Carnaig Substation EIA

Technical Appendix 10.1: Peat Slide Risk Assessment

PREPARED FOR

Scottish & Southern Electricity Networks
TRANSMISSION

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ACRONYMS AND ABBREVIATIONS

Acronym	Description
AOD	Above Ordnance Datum
BGS	British Geological Survey
EIA	Environmental Impact Assessment
ERM	Environmental Resources Management
FoS	Factor of Safety
NPF4	National Planning Framework 4
OSNGR	Ordnance Survey National Grid Reference
OS	Ordnance Survey
PSRA	Peat Slide Risk Assessment
SSEN	Scottish and Southern Electricity Networks
THC	The Highland Council
WFD	Water Framework Directive

1. INTRODUCTION

1.1 BACKGROUND

Environmental Resources Management (ERM) was commissioned by Scottish and Southern Electricity Networks Transmission (SSEN) (the Applicant) to carry out a Peat Slide Risk Assessment (PSRA) to support an Environmental Impact Assessment (EIA) consent to install and operate the proposed Carnaig Substation (the Proposed Development).

The Proposed Development layout is shown in **Figure 10.1.1**, included within **Appendix A**. The area within the redline boundary presented on **Figure 10.1.1** is hereon defined as 'the Site'.

This PSRA has been prepared to inform consultees to the application of the potential risk of any peat slide.

This PSRA will ensure that the Proposed Development constitutes a construction project that complies with good practice in accordance with Scottish Government guidance[1] in assessing the likelihood and consequence of such an event.

The PSRA is accompanied by the following appendices:

- Appendix A – Figures;
- Appendix B – Factor of Safety Records; and
- Appendix C – Hazard Rank Assessment Records.

1.2 SCOPE AND PURPOSE

This PSRA provides factual information on the peat survey results relating to the proposed Site Infrastructure locations. The desk-based information and Site surveys have been utilised to assess the potential risk of any peat landslide. The methodology adopted and details on the assessment are outlined in Sections 3, 4 and 5. The assessment has been undertaken in accordance with Scottish Government Guidance[1] in assessing the likelihood and consequence of such an event.

1.3 PROJECT TEAM

TABLE 1-1: PROJECT TEAM

Team Member	Job Title	Qualifications	No. Years Experience
Miné van der Berg	Consulting Senior Associate	MSc	3 Years
Gregor Hirst	Senior Engineer	BSc (Hons)	8 Years
Tomos Ap Tomos	Technical Director	BEng (Hons) MCIHT	25 Years

[1] Scottish Government (2017) Proposed Electricity Generation Developments: Peat Landslide Hazard Best Practice Guide [online] Available at: https://www.gov.scot/publications/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/ (Accessed 10/07/2024)

This assessment was undertaken by Miné van der Berg, a Geo-Environmental Engineer with three years' experience (two of those in ground conditions), and was supported by Gregor Hirst, a Geo-Environmental Engineer with eight years. This Chapter has been technically reviewed by Tomos Ap Tomos, Technical Director of Engineering with 25 years of experience.

2. SITE INFORMATION

2.1 SITE DESCRIPTION AND TOPOGRAPHY

The Site is located on the north-western slope of Meall Mòr, adjacent to the south-western boundary of the existing 275 kV Loch Buidhe Substation. Access to the existing 275 kV Loch Buidhe Substation is taken off Lochbuie Road, to the north-west of the Site. The Site lies approximately 9.5 km to the north-east of Bonar Bridge, within The Highland Council (THC) area, centred on Ordnance Survey National Grid Reference (OSNGR) 265194 E, 897429 N.

Currently, the Site predominantly comprises commercial forestry, of which a significant proportion has been felled. There are several minor watercourses present within the Site boundary, including Alltan Dubh which runs in a north-westerly direction towards Allt Garbh-airigh in the north west of the Site, Allt Glach-bhuaile is present in the east of the Site running east then north into Loch Buidhe. Allt na Sean-airigh is present in the south eastern section of the Site, running south into Loch an Lagain, while Allt an t-Sleasdairigh is present in the south western extent of the Site, also running south into Loch an Lagain.

Existing ground levels at the Site range between approximately 230 m Above Ordnance Datum (AOD) in the south-east to approximately 200 m AOD in the north-west adjacent to the existing 275 kV Loch Buidhe Substation access track.

Details of the proposed development are included in **Chapter 2: Project Description** of this EIA with the proposed development presented in **Figure 2.1**.

2.2 THE PROPOSED DEVELOPMENT

The Proposed Development consists of the following main components:

- A new bellmouth and access road to the Proposed Development from the public highway;
- A temporary construction compound;
- A drainage and a Sustainable Drainage System (SuDS) retention basin with access track to the west;
- A new level platform (approximately 530 metres (m) by 320 m) to be delivered through cut and fill earthworks. An outdoor Air Insulated Substation (AIS), 400 kV substation complete with 400 kV double busbar arrangement will be installed ;
- Installation of two new Super Grid Transformers (SGTs) and other associated equipment;
- A new substation control building (approximately 20 m by 48 m);
- Installation of Underground Cable (UGC) to connect the Proposed Development to the existing Loch Buidhe Substation;
- Erection of a 2.4 m high palisade security fencing with a 1.6 m electrified anti-climbing extension security fence around the perimeter of the platform;
- Post construction mitigation measures including peatland restoration and landscape mitigation planting; and
- Biodiversity enhancement works including native species planting and habitat creation.

2.3 AERIAL PHOTOGRAPHY REVIEW

A review of aerial photography available for the Site was undertaken using Google Earth. Image 2-1 shows the aerial photography from 2023 of the Site and surrounding areas. There are tracks on the Site as well as established forestry plantations. There is an existing substation on the Site and the forestry in the vicinity of this substation has been felled.

IMAGE 2-1: AERIAL IMAGERY OF THE SITE IN 2023

2.3.1 HISTORICAL IMAGERY

In addition to the aerial view of the Site shown in Image 2-1, historical Google Earth imagery of the Site between 1985 and 2021 is shown in Table 2-1.

Earliest historical mapping shows the Site to be undeveloped moorland with a track running approximately north west to south east through the Site. Forestry is shown to be present across the entirety of the Site other than the northern extent by 2007. The existing Loch Buidhe substation appears in the northern Site area from 2016 mapping, whilst felling in the northern forestry blocks has commenced by 2021.

TABLE 2-1: HISTORICAL IMAGERY REVIEW

1985

2007

2016

2021

2.4 PUBLISHED GEOLOGY

2.4.1 SUPERFICIAL SOILS

The BGS 1:50,000 superficial deposits map[2] indicates that most of the Site is situated on superficial deposits comprising Peat at the very north and south of the Site, as well as a few instances throughout the centre of the Site shown to be situated on Till and Morainic Deposits (Undifferentiated), comprising Diamicton, Sand and Gravel.

The national soil map of Scotland[3] indicates that most of the Site (excluding southern and western boundaries) is situated on component soils comprising peaty gleys with dystrophic blanket peat with peaty gleyed podzols; soils which are part of the Gleys major soil group and Peaty Gleys major soil subgroup. The very west, and south of the Site is shown to be situated on component soils comprising peaty gleyed podzols with dystrophic semi-confined peat with peaty gleys; soils which are part of the Podzols major soil group and the peaty gleyed podzols major soil subgroup.

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[2] BGS GeoIndex (2023). Onshore GeoIndex [Online] Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html?_ga=2.232576351.1392439634.1719225346-1291810703.1719225345 (Accessed 24/06/2024)
[3] Scotland's Environment (2023). National Soils Map of Scotland [Online] Available at: https://map.environment.gov.scot/Soil_maps/?layer=1 (Accessed 24/06/2024)

The superficial soils at the Site are presented in **Figure 10.1** in **Appendix A** of the Geology & Soils Chapter.

2.4.2 SOLID GEOLOGY

The BGS 1:50,000 bedrock geology map[2] shows that most of the Site is underlain by the Altnaharra Psammite Formation comprising Psammite and Micaceous Psammite. The very south of the Site adjacent to Loch an Lagain is underlain by Migdale Pluton comprising Monzogranite. Migdale Pluton comprising Monzogranite is also noted in a few isolated instances through the centre of the Site.

The solid geology at the Site is presented in **Figure 10.2** in **Appendix A** of the Geology & Soils Chapter.

2.4.3 CARBON AND PEATLAND MAP

The Carbon and Peatland Map 2016[4] details that the Site is mostly underlain by Class 5 peat. This is not designated as a high priority peatland habitat and is classified as "*No peatland habitat recorded. May also include areas of bare soil. Soils are carbon-rich and deep peat*."

Land on the northern and western Site boundary, where no proposed infrastructure is located, is classified as Class 1 and Class 2 peat, nationally important carbon-rich soils of high conservation value, which are defined as:

- Class 1 Peat: "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value*".
- Class 2 Peat: "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas of potentially high conservation value and restoration potential*".

No development is proposed in areas of Class 1 or Class 2 peat.

The Carbon and Peatland mapping for the Site is presented in **Figure 10.3** in **Appendix A** of the Geology & Soils Chapter.

2.4.4 GEOMORPHOLOGY

Geomorphological mapping can act as a primary instrument in highlighting geological risk factors when considering peat slides. The Scottish Government guidance provides 5 basic features in which a geomorphological map should be produced:

- The position of major slope breaks (e.g. convexities and concavities);
- The position and alignment of major natural drainage features (e.g. peat gullies and streams);
- The location and extent of erosion complexes (e.g. haggs and groughs, large areas of bare peat);
- Outlines of past peat landslides (including source areas and deposits), if visible; and
- The location, extent and orientation of cracks, fissures, ridges and other pre-failure indicators.

