

# Annex P - Peat Slide Risk Assessment (PSRA)

September 2022





**ARCUS**

**ARGYLL SUBSTATIONS – CRAIG MURRAIL  
ENVIRONMENTAL APPRAISAL**

**ANNEX P**

**PEAT LANDSLIDE HAZARD AND RISK ASSESSMENT**

**JULY 2022**



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## 1 INTRODUCTION

### 1.1 Background

Arcus Consultancy Services Ltd (Arcus) was commissioned by ERM on behalf of SSEN Transmission Ltd (the Applicant) to carry out a Peat Landslide Hazard and Risk Assessment (PLHRA) to support an Environmental Assessment (EA) for the proposed Craig Murrail Substation and associated infrastructure (the Development) as part of the Argyll and Kintyre 275 kV Substations Upgrade, located approximately 3 kilometres (km) north of Lochgilhead (the Site) at National Grid Ref. 187725 691030.

The new substation and accompanying infrastructure aspects (hereby known as the Proposed Development) will be subject to Town and Country Planning, while the OHL Tie-In, Temporary Diversion accompanying towers and temporary access track (hereby known as the Associated Development) will be submitted for Section 37 consent. The Site Layout Plan is shown on **Figure 1** in **Appendix A**.

This PLHRA has been prepared to inform Argyle & Bute Council (the Council) and statutory consultees of the estimated peat excavation and re-use potential, proposed peat and soils management methodologies to be employed during construction.

It should be noted that both Development's construction schedules will be aligned. Therefore, peat excavation and re-use will be considered within the wider scope of the Project.

This PLHRA will ensure the Project constitutes a construction project that complies with good practice in accordance with Scottish Renewables (SR) and Scottish Environment Protection Agency (SEPA) guidance<sup>1</sup>.

The PLHRA is accompanied by the following appendices:

- Appendix A: Figures;
- Appendix B: Site Photographs;
- Appendix C: Hazard Rank Calculations; and
- Appendix D: Peat Coring Records.

### 1.2 Scope and Purpose

The scope of this PLHRA is to:

- Review available desk-based information on the Site;
- Undertake a site walkover survey and peat probe surveys to characterise the prevailing ground conditions and identify existing or potential peat instability;
- Report on the findings of the survey and assess the potential instability risk and estimate the hazard from any potential peat slide; and
- Recommend mitigation measures and specific construction methodologies that should be considered during the construction period, if required.

This PLHRA provides factual information on the peat survey results relating to the Proposed Development and Associated Development. The desk-based information and site surveys have been utilised to assess the potential risk of any peat slide. The methodology adopted, and details on the assessment, are outlined in **Sections 3, 4 and 5** of this PLHRA. The

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<sup>1</sup> Scottish Government (2017) Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments [Online]. Available at: <https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2017/04/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/documents/00517176-pdf/00517176-pdf/govscot%3Adocument/00517176.pdf> (Accessed 23/06/2022)

assessment has been undertaken in accordance with Scottish Government Guidance in assessing the likelihood, and consequence, of peat slide<sup>2</sup>.

### 1.3 Project team

Team Member	Job Title	Qualifications	No. Years Experience
Gregor Hirst	Senior Engineer	BSc (Hons)	6 Years
David Ballentyne	Principal Engineer	BSc (Hons)	18 Years
Tomos Ap Tomos	Technical Director	BEng (Hons) MCIHT	25 Years

This assessment was undertaken by Gregor Hirst (BSc Hons), a Geo-Environmental Engineer of 6 years, and was supported by David Ballentyne a Geo-Environmental Civil Engineer with for over 18 years of experience in ground condition assessment. This Chapter has been technically reviewed by Tomos Ap Tomos, Technical Director of Engineering.

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<sup>2</sup> Scottish Government (2017): Peat Landslide Hazard and Risk Assessments: Best Practice Guide for Proposed Electricity Generation Developments; Second Edition, April 2017 [Online]. Available at: <https://www.gov.scot/binaries/content/documents/govscot/publications/advice-and-guidance/2017/04/peat-landslide-hazard-risk-assessments-best-practice-guide-proposed-electricity/documents/00517176-pdf/00517176-pdf/govscot%3Adocument/00517176.pdf> (Accessed 23/06/2022)

## 2 SITE INFORMATION AND DESK STUDY

### 2.1 Site Description and Topography

The land within the site boundary (the Site) which contains the Proposed Development and Associated Development is located approximately 3 kilometres (km) north of Lochgilphead, covering an area of approximately 94 hectares (ha) centred on National Grid Reference (NGR) 87742 91011. The Site is located within the administrative boundary of Argyle & Bute Council (the Council). The Site is adjacent to existing Forestry Land Scotland (FLS) track associated with Achnabreac Forest, accessed from the A816 near Cairnbarn.

Topographically the Site has a gradual slope throughout from north west to south east; however, no steep gradients were observed during the walkover and the proposed infrastructure is generally located in flatter areas. The elevation of the Site ranges from around 110 metres (m) Above Ordnance Survey Datum in the south east (AOD) to around 150 m AOD in the north western sector of the Site.

There are a number of drainage channels associated with the forestry plantation at the Site, including a surface water feature which passes through a culvert beneath a track which dissects the Site from north east to south west; however, there are no recorded watercourses or lochs present within the Site boundary.

The predominant land use within the Site is commercial forestry plantation.

### 2.2 Site Walkover

The purpose of the desk study and site visit was to gain a thorough understanding of site conditions including topography, geology, existing peat instability and hydrology. The outcome of this stage of the study was to determine which areas required detailed intrusive survey (by peat probing) and ultimately provide data for the assessment of PLHRA.

A site walkover was undertaken in November 2021 prior to the commencement of the peat probing exercise. The Site was examined for evidence of peatlands, presence of landslip and localised haggling. Geological mapping and areas of interest were pre-loaded to a handheld device for reference during the site walkover. Following a review of these in parallel with the initial site walkover, the desk study aimed to identify and or verify the following:

- The general condition of peat deposits;
- Evidence of any previous peat instability;
- The presence of low lying wet/peat lands; and
- Watercourses and other potential receptors.

#### 2.2.1 Site Conditions

The Proposed Development and Associated Development are in an area of mature conifer woodland with potential for red squirrel, a protected species. It is underlain by class 5 peat and does not support peatland habitats. Lochgilphead is approximately 3 km to the south. Auchoish, long cairn Scheduled Monument is approximately 600 m to the west. Knapdale National Scenic Area is approximately 1.8 km to the north west of the Site.

Neither mining nor quarrying activities are known to have taken place at the Proposed Development or Associated Development.

Site photographs taken during the site walkover are included in **Appendix B**.

## 2.3 Published Geology

### 2.3.1 Superficial Soils

Available British Geological Survey (BGS)<sup>3</sup> indicates an absence of superficial deposits across the entirety of the Site. However, given the rural upland location, a thin covering of peaty soil is anticipated across the majority of the site.

**Figure 2** illustrates the 'Superficial Soils' map included in **Appendix A**.

### 2.3.2 Solid Geology

Published bedrock geology mapping information on solid geology indicates the eastern and southern sectors of the Site (where the proposed infrastructure is located) is underlain by Semipelite and Calcareous of the Ardrishaig Phyllite Formation. The remainder of the Site is underlain by Quartzite of the Crinan Grit Formation, other than various thin Sills and Dykes made up of intrusions of silica-poor magma, comprising a mixture of Metagabbro, Metamicrogabbro, Basalt and Metalimestone, which are present throughout the Site.

No geological faults or linear features are present at the Site or in the surrounding area.

**Figure 3** illustrates the 'Solid Geology' included in **Appendix A**.

## 2.4 Hydrology and Hydrogeology

The Site is characterised by its generally flat topography, and lies in close proximity to a watershed running from the north to the south of the Site. Water therefore flows to the Lower Badden Burn to conference with and including the Auchoish Burn to the west and the Dippin/Cuilarstich Burn to the east. Both of these river systems drain to Loch Gilp.

Lower Badden Burn to conference with and including the Auchoish Burn, passes to the west of the Site and flows in a southerly direction. This watercourse has a SEPA overall classification<sup>4</sup> of 'Moderate'. The Dippin/Cuilarstich Burn passes the Site to the east and also flows in a southerly direction, it has a SEPA overall classification of 'Moderate'.

Initial desk-based review indicated the Site is likely to be partially underlain by peat with significant quantities of pockets of deep peat in isolated areas.

The SEPA Aquifer Classification Map of Scotland<sup>5</sup> reveals that the Site is situated within an area underlain by a low productivity aquifer where flow is virtually all through fractures and other discontinuities.

The SEPA River Basin Management Plan Interactive Map reveals that the Site is underlain by the Oban and Kintyre groundwater body. This groundwater body is classified by SEPA under the Water Framework Directive<sup>6</sup> as having a status of Good.

**Figure 4** illustrates the Geomorphology of the Site and is included in **Appendix A**

## 2.5 Historical Landslip and Geomorphology

No evidence of historic landslip or peat haggling was noted during the Site walkover and topsoil, where undisturbed, generally appeared to be in good condition. Due to the presence of extensive forestry plantations at the Site, it is considered that properties of the

<sup>3</sup> British Geological Survey (2019) Geology of Britain [Online] Available at: <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> (Accessed 01/06/22)

<sup>4</sup> SEPA Water Classification Hub (2020) [Online] Available at: [Water Classification Hub \(sepa.org.uk\)](http://www.sepa.org.uk/water-classification-hub) (Accessed 01/06/2022)

<sup>5</sup> Scotland's Environment (2019) SEPA Aquifer Classification Map of Scotland [Online] Available at: <https://map.environment.gov.scot/sewebmap/> (Accessed 01/06/22)

<sup>6</sup> European Parliament (2000) Directive 2000/60/EC [Online] Available at: [https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC\\_1&format=PDF](https://eur-lex.europa.eu/resource.html?uri=cellar:5c835afb-2ec6-4577-bdf8-756d3d694eeb.0004.02/DOC_1&format=PDF) (Accessed 01/06/22)



peat deposits may have been altered and may not pose the same risk of instability as undisturbed peat. Nonetheless, the possibility of instability within peat soils cannot be discounted, especially where there are significant topographic variances and the presence of watercourses, and when there could be future deforestation.

### 3 SITE SURVEYS AND RESULTS

#### 3.1 Investigations

The existing peat depths across the Site have been determined through a peat probe survey undertaken as recommended in the NatureScot (formally Scottish Natural Heritage), Scottish Government and James Hutton Institute guidance for investigating peat<sup>7</sup>.

The probe positions for the survey were determined by the proposed layout of the Proposed Development and Associated Development and provided detailed information across the various proposed infrastructure at frequencies as follows:

- Substation – 10 m x 10 m grid to the extent of the proposed footprint;
- Temporary Works Area – 25 m x 25 m grid; and
- Tracks – Every 50 m along the centreline with perpendicular offsets, 15-25 m either side.

It should be acknowledged that natural variations in peat depth/thickness could occur between probe positions, although areas of infrastructure have undergone intensely spaced probing and this would be less likely.

#### 3.2 Summary of Peat Depths

Throughout the peat survey, a total of 483 probes were progressed. The average peat depth across the Site is 1.22 m with over 31% of probes recording depths of 0.5 m or less and a majority of probes recording peat depths of 1.00 m or less. Despite a relatively high percentage of probes recording peat depths in excess of 1.0 m, depths are largely consistent across the Site with less than 22% of locations recording peat at depths greater than 2.0 m.

The maximum peat depth recorded at the Site was 4.5 m in the north eastern sector of the Site. Peat depths of up to 2.9 m were also recorded along the south eastern edge of the proposed substation and up to 3.5 m in the vicinity of the proposed tower in the southern sector of the Site.

