Scottish & Southern Electricity Networks

TRANSMISSION

Hurlie 400kV Substation

Environmental Impact Assessment (EIA)

Volume 4 | Appendix 12.1

Flood Risk Assessment and Outline Drainage Strategy

November 2024

Scottish & Southern Electricity Networks

TRANSMISSION

CONTENTS

LIST OF ABBREVIATIONS

DTM- Digital Terrain Model
FEH- Flood Estimation Handbook
kV- Kilovolt
LUC- Land Use Consultants
NPF4- National Planning Framework 4
REFH2- Revitalised Flood Hydrograph 2 Rainfall-Runoff method
SuDS- Sustainable Drainage Systems

1. INTRODUCTION

1.1.1 This appendix presents information relevant to the Hurlie 400 kV Substation. It should be read in conjunction with **Chapter 12: Hydrology, Hydrogeology, Geology and Soils** and **Chapter 2: Development of the Proposed Development (Volume 2)** of the **EIA Report** for full details of the Proposed Development.

1.1.2 This appendix is supported by the following:

- **Figure 12.1.1: Site Location and Hydrology Features**
- **Figure 12.1.2: Site Topography (based on OS 1:25K map and Phase 1 LiDAR)**
- **Figure 12.1.3: 200-year + Climate Change Flood Map of the Burn of Day**
- **Figure 12.1.4: Surface Water Flow Pathways , showing catchment areas of Burn of Day and Burn of Baulks**

1.1.3 Kaya Consulting was commissioned by SSEN Transmission through LUC (Land Use Consultants), to undertake an initial flood risk assessment and outline drainage assessment to support the proposed development of substation infrastructure at Hurlie, in Aberdeenshire Council area (~substation centre at NGR 379680, 786570). This will aid in the design process and outline the flood risk within the vicinity of the site. Further it will outline drainage requirements and initial design at the site and provide inputs to inform the EIA Report.

2. SITE DESCRIPTION

2.1.1 The Site is located in an afforested area of Fetteresso Forest, approximately 5 km west of Stonehaven in Aberdeenshire Council. The Burn of Day flows in an easterly direction through the centre of the Site (**Figure 12.1.1**). The upper reaches of the Burn of Baulks are within the south-eastern part of the Site.

2.1.2 At the time of writing there was no topographic data covering the whole Site. However, Phase 1 LiDAR 1m DTM data covers part of the Site and includes the Burn of Day watercourse. As the LiDAR data covers the course of the Burn upstream and adjacent to the proposed substation, it was considered suitable to carry out initial flood modelling of the Burn of Day to estimate the 200-year plus climate change flood extents. The extent of the LiDAR and topography of the site are shown in **Figure 12.1.2**.

The substation platform is over 50 m from the Burn of Day and over 120 m from the upper reaches of the Burn of Baulks (**Figure 12.1.1**). The Burn of Baulks sits over 6 m below the proposed substation platform and the platform is not at risk of flooding from the Burn of Baulks, which is not considered further.

2.1.3 A review of SEPA future flood maps online[1] show no flood risk from rivers within the Site. There are areas of surface water flood risk within the Site, largely confined to the low area along the Burn of Baulks watercourse or at small, localised depressions within the forest. Based on this review the Proposed Development is not considered to be at flood risk.

2.1.4 However, it is noted that SEPA flood maps do considered river catchments less than 3 km^2. Therefore, an initial flood risk assessment was carried out to inform the layout of the Proposed Development, such that the flood risk areas of the Burn of Day could be avoided during the design.

[1] https://map.sepa.org.uk/floodmaps

3. HYDROLOGY, 2D MODELLING AND FLOOD RISK

3.1 Fluvial Flood Risk

3.1.1 Standard industry techniques were used to assess the Burn of Day catchment and estimate design flows for 200-year plus climate change event. The Burn of Baulks is well below the site and would not have an impact on flooding at the Proposed Development.

3.1.2 The Burn of Day catchment extends upstream (west) and covers an area of approximately 0.8 km^2 (see **Figure 12.1.4**). The 200-year plus climate change flow was estimated to be 3.8 m^3/s, based on FEH methods or 4.0 m^3/s, based on REFH2 methods.