[4] Scotland's Environment (2023). 2016 Carbon and Peatland Map. [Online] Available at: https://map.environment.gov.scot/Soil_maps/?layer=1
https://map.environment.gov.scot/Soil_maps/?layer=10 (Accessed 24/06/2024)

Figure 10.1.2: Geomorphological Map has been prepared to inform a baseline information of the Site with consideration given to existing site conditions through site visit and aerial photography, slope angle and geomorphological data.

From field observations and aerial review of the Site, there does not appear to be significant areas of exposed peat, scarring, hagging or drainage channels on the Site. It is unlikely for these features to be present due to the general absence of peatland vegetation at the Site with the majority of the Site comprising forestry plantation or areas of former plantation which have been felled.

Factors that could potentially lead to peat instability are shown on **Figure 10.1.2: Geomorphological Map**.

Artificial drainage is present on the Site, associated with the current and historical commercial forestry across the Site.

2.4.5 HYDROLOGY AND HYDROGEOLOGY

The BGS 1:625,000 hydrogeology map[5] shows the bedrock unit is classified as 'low productivity aquifers', whereby small amounts of groundwater may be present in near surface weathered zones and secondary fractures.

The Site is shown to be situated in the Northern Highlands Groundwater Body (SEPA ID: 150701), which has an overall Water Framework Directive (WFD) classification of "Good".

The SEPA Water Hub records Loch Buidhe (ID: 100096) to have a 'High' overall status and 'High' water quality, which is the highest possible rating.

Further details of the hydrology and hydrogeology of the Site are included in **Chapter 11: Hydrology** of this EIA.

2.4.6 METEOROLOGICAL DATA

There is no weather station located on the Site itself, so rainfall data from the closest rainfall station[6] have been included to give an indication of the rainfall expected at the Site. This data is included in Table 2-2 and includes rainfall data for the Milton of Evelix rainfall station located approximately 10 km south-east of the Site. This rainfall data was collected between June 2023 and May 2024.

TABLE 2-2: MONTHLY MEAN RAINFALL DATA (MM)

Rainfall Station	Mean Monthly Rainfall (mm)											
	Jun '23	Jul '23	Aug '23	Sept '23	Oct '23	Nov '23	Dec '23	Jan '24	Feb '24	Mar '24	Apr '24	May '24
Milton of Evelix	54.3	64.9	68.6	57.6	87.7	78.5	70.7	81.5	66.6	55.6	45.8	64.9

[5] British Geological Survey (2024) Hydrogeology Map [Online] Available at: https://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSHydroMap&_ga=2.179434020.1833967928.1720694206-1598926874.1720694182 (Accessed 11/07/2024)
[6] SEPA (2024). Rainfall Data for Scotland [Online] Available at: https://www2.sepa.org.uk/rainfall (Accessed 24/06/2024)

2.5 SOURCES OF INFORMATION

The following sources of information were used as part of the desk study investigations:

- British Geological Survey - Online GeoIndex[2];
- Geosure landslip data;
- OS topographical informationS;
- Historical OS mapping;
- Aerial and Satellite photography via Ordnance Survey and Google Earth;
- Defra 'Magic' maps[7];
- Ordnance Survey 5 m Digital Terrain Model (OS 5 mDTM);
- Soil Survey of Scotland - 'MacAulay Institute for Soil Research' 1984;
- Soil Survey of Scotland - 'Scottish Peat Surveys' 1964;
- Scottish Government (SG) - 'Peat Landslide Hazard and Risk Assessments' December 2017[1];
- Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey, Guidance on Developments on Peatland[8];
- Carbon and Peatland Mapping 2016[4];
- National Planning Framework 4 (NFP4) (2023)[9];
- Assessments by other EIA specialists (specifically hydrology and ecology for data on sensitive receptors); and
- Scotland's Environment Interactive Map[10]

No relevant comments from landowners, land managers, local residents or newspaper articles were found to inform this assessment.

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[7] Defra Magic Map [Online] Available at: Magic Map Application (defra.gov.uk) (Accessed 29/08/2024)
[8] The Scottish Government (2017) Guidance on Developments on Peatland [online] Available at: https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2018/12/peatland-survey-guidance/documents/peatland-survey-guidance-2017/peatland-survey-guidance-2017/govscot%3Adocument/Guidance%2Bon%2Bdevelopments%2Bon%2Bpeatland%2B-%2Bpeatland%2Bsurvey%2B-%2B2017.pdf (Accessed 15/07/2024)
[9] Scottish Government (2023) National Planning Framework 4. [online] https://www.gov.scot/binaries/content/documents/govscot/publications/strategy-plan/2023/02/national-planning-framework-4/documents/national-planning-framework-4-revised-draft/national-planning-framework-4-revised-draft/govscot%3Adocument/national-planning-framework-4.pdf (Accessed on 21/06/2024)
[10] Scotland's Environment (2023). Scotland's Environment Interactive Webmap [Online] Available at: https://map.environment.gov.scot/sewebmap/ (Accessed 24/07/2024)

3. GUIDANCE AND METHODOLOGY

3.1 GENERAL GUIDANCE ON PEAT FAILURE

The Scottish Government guidance 'Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments[1]', divides peat instability into two categories, 'peat slides' and 'bog bursts'. The guidance states that peat slides have a greater risk of occurrence in areas where:

- Peat is encountered at or near to ground surface level;
- The thicknesses are recorded in the region of 2.00 m (above which, in general terms, peat instability would increase with peat thickness); and
- The slope gradients are steep (between 5° and 15°).

Bog bursts are considered to have a greater risk of occurrence in areas where:

- Peat depth is greater than 1.50 m; and
- Slope gradients are shallow (between 2° and 10°).

It should be noted however that peat instability events, although uncommon, can occur out with these limits and reports of bog bursts are generally restricted to the Republic and Northern Ireland.

Preparatory factors which effect the stability of peat slopes in the short to medium-term include:

- Loss of surface vegetation (deforestation);
- Changes in sub-surface hydrology;
- Increase in the mass of peat through accumulation, increase in water content and growth of tree planting; or
- Reduction in shear strength of peat or substrate due to chemical or physical weathering, progressive creep and tension cracking.

Triggering factors which can have immediate effects on peat stability and act on susceptible slopes include:

- Intensive rainfall or snow melt causing pressures along existing or potential peat/substrate interfaces;
- Alterations to drainage patterns, both surface and sub-surface;
- Peat extraction at the toe of the slope reducing the support of the upslope material;
- Peat loading (commonly due to stockpiling) causing an increase in shear stress; and
- Earthquakes or rapid ground accelerations such as blasting or mechanical movement.

Consideration of peat stability should form an integral part of the design of the Proposed Development. While peat does not wholly provide a development constraint, areas of deep peat or peat deposits on steep slopes should be either avoided through design and micro-siting or mitigation measures should be designed to avoid potential instability and movement.

3.2 ASSESSMENT APPROACH

This PSRA has been carried out in accordance with the Scottish Government guidance[1], details of which are outlined in Section 3.1.

In 2023 the new National Planning Framework 4 (NPF4)[9] for Scotland was published. In relation to peat and the assessment of effects on resource, Policy 6 (c) of NPF4 specifically relates to soils, aiming "*to protect carbon-rich soils, restore peatlands and minimise disturbance to soils from development*". The contents of this policy are therefore also considered in this PSRA. The PSRA undertaken is based on:

- Desk based assessment;
- Site visits;
- Peat probing including infrastructure specific probing; and
- A hazard and risk ranking assessment.

The area of the Proposed Development subject to assessment was determined by initial finding from desk studies and anticipated peat deposits as well as other physical and environmental constraints.

3.3 PEAT PROBING METHODOLOGY

Initial peat probing (phase one) was undertaken in May 2024 as part of the preliminary EIA works, which combined preliminary probing and detailed peat probing within the boundaries of a Site layout iteration. The probing covered an initial design iteration at 100 m centres within all areas of proposed infrastructure or peat restoration within the Site boundary. Areas surrounding proposed infrastructure were also probed to assess any potential risk of slide events which could affect proposed infrastructure.

3.3.1 DEVELOPMENT OF HAZARD RANK

The initial stage of this PSRA comprises a desk study of existing data. Site visits and peat probing were carried out in order to supplement the available desktop information. Following collection of peat depths within the Site, the assessment was carried out to determine the potential effects on the peat resource from construction activities which would include:

- Construction of tracks;
- Foundation construction;
- Construction of the substation and Site Compounds;
- Construction of harstandings;
- excavation of cable trenches;
- Excavation of Sustainable Drainage System (SUDs Pond); and
- Temporary storage of peat.

An assessment of the peat probing data and a review of any available Site information was undertaken and a hazard rank calculated zonally across the Site reflecting risk of peat instability/constraint to construction.

Where practical, the Proposed Development layout was designed to avoid areas of a risk score above 'low'. Where this has not been achieved, areas affected have been discussed in both the EIA as having significant effect, with relative mitigation measures proposed to reduce this, and recorded on a risk register which sets out specific mitigation measures which are considered necessary to reduce the risk of inducing instability.

4. SITE SURVEYS

4.1 INTRODUCTION

The existing peat depths across the Site have been determined through a phased survey approach. The survey was initiated to inform the EIA and Site design work while supporting the PSRA.