**Table 1** summarises the recorded peat depths.

**Table 1: Peat Depth Summary**

Peat Depth Range (m)	Nº of Peat Probes	Percentage of Total
0.00 - 0.50	150	31.1
0.51 - 1.00	98	20.3
1.01 - 1.50	75	15.5
1.51 - 2.00	55	11.4
2.01 - 2.50	55	11.4
2.51 - 3.00	36	7.5
>3.00	14	2.9
Σ =	483	

The peat probe locations and depths are shown on **Figure 5** appended with this PLHRA, and detailed probing records are included in **Appendix C**. The Interpolated Peat Depths were determined using the Inverse Distance Weighting (IDW) method of interpolation to a resolution of 5 m and are illustrated on **Figure 6**.

<sup>7</sup> Scottish Government, Scottish Natural Heritage and James Hutton Institute (2017) Guidance on Developments on Peatland (Online). Available at: [Guidance+on+developments+on+peatland+-+peatland+survey+-+2017.pdf \(www.gov.scot\)](https://www.gov.scot/Resource/0045/0045.pdf) [Accessed 23/06/2022].



## 4 GUIDANCE AND METHODOLOGY

### 4.1 Overview of Guidance and Peat Failure Mechanisms

#### 4.1.1 Peat Depth and Slope

The Scottish Government guidance 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 2.0 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 1.5 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. Reports of bog bursts are generally restricted to the Republic and Northern Ireland.

Further to the general guidance above, in relation to peat depth, it is considered that the extent and depth of peat is controlled to a degree by rainfall and elevation, giving rise to three common types of peat (Boylan et al. 2008<sup>8</sup>):

- Upland Blanket Bog: Blanket bogs are typically about 3 m thick however; they can be up to 5 m thick. Generally thinning at greater elevations;
- Raised Bog: Raised bogs generally tend to be 3-12 m thick, averaging 7 m with their growth occurring above the water table; and
- Lowland Blanket Bog: Much the same as the upland version; however, they form around sea level in areas of very high rainfall.

Generally, the potential for peat instability increases with peat depth, however other instability indicators needs considered, namely slope and substrate.

#### 4.1.2 Substrate

Peat slide failures tend to occur at the interface of the peat and underlying substrate therefore, understanding the nature of the underlying substrate can provide a key factor when considering the risk stability.

Using the peat probe refusal, an estimation of the underlying materials can be determined based on:

- Gradual refusal – Clay;
- Crunching/Gritty – Weathered Rock/Sand and Gravel; or
- Abrupt Refusal/Hard – Rock.

Where sand and/or gravel is recorded, the interface is considered to be the best-case scenario with the highest friction value.

Where clay is recorded, the upper horizons of the clay are typically softened through poor drainage in this soil group with low shear strengths expected. While rock substrate provides a high strength, the surface being smooth can lead to a weak interface, with similar risk to that of a clay substrate.

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<sup>8</sup> Boylan et al (2008) Peat Slope Failure in Ireland

The presence of slip material, or evidence of peat instability would represent the worst-case scenario for the assessment of substrate.

The substrate parameters are included in the Hazard and Exposure Assessment in **Section 5** of this PLHRA.

#### **4.1.3 Other Considerations**

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 effect on peat stability and act on susceptible slopes include:

- Intensive rainfall or snow melt causing pressures along existing or potential peat/substrate interfaces;
- Snow melt;
- 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 due to blasting or mechanical movement.

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

## **4.2 Methodology**

Despite being an application under the Town and Country Planning (Scotland) Act 1997<sup>9</sup>, the PLHRA has been carried out in accordance with the Energy Consents Unit, Scottish Government guidance of 2017 titled Peat Landslide Hazard and Risk Assessments - Best Practice Guide for Proposed Electricity Generation Developments<sup>10</sup>.

In June 2014, Scottish Planning Policy<sup>11</sup> (SPP) and National Planning Framework (NPF3)<sup>12</sup> were published. In relation to peat and the assessment of effects on resource, NPF3 references SNH Scotland's National Peatland Plan<sup>13</sup>. These policy, framework and guidance documents are considered in this PLHRA.

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<sup>9</sup> Scottish Government (1997) Town and Country Planning (Scotland) Act 1997 [Online] Available at: <http://www.legislation.gov.uk/ukpga/1997/8/contents> (Accessed 20/08/21)

<sup>10</sup> Scottish Government (2017) Peat Landslide Hazard and Risk Assessment: Best Practice Guide for Proposed Electricity Generation Development [Online] Available at: <https://www.gov.scot/Publications/2017/04/8868> (Accessed 20/08/21)

<sup>11</sup> Scottish Government (2014) Scottish Planning Policy [Online] Available at: <http://www.scotland.gov.uk/Topics/Built-Environment/planning/Policy> (Accessed 20/08/21)

<sup>12</sup> Scottish Government (2014) National Planning Framework 3 [Online] Available at: <http://scotland.gov.uk/Resource/0045/00453683.pdf> (Accessed 20/08/21)

<sup>13</sup> SNH (2015) Scotland's National Peatland Plan [Online] Available at: <https://www.nature.scot/climate-change/taking-action/carbon-management/restoring-scotlands-peatlands/scotlands-national-peatland-plan> (Accessed 20/08/21)

The PLHRA undertaken is based on:

- Desk based assessment;
- Site Walkover;
- Infrastructure specific probing; and
- A hazard and risk ranking assessment.

The area of the Site subject to assessment was determined by the Proposed Development and Associated Development layout which considered both recorded peat deposits as well as other physical and environmental constraints.

#### **4.2.1 Development of Hazard Rank**

The early stages of the PLHRA including the desk study, site visit and peat probing were carried out in parallel with the assessment of wider constraints to inform the layout of the Proposed Development and Associated Development. Following identification of peat depths within the Site, the assessment has determined the potential effects on the peat resource from construction activities which would include:

- Construction of tracks;
- Foundation construction;
- Construction of hardstanding; and
- Temporary storage of peat and soils.

An assessment of the peat probing data and a review against desk study information was undertaken and a hazard rank was calculated for different zones across the site reflecting risk of peat instability/constraint to construction.

Where practical, the Proposed Development and Associated Development design would be progressed to avoid areas of a risk score above 'low'. Where this would not be achievable, areas affected would be discussed 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.

Details of the hazard and risk ranking assessment is included in **Sections 5 and 6** of this PLHRA.

## 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 slide as outlined in the Scottish Government guidance. This is applied on the principle:

$$\text{Hazard Ranking} = \text{Hazard} \times \text{Exposure}$$

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 Site.

### 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 PLHRA 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;
- Evidence of instability or potential instability;
- Vegetation cover; and
- Hydrology.

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.

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- Vegetation cover; and
- Hydrology.

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.

The Slope Gradient has been established using a Digital Terrain Model (DTM) to a resolution of 5 m which is illustrated in **Figure 7**. For the Proposed Development and Associated Development, the substrate material is also considered a relevant factor in relation to slide.

Vegetation cover and evidence of instability or potential instability were assessed during site surveys and, alongside satellite photography, informed the Geomorphology Map

presented in **Figure 4**. This information was also considered during the adoption of hazard zones across the Site, which are presented in **Figure 9: Hazard Rank Zonation Plan**.

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 Rating

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 2: 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

**Table 3: Coefficients for Peat Thickness and ground conditions**

Peat Thickness	Ground Conditions Coefficients
Peaty or organic soil (<0.5 m)	1
Thin Peat (0.5 – 1.0 m)	2
Deep Peat (>1.0 m)	3*
Deep Peat (>3.0 m)	8

\* - Note that thicker peat generally occurs in areas of shallow gradient and records and research indicate that thick peat does not generally occur on the steeper gradients.

**Table 4: 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 5**.

**Table 5: Hazard Rating**

Hazard Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
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<5	Negligible
5 to 15	Low
16 to 30	Medium
31 to 50	High
> 50	Very High

## 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 guidance states that the 'Infinite Slope' method of analysis, after Skempton and DeLory (1957), is the most well established and commonly applied method for the assessment of peat slope stability. The stability of a slope can be assessed by calculating the factor of safety  $F$ , 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  $c'$  is the effective cohesion,  $\gamma$  is the bulk unit weight of saturated peat,  $\gamma_w$  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,  $\beta$  is the angle of the slope to the horizontal and  $\phi'$  is the effective angle of internal friction. Values of  $F < 1$  indicate a slope would have undergone failure under the conditions modelled; values of  $F > 1$  suggest conditions of stability.

Assumed geotechnical parameters have been utilised in the formula to inform the stability assessment, based on literature values to inform the stability analysis, as included in **Table 6**.

**Table 6: Literature for Geotechnical Parameters of Peat**

Reference	Effective Cohesion $C'$ (kPa)	Effective Angle of Friction $\phi$ (°)	Unit Weight $\gamma$ (kN/m <sup>2</sup> )	Comments
Hanrahan et al (1967) <sup>14</sup>	5.5 – 6.1	36.6 - 43.5	-	Remoulded H4 Sphagnum peat
Hollingshead and Raymond (1972) <sup>15</sup>	4.0	34	-	-
Hollingshead and Raymond (1972)	2.4 – 4.7	27.1 – 35.4	-	Sphagnum peat (H3, mainly fibrous)
Carling (1986) <sup>16</sup>	6.52	0	10	-
Kirk (2001) <sup>17</sup>	2.7 – 8.2	26.1 – 30.4		Ombrotrophic blanket peat
Warburton et al (2003) <sup>18</sup>	5.0	23	9.68	Basal Peat
Warburton et al (2003)	8.74	21.6	9.68	Fibrous Peat

<sup>14</sup> Hanrahan et al (1967) - Hanrahan, E.T., Dunne, J.M., and Sodha, V.G. 1967. Shear strength of peat. Proceedings Geotechnical Conference, Oslo, Vol. 1, pp. 193–198.

<sup>15</sup> Hollingshead and Raymond (1972) - Hollingshead, G.W., and Raymond, G.P. 1972. Field loading tests on Muskeg, Canadian Geotechnical Journal, 9(3): 278–289.

<sup>16</sup> Carling (1986) - Peat slides in Teesdale and Weardale, northern pennines, july 1983: Description and failure mechanisms

<sup>17</sup> Kirk (2001) - Initiation of a multiple peat slide on Cuilcagh Mountain, Northern Ireland

<sup>18</sup> Warburton et al (2003) - Anatomy of a Pennine peat slide, Northern England

Dykes and Kirk (2006)	3.2	30.4	9.61	Acrotelm
Dykes and Kirk (2006)	4.0	28.8	9.71	Catotelm

$C'$  – effective cohesion (kPa), typically ranging from 2.5 to 8.5 therefore 5.0 has been adopted for the purposes of the assessment.

$\phi$  – effective angle of friction ( $^{\circ}$ ), typically ranging from 21.6 to 43.5 therefore 29.6 has been adopted for the purposes of the assessment.

$\gamma$  – unit weight (kN/m<sup>2</sup>), 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) indicate that a relatively high value of F=1.4 should be used to identify slopes with the potential for instability. Adopting this approach, high risk areas are indicated where F is <1.0, medium risk areas are indicated as 1.01 to 1.50 and >1.5 are low risk.

Using digital terrain modelling and GPS co-ordinates of each peat probe, a factor of Safety, F has been calculated for each probe locations which has been interpolated through ArcGIS Spatial Analyst tools. The Factor of Safety Assessment provides a sense check of the ranking based system, providing an absolute approach to the 'Factor of Safety Plan' is shown on **Figure 8**.

The results of the Factor of Safety calculations indicated all points on the Site as low risk. This was primarily due to the light undulating topography and generally flat-lying conditions on the Site.

## 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 existing and/or proposed infrastructure, watercourses and associated tributaries and sensitive habitats.

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.

## 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 7: Coefficients for Receptor Type**

Receptor	Receptor Coefficients
Road, path or track	3
Minor water feature	6
Site infrastructure	6
Dwelling	8
Major water feature	8
Blanket bog	8

**Table 8: 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 9: 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:

$$\text{Exposure Rating Coefficient} = \text{Receptor} \times \text{Distance} \times \text{Elevation}$$

From the Exposure Rating Coefficient, the risk to stability can be ranked as set out in **Table 10**.

