and 400 kV substation, comprising:

- Three 132/400 kV Super Grid Transformer (SGTs) buildings, each with an overall footprint of around 45 m by 78 m and a maximum height of 20m. They would be enclosed to protect from the weather and reduce the noise impact;
- 400 kV GIS substation building and associated control building; and
- 132kV GIS substation building and associated control building.

The following ancillary works:

- Vegetation clearance;
- Upgrade existing or establishment of new junction bellmouths;
- The diversion and/or culverting of an existing land drainage channel;
- Extraction of rock from borrow areas or quarries;
- Establishment of temporary and permanent access for the construction and maintenance of the Proposed Development;
- Establishment of new drainage channels and attenuation ponds for site drainage
- Establishment and reinstatement of temporary site compounds; and

Establishment and reinstatement of borrow areas for peat management.

The Scottish Government Best Practice Guidance (BPG) provides a screening tool to determine whether a peat landslide hazard and risk assessment (PLHRA) is required [1]. This is in the form of a flowchart, which indicates that where blanket peat is present, slopes exceed 2° and proposed infrastructure is located on peat, a PLHRA should be prepared. These conditions exist at the Proposed Development site and therefore a PLHRA is required.

While this guidance applies only to Section 36 applications, it is good practice to undertake stability assessments wherever peat may be present in coincidence with proposed infrastructure. These conditions exist at the Proposed Development site and therefore a PLHRA has been undertaken.

1.2 Scope of Work

The scope of the PLHRA is as follows:

- Characterise the peatland geomorphology of the site to determine whether prior incidences of instability have occurred and whether contributory factors that might lead to instability in the future are present across the site.

- Determine the likelihood of a future peat landslide under natural conditions and in association with construction activities associated with the Proposed Development.
- Identify potential receptors that might be affected by peat landslides, should they occur, and quantify the associated risks.
- Provide appropriate mitigation and control measures to reduce risks to acceptable levels such that the Proposed Development is developed safely and with minimal risks to the environment.

The contents of this PLHRA have been prepared in accordance with the BPG, noting that the guidance "*should not be taken as prescriptive or used as a substitute for the developer's [consultant's] preferred methodology*" [1]. The first edition of the Scottish Government Best Practice Guidance (BPG) was issued in 2007 and provided an outline of expectations for approaches to be taken in assessing peat landslide risks on wind farm sites. After ten years of practice and industry experience, the BPG was reissued in 2017, though without fundamental changes to the core expectations. A key change was to provide clearer steer on the format and outcome of reviews undertaken by the Energy Consents Unit (ECU) checking authority and related expectations of report revisions, should they be required.

In section 4.1 of the BPG, the key elements of a PLHRA are highlighted, as follows [1]:

i. An assessment of the character of the peatland within the application boundary including thickness and extent of peat, and a demonstrable understanding of site hydrology and geomorphology.

ii. An assessment of evidence for past landslide activity and present-day instability e.g. pre-failure indicators.

iii. A qualitative or quantitative assessment of the potential for or likelihood of future peat landslide activity (or a landslide susceptibility or hazard assessment).

iv. Identification of receptors (e.g. habitats, watercourses, infrastructure, human life) exposed to peat landslide hazards; and

v. A site-wide qualitative or quantitative risk assessment that considers the potential consequences of peat landslides for the identified receptors.

Section 1.3 describes how this report addresses this indicative scope.

1.3 Report Structure

This report is structured as follows:

- Section 2 gives context to the landslide risk assessment methodology through a literature based account of peat landslide types and contributory factors, including review of any published or anecdotal information available concerning previous instability at or adjacent to the site.
- Section 3 provides a site description based on desk study and site observations, including consideration of aerial or satellite imagery, digital elevation data, geology and peat depth data.

- Section 4 describes the approach to and results of an assessment of peat landslide likelihood under both natural conditions and in association with construction of the Proposed Development.
- Section 5 describes the approach to and results of a consequence assessment that determines potential impacts on site receptors and the associated calculated risks.
- Section 6 provides mitigation and control measures to reduce or minimise these risks prior to, during and after construction.

Assessments within the PLHRA have been undertaken alongside assessments for the Peat Management Plan (Appendix 10.2) and have been informed by results from a peat survey. Where relevant information is available elsewhere in the Environmental Impact Assessment Report (EIAR), this is referenced in the text rather than repeated in this report.

1.4 Approaches to Assessing Peat Instability for the Proposed Development

This report approaches assessment of peat instability through both a qualitative contributory factor-based approach and via more conventional stability analysis (through limit equilibrium or Factor of Safety (FoS) analysis). The advantage of the former is that many observed relationships between reported peat landslides and ground conditions can be considered together where a FoS is limited to consideration of a limited number of geotechnical parameters. The disadvantage is that the outputs of such an approach are better at illustrating relative variability in landslide susceptibility across a site rather than absolute likelihood.

The advantage of the FoS approach is that clear thresholds between stability and instability can be defined and modelled numerically, however, in reality, there is considerable uncertainty in input parameters and it is a generally held view that the geomechanical basis for stability analysis in peat is limited given the nature of peat as an organic, rather than mineral soil.

To reflect these limitations, both approaches are adopted and outputs from each approach integrated in the assessment of landslide likelihood. **Error! Reference source not found.**Plate 1.2 shows the approach:

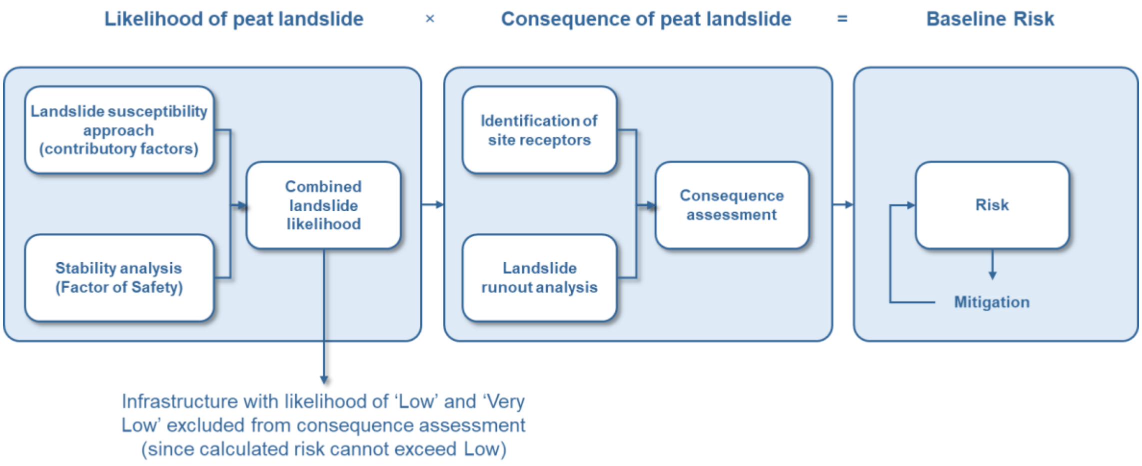


Plate 1.2 Risk assessment approach

1.5 Team Competencies

This PLHRA has been undertaken by Dr Andy Mills BSc MSc PhD, a Chartered Geologist (Geological Society of London) with 25+ years experience of mapping and interpreting peatland terrains and peat instability features. Peat depth probing and walkover survey were undertaken by Fluid Environmental Consulting, a highly experienced peatland survey team, and site observations and photographs were made available from these surveys to the PLHRA team.

2 Background to Peat Instability

2.1 Peat Instability in the UK and Ireland

This section reviews published literature to highlight commonly identified landscape features associated with recorded peat landslides in the UK and Ireland. This review forms the basis for identifying similar features at the Proposed Development and using them to understand the susceptibility of the site to naturally occurring and human induced peat landslides.

Peat instability, or peat landslides, are a widely documented but relatively rare mechanism of peatland degradation that may result in damage to peatland habitats, potential losses in biodiversity and depletion of peatland carbon stores [2]. Public awareness of peat landslide hazards increased significantly following three major peat landslide events in 2003, two of which had natural causes and one occurring in association with a wind farm.

On 19th September 2003, multiple peat landslide events occurred in Pollatomish (Co. Mayo, Ireland; Creighton and Verbruggen, 2003) and in Channerwick in the Southern Shetland Islands (Mills et al, 2007). Both events occurred in response to intense rainfall, possibly as part of the same large-scale weather system moving northeast from Ireland across Scotland. The former event damaged several houses, a main road and washed away part of a graveyard. Some of the landslides were sourced from areas of turbary (peat cutting) with slabs of peat detaching along the cuttings. The landslides in Channerwick blocked the main road to the airport and narrowly missed traffic using the road. Watercourses were inundated with peat, killing fish inland and shellfish offshore (Henderson, 2005).

In October 2003, a peat failure occurred on an afforested wind farm site in Derrybrien, County Galway, Ireland, causing disruption to the site and large-scale fish kill in the adjoining watercourses (Lindsay and Bragg, 2004).

The Derrybrien event triggered interest in the influence of wind farm construction and operation on peatlands, particularly in relation to potential risks arising from construction induced peat instability. In 2007, the (then) Scottish Executive published guidelines on peat landslide hazard and risk assessment in support of planning applications for wind farms on peatland sites. While the production of PLHRA reports is required for all Section 36 energy projects on peat, they are now also regarded as best practice for smaller wind farm applications. The guidance was updated in 2017 (Scottish Government, 2017).

Since then, a number of peat landslide events have occurred both naturally and in association with wind farms (e.g. **Plate 2.1**) and other non-wind farm infrastructure. In the case of wind farm sites, these have rarely been reported, however landslide scars of varying age are visible in association with wind farm infrastructure on Corry Mountain, Co. Leitrim, at Sonnagh Old Wind Farm, Co. Galway (near Derrybrien; Cullen, 2011), and at Corkey Wind Farm, Co. Antrim. In December 2016, a plant operator was killed during excavation works in peat at the Derrysallagh wind farm site in Co. Leitrim (Flaherty, 2016) on a plateau in which several published examples of instability had been previously reported. A peat landslide was also reported in 2015 near the site of a proposed road for the Viking Wind Farm on Shetland (The Shetland Times, 2015) though this was not in association with construction works, which had yet to commence. Subsequently, a second failure, this-time construction-induced, was recorded in Mid-Kame at Viking in 2022 (Shetland News, 2022), and more recently a failure was reported in association with interconnector works for Viking (The Shetland Times, 2024). Neither of the latter two construction-related failures were true peat slides (in morphological terms) but nevertheless significant volumes of peat were displaced in both cases.

Other recent natural events include another failure in Galway at Clifden in 2016 (Irish News, 2016), Cushendall, Co. Antrim (BBC, 2014), in the Glenelly Valley, Co. Tyrone in 2017 (BBC, 2018), Drumkeeran in Co. Leitrim in July 2020 (Irish Mirror, 2020) and Benbrack in Co Cavan in July 2021 (The Anglo-Celt, 2021). Noticeably, the vast majority of reported failures since 2003 have occurred in Ireland and Northern Ireland, with one reported Scottish example occurring on the Shetland Islands (Mid Kame), an area previously associated with peat instability. Two occurrences of instability in association with construction works on the Viking Wind Farm have been reported (July 2022 and May 2024), though in both cases, these have involved failure of peat or mineral spoil at track margins rather than the triggering of a new 'peat slide' by groundworks.