3.1.3 A 2D hydraulic model was set up using Flood Modeller Pro hydraulic software using the 1 m LiDAR data. The most conservative flows were used within the model, with culverts modelled as fully blocked. The manning's *n* value was set to 0.06 to represent a heavily vegetated channel. A 1 m grid cell resolution was used within the model.

3.1.4 The results for the 200-year plus climate change scenario indicate that the floodplain is largely constrained within the Burn of Day. The results are shown in **Figure 12.1.3**. Based on NPF4, development should be avoided within the flood risk area shown in **Figure 12.1.3**.

3.1.5 Based on the current location of the substation, the upper reaches of the Burn of Baulks are over 120 m south-east of the proposed substation platform and over 6 m lower than the substation location. Hence, the proposed substation is not considered to be at flood risk from the Burn of Baulks and no modelling of this burn was undertaken.

3.2 Surface Water Flood Risk

3.2.1 Ground levels rise to the north and west of the proposed substation platform. During an extreme event, i.e. exceeding the capacity of any land drains, the Site is considered to be at risk of flooding from surface water runoff from higher ground. Surface water risk has been considered in the design of the site layout, with water intercepted along the upslope boundary to route any flood waters able to enter the site, through the site to the watercourse without increased flooding.

3.3 Groundwater

3.3.1 The SEPA Flood Map does not show the Site to be at risk of groundwater flooding. Generally, flooding from groundwater as a primary source is uncommon in Scotland.

4. OUTLINE DRAINAGE STRATEGY

4.1 Existing Drainage and Ground Conditions

4.1.1 At present a detailed Site Investigation report is not available.

4.1.2 It is recommended that ground investigations such as soakaway testing is undertaken to ascertain the underlying geology and the potential for discharging surface water via infiltration solutions. Given the potentially large impermeable areas, this could potentially reduce surface water attenuation features such as detention basins.

4.1.3 Based on a review of the available LiDAR topographic data, it is noted that most of the Site currently drains towards the Burn of Day, but part of the south-eastern plot area drains towards the Burn of Baulks, see **Figure 12.1.4**. The drainage strategy should mimic the existing (greenfield) arrangements as far as possible. The drainage design proposed drains attenuated Sustainable Urban Drainage Systems (SuDS) discharges from the substation platform to both watercourses in approximately the same ratio as the existing drainage (see **Figure 3.4** in **Volume 2 Chapter 3 Description of Proposed Development).** Detailed design should be discussed and agreed with Aberdeenshire Council.

4.2 SuDS and Potential Strategies

4.2.1 Sustainable Urban Drainage Systems (SuDS) are used to manage surface water runoff effectively within a development to mitigate against the impacts associated with an increase in the impermeable area such as increased flows and exacerbated flooding downstream.

4.2.2 Attenuating runoff within on-site attenuation cells that discharge to the Burn of Day (and the Burn of Baulks) at 2-year greenfield runoff rates is the most viable option due to the absence of infiltration testing results.

4.3 Proposed Surface Water Drainage Strategy

4.3.1 The proposed surface water drainage strategy seeks to provide a sustainable and integrated surface water management scheme for the whole site and aims to maintain or reduce downstream flood risk by managing discharges from the site to the local water environment in a controlled manner.

4.3.2 The measures outlined in the following sections will be implemented to ensure that greenfield runoff rates are maintained during the construction and operational phases of the Proposed Development.

4.3.3 In compliance with the above, the drainage strategy has been developed to meet the following key principles;

- Mimic existing (greenfield) drainage arrangements as far as possible;
- Avoid increases in the greenfield rate, volume and frequency of offsite discharge;
- Avoid significant deterioration in water quality of discharges and no detrimental impact in downstream water quality;
- Achieve the above criteria for all storms up to and including the 200-year event; and
- Incorporate an allowance for climate change (39%).

4.3.4 Runoff from the developed platform (including construction compound) will be managed through surface water drainage on the platform conveyed to a detention basin (or basins) that will be located downslope of the platform, within the planning application (red line) boundary. The detention basins will drain to the Burn of Day and the Burn of Baulks via outfalls restricted to the 2-year greenfield runoff rate.