Phase 1 of the peat depth surveys was undertaken in May 2024, as discussed in Section 3.3.

This probing data was supplemented by probing data collected by SSEN in 2023. These points were taken at more frequent intervals averaging 25 m spacing across the areas proposed for development.

This phase one probing was used to determine the distribution of peat across the Site. This peat distribution was used to refine the Site infrastructure layout.

A detailed ground investigation was undertaken by IGNE during the period 9th of October to the 24th of November 2023. Twenty boreholes were sunk by dynamic sampling and rotary core drilling methods, and twenty-two trial pits were excavated by mechanical means. In addition Two hundred and forty-one peat probes were undertaken across the site.

4.2 PEAT DEPTH

A total of 651 peat probes were taken throughout the peat surveys. Recorded peat depths of 0.50 m or less accounted for 49.2% of the total probing results with a further 20.7% of probes recording depths of 1.00 m or less. The majority of the Site does not have deep peat however there are significant areas of deeper peat in the north-west of the Site and the eastern side of the Site, where topography is typically flatter. Table 4-1 shows a summary of the distribution of peat depths across the Site.

The deepest pocket of peat, up to 4.95 m, is located in a lower lying area of the Site in the north-west. This point is not beneath any proposed infrastructure.

TABLE 4-1: PEAT DEPTH SUMMARY

Peat Depth (m)	Total Probes	% Total
0.00 - 0.50	320	49.2%
0.51 - 1.00	135	20.7%
1.01 - 1.50	57	8.8%
1.51 - 2.00	56	8.6%
2.01 - 2.50	33	5.1%
2.51 - 3.00	27	4.1%
3.01 - 4.00	20	3.1%
>4.01	3	<1.0%
Total	**651**	**100.0%**

Summary results from the IGNE ground investigation encountered peat in depths ranging from 0.3m to 2.0m in 18 of the 20 boreholes averaging 1.05m. The type of peat was recorded as typically dark brown pseudo-fibrous peat described as H3 to H6 on the von Post scale (very slight to moderately high decomposition). Peat was also recorded in all of the trial pits with depths ranging from 0.4m to 2.7m averaging 1.2m. Not all trial pits were classified on the von post scale, the 5 that were ranged between H4 to H6 (slight to moderately high decomposition) all were described as spongy dark brown pseudofibrous peat.

5. HAZARD AND EXPOSURE ASSESSMENT

5.1 BACKGROUND

A 'Hazard Ranking' system has been applied across the Site based on the analysis of risk of peat landslide as outlined in the Scottish Government guidance. This is applied on the principle:

Hazard Ranking = Hazard x Exposure

Where 'Hazard' represents the likelihood of any peat slide event occurring and 'Exposure' being the impact or consequences that a peat slide may have on sensitive receptors that exist on and around the study area.

5.2 METHODOLOGY

The determination of Hazard and Exposure values is based on a number of variables which impact the likelihood of a peat slide (the Hazard), and the relative importance of these variables specific to the Site.

Similarly, the consequences or Exposure to receptors is dependent on variables including the particular scale of a peat slide, the distance it will travel and the sensitivity of the receptor.

In the absence of a predefined system, the approach to determining and categorising Hazard and Exposure is determined on a Site-by-Site basis. The particular system adopted for the Development PSRA assessment is outlined in the following sub sections.

5.3 HAZARD ASSESSMENT

The potential for a peat slide to occur during the construction depends on several factors, the importance of which can vary from site to site. The factors requiring considerations would typically include:

- Peat depth;
- Slope gradient;
- Substrate material;
- Hydrology;
- Distance between the closest receptor and the point being evaluated;
- Evidence of instability or potential instability; and
- Vegetation cover.

Of these, peat depth and slope gradient are considered to be principal factors. Without a sufficient peat depth and a prevailing slope, peat slide hazard would be negligible. For the Proposed Development, the substrate material is also considered a relevant factor in relation to slide.

The slope data is derived from OS 5 m DTM. The slope gradients for the Site are illustrated on **Figure 10.1.3** in **Appendix A** of this PSRA.

Hazard rankings at each probe point were determined by assigning coefficients based on peat depth, slope gradient and substrate material as outlined in Section 5.4.

The other factors have not been assigned coefficients but have nonetheless been built into the assessment. With regards to hydrology, major and minor watercourses are assigned different coefficients to reflect the sensitivity of the receptor with the distance of each probe from a watercourse affecting its hazard ranking.

No existing peat instability was recorded at the Site, however in the event that slip material is recorded at a probing point, this is fed into the hazard assessment and the highest substrate coefficient is assigned to reflect the highest potential level of hazard.

Vegetation plays a key role on both peatland quality and in reducing the risk of instability in peatland. Vegetation provides structure to the upper soil horizons and acts as an important regulator of water content in peat above the water table. The presence of bare or eroded peat can be an indicator of instability risk due to the lack of vegetation providing stability. No bare peat or historic peat cutting has been recorded at the Site. The presence of forestry and requirement for felling can also present a risk of instability due to the removal of established root systems and resulting lack of vegetation. There are several areas of established forestry on the Site and this may pose an increased risk of slide risk on the Site due to vegetation clearance. The recorded habitat across a majority of the Site is ‘w2c - other coniferous woodland’, with isolated areas of ‘g1b upland acid grassland’ and ‘f1a6 – Degraded blanket bog’ recorded in historic forestry rides where plantation has not taken place.

Further details of vegetation present at the Site are discussed in Chapter 7: Ecology and the associated Technical Appendices.

Due to the nature of the assessment and number of data points used to establish hazard ranking, gathering hydrological data at each probe point through the use of groundwater boreholes and a subsequent monitoring period is considered impractical. Therefore, an assumption on groundwater levels has been adopted for the assessment that 90% of the peat at each probe location is below the water table. As such, it is assumed that the water table across the Site is relatively high.

5.4 HAZARD RANKING

When several factors may impact on the Hazard potential, a relative ranking process is applied attributing different weighting to each factor as shown below.

TABLE 5-1: COEFFICIENTS FOR SLOPE GRADIENTS

Slope Angle (degrees)	Slope Angle Coefficients
Slope < 2°	1
2° < Slope < 4°	2
4° < Slope < 8°	4
8° < Slope < 15°	6
Slope >15°	8

The Slope Map included as **Figure 10.1.3** in **Appendix A** shows the slopes found across the Site.

TABLE 5-2: COEFFICIENTS FOR PEAT THICKNESS AND GROUND CONDITIONS

Peat Thickness (metres)	Ground Conditions Coefficients
Peaty or organic soil (<0.50 m)	1
Thin Peat (0.50 – 1.00 m)	2
Deep Peat (1.00 – 3.00 m)	3
Deep Peat (>3.00 m)	8

TABLE 5-3: COEFFICIENTS FOR SUBSTRATE

Substrate Material	Substrate Coefficients
Sand/gravel	1
Rock	1.5
Clay	2
Not proven	2
Slip material (Existing materials)	5

The Hazard Rating Coefficient for a particular location is calculated using the following equation:

$$\text{Hazard Rating Coefficient} = \text{Slope Gradient} \times \text{Peat Thickness} \times \text{Substrate}$$

From the Hazard Rating Coefficient, the risk to stability can be ranked as set out in Table 7.

TABLE 5-4: HAZARD RANKING

Hazard Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
< 6 Negligible	1
7 to 12 Low	2
13 to 24 Medium	3
25 to 30 High	4
>30 Very high	5

This risk of peat slide will be mitigated in the first instance by micrositing from areas with high risk of failure to areas of low or negligible risk, where possible, which would generally mean micrositing to shallower peat, areas that are not covered by a sensitive habitat, or areas with flatter slopes. Mitigation measures will also be implemented such as visual inspections and monitoring during construction in areas with the potential for peat slide risk and avoiding loading slopes. Best practice measures relating to drainage of the peat will also be implemented prior to and during construction in order to mitigate the risk of failure.

5.5 PEAT STABILITY ASSESSMENT

The likelihood of a particular slope or hillside failing can be expressed as a Factor of Safety. For any potential failure surface, there is a balance between the weight of the potential landslide (driving force or shear force) and the inherent strength of the soil or rock within the hillside (shear resistance).

The stability of a slope can be assessed by calculating the factor of safety (FoS), which is the ratio of the sum of resisting forces (shear strength) and the sum of the destabilising forces (shear stress):

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

Where F is the FoS, c′ is the effective cohesion, γ is the bulk unit weight of saturated peat, γw is the unit weight of water, m is the height of the water table as a fraction of the peat depth, z is the peat depth in the direction of normal stress, β is the angle of the slope to the horizontal and ϕ ′ is the effective angle of internal friction.

- Values of F < 1 indicate a slope would have undergone failure under the conditions modelled; and
- Values of F > 1 suggest conditions of stability.

Peat failures occur due to a combination of pre-existing factors including the morphological, geomorphological, hydrological, and geological trigger factors. Trigger factors could include heavy rainfall events, the loading of the peat, and excavation of the peat. Peat slides occur when a mass of peat moves as an intact body down a slope. Slides generally occur on a shear plane, usually located close to the base of the peat. The dominant failure method in peat failures looked at by Boylan et al (2008)[11] in Ireland was planar failure as opposed to bog bursts.

5.5.1 GEOTECHNICAL PARAMETERS

Peat possesses significant shear strength considering that it can consist of moisture contents of more than 900%. This can be attributed to the small amounts of solid plant matter present within the peat. Water within peat is held in three states, free water within cavities in the soil matrix, capillary water within plant matter and adsorbed water bound to soil particles. Most of the water is held in the soil cavities and can therefore be removed by drainage or consolidation. The hydrological properties of peat play a significant role in the failure of peat (Boylan et al [2008]).