**Table 10: Exposure Rating**

Exposure Rating Co-efficient	Potential Stability Risk (Pre-Mitigation)
<6	Very Low
6 to12	Low
13 to 24	High
24 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, the Hazard and Exposure Rating Coefficient derived from the coefficient tables are normalised as shown in **Table 11**.

**Table 11: 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 Rank Assessment is included in **Appendix C** of this PLHRA.

## 6 HAZARD RANKING

Having identified the rating coefficients in **Section 5** of this PLHRA, 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 **Tables 12** and **13** below:

**Table 12: 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 13: 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	
	<b>Exposure Rating</b>					

Receptor exposure was assessed for each of the five hazard zones using the approach in **Section 5**. A summary of the Hazard Ranking result for each identified area is summarised in **Table 14** and is presented in **Figure 9** - Hazard Ranking 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

### 7.1 General

The PLHRA has shown the Site to be of 'negligible' and 'low' hazard ranking with no areas of 'medium' or 'high' hazard ranking.

Of the 483 probe points, all were 'negligible' other than nine where 'low' hazard rankings were recorded. No 'medium' or 'high' risk areas have been identified within the Proposed Development or Associated Development and therefore a significant risk of peat slide is not considered to present based on the Hazard Ranking assessment. Nonetheless, a risk from peat slide may still exist and mitigation measures as outlined in **Section 7.3** of this PLHRA 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. It should be acknowledged that the hazard zonation plan is based on the pre-mitigation status.

While specific recommended mitigation in 'low' ranked areas are proposed, other mitigation is embedded in the design. It is also necessary for detailed design and construction of the Proposed Development and Associated Development to be undertaken in a competent and controlled manner.

The embedded mitigation and good practice measures are set out in **Section 7.2** of this PLHRA. 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 during construction of the Proposed Development and Associated Development.

**Table 14: Hazard Ranking**

Hazard Area and Infrastructure		Unmitigated Hazard		Mitigated Hazard	
Hazard Area	Infrastructure Affected	Ranking	Key Aspects	Specific Actions	Ranking
H1	Proposed Substation	Low	<p>Location and topography: Zone covering northern quarter of the proposed substation in the western Site area.</p> <p>Hydrology: No watercourses run through this hazard zone</p> <p>Peat Depth: 0.1 m - 2.5 m. Generally, &lt;1.0 m</p> <p>Slope Gradient: 0° to &lt;10°</p> <p>Exposure: Proposed infrastructure</p>	<p>Best practice measures in relation to drainage prior to and during construction will be implemented as outlined in <b>Annex P: Water Construction Environmental Management Plan (WCEMP)</b> and management of peat and peaty soils as outlined in <b>Annex N: Peat Management Plan (PMP)</b>.</p> <p>During construction visual inspections and monitoring in</p>	Negligible

Hazard Area and Infrastructure		Unmitigated Hazard		Mitigated Hazard	
				areas with the potential for peat slide risk should take place.	
<b>H2</b>	Proposed Substation	Negligible	<p>Location and topography: South western Site area covering remaining three quarters of the Proposed Substation area.</p> <p>Hydrology: No watercourses run through this hazard zone</p> <p>Peat Depth: 0.0 m – 3.1 m. Generally, &lt;2.00 m</p> <p>Slope Gradient: 0° to &lt;30°</p> <p>Exposure: Proposed infrastructure</p>	Best practice measures in relation to drainage prior to and during construction will be implemented as outlined in <b>Annex N: WCEMP</b> and management of peat and peaty soils as outlined in <b>Annex O: PMP</b> .	Negligible
<b>H3</b>	Proposed Temporary Access Track, Pylon 2	Low	<p>Location and topography: Flat area covering the southern sector of the Site</p> <p>Hydrology: No watercourses run through this hazard zone</p> <p>Peat Depth: 1.80 m – 3.50 m. Generally, &lt;3.00 m</p> <p>Slope Gradient: 0° to &lt;5°</p> <p>Exposure: Proposed infrastructure</p>	Best practice measures in relation to drainage prior to and during construction will be implemented as outlined in <b>Annex O: WCEMP</b> and management of peat and peaty soils as outlined in <b>Annex N: PMP</b> .  During construction visual inspections and monitoring in areas with the potential for peat slide risk should take place.	Negligible
<b>H4</b>	Proposed Temporary Access Track, Pylon 1	Negligible	Location and topography: Area covering the south	Best practice measures in relation to drainage prior to	Negligible



Hazard Area and Infrastructure		Unmitigated Hazard		Mitigated Hazard	
			eastern sector of the Site  Hydrology: No watercourses run through this hazard zone  Peat Depth: 0.1 m – 2.3 m. Generally, <1.00 m  Slope Gradient: 0° to <10°  Exposure: Proposed tracks	and during construction will be implemented as outlined in <b>Annex O: WCEMP</b> and management of peat and peaty soils as outlined in <b>Annex N: PMP</b> .	
<b>H5</b>	Proposed Temporary Works Area and Temporary Track	Negligible	Location and topography: Large area covering the north eastern sector of the Site  Hydrology: No watercourses run through this hazard zone  Peat Depth: 0.1 m – 4.5 m. Generally, <1.50 m  Slope Gradient: 0° to <15°  Exposure: Proposed infrastructure	Best practice measures in relation to drainage prior to and during construction will be implemented as outlined in <b>Annex O: WCEMP</b> and management of peat and peaty soils as outlined in <b>Annex N: PMP</b> .	Negligible

## 7.2 Embedded Mitigation

Embedded mitigation includes measures taken during design of the Proposed Development and Associated Development to reduce the potential for peat slide risk. In summary the principal measures that have been taken are:

- Locating infrastructure on shallower slopes, where possible; and
- Locating infrastructure on areas of shallow peat (or no peat) where possible.

## 7.3 Peat Slide Mitigation Recommendations

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

- Ground investigations prior to detailed design;

- Identification of areas sensitive to changes in drainage regime prior to detailed design;
- Update the PLHRA as necessary following detailed ground investigations;
- Development of a drainage strategy that will not create areas of concentrated flow and will not affect the current peatland hydrology;
- Design of a Development 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;
- Identification of suitable areas for stockpiling material during construction prior to commencement of works; and
- Consideration of specific construction methods appropriate for infrastructure in peat land (i.e. geogrids) as part of design Development.

## 8 CONCLUSIONS

This PLHRA has been undertaken for the Proposed Development and Associated Development in accordance with best practice, as detailed in **Section 4.2** of the PLHRA. The early stages of the assessment included a desk study, historic peat probing across the Site, followed by completion of Phase 1 peat probing and a further intensive probing exercise on the finalised Site layout design. The information gathered during this investigation was used to develop a Hazard Ranking across the Site.

The findings of the probing indicate that the majority of the Proposed Development and Associated Development are underlain by peat less than 1.25 m in thickness with the exception of P2 which lies in an area where peat was recorded up to 3.5 m. While pockets of deep peat were recorded during the peat probing, deeper across the wider site area, the Proposed Development and Associated Development were designed to largely avoid these areas.

Based on the scope of the study, the PLHRA has indicated that the majority of the Site is generally of 'negligible' hazard ranking with two areas highlighted as 'low' hazard ranking.

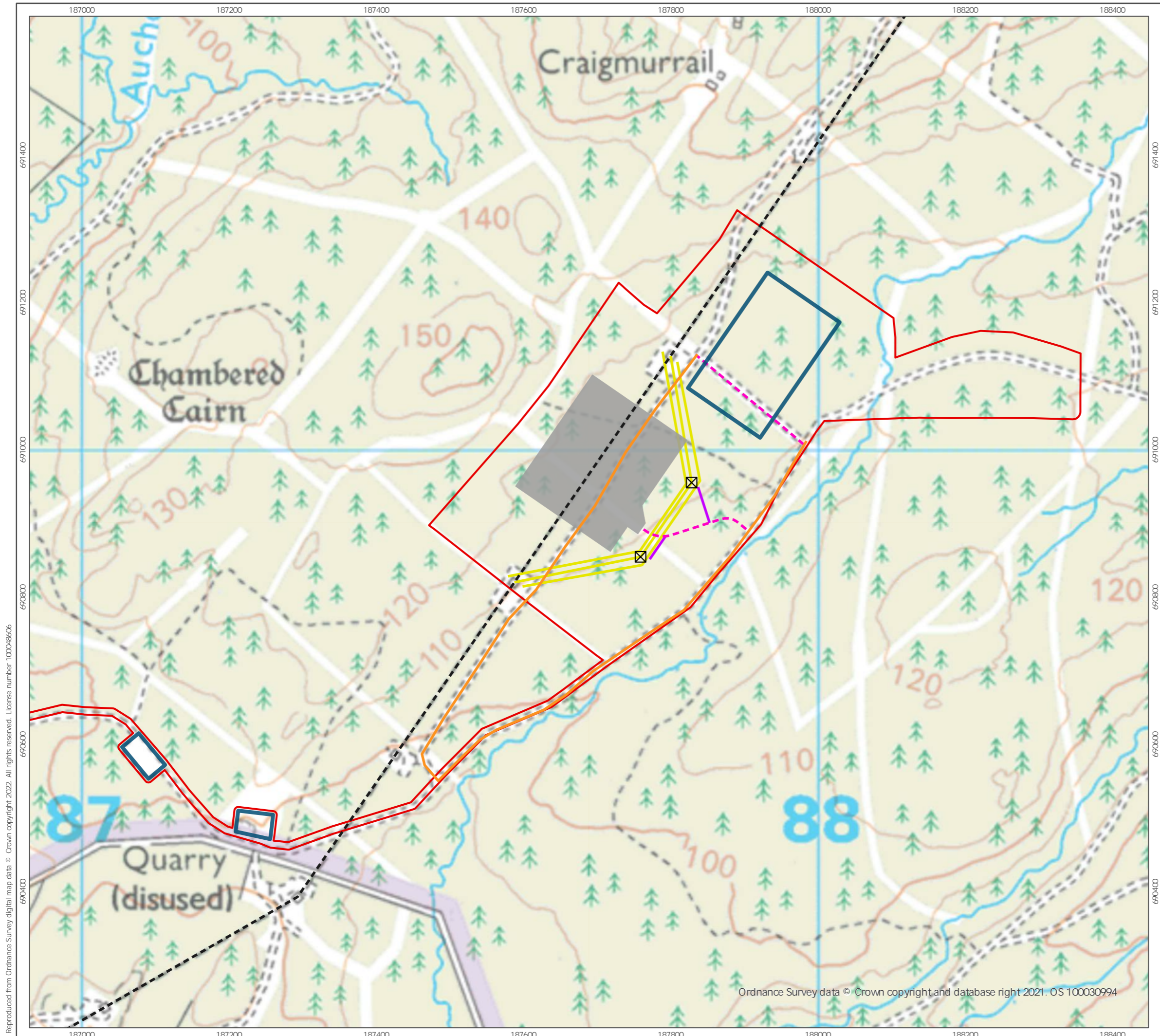
Notwithstanding the findings of the PLHRA, the final design of infrastructure should be carefully sited and micro-siting adopted if required in order to maintain the design objective of avoiding any potential peat slide risk.

## 9 SOURCES OF INFORMATION

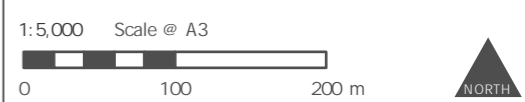
The following sources of information were used as part of the desk study investigations:

- British Geological Survey - Online GeoIndex;
- Ordnance Survey (OS) topographical information;
- Aerial and Satellite photography.
- Soil Survey of Scotland - MacAulay Institute for Soil Research (1984);
- Soil Survey of Scotland - Scottish Peat Surveys (1964);
- Scottish Government - Peat Landslide Hazard and Risk Assessments (2017);
- Scottish Government, Scottish Natural Heritage, SEPA (2017) Peatland Survey, Guidance on Developments on Peatland;
- The Scottish Government - Scotland's Third National Planning Framework (2014);
- The Scottish Government - Scottish Planning Policy (2014);
- Assessments by other technical specialists (specifically hydrology and ecology for data on sensitive receptors); and
- Scotland's Environment Interactive Map.