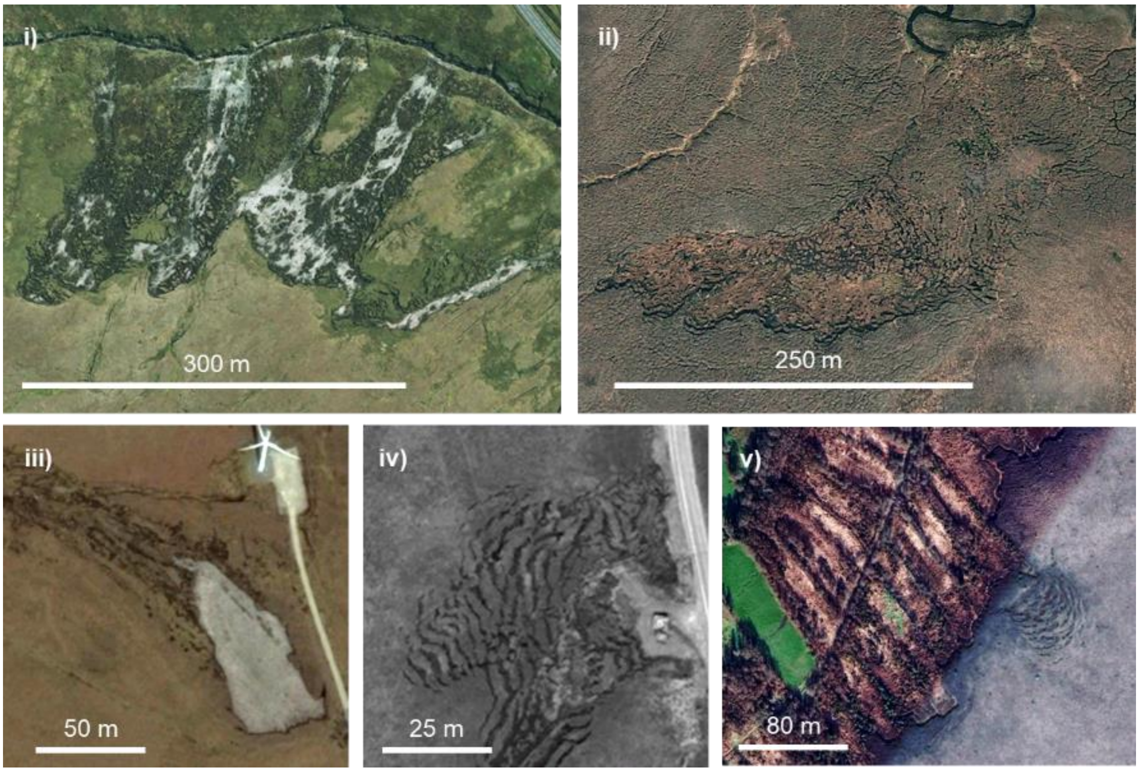


Plate 2.1 Characteristic peat landslide types in UK and Irish peat uplands: Top row - natural failures: i) multiple peat slides with displaced slabs and exposed substrate, ii) retrogressive bog burst with peat retained within the failed area; Bottom row - failures possibly induced by human activity: iii) peat slide adjacent to turbine foundation, iv) spreading around foundation, v) spreading upslope of cutting

This section of the report provides an overview of peat instability as a precursor to the site characterisation in Section 3 and the hazard and risk assessment provided in Sections 4 and 5. Section 2.2 outlines the different types of peat instability documented in the UK and Ireland. Section 2.3 provides an overview of factors known to contribute to peat instability based on published literature.

2.2 Types of Peat Instability

Peat instability is manifested in a number of ways (Dykes and Warburton, 2007) all of which can potentially be observed on site either through site walkover or remotely from high resolution aerial photography:

- **minor instability:** localised and small-scale features that are not generally precursors to major slope failure and including gully sidewall collapses, pipe ceiling collapses, minor slumping along diffuse drainage pathways (e.g. along flushes); indicators of incipient instability including development of tension cracks, tears in the acrotelm (upper vegetation mat), compression ridges, or bulges / thrusts (Scottish Government, 2017); these latter features may be warning signs of larger scale major instability (such as landsliding) or may simply represent a longer term response of the hillslope to drainage and gravity, i.e. creep.
- **major instability:** comprising various forms of peat landslide, ranging from small scale collapse and outflow of peat filled drainage lines/gullies (occupying a few-10s cubic metres), to medium scale peaty-debris slides in organic soils (10s to 100s cubic metres) to large scale peat slides and bog bursts (1,000s to 100,000s cubic metres).

Evans and Warburton (2007) present useful contextual data in a series of charts for two types of large-scale peat instability – peat slides and bog bursts. The data are based on a peat landslide database compiled by Mills (2002) which collates site information for reported peat failures in the UK and Ireland. Separately, Dykes and Warburton (2007) provide a more detailed classification scheme for landslides in peat based on the type of peat deposit (raised bog, blanket bog, or fen bog), location of the failure shear surface or zone (within the peat, at the peat-substrate interface, or below), indicative failure volumes, estimated velocity and residual morphology (or features) left after occurrence.

For the purposes of this assessment, landslide classification is simplified and split into three main types, typical examples of which are shown in **Plate 2.1**. Dimensions, slope angles and peat depths are drawn from charts presented in Evans and Warburton (2007). The term “peat slide” is used to refer to large-scale (typically less than 10,000 of cubic metres) landslides in which failure initiates as large rafts of material which subsequently break down into smaller blocks and slurry. Peat slides occur ‘top-down’ from the point of initiation on a slope in thinner peats (between 0.5 m and 1.5 m) and on moderate slope angles (typically 5°-15°, see **Plate 2.2**).

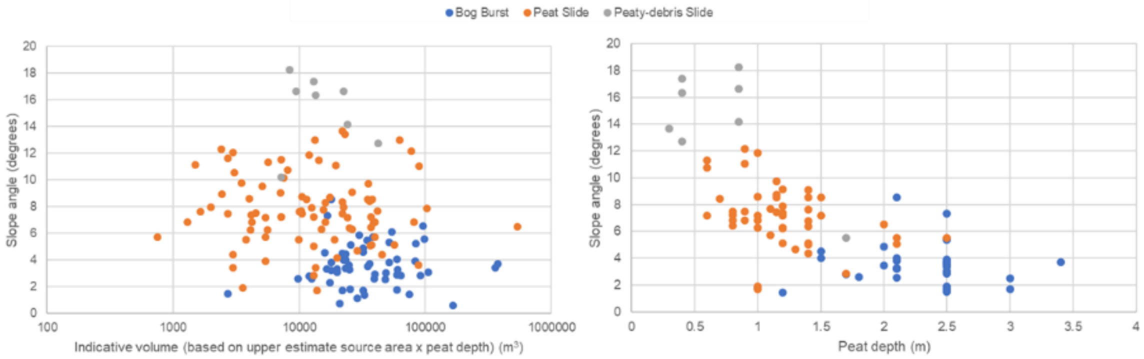


Plate 2.2 Reported slope angles and peat depths associated with peat slides and bog bursts (from literature review of locations, depths and slope angles, after Mills, 2002)

The term “bog burst” is used to refer to very large-scale (usually greater than 10,000 of cubic metres) spreading failures in which the landslide retrogresses (cuts) upslope from the point of failure while flowing downslope. Peat is typically deeper (greater than 1.0m and up to 10m) and more amorphous than sites experiencing peat slides, with shallower slope angles (typically 2°-5°). Much of the peat displaced during the event may remain within the initial failure zone. Bog bursts are rarely (if ever) reported in Scotland other than in the Western Isles (e.g. Bowes, 1960).

The term “peaty soil slide” is used to refer to small-scale (1,000s of cubic metres) slab-like slides in organic soils (i.e. they are <0.5 m thick). These are similar to peat slides in form, but far smaller and occur commonly in UK uplands across a range of slope angles (Dykes and Warburton, 2007). Their small size means that they often do not affect watercourses and their effect on habitats is minimal.

2.2.1 Peat Landslides on Lewis

A number of peat landslides are known to have occurred on Lewis (Plate 2.2a), and Lewis is relatively unusual for a non-Irish setting in exhibiting failures with bog burst morphology. Bowes (1960) reported a ‘bog burst’ on Lewis that occurred in 1959, which, on closer inspection appears to be a peat slide that occurred when a loch-side peatland margin broke and resulted in a translational peat slide that subsequently drained Loch nan Learga upslope (Plate 2.2b) into Loch Mòr Shèlibridh downslope. A further four failures are visible within 10 km of Stornoway (Plates 2c-f), some having peat slide morphology and others being characteristic of bog bursts. From Google Earth Pro imagery, all pre-date 2007.

No failures have been reported in association with the cutting works within the Site or in association with constructed wind farm infrastructure outside Stornoway.

2.2.2 Factors Contributing to Peat Instability

Peat landslides are caused by a combination of factors – triggering factors and reconditioning factors (Dykes and Warburton, 2007; Scottish Government, 2017). Triggering factors have an immediate or rapid effect on the stability of a peat deposit whereas preconditioning factors influence peat stability over a much longer period. Only some of these factors can be addressed by site characterisation.

Preconditioning factors may influence peat stability over long periods of time (years to hundreds of years), and include:

i. Impeded drainage caused by a peat layer overlying an impervious clay or mineral base (hydrological discontinuity).

ii. A convex slope or a slope with a break of slope at its head (concentration of subsurface flow).

iii. Proximity to local drainage, either from flushes, pipes or streams (supply of water).

iv. Connectivity between surface drainage and the peat/impervious interface (mechanism for generation of excess pore pressures).

v. Artificially cut transverse drainage ditches, or grips (elevating pore water pressures in the basal peat-mineral matrix between cuts, and causing fragmentation of the peat mass).

vi. Increase in mass of the peat slope through peat formation, increases in water content or afforestation.

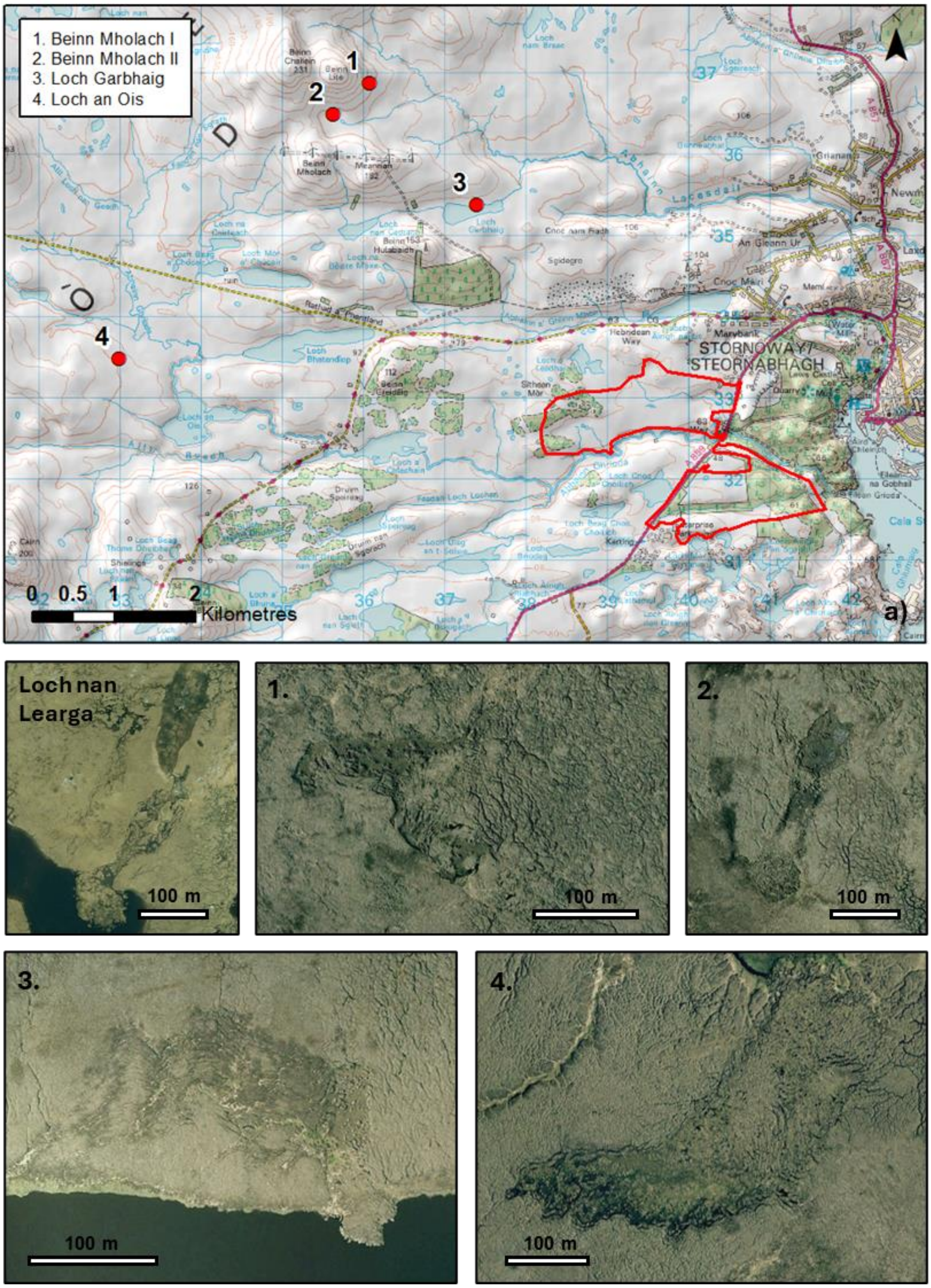


Plate 2.3 Bog bursts and peat slides on the Isle of Lewis - Upper panel: failures in the vicinity of Stornoway; top left photo: the Loch nan Learga 'bog burst' (Bowes, 1960), 1. Beinn Mholach I peat slide, 2. Beinn Mholach II peat slide, 3. Loch Garbhaig peat slide, 4) Loch an Ois bog burst