TABLE 5-5: LITERATURE FOR GEOTECHNICAL PARAMETERS OF PEAT

Reference	Effective Cohesion C' (kPa)	Effective Angle of Friction ϕ (°)	Unit Weight γ (kN/m²)	Comments
Hanrahan et al (1967)[11]	5.5 – 6.1	36.6 – 43.5	-	Remoulded H4* Sphagnum peat

[11] Boylan et al (2008) - Discussion of 'Peat slope failure in Ireland' by N. Boylan, P. Jennings & M. Long, Quarterly Journal of Engineering Geology and Hydrogeology, 41, 93–108

Reference	Effective Cohesion C' (kPa)	Effective Angle of Friction ϕ (°)	Unit Weight γ (kN/m²)	Comments
Hollingshead and Raymond (1972)[12]	4.0	34.0	-	-
Hollingshead and Raymond (1972)	2.4 – 4.7	27.1 – 35.4	-	Sphagnum peat (H3, mainly fibrous)
Carling (1986)[13]	6.52	0.0	10.00	-
Kirk (2001)[14]	2.7 – 8.2	26.1 – 30.4		Ombrotrophic blanket peat
Warburton et al (2003)[15]	5.0	23.0	9.68	Basal Peat
Warburton et al (2003)	8.74	21.6	9.68	Fibrous Peat
Dykes and Kirk (2006)	3.2	30.4	9.61	Acrotelm**
Dykes and Kirk (2006)	4.0	28.8	9.71	Catotelm***

* The degree of humification of peat samples is estimated in the field according to the method devised by the Swedish botanist L. von Post by squeezing a small amount of peat in the hand and the water and / or peat exuded indicates, by its colour and consistency, the degree to which the peat has undergone humification or, more correctly, a type of decomposition which includes breakdown under anaerobic conditions. The von Post scale ranges from H1 to H10, the higher the number the higher the degree of humification.

** • Acrotelm is the upper layer of peat, quite fibrous and contains plant roots. Acrotelmic peat is relatively dry, generally lying above the groundwater table and has some tensile strength.

***• Catotelm is the lower layer of peat which is highly amorphous and has a very high water content. Catotelm generally lies below the ground water table and has a very low tensile strength.

In the absence of historical hydrological monitoring across the Site, an assumption on groundwater levels has been adopted for the assessment, that 90% of the peat column at each probe location is below the water table, an overall conservative approach. While the assessment considers the recorded data at each of the peat probes to establish hazard ranking for the purposes of the peat stability analysis, groundwater depth is conservatively assumed to be within close proximity of the surface, based on the understanding of peat and its hydrological properties that it can consist of up to 90% water by volume.

Assumed geotechnical parameters have been sought from various literature values and for the purposes of the assessment in this report have the following average values have been utilised in the formula to inform the stability assessment:

- C' – effective cohesion (kPa), typically ranging from 2.5 to 8.5 therefore 5.0 has been adopted for the purposes of the assessment.
- ϕ – effective angle of friction (°), typically ranging from 21.6 to 43.5 therefore 23 has been adopted for the purposes of the assessment.
- ϒ – unit weight (kN/m^2), typically ranging from 9.61 to 10, therefore 10 has been adopted for the purposes of the assessment.

In accordance with the best practice method, F values of <1.0 indicate slopes that would experience failure under the modelled conditions and as such are considered areas of high risk. However, Boylan et al (2008)[12] indicate that a relatively high value of F=1.4 should be used to identify slopes with the potential for instability. Adopting a similar and more onerous approach, high risk areas are indicated where F is <1.0, medium risk areas are indicated between 1.0 to 1.5, low risk negligible values >1.5.

According to Boylan et al (2008), it is unlikely that undrained conditions would exist for many in situ tests due to the higher permeability of peat as compared to clay soils. They found that the application of both drained and undrained analysis in peat failure analysis are questionable. Furthermore, they found that the mode of failure for peat is likely partially drained. Due to this the effective stress strength method (assuming steady seepage of groundwater parallel to ground level) was used with the abovementioned mitigation measure of increasing the F value where slip occurs.

Using digital terrain modelling and GPS co-ordinates of each peat probe, a factor of Safety, F has been calculated for each probe location which has been created through ArcGIS Spatial Analyst tools.

The FoS analysis completed on the probes indicates that of the 651 points to date, all of the probes are at low risk of failure.

The Factor of Safety Plan is presented in **Figure 10.1.4** in **Appendix A**.

5.5.2 SENSITIVITY ANALYSIS

In order to evaluate the effects of loading on peat a sensitivity analysis was carried out.

The points that are located beneath proposed infrastructure that will be loaded (the peat re-use areas) will be subject to an undrained analysis and applied load. As with the drained analysis discussed in Section 5.5, the stability of a slope can be assessed by calculating the FoS, which is the ratio of the sum of resisting forces (shear strength) and the sum of the destabilising forces (shear stress):

$$FoS = \frac{c_u}{(z\gamma + \mathrm{P})\cos\beta\sin\beta}$$

[12] Boylan et al (2008) - Discussion of 'Peat slope failure in Ireland' by N. Boylan, P. Jennings & M. Long, Quarterly Journal of Engineering Geology and Hydrogeology, 41, 93–108

The relevance of the parameters of the equation are defined below and outlined in the Roadex Network – Engineering considerations of peat[13]:

- C_u = Undrained shear strength of peat (kPa)
- γ = density of peat (kg/m³)
- z = peat depth perpendicular to slope (m)
- P = applied load (kPa)
- β = slope angle (degrees)

A nominal load of 20 kPa was applied to points in peat relocation and re-use areas. This is derived from the unit weight of peat (discussed in Section 5.5.1) and taking the maximum height of peat stacked in the re-use area of 2 m.

5.6 EXPOSURE ASSESSMENT

The main exposure receptors identified within the Site and surrounding area which could potentially be affected in the event of a peat slide were blanket bog habitats, the existing Loch Buidhe substation, existing tracks, watercourses and proposed infrastructure.

The impact of a peat slide on receptors can be assessed on a relative scale based on the potential for loss of habitat, a historical feature or disruption/danger to the public. To effectively assess the impact, the assessment of Exposure effect must also consider the distance between the hazard and the receptor, and the relative elevation between the two.

The results of the FoS sensitivity analysis shows that the entire Site remains at a low risk of failure, even with the added load.

5.7 EXPOSURE RATING

Similar to the Hazard Rating, the Exposure Ratings were determined using relative ranking process by attributing the different weighting systems to each factor as shown below:

TABLE 5-6: COEFFICIENTS FOR RECEPTOR TYPE

Receptor	Receptor Coefficients
Tracks/footpaths	2
Proposed infrastructure, minor/private roads	3
Minor watercourses and tributaries, other infrastructure (pipelines, motorways, dwelling, business properties)	6
Residential Properties, major watercourses/lochs, sensitive habitat eg. blanket bog	8

[13] Roadex Network (n.d.) Lesson 2: Roads on Peat: 5. Engineering considerations of peat [online] Available at: https://www.roadex.org/e-learning/lessons/roads-on-peat/engineering-considerations-of-peat/ (Accessed 19/07/2024)

TABLE 5-7: COEFFICIENTS FOR DISTANCE FROM RECEPTOR

Distance from Receptor	Distance Coefficients
>1 km	1
100 m to 1 km	2
10 m to 100 m	3
<10 m	4

TABLE 5-8: COEFFICIENTS FOR RECEPTOR ELEVATION

Receptor Elevation	Elevation Coefficients
<10 m	1
10 m to 50 m	2
50 m to 100 m	3
>100 m	4

The Exposure Rating Coefficient for a particular location is calculated using the following equation:

Exposure Rating Coefficient = Receptor X Distance X Elevation

From the Hazard Rating Coefficient, the risk to stability can be ranked as set out in Table 5-9.

TABLE 5-9: EXPOSURE RATING

Exposure Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
<6	Very Low
7 to 12	Low
13 to 24	High
25 to 30	Very High
>30	Extremely High

5.8 RATING NORMALISATION

In order to achieve an overall Hazard Ranking in accordance with the Scottish Government guidance[1], the Hazard and Exposure Rating Coefficient derived from the coefficient tables are normalised as shown in Table 5-10.

TABLE 5-10: RATING NORMALISATION

Hazard Rating		Exposure Rating	
Current Scale	**Normalised Scale**	**Current Scale**	**Normalised Scale**
< 5 Negligible	1	<6 Very Low	1
5 to 15 Low	2	6 to 12 Low	2
15 to 30 Medium	3	13 to 24 High	3
30 to 50 High	4	25 to 30 Very High	4
>50 Very high	5	>30 Extremely High	5

The record of the Hazard Risk Assessment is included in Appendix D of this PSRA.

6. HAZARD RANKING

Having identified the rating coefficients as defined in Section 5 of this report, it is possible to categorise areas of the Site with a Hazard Ranking by multiplying the Hazard and Exposure Rating. Hazard Ranking and associated suggested actions matrix are shown in Table 6-1 and Table 6-2 below:

TABLE 6-1: HAZARD RANKING AND SUGGESTED ACTIONS

Hazard Ranking		Action Suggested in the Scottish Executive Guidance
17-25	High	Avoid project development at these locations.
11-16	Medium	Project should not proceed unless hazard can be avoided or mitigated at these locations, without significant environmental impact, in order to reduce hazard ranking to low or less.
5-10	Low	Project may proceed pending further investigation to refine assessment. Mitigation of hazards maybe required through micro-siting or re-design at these locations.
1-4	Negligible	Project should proceed with monitoring and mitigation of peat landslide hazards at these locations as appropriate.