## **APPENDIX A - FIGURES**



- Existing Access Tracks
- Existing Inveraray to Crossaig Overhead Line
- Proposed Development
- Indicative Town and Country Planning Boundary
- Proposed Substation Temporary Works Area
- Proposed Substation Layout
- Proposed Permanent Access Tracks
- Associated Development
- Proposed Indicative Tower Location
- New Temporary Tracks
- Overhead Line



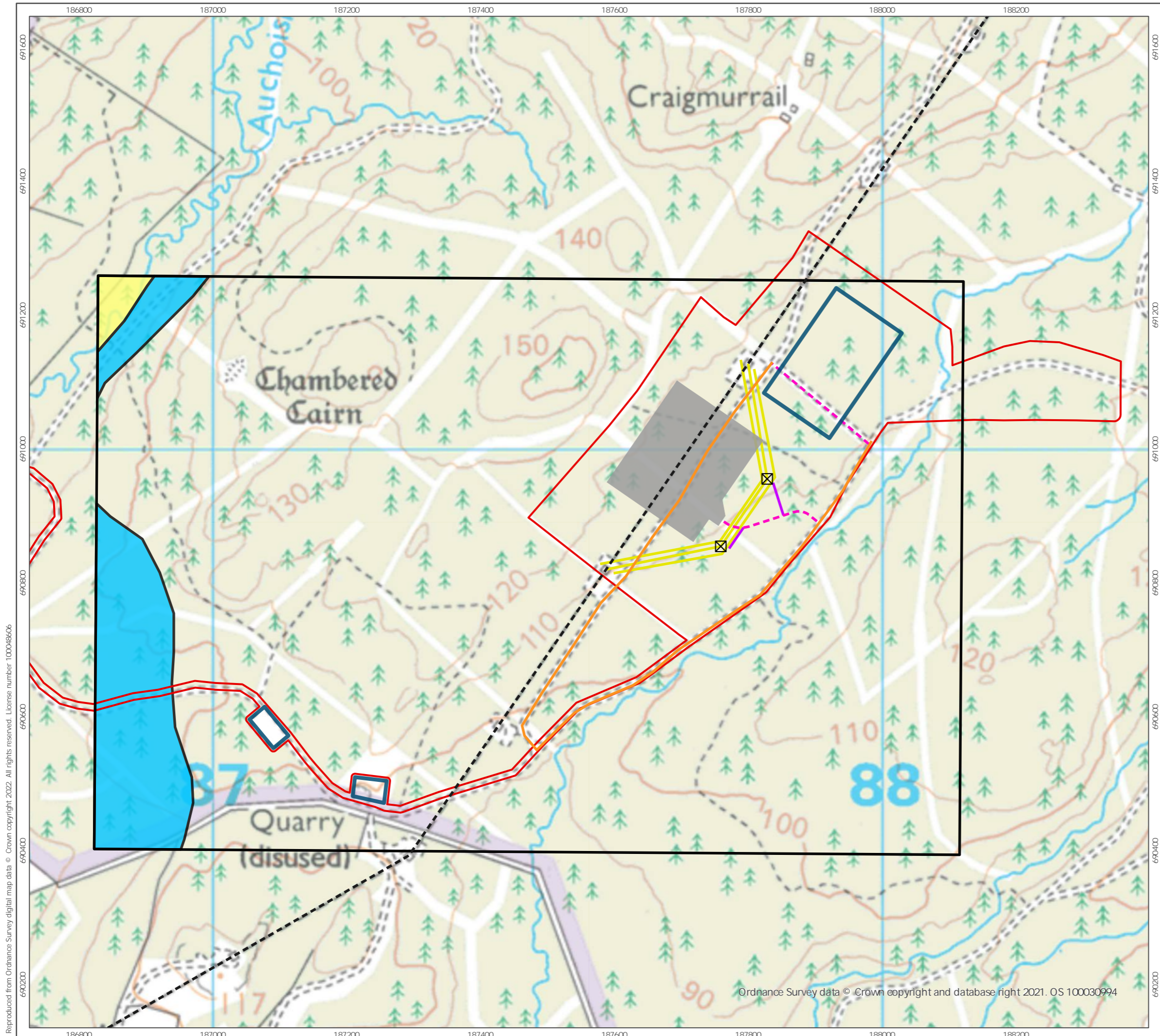
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Site Layout Plan  
Figure 1

Craig Murrail  
Annex N:  
Peat Slide Risk Assessment

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- Proposed Indicative Tower Location
- New Temporary Tracks
- Overhead Line
- Superficial Soils
- Alluvium
- Till, Devensian
- Superficial Soils Not Mapped



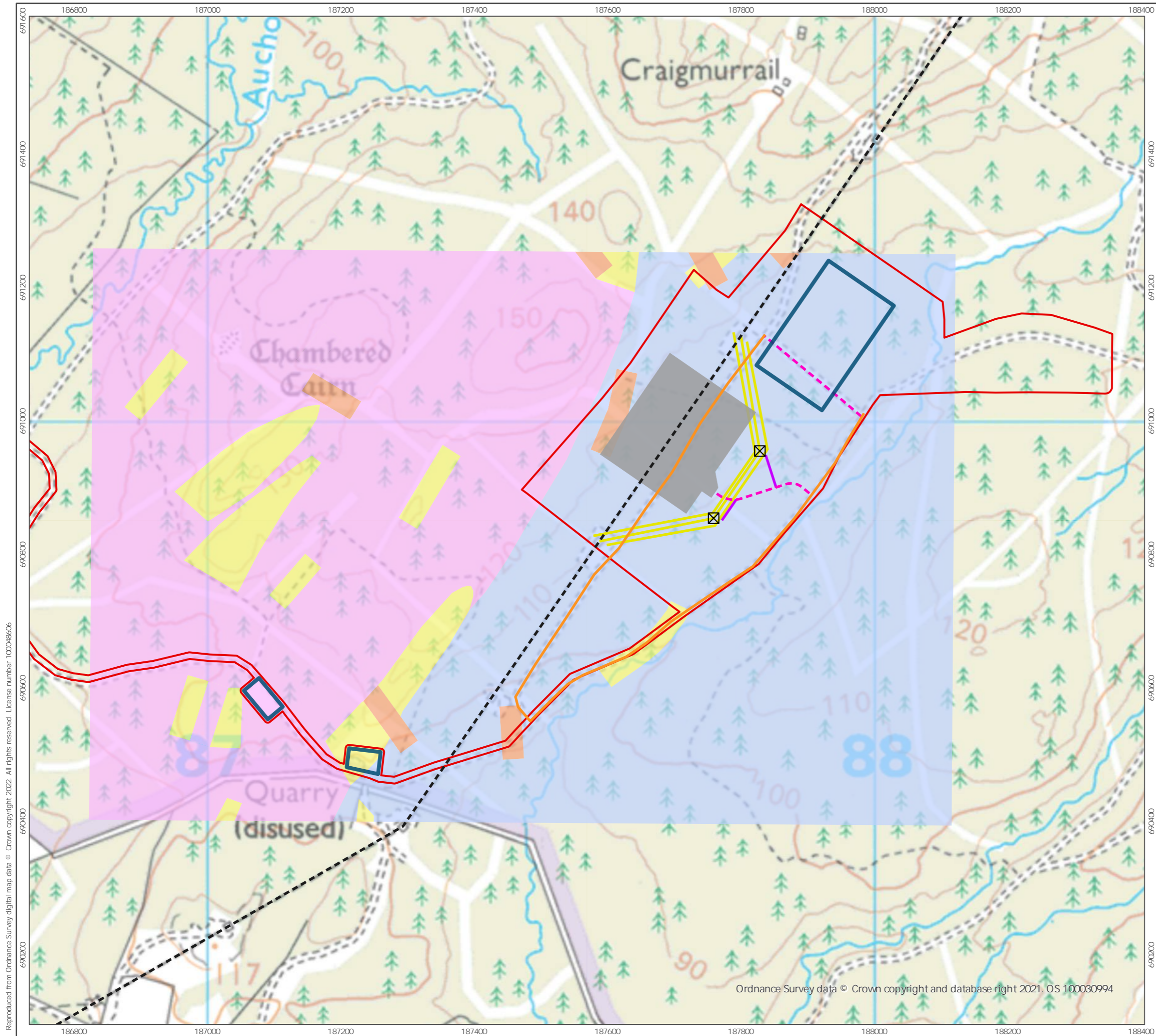
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Superficial Soils  
Figure 2

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- Proposed Permanent Access Tracks
- Associated Development**
- Proposed Indicative Tower Location
- New Temporary Tracks
- Overhead Line
- Solid Geology**
- Ardrishaig Phyllite Formation
- Crinan Grit Formation
- Dalradian Supergroup
- Mull Dyke-Swarm



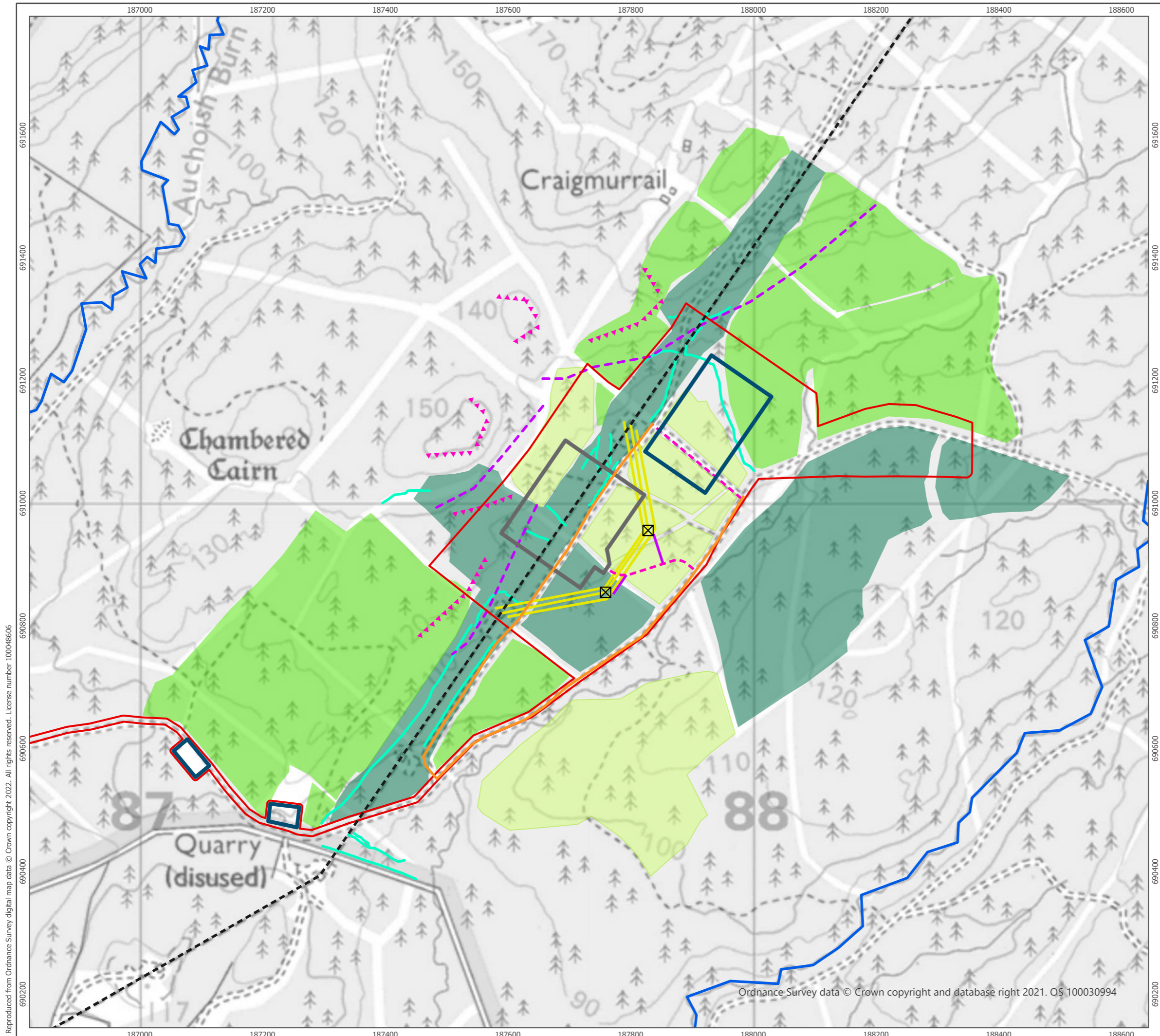
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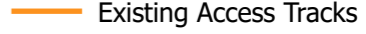
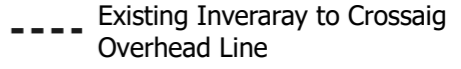
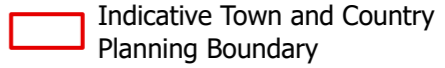
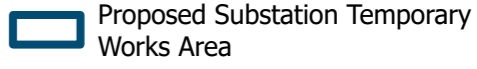
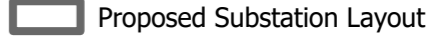
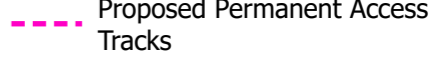
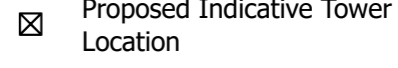