vii. Reduction in shear strength of peat or substrate from changes in physical structure caused by progressive creep and vertical fracturing (tension cracking or desiccation cracking), chemical or physical weathering or clay dispersal in the substrate.

viii. Loss of surface vegetation and associated tensile strength (e.g. by burning or pollution induced vegetation change).

ix. Increase in buoyancy of the peat slope through formation of sub-surface pools or water-filled pipe networks or wetting up of desiccated areas.

x. Afforestation of peat areas, reducing water held in the peat body, and increasing potential for formation of desiccation cracks which are exploited by rainfall on forest harvesting.

Triggering factors are typically of short duration (minutes to hours) and any individual trigger event can be considered as the 'straw that broke the camel's back':

i. Intense rainfall or snowmelt causing high pore pressures along pre-existing or potential rupture surfaces (e.g. between the peat and substrate).

ii. Rapid ground accelerations (e.g. from earthquakes or blasting).

iii. Unloading of the peat mass by fluvial incision or by artificial excavations (e.g. cutting).

iv. Focusing of drainage in a susceptible part of a slope by alterations to natural drainage patterns (e.g. by pipe blocking or drainage diversion).

v. Loading by plant, spoil (including peat) or infrastructure.

External environmental triggers such as rainfall and snowmelt cannot be mitigated against, though they can be managed (e.g. by limiting construction activities during periods of intense rain). Unloading of the peat mass by excavation, loading by plant and focusing of drainage can be managed by careful design, site specific stability analyses, informed working practices and monitoring.

2.2.3 Consequences of Peat Instability

Both peat slides and bog bursts have the potential to be large in scale, disrupting extensive areas of blanket bog and with the potential to discharge large volumes of material into watercourses. A key part of the risk assessment process is to identify the potential scale of peat instability should it occur and identify the receptors of the consequences. Potential sensitive receptors of peat failure are:

- The development infrastructure.
- Site workers and plant (risk of injury / death or damage to plant).
- Wildlife (disruption of habitat) and aquatic fauna, including designated sites.
- Watercourses and lochs (particularly associated with public water supply), included designated watercourses.
- Site drainage (blocked drains / ditches leading to localised flooding / erosion);
- Public properties and publicly used infrastructure (such as roads and railways); and
- Visual amenity (scarring of landscape).

While peat failures may cause visual scarring of the peat landscape, most peat failures revegetate fully within 50 to 100 years and are often difficult to identify on the ground after this period of time (Feldmeyer-Christe and Küchler, 2002; Mills, 2002). Typically, it is short-term (seasonal) effects on watercourses that are the primary concern or impacts on public water supply, while the cost, programme and reputational implications of cleaning up a pollution event may be significant for the project owner.

3 Site Characterisation

3.1 Topography

The Proposed Development is located on gently undulating lowland peatlands to the south of Stornoway in an area referred to as Arnish Moor. Elevations vary between 70 m AOD in the south of the Site and 20 m AOD closer to the coast, falling gently from west to east and from 65 m to 40 m between the gentle ridge that will host the AC/DC platform and the un-named watercourses that trisect the site to the north and south (Figure 10.3.1). Plate 3.1 shows a 3D perspective view of the Arnish Moor site.

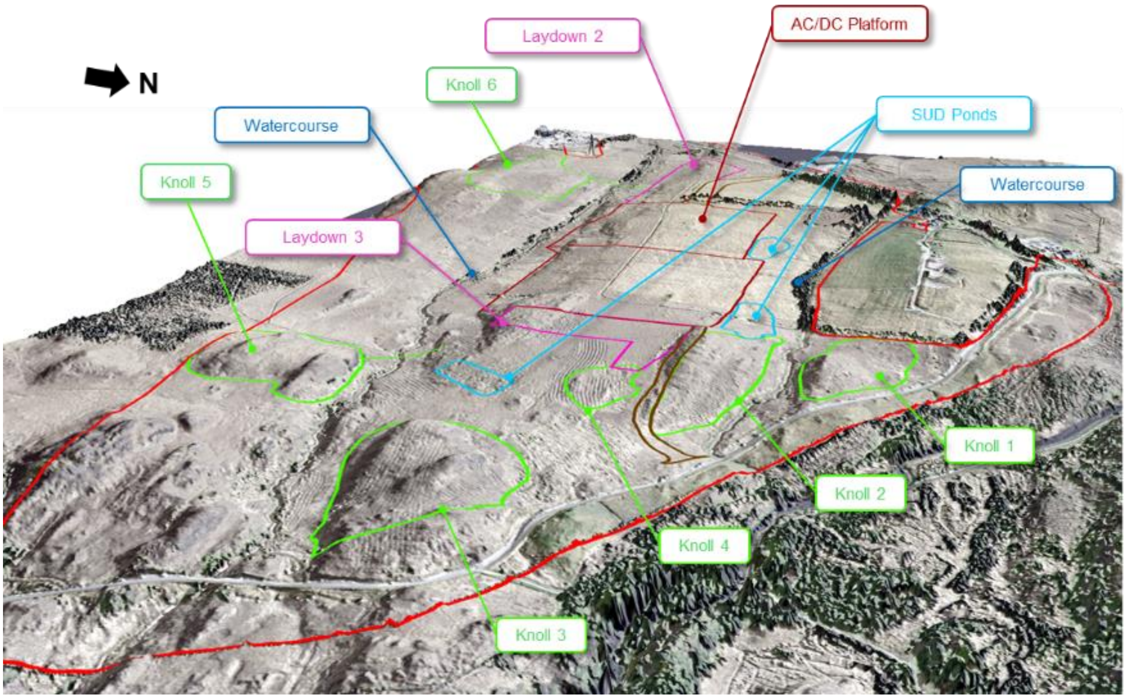


Plate 3.1 3D perspective view of the Arnish Moor site due to host the Proposed Development (a vertical exaggeration of 1.5x has been applied to better indicate the topography, which is very subdued)

Slope angles are gentle across Arnish Moor (< 3°), except closer to the watercourses and on the flanks of rock knolls that rise out of the peat deposits across the site (Figure 10.3.2), where locally and over short distances slopes exceed 10°.

At Creed North, elevations fall from c. 75 m AOD in the northwest to c. 40 m where the River Creed passes under the A859. Elevations generally fall and rise over a series of gentle ridges towards the Creed. Nearly the entire extent of Creed North has been heavily cutover for peat extraction, with the exception of the limited floodplain adjacent to the River Creed (Plate 3.2). In the north of the Site, there is a council operated grit store accessed from the A859, and this area forms part of the peat reuse proposals (see Appendix 10.2, ‘OPMP’).

Slope angles across Creed North, like Arnish Moor, are gentle (<3°), except on the north side of the River Creed where they are moderate (> 5°) in proximity to an east-to-west aligned former railway line that was used to shuttle peat back and forth from cuttings to its point of collection.

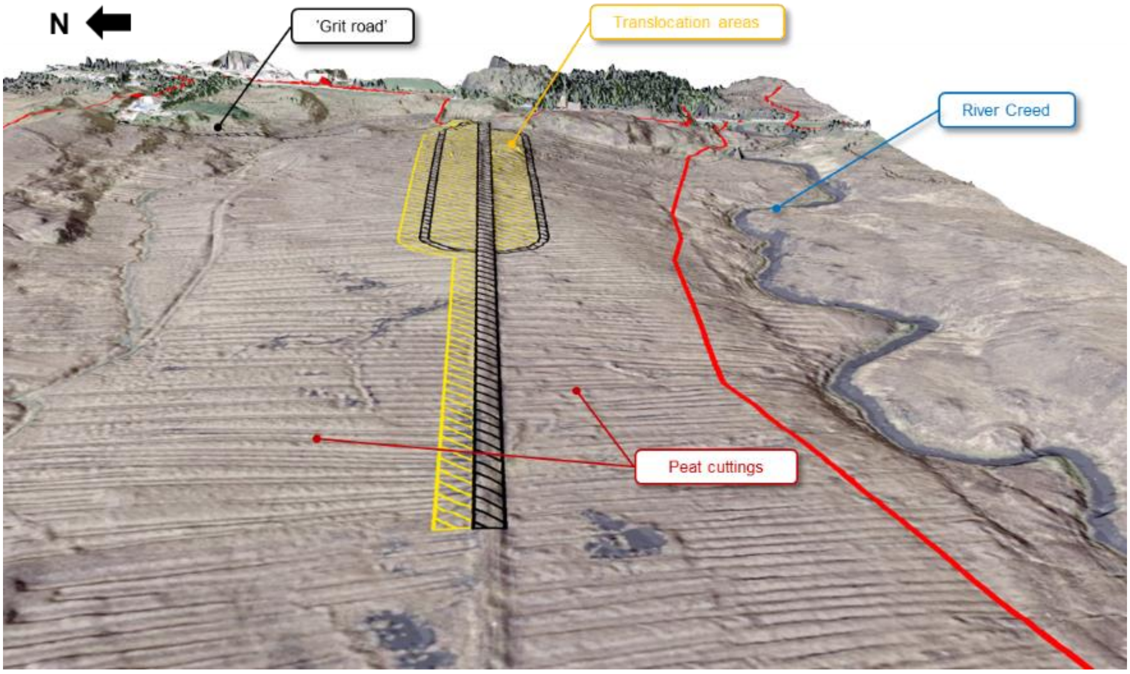


Plate 3.2 3D perspective view of the Creed North area under consideration for peat translocation works (a vertical exaggeration of 1.5x has been applied to better indicate the topography, which is very subdued)

3.2 Geology

Figure 10.3.3 shows the solid geology of the site mapped from 1:50,000 scale publicly available BGS digital data and indicates the Arnish Moor area to be underlain by Lewisian gneiss, with protocataclasites of the Outer Hebrides Thrust Zone mylonites complex in the west of the Site extending out into Creed North.

The inset on Figure 10.3.3 shows the superficial geology of the site, also derived from BGS digital data, indicating peat over most of the site, except where superficial geology is unmapped. There are no geological designations within the Site.

Initial findings from ground investigations within Creed North and Arnish Moor show a thin layer of granular and sometimes cohesive till overlying the bedrock.