TABLE 6-2: HAZARD RANKING MATRIX

Hazard Rating	5	Low	Low	Medium	High	High
	4	Negligible	Low	Medium	Medium	High
	3	Negligible	Low	Low	Medium	Medium
	2	Negligible	Negligible	Low	Low	Low
	1	Negligible	Negligible	Negligible	Negligible	Low
		1	2	3	4	5
		Exposure Rating				

Receptor exposure was assessed for each of the hazard zones using the approach in Section 5. A summary of the Hazard Ranking result for each identified area is summarised in Section 7. and is presented in **Figure 10.1.5: Hazard Rank Zonation Plan**. The zonation is based on a combination of considerations, including calculated hazard result, peat depth, topography, receptors and land uses.

7. SLIDE RISK AND MITIGATION

In order to complete the PSRA for the Site, the worst case scenario for development across the Site was considered.

Figure 10.2.3 in **Appendix A** of the Outline Peat Management Plan (oPMP) (Peat Re-Use Areas) indicates the locations of the non-bunded peat relocation areas and the proposed peat re-use area. The oPMP details the re-use peat depths, but the non-bunded peat relocation areas have maximum depths of 2.0 m that has been applied. The peat re-use area has had a blanket 0.6 m of peat applied to it for the purposes of the hazard risk assessment calculations, this area will have an average depth of 0.3 m and a maximum depth of 0.6 m. The maximum depth has been applied throughout the hazard ranking calculation.

7.1 GENERAL

The PSRA has shown the majority of the Site to be of a Low and Negligible risk with isolated points that are at medium risk of peat slide. The medium risk points are generally located on steep slopes and within zones of blanket bog. There are some medium risk points located beneath and around the proposed substation, these points are located in areas of deeper peat and are spread throughout the proposed substation area. The Hazard Ranking Plan for the development is shown in **Figure 10.1.5** in **Appendix A** of this PSRA. The Hazard Ranking Plan does not take mitigation measures outlined in Table 7-1 into account.

The medium risk points identified in the analysis are present across the Site, however they are typically isolated points with low or negligible points surrounding them. There is an area beneath the proposed substation and surrounding area with a total of 16 medium risk points (out of 296 probes in the area). These medium risk points are spread throughout the substation and surrounding area. Of these 16 points, two are located beneath the substation, two are located beneath proposed tracks and the remaining 12 are located in the area surrounding the substation and associated infrastructure. There are an additional four points located throughout the Site. These points are isolated occurrences and therefore, with the appropriate mitigation measures and monitoring outlined in Table 7-1, the risks associated with the points can be mitigated to result in a low risk.

Further to the hazard ranking, a FoS assessment has been undertaken, which provides a sense check of the ranking based system as outlined in Section 5.5 of this PSRA. The 'Factor of Safety Plan' is shown in **Figure 10.1.4** in **Appendix A** of this PSRA and demonstrates that the entire Site is located in areas with low risk of failure.

As described in Section 5.5 the FoS calculations take peat depth and slope into account, which are the main geotechnical parameters for a peat slide event. The Hazard Rank Assessment takes the effects of a peat slide event into consideration and in this assessment all of the points that have returned medium risk points have Sensitive Habitat in the form of degraded blanket bog listed as the closest receptor. This significantly increases the hazard ranking, even though the risk of a failure event (as shown by the FoS calculation) is low.

There is a risk of peat slide on the Site and mitigation measures as outlined in Table 7-1 and Section 7.3 of this PSRA should be applied to minimise any risk.

Where the hazard ranking has been lowered through mitigation measures, the original ranking will remain in the overall hazard zoning plan and it should be acknowledged that the hazard zonation plan is based on the pre-mitigation status.

While the specific recommended mitigation is proposed, other mitigation is embedded in the design at EIA stage, as outlined in Chapter 3: Site Selection Process and Alternatives. It is also necessary for detailed design and construction of the Proposed Development infrastructure to be undertaken in a competent and controlled manner.

The embedded mitigation and good practice measures are set out in Section 7.3 and 7.4 of this PSRA. It should be noted that the mitigation measures defined are not exclusive and other forms of mitigation may well be required and should be implemented by the Principal Contractor during construction of the Proposed Development. Table 7-1 provides details of the hazard areas and outlines specific mitigation actions for each area.

TABLE 7-1: HAZARD RANK

Hazard Area and Infrastructure		Unmitigated Hazard		Mitigated Hazard	
Hazard Area	**Infrastructure Affected**	**Ranking**	**Key Aspects**	**Specific Actions**	**Ranking**
H1	Construction Compound, Substation, Access tracks, underground cabling and SUDS Pond	Low	Location: This zone covers the majority of the north western portion of the Site. Hydrology: There are no watercourses in this zone but there are zones of blanket bog. Peat Depths: Maximum peat depth of 4.95 m, and average peat depth of 1.38 m. Topography: The slope in this zone ranges from 1° to 8°. Receptors: Roads and tracks, sensitive habitat, site infrastructure.	Best practice measures in relation to drainage prior to and during construction will be implemented as well as the management of peat and peaty soils as outlined in Technical Appendix 10.2 oPMP. A Geotechnical Risk Register should be completed as part of the design phase and geotechnical supervision should be provided throughout the construction phase. During construction visual inspections and monitoring in areas with the potential for peat slide risk should take place. Placement of excavated materials on slopes should be avoided with all excavated materials placed in temporary storage mounds positioned at safe slope gradients and certified by a geotechnical engineer. Use of heavy plant machinery on slopes should be avoided where possible to minimise loading of slopes. All earthworks and excavations should be designed and undertaken in such a way as to avoid any excavation of toe support material. Micro-siting into areas of thinner peat where possible.	Negligible
H2	Restoration Area	Low	Location: This zone covers the majority of the north eastern and central portion of the Site. Hydrology: There are minor watercourses in this zone. There are zones of blanket bog.	Best practice measures in relation to drainage prior to and during construction will be implemented as well as the management of peat and peaty soils as outlined in Technical Appendix 10.2 oPMP.	Negligible

Hazard Area and Infrastructure		Unmitigated Hazard		Mitigated Hazard	
			Peat Depths: Maximum peat depths of 3.9 m and average peat depth of 0.81 m. Topography: The slope in this zone ranges from 0° to 18°. Receptors: Roads and tracks and sensitive habitat.	Active groundwater monitoring to be undertaken in restoration areas for an agreed period (e.g 5 years) A Geotechnical Risk Register should be completed as part of the design phase and geotechnical supervision should be provided throughout the construction phase. Visual inspections and monitoring in areas with the potential for peat slide risk and peat relocation areas should take place during and following construction. Placement of excavated materials on slopes should be avoided with all excavated materials placed in temporary storage mounds positioned at safe slope gradients and certified by a geotechnical engineer. Use of heavy plant machinery on slopes should be avoided where possible to minimise loading of slopes. All earthworks and excavations should be designed and undertaken in such a way as to avoid any excavation of toe support material. Reinstatement of peat in peat relocation areas should not be undertaken on slopes greater than 4% (2.29°).	
H3	-	Negligible	Location: This zone covers the southern portion of the Site. Hydrology: There are minor watercourses in this zone. There are also zones of blanket bog. Peat Depths: Maximum peat depths of 3.9 m and average peat depth of 0.35 m. Topography: The slope in this zone ranges from 1° to 27°. Receptors: Minor watercourses, roads and tracks and sensitive habitat.	Best practice measures in relation to drainage prior to and during construction will be implemented as well as the management of peat and peaty soils as outlined in Technical Appendix 10.2 oPMP.	Negligible

7.2 PEATLAND RESTORATION

Peatland restoration will take place on Site in order to reuse the peat generated from the development. More information on the restoration can be found in Technical Appendix 10.2: outline Peat Management Plan and Chapter 7: Ecology.

7.3 EMBEDDED MITIGATION

Embedded mitigation includes measures taken during design of the Proposed Development as actively informed by the peat probing survey work to reduce the potential for peat slide risk. In summary, the principal measures that have been taken are:

- Locating proposed infrastructure on shallower slopes, where possible; and
- The avoidance of placing temporary peat storage areas on medium risk, and on peat deeper than 1.0 m; and
- Locating proposed infrastructure in areas of shallow peat (or no peat), where possible.