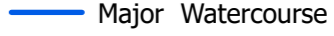
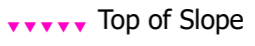


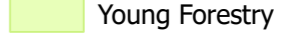
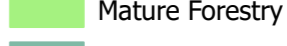

Solid Geology  
Figure 3



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-  Existing Access Tracks
-  Existing Inveraray to Crossaig Overhead Line
- Proposed Development**
-  Indicative Town and Country Planning Boundary
-  Proposed Substation Temporary Works Area
-  Proposed Substation Layout
-  Proposed Permanent Access Tracks
- Associated Development**
-  Proposed Indicative Tower Location
-  New Temporary Tracks
-  Overhead Line
- Geomorphology**
-  Major Watercourse
-  Top of Slope
-  Bottom of Slope
-  Artificial Drainage
-  Young Forestry
-  Mature Forestry
-  Deforested Area

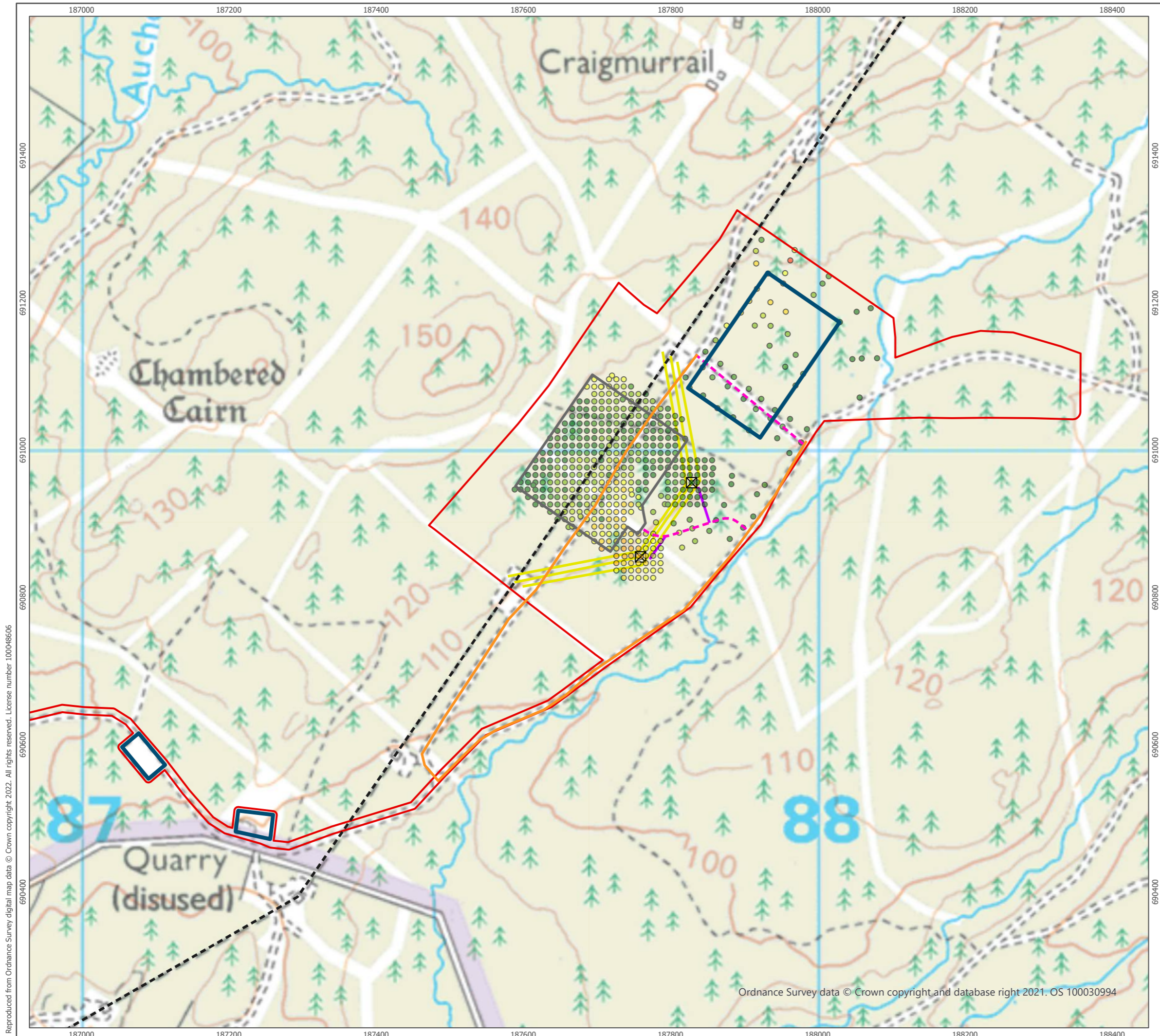
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 0 125 250 m 



















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**Geomorphology Map**  
Figure 4

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-  Proposed Substation Layout
-  Proposed Permanent Access Tracks
- Associated Development**
-  Proposed Indicative Tower Location
-  New Temporary Tracks
-  Overhead Line
- Recorded Peat Depths (m)**
-  0.01 - 0.50
-  0.51 - 1.00
-  1.01 - 1.50
-  1.51 - 2.00
-  2.01 - 2.50
-  2.51 - 3.00
-  3.01 - 3.50
-  3.51 - 4.00
-  4.01 - 4.50

1:5,000 Scale @ A3  



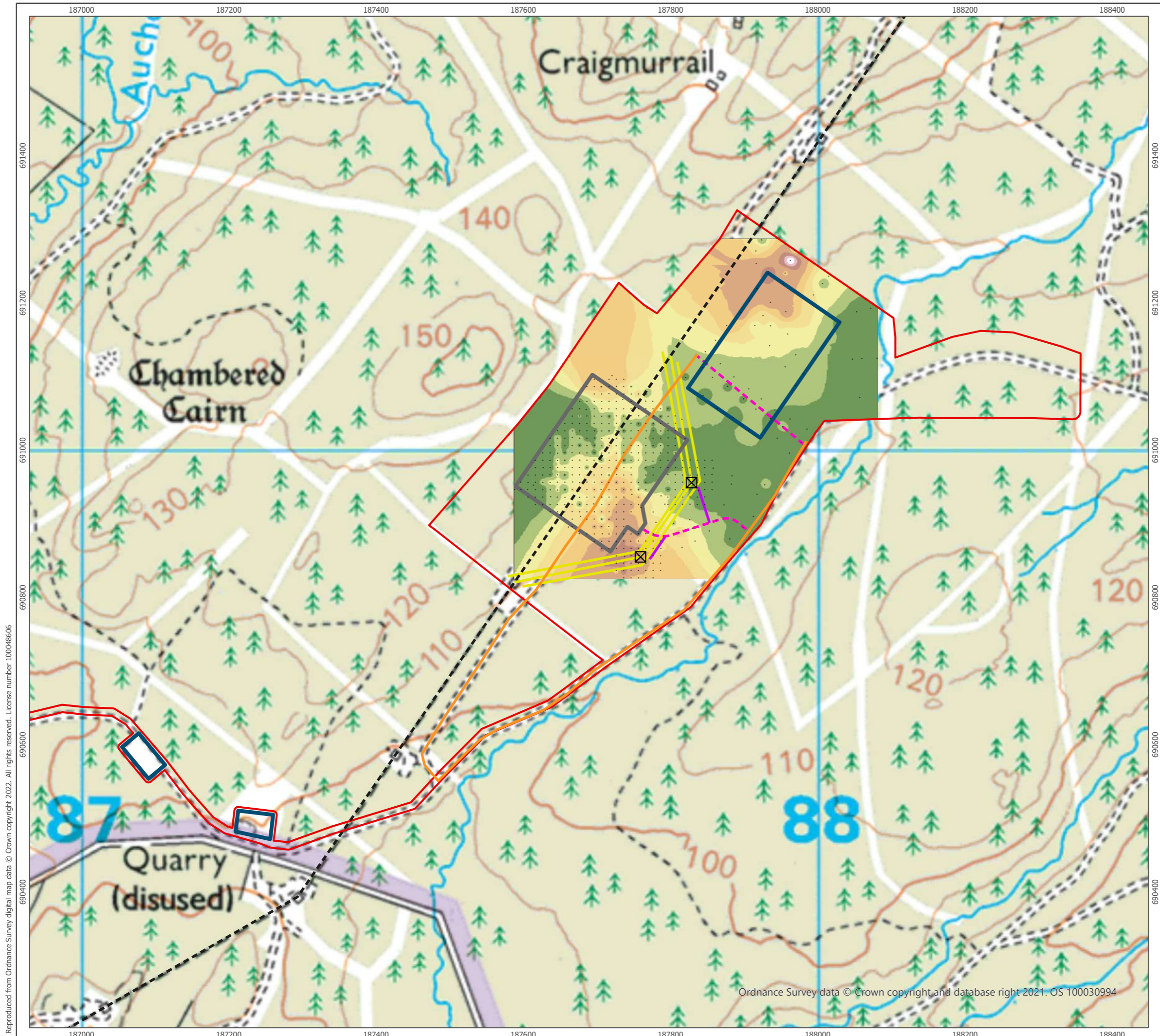
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






**Recorded Peat Depths**  
Figure 5



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-  Peat Probe Location
-  Existing Access Tracks
-  Existing Inveraray to Crossaig Overhead Line
- Proposed Development**
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-  Proposed Substation Layout
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- Associated Development**
-  Proposed Indicative Tower Location
-  New Temporary Tracks
-  Overhead Line
- Interpolated Peat Depths (m)**
-  0.00 - 0.50
-  0.51 - 1.00
-  1.01 - 1.50
-  1.51 - 2.00
-  2.01 - 2.50
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1:5,000 Scale @ A3  