3.3 Hydrology

The Proposed Development area within Arnish Moor hosts two minor, un-named watercourses that flow west-to-east to the south and north of the infrastructure footprints. These watercourses extend from an area of planar bog to the west of the A859 that hosts Loch Cnoc a' Choilich and Loch Beag Cnoc a' Choilich. Both watercourses join the River Creed within 1 km of the bay to the east. The watercourses are very small in dimension, barely more than ditches (see Plate 3.3) and do not have the capacity to convey material 'downstream' nor does the catchment area have the capacity to accommodate large flows.

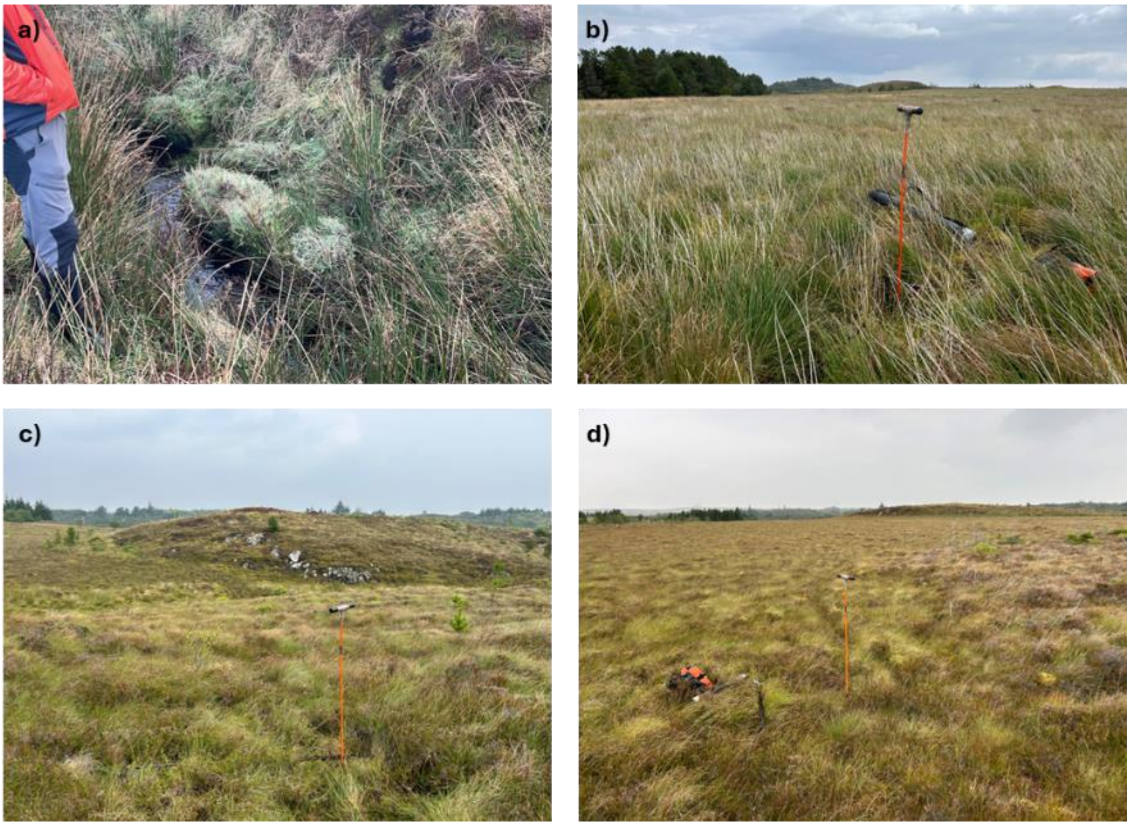


Plate 3.3 a) Small dimensions of the southern un-named watercourse, b) grassy sward in the area modified by ground improvements within Macaulay Farm, c) Rock Knoll 1 to the north of the northern un-named watercourse, d) unimproved ground east of the proposed DC platform (Photos provided by McGowan Environmental Ltd and Fluid Environmental Consulting)

The Macaulay Farm area, which sits between the minor watercourses that run to the north and south of the Proposed Development, has been drained in the past, presumably as part of the ground improvements undertaken for agricultural research (see Figure 10.3.4).

The Abhainn Ghrioda (River Creed) flows east outside the south boundary of Creed North. A further un-named tributary flows east to join the Abhainn Ghrioda within the Creed North area. There are no drains in this area.

While the River Creed is not designated, it is of High overall condition, while Stornoway Harbour is of Good overall condition (SEPA, 2024) and is fished by the Stornoway Angling Association (SAA) for salmon and sea trout, as well as containing spawning grounds for these species. The SAA has previously raised concerns about construction activities and potential for peat landslides in association with infrastructure proposals around Stornoway. Further consideration of hydrological receptors is provided in EIA-R Chapter 9.

The river has the capacity to convey landslide debris (should a landslide occur) throughout the length adjacent to / within the Project boundary into Stornoway Harbour, a total distance of less than 5 km. The minor tributary running through the centre of the proposed restoration area in Creed North does not have capacity for conveyance due to its very small dimensions, and neither do the two minor watercourses to the north and south of the Proposed Development.

3.4 Peat Depth

A total of 8,925 peat depth probes were used to characterise the peat deposits at the Site. Probing was collected on a 10 m Phase 2 grid across the full extent of proposed constructed infrastructure, as well as more widely in order to understand potential for peat reuse in the Arnish Moor and Creed North area. Figure 10.3.5 shows the interpolated peat depth model and supporting peat probe locations across the full Site (Arnish Moor and Creed North).

At Arnish Moor, peat is present over large parts of the Site, typically deepest and exceeding 3 m in the east and west of the Site, thinning rapidly over the rock knolls that occupy the southern side of the gentle ridge and the east end of the site adjacent to the Arnish Road. Peat remains relatively deep over the wider Arnish Moor area, particularly south of the southern burn.

At Creed North, peat depth probing was undertaken on a 50 m grid, extending around 1.25 km from the A859. Additional probing was collected to support proposed restoration activities, with more dense probing along the north and south ‘lozenge’ tracks running parallel to the railway / spine road (see Appendix 10.2, OPMP) and along a corridor within which an access road is proposed from the Council owned grit-store in the north of the Site. While depths are relatively shallow close to the A859 (generally less than 1 m), they increase rapidly with distance and are frequently in excess of 3.0 m within 400 m of the western edge of the dataset.

3.5 Peat Geomorphology and Condition

Geomorphological mapping of the Site undertaken using satellite imagery and LIDAR data indicates the Arnish Moor site to be a simple, planar bog, with localised rock outcrops (referred to as rock knolls in this report) and with very limited evidence for active geomorphological processes (gullying and erosion) or features of interest (bog pools, ladder morphology etc). Site mapping was supplemented with site observations undertaken by Sam Hesling BEng (CEng, MIMechE, MEI), a peat restoration specialist with 18 years’ experience working in Scottish uplands on renewable and restoration projects. Mapping and site observations indicated no evidence of peat instability within the Arnish Moor or Creed North areas, although peat landslides have been documented within 10 km of Stornoway in at least four locations (see Plate 2.3).

The Carbon and Peatland 2016 Map indicates the site to comprise (inset, Figure 10.3.4) entirely Class 1 peatlands. Despite this, there are no designations within Arnish Moor or Creed North, and the compromised nature of peat soils in Creed North (from cutting) and Arnish Moor (from ground treatments) would indicate there is room for peatland improvement in both areas.

3.6 Land Use

At Arnish Moor, land use is limited to unsuccessful tree planting and past periods of grazing, and there are no land-use related constraints to construction within the area proposed for development. Other than the Arnish Road to the east and the A859, public infrastructure is limited.

At Creed North, the eastern extent of the Site is traversed by an existing overhead line (OHL), a buried water main and a buried fibre optic cable. The council’s grit store lies in the north of the Creed North area. Immediately south of the grit store is an area of contaminated land.

The A859 separates the two areas and is the principal route for access to the south of the island and to Harris from Stornoway. The Arnish Road connects ports in the harbour to the mainland and is also important infrastructure. Proposals are in place for realignment of the Arnish Road as part of the port works, and this has acted as a spatial constraint on the eastern edge of the Proposed Development.

4 Assessment of Peat Landslide Likelihood

4.1 Introduction

This section provides details on the landslide susceptibility and limit equilibrium approaches to assessment of peat landslide likelihood used in this report. The assessment of likelihood is a key step in the calculation of risk, where risk is expressed as follows:

Risk = Probability of a Peat Landslide x Adverse Consequences

The probability of a peat landslide is expressed in this report as peat landslide likelihood, and is considered below.

Due to the variability in peat depth and slope angle, including gentle slopes with deep peat and moderate slopes with shallower peat, both peat slide and bog burst mechanisms are considered in this report. This is in keeping with the most likely mode of failure for the peat depths and slope angles present at the site (see Figures 9.3.1 and 9.3.4) and the combination of failure mechanisms in evidence elsewhere on Lewis (see Plate 2.23).

4.2 Limit Equilibrium Approach

4.2.1 Overview

Stability analysis has been undertaken using the infinite slope model to determine the Factor of Safety (FoS) for a series of 25 m x 25 m grid cells within the Proposed Development boundary. This is the most frequently cited approach to quantitatively assessing the stability of peat slopes (e.g. Scottish Government, 2017; Boylan et al, 2008; Evans and Warburton, 2007; Dykes and Warburton, 2007; Creighton, 2006; Warburton et al, 2003; Carling, 1986). The approach assumes that failure occurs by shallow translational landsliding, which is the mechanism usually interpreted for peat slides. Due to the relative length of the slope and depth to the failure surface, end effects are considered negligible and the safety of the slope against sliding may be determined from analysis of a ’slice’ of the material within the slope.

The stability of a peat slope is assessed by calculating a Factor of Safety, F, which is the ratio of the sum of resisting forces (shear strength) and the sum of driving forces (shear stress) (Scottish Government, 2017):

$$F = \frac{c' + (\gamma - h\gamma_w) z \cos^2 \beta \tan \phi'}{\gamma z \sin \beta \cos \beta}$$

In this formula c’ is the effective cohesion (kPa), γ is the bulk unit weight of saturated peat (kN/m^3), γw is the unit weight of water (kN/m^3), z is the vertical peat depth (m), h is the height of the water table as a proportion of the peat depth, β is the angle of the substrate interface (°) and ϕ’ is the angle of internal friction of the peat (°). This form of the infinite slope equation uses effective stress parameters, and assumes that there are no excess pore pressures, i.e. that the soil is in its natural, unloaded condition. The use of cut and fill foundations and tracks across almost the whole construction footprint suggest this is an appropriate approach. The choice of water table height reflects the full saturation of the soils that would be expected under the most likely trigger conditions, i.e. heavy rain.

Where the driving forces exceed the shear strength (i.e. where the bottom half of the equation is larger than the top), F is < 1, indicating instability. A factor of safety between 1 and 1.4 is normally taken in engineering to indicate marginal stability (providing an allowance for variability in the strength of the soil, depth to failure, etc). Slopes with a factor of safety greater than 1.4 are generally considered to be stable. The formula used is unfactored, and in the event of consent, location site-specific site stability analysis conforming to the requirements of EC7 design would be advised in all locations where peat is subject to groundworks or loading.

There are numerous uncertainties involved in applying geotechnical approaches to peat, not least because of its high water content, compressibility and organic composition (Hobbs, 1986; Boylan and Long, 2014). Peat comprises organic matter in various states of decomposition with both pore water and water within plant constituents, and the frictional particle-to-particle contacts that are modelled in standard geotechnical approaches are different in peats. There is also a tensile strength component to peat which is assumed to be dominant in the acrotelm, declining with increasing decomposition and depth. As a result, analysis utilising geotechnical approaches is often primarily of value in showing relative stability across a site given credible and representative input parameters rather than in providing an absolute estimate of stability. Representative data inputs have been derived from published literature for drained analyses considering natural site conditions.