7.4 PEAT SLIDE MITIGATION RECOMMENDATIONS

The following mitigation measures should be adopted post consent stage to validate the PSRA and influence the detailed design of the Proposed Development:

- A Geotechnical Risk Register should be completed as part of the design phase;
- Geotechnical supervision should be provided throughout the construction phase;
- Identification of areas sensitive to changes in drainage regime prior to detailed design;
- Update the PSRA as necessary following any additional detailed ground investigations;
- The micrositing of Site infrastructure away from medium risk points;
- Implementing a suitable inspection programme in order to regularly monitor the areas for instability (such as ground movement, tension cracks, groundwater issues, etc.) during the construction process, with the use of settlement alarms as appropriate;
- During construction, appropriate supporting structures should be put into place to prevent cracks or the development of tension cracks;
- Use of heavy plant machinery on slopes should be avoided where possible to minimise loading of slopes;
- The toes of slopes should not be cut, so construction should take place from working up-to-downslope;
- Stepping or battering back of excavations to a safe angle (as determined through a detailed slope stability assessment by a competent temporary works designer) or construction of a temporary retaining structure to support the peat during construction, where required;
- Ensure that new excavation is not scheduled for times when heavy precipitation is forecasted and ensure that sufficient drainage measures are in place during construction activities;
- The presence of bare peat during restoration or storage should be minimised where possible by utilizing excavated turves and establishing an appropriate revegetation strategy;

- Development of a drainage strategy that will not create areas of concentrated flow and will not affect the current peatland hydrology, particularly at points where a medium peat slide risk has been identified;
- Design of a drainage system for tracks and hardstanding that will require minimal ongoing maintenance during the operation of the substation;
- Inspection and maintenance of the drainage systems during construction and operation;
- Undertake active groundwater monitoring in restoration areas for an agreed period (e.g 5 years)
- Identification of suitable areas for stockpiling material during construction prior to commencement of works to minimize loading of peat to be agreed with geotechnical engineer;
- Placement of excavated materials on slopes should be avoided with all excavated materials placed in temporary storage mounds positioned at safe slope gradients and certified by a geotechnical engineer; and
- Consideration of specific construction methods appropriate for infrastructure in peatland (i.e. geogrids) as part of design development.

8. CONCLUSION

This PSRA has been undertaken for the Proposed Development in accordance with Scottish Government guidance[1], as outlined in Section 3 of this PSRA. The early stages of the assessment included a desk study, historical review, detailed probing of the infrastructure zone, followed by further peat probing across the Site. The information gathered during this investigation was used to develop a Hazard Ranking across the Proposed Development Site.

The findings of the peat probing indicate that there are areas on site with deep peat, but that the majority of the Site does not have peat with depths greater than 1.0 m. There is generally a low risk of peat slide on the Site, with isolated medium risk points. Risks can be mitigated through construction monitoring, proper drainage, and micrositing where required. According to the hazard risk assessment the maximum residual hazard posed to the Site is low risk after mitigation measures have been implemented.

Based on the scope of the study, the PSRA has indicated that the Site is generally of low and negligible hazard ranking, with limited points of medium hazard ranking. It is considered that following the implementation of mitigation measures outlined in Table 7-1 and Section 7 of this PSRA, the maximum residual hazard posed to the Development will be low.

Notwithstanding this, infrastructure locations and existing site conditions should be checked on Site at the time of construction and micro-siting adopted in order to maintain the design objective of avoiding any potential peat slide risk.

9. REFERENCES

Scottish Government (2017) Proposed Electricity Generation Developments: Peat Landslide Hazard Best Practice Guide [online] Available at: Proposed electricity generation developments: peat landslide hazard best practice guide – (https://www.gov.scot/publications/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/) (Accessed 10/07/2024)

BGS GeoIndex (2023). Onshore GeoIndex, [Online] Available at: (https://www.bgs.ac.uk/map-viewers/geoindex-onshore/) (Accessed 24/06/2024)

Scotland's Environment (2023). National Soils Map of Scotland. (https://soils.environment.gov.scot/maps/soil-maps/national-soil-map-of-scotland/) (Accessed 24/06/2024)

Scotland's Environment (2023). 2016 Carbon and Peatland Map. (https://soils.environment.gov.scot/maps/thematic-maps/carbon-and-peatland-2016-map/) (Accessed 24/06/2024)

British Geological Survey (2024) Hydrogeology Map [Online] (https://www2.bgs.ac.uk/groundwater/datainfo/hydromaps/home.html) (Accessed 11/07/2024)

SEPA (2024). Rainfall Data for Scotland [Online] (https://www2.sepa.org.uk/rainfall/) (Accessed 24/06/2024)

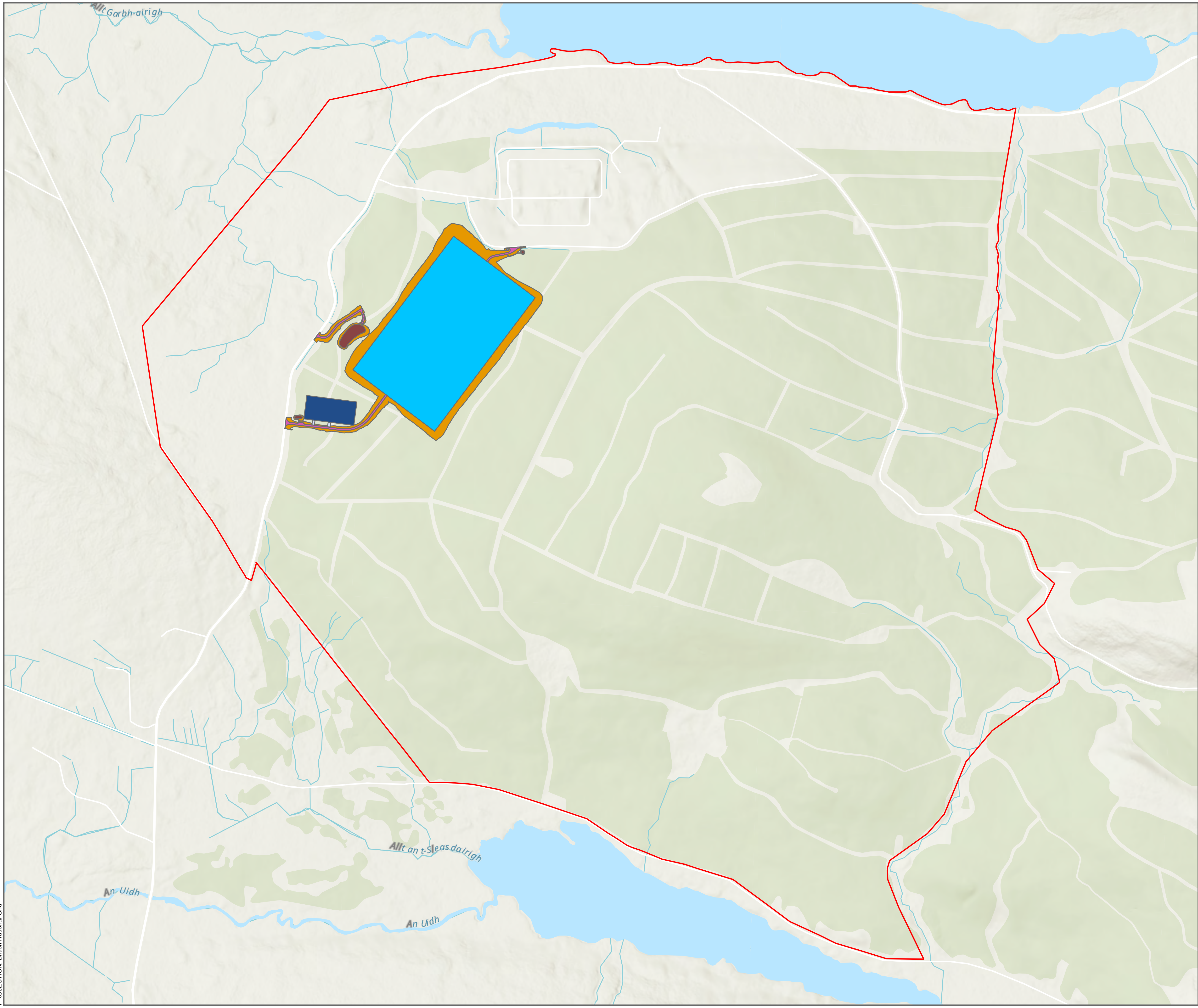
British Geological Survey (2024) Online GeoIndex [Online] https://www.bgs.ac.uk/map-viewers/geoindex-onshore/ (Accessed 11/07/2024)

The Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments [online] (https://www.gov.scot/publications/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/pages/4/ (www.gov.scot) (Accessed 15/07/2024)

The Scottish Government (2017) Guidance on Developments on Peatland [online] (https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2018/12/peatland-survey-guidance/documents/peatland-survey-guidance-2017/peatland-survey-guidance-2017/govscot%3Adocument/Guidance%2Bon%2Bdevelopments%2Bon%2Bpeatland%2B-%2Bpeatland%2Bsurvey%2B-%2B2017.pdf) (www.gov.scot) (Accessed 15/07/2024)

Scottish Government (2023) National Planning Framework 4. [online] (https://www.gov.scot/publications/national-planning-framework-4/) (Accessed on 21/06/2024)

APPENDIX A FIGURES



Site Boundary

Site Infrastructure

- Access Track
- Construction Compound
- Drainage Channel
- Earthworks
- SUDs Pond
- Substation Platform
- Temp Access Track

0 100 200 300 400 500
Metres

N

SCALE: See Scale Bar	VERSION: A01
SIZE: A3	DRAWN: MV
PROJECT: 0699566	CHECKED: RW
DATE: 24/07/2024	APPROVED: SC

Figure 10.1.1
Site Layout

ERM

Scottish & Southern Electricity Networks
TRANSMISSION

PROJECTION: British National Grid

Esri, Intermap, NASA, NGA, USGS, Esri Community Maps Contributors, Esri UK, Esri, TomTom, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