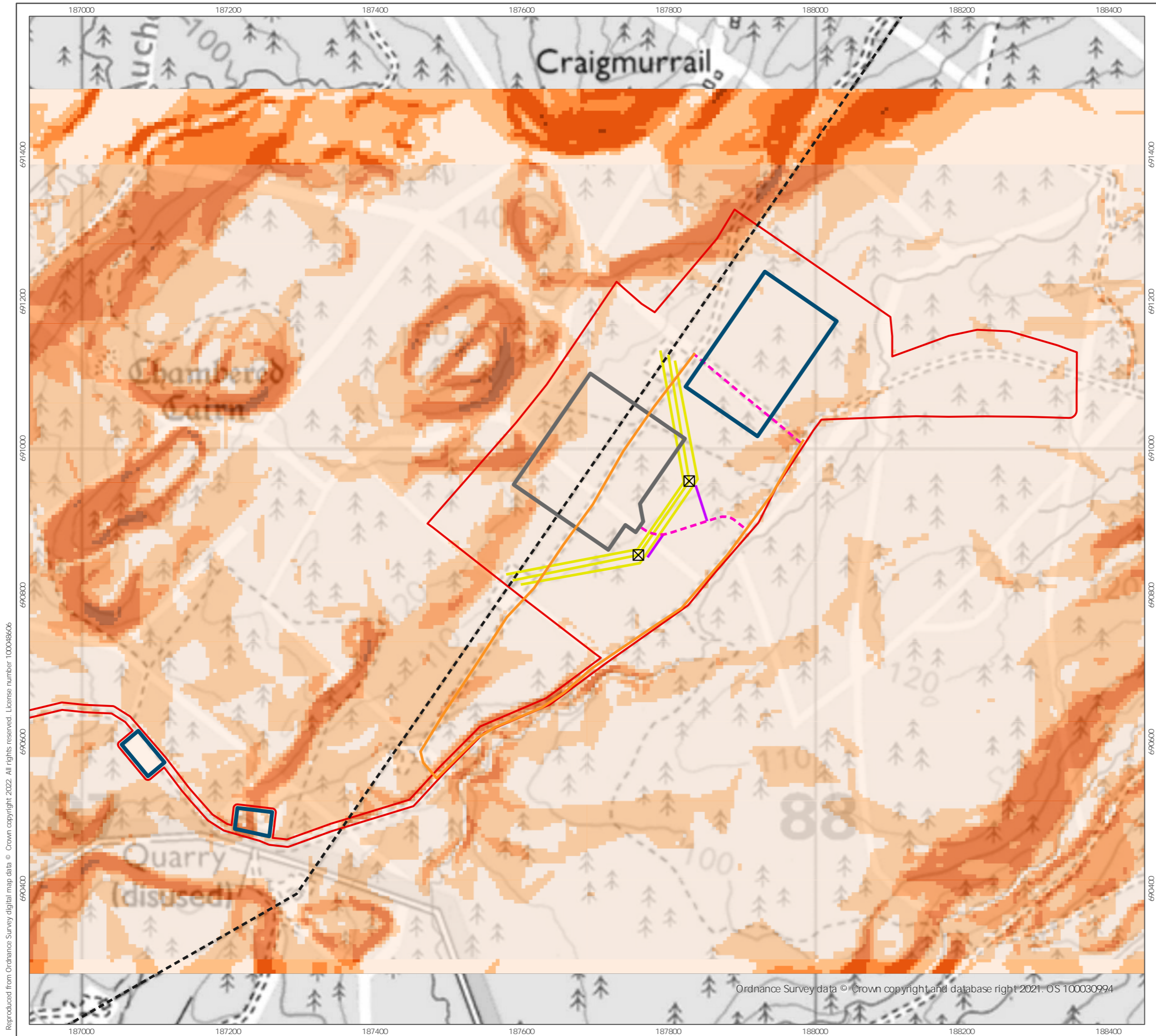
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**Interpolated Peat Depths**  
 Figure 6

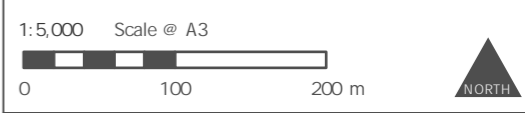
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- Existing Access Tracks
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- Proposed Substation Temporary Works Area
- Proposed Substation Layout
- Proposed Permanent Access Tracks
- Associated Development**
- Proposed Indicative Tower Location
- New Temporary Tracks
- Overhead Line
- Slope Gradient (deg)**
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 30
- 30 - 90



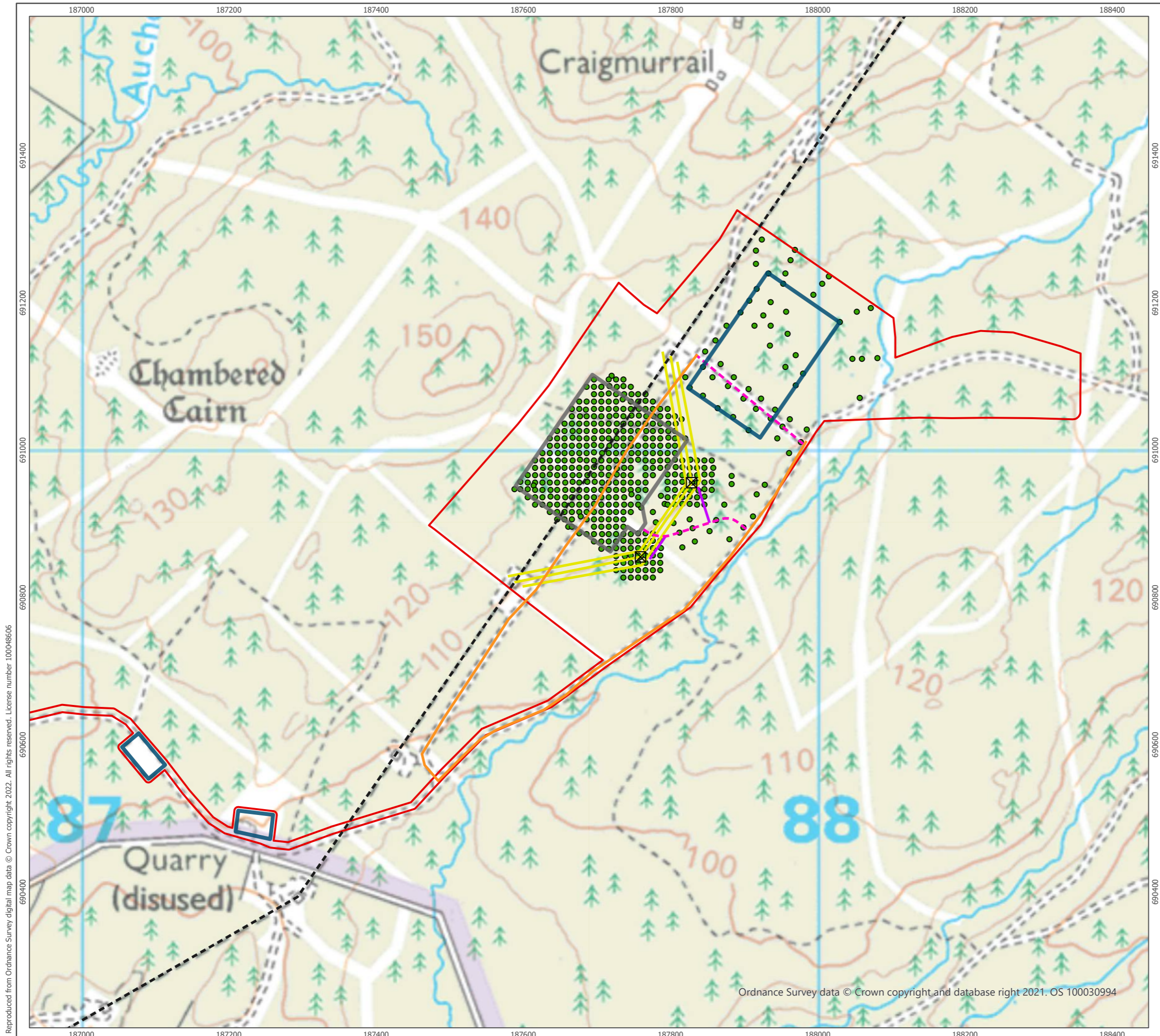
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Slope Map  
Figure 7

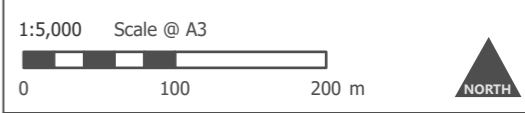
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-  Proposed Substation Layout
-  Proposed Permanent Access Tracks
- Associated Development**
-  Proposed Indicative Tower Location
-  New Temporary Tracks
-  Overhead Line
- Factor of Safety**
-  Low Risk



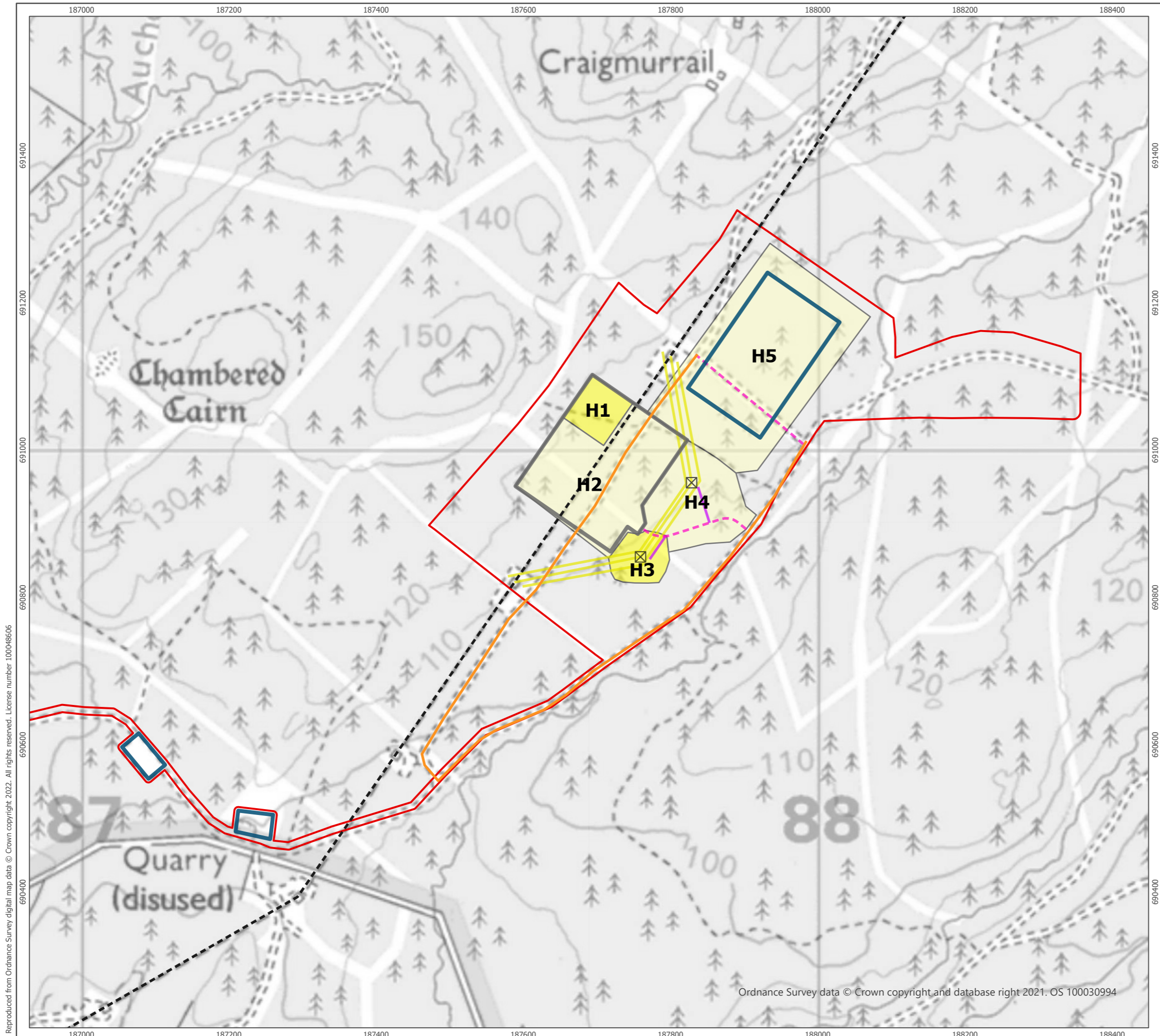
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**Factor of Safety Plan**  
Figure 8