4.2.2 Data Inputs

Stability analysis was undertaken in ArcMap GIS software. A 25 m x 25 m grid was superimposed on the full site extent and key input parameters derived for each grid cell. In total, c. 2,653 grid cells were analysed across Arnish Moor (2,165) and Creed North (488). A 25 m x 25 m cell size was chosen because it is sufficiently small to define a credible landslide size and avoid ‘smoothing’ of important topographic irregularities.

Two forms of analysis have been undertaken:

i. **Baseline stability:** input parameters correspond to undisturbed peat, prior to construction, and under water table conditions typically associated with instability (i.e. full saturation). Effective stress parameters are used in a drained analysis.

ii. **Modified (loaded) stability:** input parameters correspond to peat loaded by overburden up to a depth of 1.5 m, as proposed in the Creed North restoration area (see Appendix 10.2, OPMP). Effective stress parameters are used in this drained analysis since peat is assumed to be deposited in layers, allowing sufficient time for pore pressures to dissipate.

Undrained short-term loading resulting from placing thin layers of peat sequentially as overburden on existing peat is considered to be sufficiently low not to destabilise underlying in-situ peat (based on prior analyses in similar settings). This should be confirmed post-consent during detailed design, using a total stress analysis with laboratory derived parameters obtained from representative field samples acquired during ground investigation.

Areas where peat has been excavated (e.g. the excavated peat itself and the peat upslope of the excavation) have not been modelled since it is assumed that safe systems of work will include buttressing of / support to excavations (see Section 6).

Table 4.1 shows the input parameters and assumptions for the baseline stability analysis. The shear strength parameters c' and ϕ’ are usually derived in the laboratory using undisturbed samples of peat collected in the field and therefore site specific values are often not available ahead of detailed site investigation for a development. Therefore, for this assessment, a literature search has been undertaken to identify a range of credible but conservative values for c' and ϕ’ quoted in fibrous and humified peats. FoS analysis was undertaken with conservative ϕ’ of 20° and values of 2 kPa and 5 kPa for c’. These values fall at the low end of a large range of relatively low values (when compared to other soils).

The modified stability analysis assumes build up of peat in layers up to a depth of 1.5 m (see Appendix 10.2 OPMP). While the target depth of translocation in the OPMP is 1.0 m, this is a mean depth that will vary in and out of the cuttings, typically between 0.5 m and 1.5 m. Therefore, the higher load has been used in a conservative approach.

The analysis assumes pre-loading of the peat by floating track during which the track is built in layers and pore pressures are allowed to dissipate. The combined weight of the track and peat are then modelled in an undrained analysis utilising the heaviest vehicle loads likely to use the access the track.

4.2.3 Results

The outputs of the drained analysis (effective stress) are shown for both parameter combinations in Figure 10.3.6. The more conservative combination (minimum c’ and ϕ’, inset panels) suggests that many parts of the site are either unstable (F < 1) or of marginal stability (F < 1.4) which is not consistent with site observations nor with the stability of peat in general – peat landslides are very rare occurrences given the wide distribution of peat soils in England, Scotland and Wales. The less conservative combination (main panel) gives more credible results, with only isolated areas of locally steeper slope showing marginal stability (F < 1.4). On inspection, these locations are typically associated with the sidewalls of rock knolls where the peat depth model may have overstated peat depths but where slope angles are still relatively steep.

Parameter	Values	Rationale	Source
Effective cohesion (c')	2, 5	Credible conservative cohesion values for humified peat based on literature review	5, basal peat (Warburton et al., 2003) 8.74, fibrous peat (Carling, 1986) 7 - 12, H8 peat (Huat et al, 2014) 5.5 - 6.1, type not stated (Long, 2005) 3, 4, type not stated (Long, 2005) 4, type not stated (Dykes and Kirk, 2001)
Bulk unit weight (γ)	10.5	Credible mid-range value for humified catotelmic peat	10.8, catotelm peat (Mills, 2002) 10.1, Irish bog peat (Boylan et al 2008)
Effective angle of internal friction (ϕ')	20, 30	Credible conservative friction angles for humified peat based on literature review (only 20° used in analysis)	40 - 65, fibrous peat (Huat et al, 2014) 50 - 60, amorphous peat (Huat et al, 2014) 36.6 - 43.5, type not stated (Long, 2005) 31 - 55, Irish bog peat (Hebib, 2001) 34 - 48, fibrous sedge peat (Farrell & Hebib, 1998)

Parameter	Values	Rationale	Source
			32 - 58, type not stated (Long, 2005) 23, basal peat (Warburton et al, 2003) 21, fibrous peat (Carling, 1986)
Slope angle from horizontal (β)	Various	Mean slope angle per 25 m x 25 m grid cell	5 m digital terrain model of site downsampled from 1 m LiDAR
Peat depth (z)	Various	Mean peat depth per 25 m x 25 m grid cell	Interpolated peat depth model of site
Height of water table as a proportion of peat depth (h)	1	Assumes peat mass is fully saturated (normal conditions during intense rainfall events or snowmelt, which are the most likely natural hydrological conditions at failure)	

Table 4.1 Geotechnical parameters for drained infinite slope analysis

The modified stability analysis using a 1.5 m peat load in Creed North indicates stability under loading in all areas proposed for translocation of peat, while the Best Estimate parameters for construction show stability across the restoration areas as a whole.

It should be noted that limit equilibrium methods are not well suited to analysis of retrogressive failures (bog bursts) on gentle slopes in which liquefaction of basal materials may play a key role in failure, and therefore in this report, more emphasis is placed on the qualitative likelihood assessment described in Section 4.3). Nevertheless, post-consent, an EC7 compliant stability analysis should be undertaken to determine short and long-term stability using site derived geotechnical parameters and validate detailed design.

4.3 Landslide Susceptibility Approach

4.3.1 Overview

The landslide susceptibility approach is based on the layering of contributory factors to produce unique ‘slope facets’ that define areas of similar susceptibility to failure. These slope facets vary in size and are different to the regular grid used for the FoS approach. The number and size of slope facets varies from one part of the site to another according to the complexity of ground conditions. In total, c. 3,026 facets were considered in the analysis (Arnish Moor: 2,619; Creed North: 407), with an average area of c. 690 m^2 (or an average footprint of c. 26 m x 26 m, consistent with smaller to medium scale peaty soil or peat slides reported in the published literature.

Eight contributory factors are considered in the analysis: slope angle (S), peat depth (P), substrate geology (G), peat geomorphology (M), drainage (D), slope curvature (C), forestry (F), and land use (L). For each factor, a series of numerical scores between 0 and 3 are assigned to factor ‘classes’, the significance of which is tabulated for each factor. The higher a score, the greater the contribution of that factor to instability for any particular slope facet. Scores of 0 imply neutral / negligible influence on instability.

Factor scores are summed for each slope facet to produce a peat landslide likelihood score (S_{PL}), the maximum being 24 (8 factors, each with a maximum score of 3).

$$S_{PL} = S_S + S_P + S_G + S_M + S_D + S_C + S_F + S_L$$

In practice, a maximum score is unlikely, as the chance of all contributory factors having their highest scores in one location is very small. The following sections describe the contributory factors, scores and justification for the Proposed Development.

4.3.2 Slope Angle (S)

Table 4.2 shows the slope ranges, their association with instability and related scores for the slope angle contributory factor. Slope angles were derived from the downsampled LiDAR digital terrain model shown on Figure 10.3.2 and scores assigned based on reported slope angles associated with peat landslides rather than a simplistic assumption that 'the steeper a slope, the more likely it is to fail'. A differentiation in scores is applied for peat slides and bog bursts reflecting the shallower slopes on which the latter are most frequently observed.

Slope range (°)	Association with instability	Peat slide	Bog burst
≤2.5	Slope angle ranges for peat slides and bog bursts are based on lower and upper limiting angles for observations of occurrence (see Plate 2.2 and increase with increasing slope angle until the upper limiting angle e.g. peat slides are not observed on slopes <2.5°, while bog bursts are not observed on slopes > 7.5°). It is assumed that beyond 7.5° the mode of failure will be peat slides.	0	2
2.5 - 5.0		1	3
5.0 – 7.5		3	0
7.5 - 10.0		3	0
10 – 15.0		3	0
>15.0		3	0

Table 4.2 Slope classes, association with instability and scores

Figure 10.3.7 shows the distribution of slope angle scores across the site. The gentle slopes mean that much of the Site has moderate to high scores for bog bursts, but lower scores for peat slides.

4.3.3 Peat Depth (P)

Table 4.3 shows the peat depths, their association with instability and related scores for the peat depth contributory factor. Peat depths were derived from the peat depth model shown on Figure 10.3.5 and reflect the peat depth ranges most frequently associated with peat landslides (see Plate 2.2).

Peat depth (m)	Association with instability	Peat slide	Bog burst
>1.5	Bog bursts are the dominant failure mechanism in this depth range where basal peat is more likely to be amorphous	1	3
0.5 - 1.5	Peat slides are the dominant failure mechanism in this depth range where basal peat is less likely to be amorphous	3	0

Peat depth (m)	Association with instability	Peat slide	Bog burst
<0.5	Organic soil rather than peat, failures would be peaty-debris slides rather than peat slides or bog bursts and are outside the scope	0	0

Table 4.3 Peat depth classes, association with instability and scores

The distribution of peat depth scores is shown on Figure 10.3.7. Due to relatively deep peat across the Site, much of the site has the highest score for bog bursts but a lower score for peat slides.

4.3.4 Substrate Geology (G)

Table 4.4 shows substrate type, association with instability and related scores for the substrate geology contributory factor. The shear surface or failure zone of reported peat failures typically overlies an impervious clay or mineral (bedrock) base giving rise to impeded drainage. This, in part, is responsible for the presence of peat, but also precludes free drainage of water from the base of the peat mass, particularly under extreme conditions (such as after heavy rainfall, or snowmelt).

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

Substrate Geology	Association with instability	Peat slide	Bog burst
Cohesive (clay) or iron pan	Failures are often associated with clay substrates and/or iron pans	3	3
Granular clay or clay dominated alluvium	Failures are more frequently associated with substrates with some clay component	2	2
Granular or bedrock	Failures are less frequently associated with bedrock or granular (silt / sand / gravel) substrates	1	1

Table 4-1 Substrate geology classes, association with instability and scores

Probing and trial pits undertaken across the site indicated primarily bedrock or granular ‘blue’ clays using the refusal method. Accordingly, the full site is treated as if underlain by granular clay, the more conservative of the two scores (Figure 10.3.7).

4.3.5 Peat Geomorphology (M)

Table 4.5 shows the geomorphological features typical of peatland environments, their association with instability and related scores. Being an open moorland site (rather than afforested), there is a strong degree of confidence in the identification and mapping of these features, where present.

Geomorphology	Association with instability	Peat slide	Bog burst
Incipient instability (cracks, ridges, bulging)	Failures are likely to occur where pre-failure indicators are present	3	3
Planar with pipes	Failures generally occur on planar slopes, and are often reported in areas of piping	3	3
Planar with pools / quaking bog	Bog bursts are more likely in areas of perched water (pools) or subsurface water bodies (quaking bog)	2	3
Flush / Sphagnum lawn (diffuse drainage)	Peat slides are often reported in association with areas of flushed peat or diffuse drainage	3	2
Planar (no other features)	Failures generally occur on planar slopes rather than dissected or undulating slopes	2	2
Peat between rock outcrops	Failures are rarely reported in areas of peat with frequent rock outcrops	1	1
Slightly eroded (minor gullies)	Failures are rarely reported in areas with gullying or bare peat	1	1
Heavily eroded (extensive gullies) / bare peat	Failures are not reported in areas that are heavily eroded or bare	0	0
Afforested / deforested peatland	Considered within Forestry (F), see below	0	0

Table 4.5 Peat geomorphology classes, association with instability and scores

Figure 10.3.7 shows the geomorphological classes from Figure 10.3.4 re-coloured to correspond with Table 4.5. In Arnish Moor, the Site generally comprises planar peatland with little in the way of geomorphological features, while in Creed North, the vast majority of the site has been cutover, with its surface and subsurface hydrology disrupted by removal of layers of peat (therefore receiving a minimal score).