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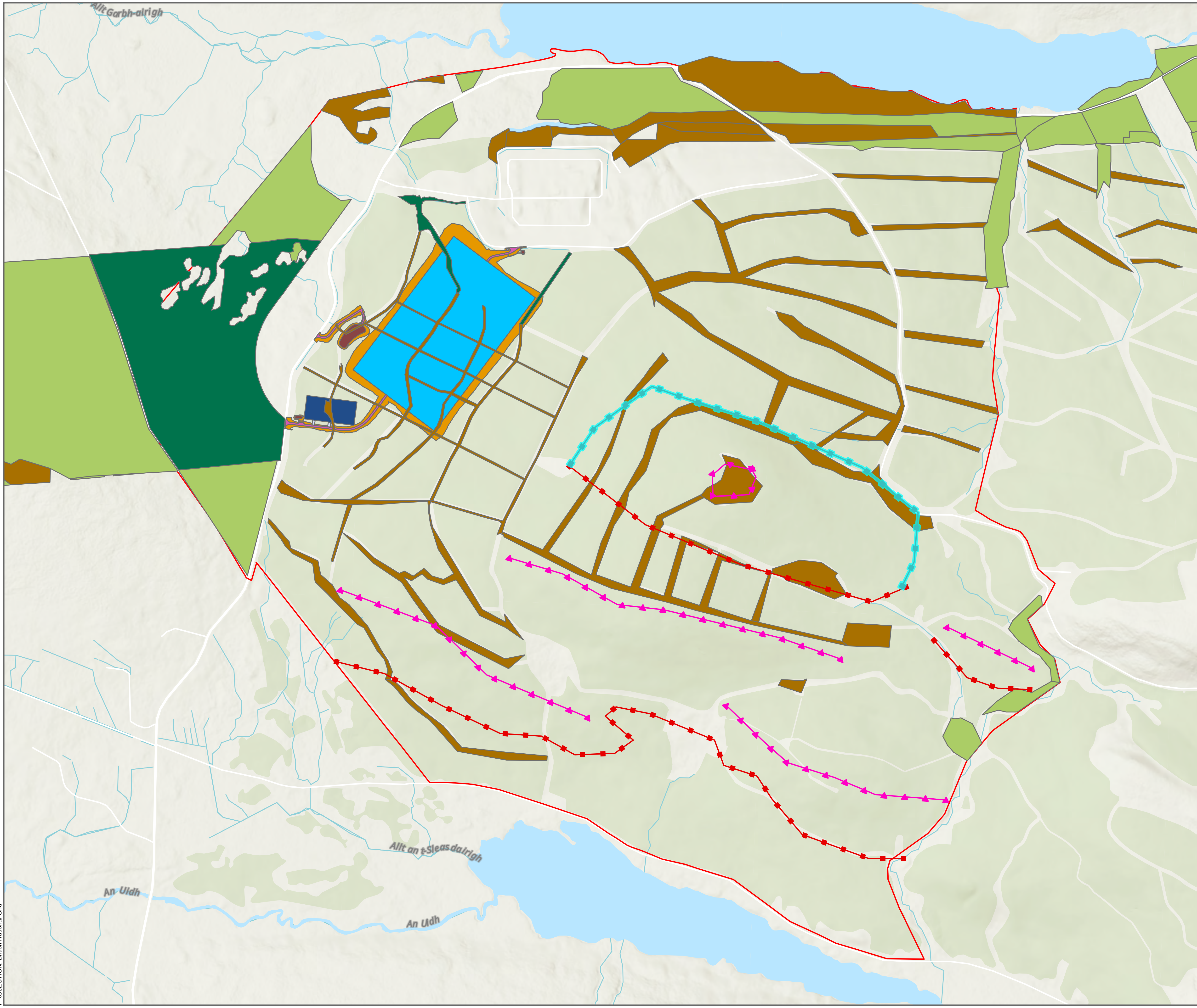

Site Boundary
Top of Slope
Bottom of Slope

Site Infrastructure

Access Track
Construction Compound
Drainage Channel
Earthworks
SUDs Pond
Substation Platform
Temp Access Track

UK Habitat

f1a - Blanket bog
f1a5 - Blanket bog (H7130)
f1a6 - Degraded blanket bog

0 100 200 300 400 500
Metres

N

SCALE: See Scale Bar	VERSION: A01
SIZE: A3	DRAWN: MV
PROJECT: 0699566	CHECKED: RW
DATE: 24/07/2024	APPROVED: SC

Figure 10.1.2
Geomorphological Map

ERM

Scottish & Southern Electricity Networks
TRANSMISSION

PROJECTION: British National Grid

Esri, Intermap, NASA, NGA, USGS, Esri Community Maps Contributors, Esri UK, Esri, TomTom, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

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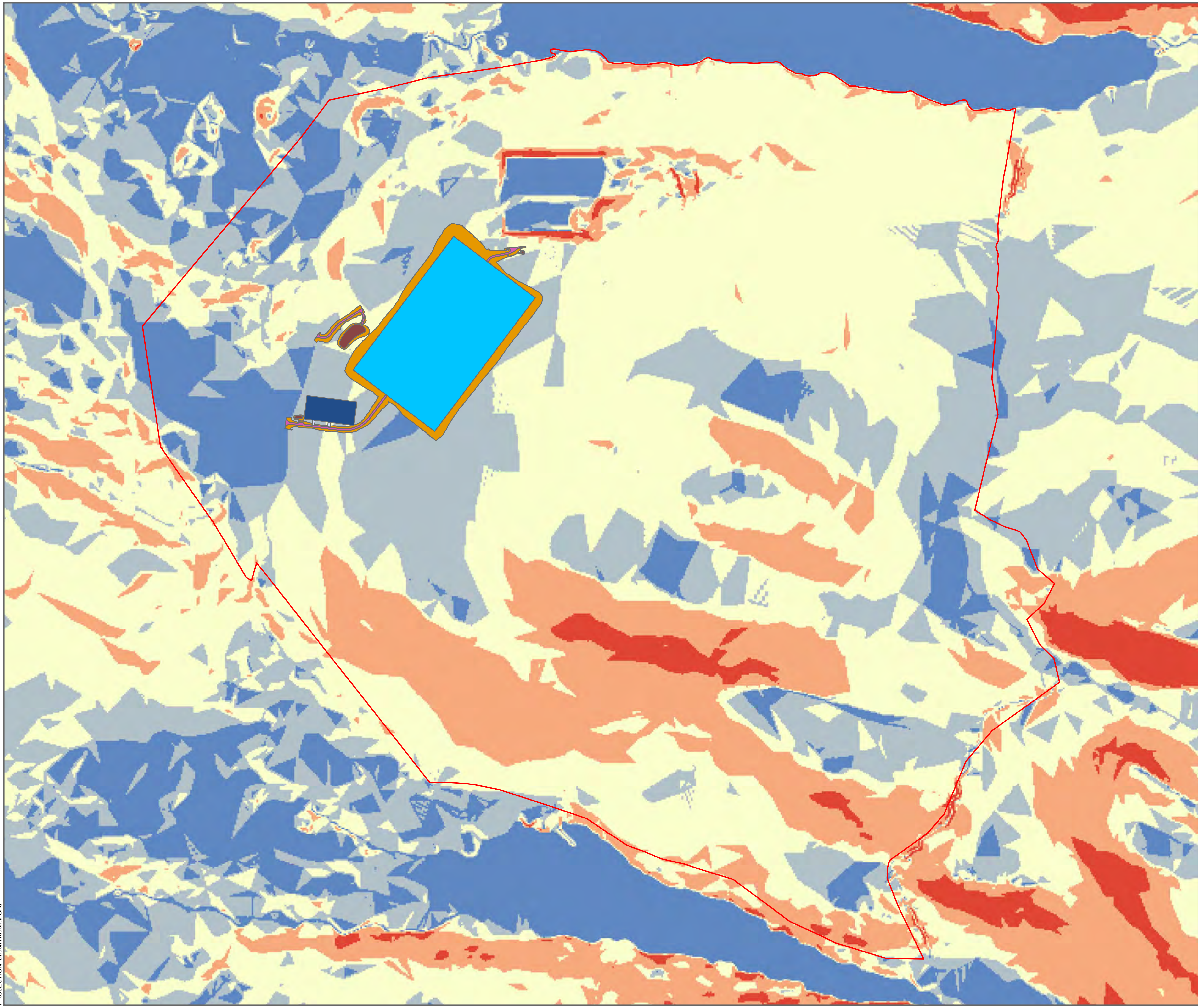

Site Boundary

Site Infrastructure

- Access Track
- Construction Compound
- Drainage Channel
- Earthworks
- SUDs Pond
- Substation Platform
- Temp Access Track

Slope (degrees)