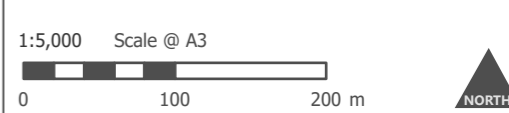
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**Annex N:**  
**Peat Slide Risk Assessment**

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- Existing Access Tracks
- Existing Inveraray to Crossaig Overhead Line
- Proposed Development**
- Indicative Town and Country Planning Boundary
- Proposed Substation Temporary Works Area
- Proposed Substation Layout
- Proposed Permanent Access Tracks
- Associated Development**
- Proposed Indicative Tower Location
- New Temporary Tracks
- Overhead Line
- Hazard Rank Zonation**
- Negligible
- Low



Produced By: BM	Ref: 4534-REP-026
Checked By: DB	Date: 13/07/2022

**Hazard Rank Zonation Plan**  
Figure 9

**Craig Murrail**  
**Annex N:**  
**Peat Slide Risk Assessment**

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## APPENDIX B - SITE PHOTOGRAPHS

*Photograph 1 – View west across proposed substation area*



*Photograph 2 – View east across proposed substation area*



***Photograph 3 – View south from northern site area***



***Photograph 4 – View north across proposed substation area***





***Photograph 5 – Culvert over drainage ditch in central Site area***



***Photograph 6 – Forestry plantation within southern site area***



## **APPENDIX C – HAZARD RANK ASSESSMENT RECORDS**

4534 - Argyll Substations - PSRA - Tabulated Peat Profile Data - May 2022



ID	X	Y	Z	SLOPE	Slope Co-efficient	PEAT DEPTH	Peat Level	Peat Co-efficient	Gen Substrate	Substrate Co-eff.	Risk Rating Coefficient	Risk Rating Normalisation	Receptor	Receptor Co-eff.	Z Receptor	Distance	Receptor Dist Co-eff.	Z Difference (remove +/-)	Receptor elevation Co-eff	Impact Rating	Impact Rating Normalisation	Hazard Ranking
1	187970	691088	116.05332	1.65295	1	0.9	115.155332	2	R	1.5	2	1	Site Infrastructure	3	116.032812	0.993964	0.02252	1	12	2	2	
2	187980	691104	116.447397	1.80651	1	0.6	115.847397	2	G	1.5	2	1	Site Infrastructure	3	116.426007	1.009153	0.04139	1	12	2	2	
3	187970	691126	116.05242	1.49222	1	0.8	115.750242	2	G	1.5	2	1	Site Infrastructure	3	116.032812	0.849292	0.03633	1	12	2	2	
4	187956	691113	116.07361	1.00016	1	1	115.173612	2	R	1.5	3	1	Site Infrastructure	3	116.066156	0.516274	0.007305	1	12	2	2	
5	187935	691142	116.616635	1.04083	1	0.9	115.616635	2	R	1.5	3	1	Site Infrastructure	3	116.591757	1.371711	0.024878	1	12	2	2	
6	187959	691138	116.50506	1.04508	1.2	1.2	115.305063	2	G	1.5	3	1	Site Infrastructure	3	116.561176	0.951308	-0.01057	1	12	2	2	
7	187957	691188	116.623072	1.62071	1	2.9	113.723073	2	G	1	3	1	Site Infrastructure	3	116.644858	1.199784	-0.021786	1	12	2	2	
8	187953	691226	117.782318	1.88501	1	3	114.782318	2	G	1	3	1	Site Infrastructure	3	117.720254	1.542554	0.002604	1	12	2	2	
9	187931	691240	117.842821	1.59747	1	2.3	114.642821	2	G	1	3	1	Site Infrastructure	3	117.829304	1.439868	0.003307	1	12	2	2	
10	187917	691219	116.515069	4.219604	1	3	113.961069	2	G	1.5	3	1	Site Infrastructure	3	116.527903	0.424823	0.004806	1	12	2	6	
11	187936	691201	116.808317	2.736889	2	3.9	113.908317	2	G	1	3	1	Site Infrastructure	3	116.808386	1.196802	0.004331	1	12	2	2	
12	187936	691169	116.624055	0.79471	1	1.2	115.424055	2	G	1	3	1	Site Infrastructure	3	116.629154	0.423605	-0.002099	1	12	2	2	
13	187914	691169	116.832825	0.718991	1	1.1	115.782825	2	G	1	3	1	Site Infrastructure	3	116.830807	1.056098	-0.012482	1	12	2	2	
14	187895	691187	116.962102	2.01871	1	3	113.962103	2	G	1	3	1	Site Infrastructure	3	116.962762	0.019674	-0.00006	1	12	2	2	
15	187926	691183	116.720984	0.725496	1	1.7	115.019843	2	G	1	3	1	Site Infrastructure	3	116.712156	0.184776	-0.002172	1	12	2	2	
16	187907	691203	116.54264	1.709911	1	2.8	113.542643	2	R	1.5	3	1	Site Infrastructure	3	116.520885	0.512662	0.003255	1	12	2	2	
17	187876	691169	117.588928	1.390114	1	2.4	115.158928	2	G	1.5	4.5	1	Site Infrastructure	3	117.453112	5.765254	0.105816	1	12	2	2	
18	187861	691149	117.226094	1.597011	1	1.4	115.820943	2	G	1	3	1	Site Infrastructure	3	117.092008	6.766164	0.133186	1	12	2	2	
19	187847	691234	116.983729	1.52451	1	1	115.981729	2	R	1.5	3	1	Site Infrastructure	3	116.964909	0.202227	0.116879	1	12	2	2	
20	187868	691117	116.548835	0.597362	1	0.8	115.748835	2	G	1	3	1	Site Infrastructure	3	116.543102	0.532179	0.005733	1	12	2	2	
21	187886	691099	116.433047	0.82157	1	0.8	115.833047	2	G	1	2	1	Site Infrastructure	3	116.423398	0.87402	0.009649	1	12	2	2	
22	187906	691083	116.030004	1.478631	1	1	115.030004	2	G	1	2	1	Site Infrastructure	3	116.018455	0.986099	0.011549	1	12	2	2	
23	187923	691079	115.88402	1.48325	1	0.9	114.784022	2	G	1	2	1	Site Infrastructure	3	115.664451	0.792765	0.019969	1	12	2	2	
24	187942	691055	115.302719	1.466115	1	0.5	114.802719	2	G	1	1	1	Site Infrastructure	3	115.310451	0.377192	-0.007732	1	12	2	2	
25	187936	691043	115.038197	1.432096	1	0.2	114.818197	2	G	1	1	1	Site Infrastructure	3	115.027903	0.467311	0.010394	1	12	2	2	
26	187916	691056	115.320216	1.44498	1	0.9	114.430216	2	G	1	1	1	Site Infrastructure	3	115.320676	1.009108	0.014225	1	12	2	2	
27	187899	691070	115.701394	1.469244	1	0.4	115.301394	2	G	1	1	1	Site Infrastructure	3	115.68003	0.863737	0.012164	1	12	2	2	
28	187878	691087	116.172267	1.162026	1	0.4	115.772267	2	G	1	1	1	Site Infrastructure	3	116.176428	0.240211	-0.004161	1	12	2	2	
29	187857	691099	116.327617	0.619531	1	0.6	115.732617	2	G	1	1	1	Site Infrastructure	3	116.327316	0.510272	-0.000389	1	12	2	2	
30	187844	691113	116.469305	1.351186	1	0.9	115.569305	2	G	1	2	1	Site Infrastructure	3	116.434995	1.700536	0.03461	1	12	2	2	
31	187820	691099	116.414188	2.28427	1	0.4	116.014188	2	G	1	2	1	Site Infrastructure	3	116.209278	11.698813	0.20491	1	9	1	1	
32	187826	691085	116.55973	1.120991	1	1	115.059732	2	G	1	2	1	Site Infrastructure	3	116.560531	0.314413	-0.000801	1	12	2	2	
33	187844	691074	115.872908	1.106644	1	1	115.072908	2	G	1	2	1	Site Infrastructure	3	115.886021	0.989493	-0.011493	1	12	2	2	
34	187864	691057	115.541993	1.210343	1	0.9	114.641993	2	G	1	2	1	Site Infrastructure	3	115.541626	1.166667	0.003067	1	12	2	2	
35	187885	691045	115.142676	1.495922	1	0.1	115.042676	2	G	1	1	1	Site Infrastructure	3	115.151508	0.45148	-0.002005	1	12	2	2	
36	187906	691027	114.73979	1.48228	1	0.9	113.619794	2	G	1	1	1	Site Infrastructure	3	114.620023	0.202227	-0.002913	1	12	2	2	
37	187786	691056	115.128393	2.654789	2	1.2	113.928393	2	G	1	6	1	Site Infrastructure	3	114.620762	15.119793	0.507631	1	9	1	1	
38	187796	691036	115.09607	1.904101	1	0.3	114.796071	2	G	1	1	1	Site Infrastructure	3	114.514533	20.582973	0.581354	1	9	1	1	
39	187806	691036	114.82424	1.74331	1	0.7	114.310604	2	G	1	1	1	Site Infrastructure	3	114.824242	17.950245	0.146038	1	9	1	1	
40	187815	691042	114.735159	1.745988	1	1	114.035159	2	G	1	2	1	Site Infrastructure	3	114.2236	19.271583	0.515559	1	9	1	1	
41	187807	691036	114.24532	1.738561	1	0.9	113.624532	2	G	1	2	1	Site Infrastructure	3	114.2236	10.130795	0.300932	1	9	1	1	
42	187797	691036	114.48206	1.71741	1	0.8	113.682062	2	G	1	2	1	Site Infrastructure	3	114.482062	4.784343	0.109559	1	9	1	1	
43	187797	691046	114.784766	1.749351	1	1	114.084766	2	G	1	1	1	Site Infrastructure	3	114.415601	12.407223	0.369165	1	9	1	1	
44	187797	691026	114.185756	1.745118	1	0.1	114.085756	2	G	1	1	1	Site Infrastructure	3	114.196602	0.947946	-0.013846	1	12	2	2	
45	187797	691017	113.838216	1.781141	1	0.3	113.828161	2	G	1	1	1	Site Infrastructure	3	113.889605	0.716333	-0.006789	1	12	2	2	
46	187787	691026	114.133975	1.749661	1	0.7	113.433975	2	G	1	1	1	Site Infrastructure	3	114.159902	1.109699	-0.012627	1	12	2	2	
47	187776	691026	114.088113	1.747784	1	0.8	113.788113	2	G	1	1	1	Site Infrastructure	3	114.111602	1.127004	-0.013489	1	12	2	2	
48	187767	691026	114.088903	1.870571	1	0.3	113.258903	2	G	1	1	1	Site Infrastructure	3	114.07796	0.727202	-0.020297	1	12	2	2	
49	187776	691026	114.088113	1.912611	1	0.4	113.988113	2	G	1	1	1	Site Infrastructure	3	114.111602	1.127004	-0.013488	1	12	2	2	
50	187786	691036	114.488115	1.77609	1	1.1	113.388115	2	G	1	1	1	Site Infrastructure	3	114.415603	1.127004	-0.013488	1	12	2	2	
51	187786	691046	114.711173	1.809297	1	0.3	114.441173	2	G	1	1	1	Site Infrastructure	3	114.562123	7.132154	0.173992	1	12	2	2	
52	187806	691036	114.238114	1.74779	1	0.1	114.238114	2	G	1	1	1	Site Infrastructure	3	114.171601	1.127004	-0.014613	1	12	2	2	
53	187777	691046	114.790245	2.688094	2	0.9	113.890245	2	G	1	4	1	Site Infrastructure	3	114.753022	1.961999	0.050043	1	12	2	2	
54	187766	691036	114.454453	2.74921	2	0.7	113.754453	2	G	1	4	1	Site Infrastructure	3	114.488862	1.127004	-0.044409	1	12	2	2	
55	187756	69																				