4.3.6 Artificial Drainage (D)

Table 4.6 shows artificial drainage feature classes, their association with instability and related scores. Transverse (or contour aligned) / oblique artificial drainage lines may reduce peat stability by creating lines of weakness in the peat slope and encouraging the formation of peat pipes. A number of peat failures have been identified in published literature which have failed over moorland grips (Warburton et al, 2004). The influence of changes in hydrology becomes more pronounced the more transverse the orientation of the drainage lines relative to the overall slope.

Drainage Feature	Association with instability	Peat slide	Bog burst
Drains aligned along contours (<15 °)	Drains aligned to contour create lines of weakness in slopes	3	3

Drainage Feature	Association with instability	Peat slide	Bog burst
Drains oblique (15-60°) to contour	Most reports of peat slides and bog bursts in association with drainage occurs where drains are oblique to slope	2	2
Drains aligned downslope (<30° to slope)	Failures are rarely associated with artificial drains parallel to slope or adjacent to natural drainage lines	1	1
No / minimal artificial drainage	No influence on stability	0	0

Table 4.6 Drainage feature classes, association with instability and scores

The effect of drainage lines is captured through the use of a 30 m buffer on each artificial drainage line (producing a 60 m wide zone of influence) present within the peat soils at the site. Each buffer is assigned a drainage feature class based on comparison of the drainage axis with elevation contours (transverse, oblique or aligned, as shown in **Error! Reference source not found.**). Buffers are shown on Figure 10.3.7. Only Arnish Moor is affected by drains, these generally being shallow in comparison to the full depth of peat, and relatively well vegetated.

4.3.7 Slope Curvature (C)

Table 4.7 shows slope (profile) curvature classes, association with instability and related scores. Convex and concave slopes (i.e. positions in a slope profile where slope gradient changes by a few degrees) have frequently been reported as the initiation points of peat landslides by a number of authors. The geomechanical reason for this is that convexities are often associated with thinning of peat, such that thicker peat upslope applies stresses to thinner 'retaining' peat downslope. Conversely, buckling and tearing of peat may trigger failure at concavities (e.g. Dykes & Warburton, 2007; Boylan and Long, 2011). However, review of reported peat landslide locations against Google Earth elevation data indicates that the majority of peat slides occur on rectilinear (straight) slopes and that the reporting of convexity as a key driver may be misleading. Accordingly, rectilinear slopes are assigned the highest score.

Profile Curvature	Association with instability	Peat slide	Bog burst
Rectilinear Slope	Peat slides are most frequently reported on rectilinear slopes, while bog bursts are often reported on rectilinear slopes	3	2
Convex Slope	Peat slides are often reported on or above convex slopes while bog bursts are most frequently associated with convex slopes	2	3
Concave Slope	Peat failures are occasionally reported in association with concave slopes	1	1

Table 4.7 Slope curvature classes, association with instability and scores

The digital terrain model and OS contours were used to identify areas of noticeable slope convexity across the site (Figure 10.3.7). Axes of convexity (running along the contour) were assigned a 50 m buffer to produce 100 m (upslope to downslope) convexity zones and these were assigned scores in accordance with Table 4.7 above.

4.3.8 Forestry (F)

Table 4.8 shows forestry classes, their association with instability and related scores. A report by Lindsay and Bragg (2004) on Derrybrien suggested that row alignments, desiccation cracking and loading (by trees) could all influence peat stability.

Forestry Class	Association with instability	Peat slide	Bog burst
Deforested, rows oblique to slope	Deforested peat is less stable than afforested peat, and inter ridge cracks oblique to slope may be lines of weakness	3	3
Deforested, rows aligned to slope	Deforested peat is less stable than afforested peat, but slope aligned inter ridge cracks have less impact	2	2
Afforested, rows oblique to slope	Afforested peat is more stable than deforested peat, but inter ridge cracks oblique to slope may be lines of weakness	2	2
Afforested, rows aligned to slope	Afforested peat is more stable than deforested peat, but potentially less stable than unforested (never planted) peat	1	1
Windblown	Windblown trees have full disruption to the underlying peat and residual hydrology due to root plate disturbance	0	0
Not afforested	No influence on stability	0	0

Table 4.8 Forestry classes, association with instability and scores

None of the site is afforested, although ground preparation has been undertaken (but not planted) in the east of Arnish Moor, and some scrubby ground flora is present. Ploughed areas have been assigned a score of 2 to reflect the potential influence of ploughing on disruption of surface tensile strength (see Figure 10.3.7).

4.3.9 Land use (L)

Table 4.9 shows land use classes, association with instability and related scores. A variety of land uses have been associated with peat failures (see 2.2.2).

Land Use	Association with instability	Peat slide	Bog burst
Machine cutting (deep slots)	Machine cutting may compartmentalise slopes, but has been reported primarily in association with peat slides	3	2
Quarrying	Quarrying may remove slope support from upslope materials, and has been observed with spreading failures (bog bursts)	2	3

Land Use	Association with instability	Peat slide	Bog burst
Hand cutting (turbary)	Hand cutting may remove slope support from upslope materials, and has been reported with raised bog failures	1	2
Burning (deep cracking to substrate)	Failures are rarely associated with burning, but deep desiccation cracking will have the most severe effects	2	2
Burning (shallow cracking)	Failures are rarely associated with burning, shallow desiccation cracking will have very limited effects	1	1
Grazing	Failures have not been associated with grazing, no influence on stability	0	0

Table 4.9 Land use classes, association with instability and scores

Cutting is the primary land use on site. Where peat has been largely removed or is very thin due to cutting, the peat surface is considered as planar and is unscored. Areas upslope of cutting where cutting has removed the support from the slopes above are normally assigned a high score, however, there are minimal areas of intact peat upslope of cuttings, and therefore no scores are assigned for this land use (see Figure 10.3.7).

4.3.10 Generation of Slope Facets

The eight contributory factor layers shown on Figure 10.3.7 were combined in ArcMap to produce approximately 3,026 slope facets. Scores for each facet were then summed to produce a peat landslide likelihood score. These likelihood scores were then converted into descriptive 'likelihood classes' from 'Very Low' to 'Very High' with a corresponding numerical range of 1 to 5 (in a similar format to the Scottish Government BPG).

Summed Score from Contributory Factors	Typical site conditions associated with score	Likelihood (Qualitative)	Landslide Likelihood Score
≤ 7	Unmodified peat with no more than low weightings for peat depth, slope angle, underlying geology and peat morphology	Very Low	1
8 - 12	Unmodified or modified peat with no more than moderate or some high scores for peat depth, slope angle, underlying geology and peat morphology	Low	2
13 - 17	Unmodified or modified peat with high scores for peat depth and slope angle and / or high scores for at least three other contributory factors	Moderate	3
18 - 21	Modified peat with high scores for peat depth and slope angle and several other contributory factors	High	4

Summed Score from Contributory Factors	Typical site conditions associated with score	Likelihood (Qualitative)	Landslide Likelihood Score
> 21	Modified peat with high scores for most contributory factors (unusual except in areas with evidence of incipient instability)	Very High	5

Table 4.10 Likelihood classes derived from the landslide susceptibility approach

Table 4.10 describes the basis for the likelihood classes. A judgement was made that for a facet to have a moderate or higher likelihood of a peat landslide, a likelihood score would be required exceeding both the worst case peat depth and slope angle scores summed (3 in each case, i.e. 3 x 2 classes) alongside three intermediate scores (of 2, i.e. 2 x 3 classes) for other contributory factors. This means that any likelihood score of 13 or greater would be equivalent to at least a moderate likelihood of a peat landslide. Given that the maximum score attainable is 24, this seems reasonable.

4.4 Results

Figure 10.3.8 shows the outputs of the landslide susceptibility approach for bog bursts in the main panel and for peat slides in two insets (one for Creed North and one for Arnish Moor).

At Arnish Moor, there are areas of Moderate susceptibility to bog burst on the north flanks of the gentle ridge abutting the northern minor watercourse and on the north facing slopes south of the southern watercourse. Otherwise, likelihoods are generally Low and locally Very Low. At Creed North, the likelihoods are Low to Very Low across the full site. The results seem reasonable, since intact peat is far more likely to contain intact hydrological systems that can enable peat instability, while cutover peat is fragmented, and only large areas of ‘intact’ peat adjacent to cuttings would be expected to fail (and only then under exceptional conditions).

Results are similar for peat slides, again with Low and Very Low likelihoods dominating Creed North and smaller areas of Moderate susceptibility at Arnish Moor, again on the north facing slopes and locally within Borrow Area 5.

For either mode of failure, there are no areas of High or Very High susceptibility.

4.4.1 Combined Landslide Likelihood

Figure 10.3.9 shows in purple any proposed areas of infrastructure of greater than 25 m in length intersecting with areas of Moderate or higher landslide susceptibility (from the contributory factor approach for both bog bursts and peat slides) or Factor of Safety of 1.4 or less (from the limit equilibrium approach). A 25 m overlap has been selected as this is considered the minimum size of a potentially environmentally significant landslide. In order for there to be a “Medium” or “High” risk (Scottish Government, 2017), likelihoods must be “Moderate” or higher (see Plate 4.1 below) and hence this provides a screening basis for the likelihood results.

The following areas >25 m in dimension overlap with Moderate likelihoods or Factor of Safety < 1.4 (Marginally Stable or Unstable):

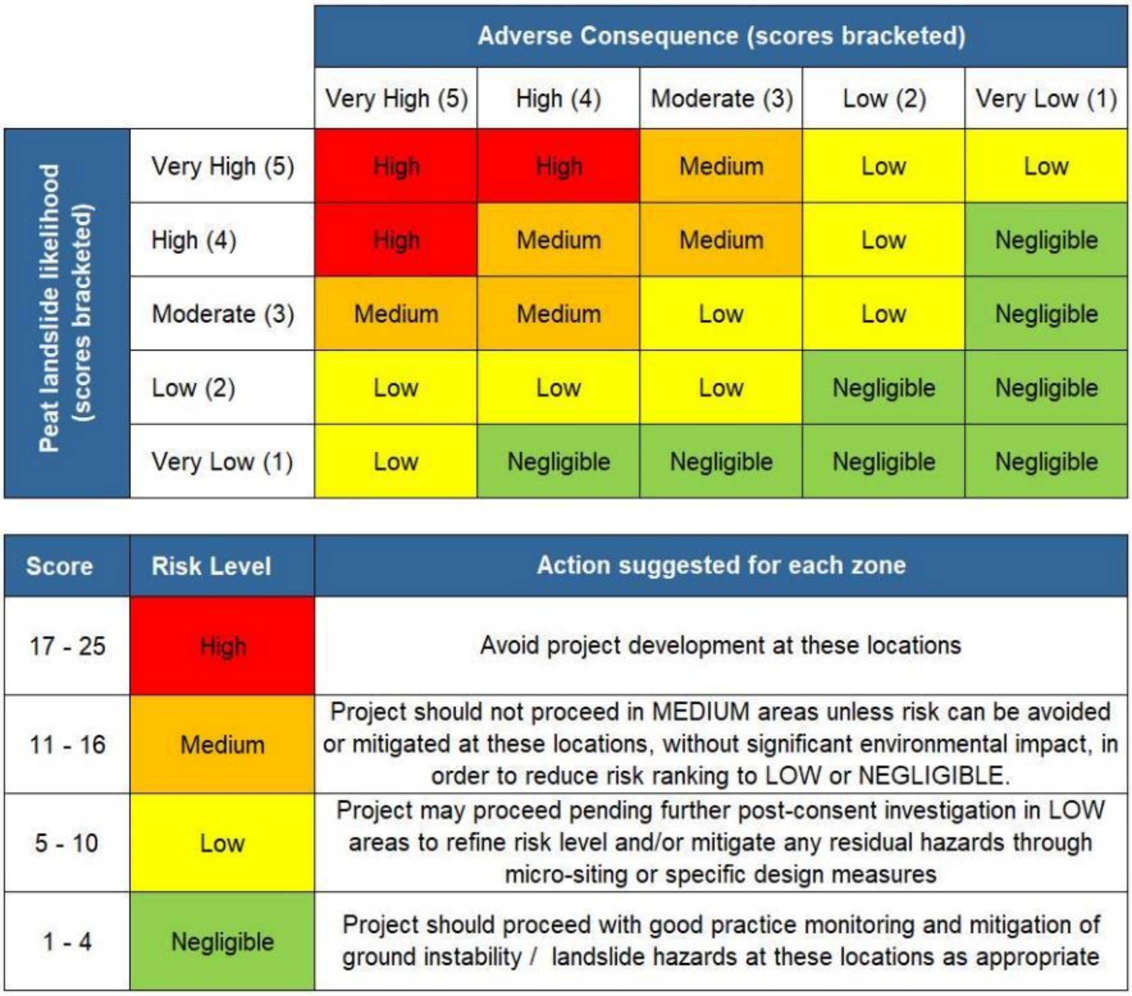
- A c. 60 x 70 m area in the centre of LD3, extending slightly into the eastern end of the DC platform;