- < 2.00°
- 2.01° - 4.00°
- 4.01° - 8.00°
- 8.01° - 15.00°
- > 15.01°

0 100 200 300 400 500
Metres

N

SCALE: See Scale Bar	VERSION: A01
SIZE: A3	DRAWN: MV
PROJECT: 0699566	CHECKED: RW
DATE: 24/07/2024	APPROVED: SC

Figure 10.1.3
Slope Map

ERM

Scottish & Southern Electricity Networks
TRANSMISSION

PROJECTION: British National Grid

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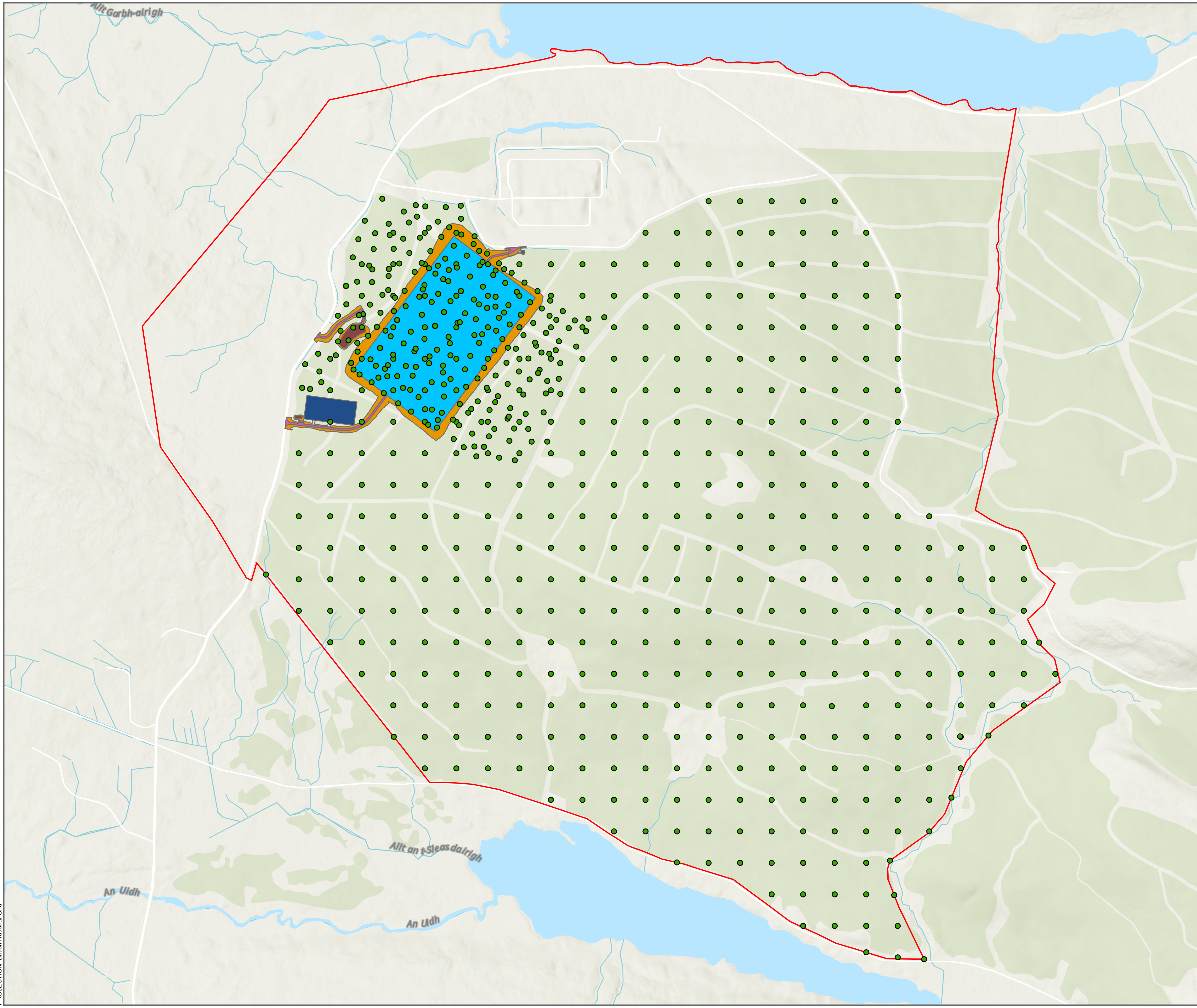


Site Boundary

Site Infrastructure

- Access Track
- Construction Compound
- Drainage Channel
- Earthworks
- SUDs Pond
- Substation Platform
- Temp Access Track

Factor of Safety

- Low

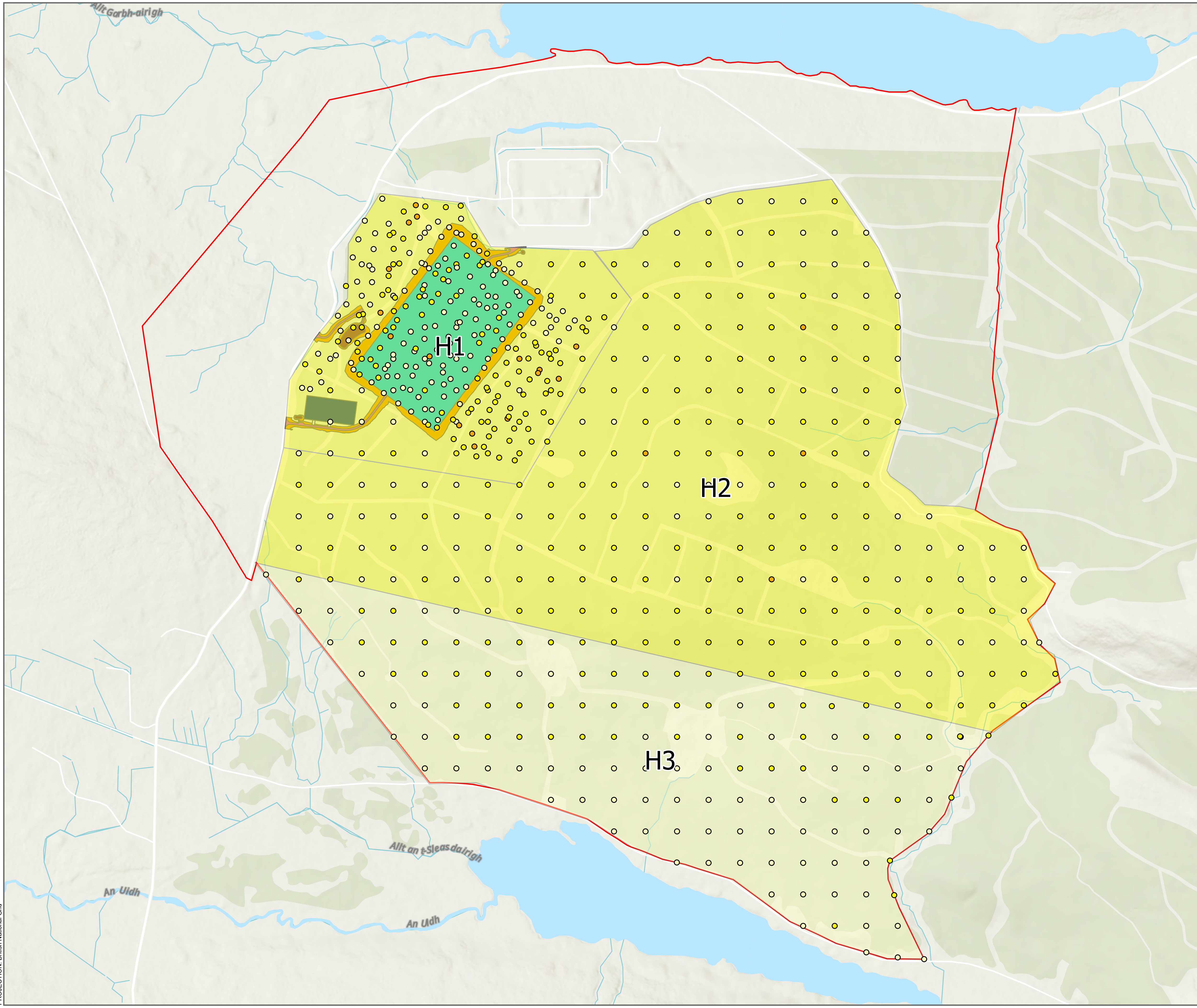
0 100 200 300 400 500
Metres

N

SCALE: See Scale Bar	VERSION: A01
SIZE: A3	DRAWN: MV
PROJECT: 0699566	CHECKED: RW
DATE: 24/07/2024	APPROVED: SC

Figure 10.1.4
Factor of Safety Plan

Path: \\uksprdgisfs01\Data\Arcus\Projects\0699566 - Loch Buidhe\Workspace\Engineering\0699566 Loch Buidhe - Engineering\0699566 Loch Buidhe - Engineering.aprx



Site Boundary

Site Infrastructure

- Access Track
- Construction Compound
- Drainage Channel
- Earthworks
- SUDs Pond
- Substation Platform
- Temp Access Track

Hazard Rank

- Negligible
- Low
- Moderate

Hazard Rank Zone

- Low
- Negligible

0 100 200 300 400 500
Metres
N

SCALE: See Scale Bar	VERSION: A01
SIZE: A3	DRAWN: MV
PROJECT: 0699566	CHECKED: RW
DATE: 24/07/2024	APPROVED: SC

Figure 10.1.5
Hazard Rank Plan

ERM
Scottish & Southern Electricity Networks
TRANSMISSION

PROJECTION: British National Grid

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Path: \\uksprdgisfs01\Data\Arcus\Projects\0699566 - Loch Buidhe\Workspace\Engineering\0699566 Loch Buidhe - Engineering\0699566 Loch Buidhe - Engineering.aprx

ERM

APPENDIX B FACTOR OF SAFETY RECORDS

APPENDIX C HAZARD RANK ASSESSMENT RECORDS

ERM HAS OVER 160 OFFICES ACROSS THE FOLLOWING COUNTRIES AND TERRITORIES WORLDWIDE

Argentina
Australia
Belgium
Brazil
Canada
China
Colombia
France
Germany
Ghana
Guyana
Hong Kong
India
Indonesia
Ireland
Italy
Japan
Kazakhstan
Kenya
Malaysia
Mexico
Mozambique

The Netherlands
New Zealand
Peru
Poland
Portugal
Romania
Senegal
Singapore
South Africa
South Korea
Spain
Switzerland
Taiwan
Tanzania
Thailand
UAE
UK
US
Vietnam

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