326	187836	690976	112.410481	3.890007	2	0.2	112.210481	1	R	1.5	4	1	11215954	18.112965	3	1.194527	1	9	1	1
327	187827	690987	112.393254	2.450175	2	0.2	112.393254	1	C	2	4	1	11232979	19.17489	3	-0.239725	1	9	1	1
328	187826	690976	112.359926	3.883682	1	0.2	112.359926	1	G	1	2	1	11119154	17.25889	3	1.107972	1	9	1	1
329	187826	690966	111.400478	3.890271	1	0.3	111.400478	1	R	1.5	2	1	11119154	17.25889	3	1.107972	1	9	1	1
330	187829	690956	110.003759	3.878266	1	0.4	110.003759	1	G	1	2	1	11107194	1.25494	4	-0.068195	1	12	2	1
331	187826	690946	110.362628	3.637307	1	0.5	109.852628	1	R	1	2	1	11078953	6.648328	4	-0.431325	1	12	2	1
332	187826	690977	109.794112	2.914746	1	0.4	109.386112	1	R	1	2	1	10980797	12.22086	3	-0.125663	1	12	2	1
333	187816	690936	109.339469	2.765454	2	0.6	109.339469	2	R	1.5	2	1	11078953	18.876662	3	-0.844444	1	1	2	1
334	187817	690946	110.366956	3.002512	1	0.5	109.886956	1	G	1	2	1	11078953	10.851163	3	-0.397358	1	9	1	1
335	187816	690957	111.020942	2.809121	1	0.8	110.220942	1	R	1	2	1	11105594	3.020904	3	-0.529942	1	12	2	1
336	187816	690966	111.660481	3.852542	1	0.6	111.050481	1	R	1	2	1	11119154	11.688587	3	0.468527	1	1	1	1
337	187816	690977	112.818131	3.886131	2	0.5	111.858131	1	G	1	2	1	113.02098	16.450566	3	-0.669149	1	9	1	1
338	187816	690986	112.843044	2.626262	1	0.3	112.643044	1	G	1	2	1	113.212979	11.049863	3	-0.289935	1	9	1	1
339	187806	690967	112.203605	2.464412	1	0.2	112.203605	1	R	1	2	1	112.02098	2.464219	3	-0.092175	1	12	2	1
340	187796	690986	112.887125	2.816657	2	0.3	112.887125	2	G	1	2	1	112.917578	1.127054	4	-0.080453	1	12	2	1
341	187796	690977	112.712183	3.856121	2	0.2	112.071218	1	G	1	2	1	112.285953	1.00278	4	-0.014123	1	12	2	1
342	187807	690977	112.32593	3.880952	1	0.2	112.11593	1	G	1	2	1	112.573954	8.45027	4	-0.52641	1	12	2	1
343	187806	690967	110.642235	3.745534	2	1	110.642235	2	G	1	4	1	112.149555	13.730605	3	-0.50772	1	9	1	1
344	187806	690956	110.000025	3.033675	2	0.9	110.110002	2	G	1	4	1	111.055954	19.038468	3	-0.045949	1	9	1	1
345	187796	690967	111.644212	3.077087	2	0.5	111.144212	1	R	1.5	2	1	111.625561	10.937216	3	-0.341649	1	9	1	1
346	187796	690957	111.393112	2.761156	2	1.1	110.093112	1	G	1	2	1	111.421897	16.533763	3	-0.684887	1	9	1	1
347	187796	690947	110.73753	2.762756	2	0.1	110.73753	2	G	1.5	2	1	110.73753	16.533763	3	-0.684887	1	9	1	1
348	187806	690946	110.539467	2.763454	2	0.8	109.739467	2	R	1.5	2	1	110.789593	20.134381	3	-0.224486	1	9	1	1
349	187676	690886	110.10378	2.783972	1	0.8	109.30378	1	R	1.5	2	1	110.789593	25.296743	3	-0.690375	1	9	1	1
350	187676	690887	110.66739	1.661121	1	2	108.66739	1	G	1	3	1	110.727263	4.536234	4	-0.058873	1	12	2	1
351	187686	690886	110.47942	1.671899	1	2.4	108.47942	1	G	1	3	1	110.480783	1.127053	4	-0.032841	1	12	2	1
352	187696	690886	110.10424	1.65481	2	2	108.24424	2	R	1.5	4.5	1	112.277295	1.127053	4	-0.032841	1	12	2	1
353	187696	690876	110.043836	1.672743	1	2.5	107.543836	1	G	1	3	1	110.035913	1.183474	3	-0.007923	1	12	2	1
354	187706	690876	109.836338	1.652127	2	2.7	107.136338	2	C	2	6	1	109.867259	1.127053	4	-0.009021	1	12	2	1
355	187706	690866	109.838312	1.6937	1	1.1	106.838312	1	R	1	6	1	109.621736	3.8801	3	-0.060571	1	12	2	1
356	187716	690866	109.433833	1.675381	3	1	106.433833	3	G	1	3	1	109.465912	1.127053	4	-0.032077	1	12	2	1
357	187716	690876	109.636339	1.654592	1	2.2	106.936339	1	G	1	3	1	109.62759	1.127053	4	-0.03092	1	12	2	1
358	187716	690886	109.866339	1.646261	2	2.7	107.646339	2	G	1	3	1	109.877358	1.127053	4	-0.030919	1	12	2	1
359	187726	690966	109.847943	1.699876	1	2.7	107.447943	1	G	1	3	1	109.880794	1.127053	4	-0.032841	1	12	2	1
360	187726	690966	110.163381	2.79872	2	2.8	107.363381	2	C	12	12	1	110.212436	1.127053	4	-0.049055	1	12	2	1
361	187736	690986	109.646342	1.900641	2	2.8	106.846342	2	C	2	6	1	109.67261	1.127053	4	-0.030919	1	12	2	1
362	187736	690986	109.649233	2.460623	2	2.8	107.149233	2	C	2	6	1	109.660215	1.127053	4	-0.049052	1	12	2	1
363	187746	690916	110.193586	2.514228	2	2.4	107.793586	2	R	1.5	9	1	110.228007	1.127053	4	-0.04421	1	12	2	1
364	187736	690916	110.286144	2.204412	1	3	107.286144	1	R	1	6	1	110.303837	1.127053	4	-0.042193	1	12	2	1
365	187746	690916	110.590909	2.17356	2	2.9	107.090909	2	R	1.5	9	1	110.614208	1.127053	4	-0.050209	1	12	2	1
366	187706	691086	117.968737	3.020732	1.5	2.4	115.568737	1.5	G	1.5	9	1	118.017015	1.127053	4	-0.048278	1	12	2	1
367	187706	691086	117.979507	3.022442	2	2.1	115.879507	2	G	1.5	9	1	118.017015	0.792265	4	-0.041958	1	12	2	1
368	187696	691086	118.650215	3.447826	2.5	2.5	115.650215	2.5	R	1.5	18	1	118.721137	1.127053	4	-0.050209	1	12	2	1
369	187686	691086	118.801526	5.786206	2	2.4	116.401526	2	R	1.5	18	1	118.915588	1.127053	4	-0.114062	1	12	2	1
370	187696	691086	118.176591	3.356612	2	2.2	115.976591	2	G	1	18	1	118.229488	1.127053	4	-0.052897	1	12	2	1
371	187696	691076	117.682848	3.283921	2	1.8	115.882848	2	R	1.5	9	1	117.73189	1.127053	4	-0.049042	1	12	2	1
372	187706	691076	117.48124	2.89792	2	1.2	115.48124	2	R	1.5	9	1	117.82982	1.127053	4	-0.04712	1	12	2	1
373	187696	691066	117.20124	3.20006	1.5	1.2	116.00124	1.5	R	1.5	9	1	117.24836	1.127053	4	-0.04712	1	12	2	1
374	187686	691066	117.790993	5.658909	1	0.5	117.290993	1	G	1	4	1	117.895041	1.127053	4	-0.114048	1	12	2	1
375	187676	691056	118.14742	5.79086	1	0.3	117.84742	1	G	1	4	1	118.26017	1.127053	4	-0.13257	1	12	2	1
376	187676	691066	118.690921	5.799081	1	0.3	118.390921	1	G	1	4	1	118.74239	1.127053	4	-0.152128	1	12	2	1
377	187666	691056	119.04725	6.204245	1	0.3	118.74725	1	R	1	6	1	119.17346	1.127053	4	-0.126096	1	12	2	1
378	187666	691046	118.654715	6.48084	1	0.1	118.354715	1	R	1.5	6	1	118.703808	1.127053	4	-0.126233	1	12	2	1
379	187666	691036	118.21471	6.334901	1	0.1	118.1471	1	R	1.5	6	1	118.346094	1.127053	4	-0.131984	1	12	2	1
380	187656	691036	119.019978	6.506522	4	0.2	118.819978	4	G	1	4	1	119.173853	1.127053	4	-0.117857	1	12	2	1
381	187656	691026	118.123122	6.548091	1	0.5	117.823122	1	G	1	4	1	118.245214	1.127053	4	-0.131972	1	12	2	1
382	187646	691026	119.022755	8.193576	1	0.1	118.922755	1	R	1	4	1	119.174067	1.127053	4	-0.148852	1	12	2	1
383	187646	691016	118.705059	10.751816	6	0.9	117.85059	6	G	1	12	1	118.963282	1.127053	4	-0.206223	1	12	2	1
384	187646	691006	118.214792	12.711852	6	0.7	117.424792	6	G	1	12	1	118.394134	1.127053	4	-0.209522	1	12	2	1
385	187636	691016	120.072344	10.079466	1	0.2	120.472344	1	R	1	12	1	120.472344	1.127053	4	-0.602025	1	12	2	1
386	187636	690996	118.21623	14.903309	1	0.1	118.131623	1	R	1.5	9	1	118.535796	1.127053	4	-0.304173	1	12	2	1
387	187636	691006	119.930554	12.711886	6	0.3	119.430554	6	G	1	12	1	120.190711	1.127053	4	-0.260157	1	12	2	1
388	187626	690996	120.132864	13.7651	1	0.01	120.142864	1	R	1	12	1	120.142864	1.127053	4	-0.284647	1	12	2	1
389	187626	690986	118.201624	15.268386	8	0.01	118.191624	8	R	1.5	12	1	118.505798	1.127053	4	-0.304174	1	12	2	1
390																				

	2	4.0	2.0
	4	8.0	4.0
	8	15.0	6.0
	15	35.0	8.0
<b>Peat depths</b>		<b>Co-eff.</b>	
	0	0.5	1.0
	0.51	1.0	2.0
	1.01	3.0	3.0
	3.01	6.0	8.0
<b>Substrate</b>		<b>Co-eff.</b>	
G			1.0
H			1.5
C			2.0
not proven			2.0
slip material			5.0
<b>Receptor</b>		<b>Co-eff</b>	
Roads and Tracks			3.0
Minor Water Feature			6.0
Dwelling			6.0
Major Water Feature			8.0
Site Infrastructure			3.0
Important Habitat			8.0
<b>Receptor Dist.</b>		<b>Co-eff.</b>	
	0	10.0	4.0
	10	100.0	3.0
	100	1000.0	2.0
	1000	2000.0	1.0
<b>Receptor Elev.</b>		<b>Co-eff.</b>	
	0	10.0	1.0
	10	50.0	2.0
	50	100.0	3.0
	100	200.0	4.0
<b>risk rating normalisation</b>			
	0	5.0	1.0
	5	15.0	2.0
	15	31.0	3.0
	31	50.0	4.0
	50	100.0	5.0
<b>Impact rating normalisation</b>			
	0	10.0	1.0
	10	20.0	2.0
	20	30.0	3.0
	30	50.0	4.0
	50	100.0	5.0