- A c. 45 x 45 m area in the east of LD3;
- A 35 m x 25 m area in the centre of SuD Pond 1;
- The northern face of Borrow Area 2;
- The southern part of SuD Pond 2;
- The eastern part of Borrow Area 4;
- A 50 m length of the Eastern Access track;
- A 120 m length of the borrow area link track connecting LD3, Borrow Area 3 and Borrow Area 5; and
- A c.190 m x 40 m area on the north facing slope under the DC platform;
- Perimeter cells within the Factor of Safety assessment for Borrow Area 5.

Each of these areas is considered in turn below.

4.5 Review of Higher Susceptibility Areas

Potential source zones are shown on Figure 10.3.9 in purple. Bracketed Source Zone IDs shown on the figure are referred to in discussion of each source zone below. These short sections consider whether the source zone is likely to represent an environmental risk if a landslide occurs, and therefore whether it should be carried into the consequence assessment in Section 6.



		Adverse Consequence (scores bracketed)				
		Very High (5)	High (4)	Moderate (3)	Low (2)	Very Low (1)
Peat landslide likelihood (scores bracketed)	Very High (5)	High	High	Medium	Low	Low
	High (4)	High	Medium	Medium	Low	Negligible
	Moderate (3)	Medium	Medium	Low	Low	Negligible
	Low (2)	Low	Low	Low	Negligible	Negligible
	Very Low (1)	Low	Negligible	Negligible	Negligible	Negligible

Score	Risk Level	Action suggested for each zone
17 - 25	High	Avoid project development at these locations
11 - 16	Medium	Project should not proceed in MEDIUM areas unless risk can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce risk ranking to LOW or NEGLIGIBLE.
5 - 10	Low	Project may proceed pending further post-consent investigation in LOW areas to refine risk level and/or mitigate any residual hazards through micro-siting or specific design measures
1 - 4	Negligible	Project should proceed with good practice monitoring and mitigation of ground instability / landslide hazards at these locations as appropriate

Plate 4.1 Top: risk ranking as a product of likelihood and consequence; Bottom: suggested action given each level of calculated risk

4.5.1 The AC/DC platform area / LD3

A single area of moderate susceptibility for bog burst straddles the eastern boundary of the DC platform area and extends into the area of LD3 (1). The area is of very gentle to neutral slope and is buttressed to the south by a rock knoll. A second smaller area is present in the east of LD3 adjacent to Borrow Area 2 (2). The peat in these areas is due to be excavated in its entirety to enable construction of the platform and LD3. The working area for excavation will be along the central axis of the landform within which the platform is located, and therefore localised collapse into the working area (rather than runout beyond it) is the most likely scenario. This can be controlled by good working practices (see Section 6), and therefore these potential source zones are excluded from further assessment.

A much larger area of moderate bog burst susceptibility (10) runs along the north side of the DC platform and faces the northern watercourse with potential for ingress of landslide debris into the watercourse. This area is screened into the consequence assessment.

4.5.2 SuD Pond 1

The central section of SuD Pond 1 (3), which has a Moderate susceptibility to bog bursts, faces the northern minor watercourse. All peat in this footprint will be excavated, however, there is potential for peat to collapse into the watercourse if excavation is not carefully managed.

Therefore this source area is screened into the consequence assessment.

4.5.3 Borrow Area 2

The northern face of Borrow Area 2 (4) is immediately adjacent to the northern minor watercourse and has Moderate potential for peat slide into this watercourse, and so this source area is screened into the consequence assessment.

4.5.4 SuD Pond 2

The southern section of SuD Pond 2 (5) faces the southern minor watercourse. Again, all peat will be excavated within its footprint, however, it sits upslope of the proposed link track between LD3 and Borrow Area 3. This track will be constructed prior to the pond and will provide a buttressed hard point downslope of the pond area for the duration of its construction. Therefore, while the link track is included within the consequence assessment, it is assumed that any instability in the pond will be contained by the link track, and this source zone is screened out of the consequence assessment.

4.5.5 Borrow Area 4

Borrow Area 4 (6) lies in an area of neutral slope facing northeast in the direction of the Arnish Road. The borrow area is due to be fully excavated, however mobilisation of material in this direction could potentially impact the proposed road, and therefore this source area is carried forward into the consequence assessment.

4.5.6 Eastern Access track

The Eastern Access track runs between Borrow Area 2, Borrow Area 4 and LD3, with a short section adjacent to the Arnish Road running over a Moderate area of bog burst susceptibility (7). Impacts would be similar to those for Borrow Area 4 and the source area is carried forward into the consequence assessment.

4.5.7 Borrow area link track

The borrow area link track lies in an area of Moderate bog burst susceptibility facing towards the southern minor watercourse (8). As a result, this source area is carried into the consequence assessment.

4.5.8 Borrow Area 5

The northwest corner of Borrow Area 5 lies in an area of Moderate peat slide susceptibility (9) on a slope facing the southern minor watercourse. As with the borrow area link track, this area is carried into the consequence assessment.

Section **Error! Reference source not found.** of this report describes the consequence assessment and risk calculation for all areas where infrastructure intersects “Moderate” likelihood of a peat landslide.

5 Assessment of Consequence and Risk

5.1 Introduction

In order to calculate risks, the potential consequences of a peat landslide (both bog burst and peat slide mechanisms, given prior occurrences on Lewis) must be determined. This requires identification of receptors and an assessment of the consequences for these receptors should a peat landslide occur. This section describes the consequence assessment and then provides risk results based on the product of likelihood and consequence.

5.2 Receptors

Peat uplands are typically host to the following receptors: watercourses and associated water supplies (both private and public), terrestrial habitats (e.g. groundwater dependent terrestrial ecosystems or GWDTEs) and infrastructure, both that related to the Proposed Development and other infrastructure, e.g. roads and power lines. These are considered for the Proposed Development below.

5.2.1 Watercourses

The Proposed Development site is drained by two minor watercourses, both small in dimension with limited downstream extents outside the Site boundary prior to their confluence with the River Creed and Stornoway Bay shortly thereafter. Neither of the minor watercourses is designated, however the Creed is important for fish and has a Good status.

The watercourses are sufficiently small in dimension that it is unlikely they could convey material any distance downstream (see EIA Chapter 9, ‘Hydrology, Hydrogeology, Geology and Soils’). Were the southern watercourse to carry material beyond the culvert under the Arnish Road, debris would ultimately reach the Creed some 300 m downstream at its confluence with Stornoway Bay, where any buoyant peat material would be rapidly dispersed by the tides.

Landslide debris entering the Creed via the northern watercourse would do so c. 1 km upstream of the bay and would have the potential to smother gravels in the short term until washed through by spate flows.

Accordingly, a consequence score of 4 is assigned for ingress of material into the northern watercourse, and 3 for ingress into the southern watercourse (where impacts would be lower).

5.2.2 Habitats

While blanket bog habitats are valuable, they generally recover from instability events through revegetation over a matter of years to decades and therefore a consequence score of 3 is assigned for all open blanket bog habitats within the Proposed Development site (**Table 5**), particularly since the habitats around the source zones are generally within the Macaulay Farm area where they have been compromised by farming, drainage and ploughing.

5.2.3 Infrastructure

The Proposed Development is surrounded to the west, north and east by public roads, one of which links ports in the Bay to the island. Disruption to roads from peat landslides is generally short lived, and runout from peat failures is of relatively low velocity in comparison to failures on steeper slopes / in other materials. Nevertheless, cleanup operations may involve short term road closures and disruptions, and so a consequence score of 3 is assigned for infrastructure disruption. Due to the prevailing slope direction within the Site, only the Arnish Road is likely to be susceptible to landslide debris originating from the identified source zones.

Infrastructure that would be most affected in the event of a peat landslide would be the Proposed Development infrastructure, including personnel working to excavate peat and construct hardstandings and ponds. Peat slippage into working areas could have potentially serious consequences, including loss of life. While commercial losses would be important to the Applicant, loss of life / injury would be of greater concern, and a consequence score of 5 is assigned for any infrastructure locations subject to potential peat landslides (**Table 5**). However, risks to life can be mitigated through safe systems of working. These infrastructure risks are not considered to be 'environmental' risks and are considered separately in the consequence assessment below.

Receptor and type	Consequence	Score	Justification for Consequence Score
Watercourses - aquatic habitats (northern tributary)	Short term increase in turbidity with potential gravel smothering and fish kill	4	Undesignated watercourse, locally valued for salmon and sea trout fishing
Watercourses - aquatic habitats (southern tributary)	Short term increase in turbidity with potential very short term impacts on mouth of River Creed	3	Undesignated watercourse, access point for salmon and sea trout
Terrestrial habitats	Short to medium term loss of vegetation cover, disruption of peat hydrology, carbon release	3	Best habitats noted to be wet modified bog, long term effects unlikely following revegetation
Road infrastructure	Short term disruption to road users prior to cleanup, low likelihood of injury (road use likely to be controlled during construction)	3	Disruption to local road use and access to Stornoway ports
Project infrastructure	Damage to infrastructure, injury to site personnel, possible loss of life	5	Loss of life, though very unlikely, is a severe consequence; financial implications of damage and re-work are less significant

Table 5.1 Receptors considered in the consequence analysis

5.3 Consequence Assessment

A consequence assessment has been undertaken by determining the potential for landslides sourced at infrastructure locations with a Moderate natural likelihood of peat instability to impact the receptors identified above. The methodology is usually applied in larger open slope settings and determines the potential for landslide runout to travel between mid-slope infrastructure locations and receptors, often several hundreds of metres downslope of the source zones.

For the Proposed Development, the highest value receptors (watercourses, infrastructure and personnel) are, or will be, immediately adjacent to the source zones and therefore it can be assumed that given failure of the source zones, an impact will occur. Therefore, runout assessment has not been undertaken, and instead, consequences have been determined qualitatively for each source zone, with an associated calculation of risk (based on the product of likelihood and consequence).

For example, an area of Moderate likelihood scoring 3 (the Moderate likelihood row in the upper section of Plate 4.1) combined with an area of High consequence scoring 4 (the High consequence column on Plate 4.1) would result in a combined score of 12, or Medium risk (lower section of Plate 4.1).

5.4 Calculated Risk

Table 5.2 shows the calculated risks for the source zones screened into the consequence assessment (source zones 3, 4, 6, 7, 8, 9 and 10). This is the baseline, pre-mitigation risk.

Source Zone ID	Receptor	Likelihood	Consequence	Calculated Risk
3	Short term increase in turbidity with potential gravel smothering and fish kill	3	4	Medium (12)
4	Short term increase in turbidity with potential gravel smothering and fish kill	3	4	Medium (12)
6	Short term disruption to road users prior to cleanup, low likelihood of injury	3	3	Low (9)
7	Short term disruption to road users prior to cleanup, low likelihood of injury	3	3	Low (9)
8	Short term increase in turbidity with potential very short term impacts on mouth of River Creed	3	3	Low (9)
9	Short term increase in turbidity with potential very short term impacts on mouth of River Creed	3	3	Low (9)
10	Short term increase in turbidity with potential gravel smothering and fish kill	3	4	Medium (12)

Source Zone ID	Receptor	Likelihood	Consequence	Calculated Risk
All source zones	Damage to infrastructure, injury to site personnel, possible loss of life	3	5	Medium (15)

Table 5.2 Calculated risks

Based on the calculated risks above, site-specific good practice measures are required to reduce risks from Medium to Low for source zones 3, 4 and 10 in relation to the northern watercourse, and for all source zones for risks to personnel. Section 6 details these site-specific and more general good practice measures.

6 Risk Mitigation

6.1 Overview

Reducing risk can be achieved by identifying lower likelihood locations within which to site infrastructure, reducing the compounding effect of construction activities on this baseline likelihood, reducing the consequences in the event a landslide occurs, or combinations of all three.

Although the HVDC and AC substation platforms are in fixed positions, aspects of the ancillary works (including tracks, laydown extents and borrow area locations) may change following Planning Permission In Principle. Therefore there may be opportunities to micro-site some aspects of the proposed works, particularly if post-consent ground investigation identifies particularly unstable soils. Beyond micro-siting, reducing the effects and consequences of construction activity are the remaining risk mitigation options available. Section 6.2 provides specific risk mitigation measures for the three Medium risk locations identified in Section 5, while Sections 6.3 to 6.5 provide general good practice measures intended to reduce risks prior to, during and after construction for all locations under construction.

6.2 Site-specific Risk Mitigation

6.2.1 Source Zone 10 (DC Platform)

Source Zone 10 gives rise to a Medium risk outcome due to the moderate susceptibility within the construction location and the potential high consequences of debris ingress into the River Creed. Preventing debris transfer from the minor watercourse into the Creed will reduce the consequences to a Medium consequence (as per the southern watercourse) while careful construction will reduce the likelihood, both of these measures reducing risk.

To prevent ingress of material into the River Creed, it is recommended that catch fences are installed adjacent to the treeline along the minor watercourse and upstream of the culvert under the Arnish Road in order to hold back any larger material that may be carried as buoyant material down into the Creed.

It is likely that excavation for the DC platform will occur simultaneously from the AC working area to the west and from the Eastern Access track. In the west, localised instability, if it were to occur, would likely mobilise into the working area rather than to the north. In the east, there is a possibility that mobilised material would run north towards the stream, and therefore it is recommended that excavations for SuD Pond 1 do not take place until after the full extent of the DC footprint has been excavated. Working from higher to lower elevations during excavation, stripping in layers will help minimise vertical cut faces and reduce the likelihood of instability.

Taken together, it is considered that that these measures will reduce risk to Low or lower.

6.2.2 Source Zone 3 (SuD Pond 1)

As with Source Zone 10, Source Zone 3 gives rise to a Medium risk outcome due to the moderate susceptibility within the construction location and the potential high consequences of debris ingress into the River Creed. Preventing debris transfer from the minor watercourse will reduce the consequences to a Medium consequence (as per the southern watercourse) while careful construction will reduce the likelihood, both of these measures reducing risk.

As with Source Zone 10, it is recommended that catch fences are installed adjacent to the treeline along the minor watercourse and upstream of the culvert under the Arnish Road, in order to hold back any larger material that may be carried as buoyant material down into the Creed.

To reduce the likelihood of failure, it is recommended that peat excavation for SuD Pond 1 takes place from the upper slope in a downslope direction, working from the DC platform hardstanding and excavating in layers (in line with the OPMP). This will ensure that any instability that does occur collapses into the excavation (where it can be removed) rather than to the north toward the watercourse.

Taken together, it is considered that that these measures will reduce risk to Low or lower.

6.2.3 Source Zone 4 (Borrow Area 2)

Risks associated with Source Zone 4 are generated for the same reasons as for Source Zone 3, except over a larger extent and in association with peat removal to enable extraction of stone in Borrow Area 2. Peat is patchy over the excavation area (averaging less than 1.0 m, and in many areas much less), and as such is less likely to support deeper natural pipe networks or diffuse subsurface drainage than Source Zone 3.

As with Source Zone 3, it is recommended that catch fences are installed upstream of the culvert under the Arnish Road and below the working area between the watercourse and the northern boundary of BA2. These measures will help reduce the consequences of landslide runout, should it occur.

To reduce the likelihood of failure, it is again recommended that excavation of peat and soil is undertaken ‘top down’ from the knoll crest towards the northern limit of the borrow area. No excavation of rock should take place until all soil and peat has been removed from the full footprint of BA2. In the east of the borrow area, between the Eastern Access track and BA2 footprint, a retaining structure should be constructed to prevent collapse of deep peat into the eastern limit of the borrow area. This structure could comprise a cofferdam initially, or if a permanent solution is required, a retaining berm constructed of site derived large aggregate could provide an alternative.

Taken together, it is considered that that these measures will reduce risk to Low or Negligible.

6.3 Good Practice Prior to Construction

Site safety is critical during construction, and it is strongly recommended that detailed intrusive site investigation and laboratory analysis are undertaken ahead of the construction period in order to characterise the strength of the peat soils in the areas in which excavations are proposed.

These investigations should be sufficient to:

1. Determine the strength of free-standing bare peat excavations, and requirement for retention structures (e.g. cofferdams or equivalent).
2. Determine the strength of loaded peat (where excavators and plant are required to operate on temporary surfaces such as bog mats, or where operating directly on the bog surface).

3. Identify sub-surface water-filled voids or natural pipes delivering water to the excavation zone, e.g. through the use of ground penetrating radar or careful pre-excavation site observations.

A comprehensive Geotechnical Risk Register should be prepared post-consent, but pre-construction, detailing sequence of working for excavations, measures to minimise peat slippage, design of retaining structures for the duration of open hole works, monitoring requirements in and around the excavation and remedial measures in the event of unanticipated ground movement.

The risk register should be considered a live document and updated with site experience as infrastructure is constructed. Ideally, a contractor with experience of working in deep peat should be engaged to undertake the works.

6.4 Good Practice During Construction

The following good practice should be undertaken during construction, with all measures listed below included within a Construction Environmental Management Plan and / or Geotechnical Risk Register (as appropriate):

For excavations:

- Use of appropriate supporting structures around peat excavations to prevent collapse and the development of tension cracks.
- Avoid cutting trenches or aligning excavations across slopes (which may act as incipient back scars for peat failures) unless appropriate mitigation has been put in place.
- Implement methods of working that minimise the cutting of the toes of slope, e.g. working up-to-downslope during excavation works.
- Monitor the ground upslope of excavation works for creep, heave, displacement, tension cracks, subsidence or changes in surface water content, ensuring a banksman is specifically tasked with overseeing groundworks for the duration of peat excavation and for any period in which peat faces are left unsupported or unremediated.
- Monitor cut faces for changes in water discharge, particularly at the peat-substrate contact.
- Minimise the effects of construction on natural drainage by ensuring that natural drainage pathways are maintained or diverted such alteration of the hydrological regime of the site is minimised or avoided; drainage plans should avoid creating drainage/infiltration areas or settlement ponds towards the tops of slopes (where they may act to both load the slope and elevate pore pressures).

For cut tracks:

- Maintain drainage pathways through tracks to avoid ponding of water upslope.
- Monitor the top line of excavated peat deposits for deformation post-excavation.
- Monitor the effectiveness of cross-track drainage to ensure water remains free-flowing and that no blockages have occurred.

For floating tracks:

- Allow peat to undergo primary consolidation by adopting rates of road construction appropriate to weather conditions.

- Identify ‘stop’ rules, i.e. weather dependent criteria for cessation of track construction based on local meteorological data.
- Run vehicles at 50% load capacity until the tracks have entered the secondary compression phase.
- Prior to construction, setting out the centreline of the proposed track to identify any ground instability concerns or particularly wet zones.

For storage of peat and for restoration activities:

- Ensure stored peat is not located upslope of working areas or adjacent to drains or watercourses.
- Undertake site-specific stability analysis for all areas of peat storage (if on sloping ground) to ensure the likelihood of destabilisation of underlying peat is minimised.
- Avoid storing peat on slope gradients >3° and preferably store on ground with neutral slopes and natural downslope barriers to peat movement.
- Monitor effects of wetting / re-wetting stored peat on surrounding peat areas, and prevent water build up on the upslope side of peat mounds.
- Undertake regular monitoring of emplaced peat in restoration areas to identify evidence of creep or pressure on retaining structures (dams and berms).
- Maximise the interval between material deliveries over newly constructed tracks that are still observed to be within the primary consolidation phase.

In addition to these control measures, the following good practice should be followed:

- The geotechnical risk register prepared prior to construction should be updated with site experience as infrastructure is constructed.
- Full site walkovers should be undertaken at scheduled intervals to be agreed with the Local Authority to identify any unusual or unexpected changes to ground conditions (which may be associated with construction or which may occur independently of construction).
- All construction activities that involve disturbance to peat deposits should be overseen by an appropriately qualified geotechnical engineer (not the Environmental Clerk of Works) with experience of construction on peat sites. This is critical given the recorded history of failures on Lewis.
- Awareness of peat instability and pre-failure indicators should be incorporated in site induction, training and monthly toolbox talks to enable all site personnel to recognise ground disturbances and features indicative of incipient instability.
- A weather policy should be agreed and implemented during works, e.g. identifying ‘stop’ rules (i.e. weather dependent criteria) for cessation of track construction or trafficking.
- Monitoring checklists should be prepared with respect to peat instability addressing all construction activities proposed for site.
- An Emergency Response Plan (ERP) should be prepared to support site personnel in safely managing and mitigating the consequences of a peat instability event should it occur. The ERP should identify responsibilities for preparing for such an event and

responding to it, ensure that short and medium term mitigations plans and procedures are in place and are implemented, and identify lessons learned to reduce the likelihood of subsequent occurrences once root cause has been identified.

It is considered that taken together, these mitigation measures should be sufficient to reduce risks to construction personnel to Negligible by reducing consequences to minor injury or programme delay (i.e. Moderate consequences) with a Very Low likelihood of occurrence.

6.5 Good Practice Post-Construction (Operation)

Following cessation of construction activities, monitoring of key infrastructure locations should continue by full site walkover to look for signs of unexpected ground disturbance, including:

- Ponding on the upslope side of infrastructure sites and on the upslope side of access tracks.
- Changes in the character of peat drainage within a 50 m buffer strip of tracks and infrastructure (e.g. upwelling within the peat surface upslope of tracks, sudden changes in drainage behaviour downslope of tracks).
- Blockage or underperformance of the installed site drainage system.
- Slippage or creep of stored peat deposits.
- Development of tension cracks, compression features, bulging or quaking bog anywhere in a 50 m corridor surrounding the site of any construction activities or site works.

This monitoring should be undertaken on a quarterly basis in the first year after construction, biannually in the second year after construction and annually thereafter; in the event that unanticipated ground conditions arise during construction, the frequency of these intervals should be reviewed, revised and justified accordingly. Because slope movement in peatlands typically occur following later summer convective rainfall, site surveys are likely to be best undertaken in late September, also providing an opportunity to identify bare or drying peat that might require remedial works prior to winter.

In the event that further construction activities are required, e.g. track resurfacing, further ancillary works, remedial works or cable repairs, any activity that disturbs peat directly or indirectly should be subject to the same good practice as outlined in Section 6.4.

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