4.3.5 Based on Ordnance Survey and a site walkover survey, drainage from a small area is predicted to reach the Site from higher ground, see **Figure 12.1.4**. Accordingly, a temporary bund has been proposed along the development perimeter to function as a diversion bund, that way, only runoff generated within the developable area is captured within the attenuation cells or implementing an interception feature to allow flows out with the site to follow the pre-development pathways and will therefore not increase flood risk downstream.

4.3.6 Based on Aberdeenshire Council guidance, the capacity of the drainage storage has been sized for the 30-year plus climate change uplift event with plans demonstrating flooded areas and flow paths of excess water for storm of greater

magnitude, when the system is at capacity or exceeded. Detailed storage calculations and volumes are provided below. The design will be further iterated and verified as the detailed design of the Proposed Development proceeds.

4.3.7 Expert geotechnical advice will be sought when confirming track material.

4.4 Methodology for calculation of run-off and storage volume

4.4.1 Post-development runoff volumes have been calculated using the Wallingford Procedure.

4.4.2 Runoff volumes were calculated for a range of storm durations and return periods including an allowance for climate change, which is considered at a 39% uplift to rainfall intensity following SEPA guidance (2022).

4.4.3 In total, impermeable areas at the site have been conservatively estimated to be 2.5 ha, this assumes that approximately 12.5% of the site is impermeable.

4.4.4 The run-off factor of the hard-standing areas was set to 1.0 to represent the imperviousness of these areas.

4.4.5 The results indicate that with development in place, approximately 5,736 m^3 of surface water runoff would need to be stored within the drainage system during a 30-year plus climate change uplift storm across the site. Approximately 9,907 m^3 of surface water runoff would need to be accommodated within the site during a 200-year plus climate change uplift storm.

4.4.6 Aberdeenshire Council guidance states *"suitable attenuation calculations should be provided, to prove that on-site surface water drainage system has adequate storage capacity for a 30 year plus climate change return period rainfall event"*.

4.4.7 As discussed, ground conditions are not known at this stage. It may be possible to accommodate such volumes within a mixture of infiltration as well as detention basins (depths ranging between 1-2m depending on slopes etc.). As a minimum it is recommended that the 30-year plus climate change volume is stored. As an indication, this would require a total area of 5,736 m^2 (at 1m depth) or 2,868 m^2 (at 2m depth) and could be provided by several detention basins. Appropriate buffers would also have to be applied. There is space downgradient of the substation to the north-east and south-east for the detention basins, which will discharge to the Burn of Day and Burn of Baulks, respectively.

4.4.8 Safe flood routing should be provided to allow flows exceeding the capacity of the attenuation feature to route safely towards the Burn of Day and Burn of Baulks.

4.5 Surface Water Quality

4.5.1 The Proposed Development will be unmanned and will not be visited on a daily basis. In addition, when being visited, the usual type of vehicles are not likely to be larger vehicles such as HGVs etc.

4.5.2 Surface water at the site will be treated via SuDS measures .A water quality risk assessment should be undertaken using the SuDS hazard mitigation indices in accordance with the SuDS Manual, CIRIA Report C753.

4.5.3 Considering the low expected traffic volumes and appropriate containment of any hazardous substances, the residual pollution hazard level is considered to be low hazard levels similar to that of a low traffic road and non-residential car parking with infrequent change.

5. SUMMARY AND CONCLUSION

5.1.1 Kaya Consulting was commissioned by SSEN Transmission, through LUC (Land Use Consultants), to undertake an initial flood risk assessment and outline drainage strategy to support the proposed development of substation infrastructure in the Hurlie area. This flood and drainage statement reports initial results of 2D modelling, flood risk assessment and outline drainage strategy to feed into the early part of the design and inform the EIA.

5.1.2 2D conservative flood modelling results are shown in **Figure 12.1.3** to provide an indicative extent of the 200-year plus climate change floodplain for the Burn of Day and used to inform the design of the Proposed Development to ensure no infrastructure is placed in areas predicted to flood. The drainage design proposed will manage surface water runoff from upslope areas.

5.1.3 An outline drainage strategy for the Site is provided. A detailed drainage design will be developed as part of the detailed design stage, in consultation with Aberdeenshire Council.

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LUC

380

790

785000m.N

375000m.E

380

Scale @ A3: in 1:27,000

0 1 2 km

- Hurlie red line boundary
- Electrical layout and fence line
- Surface water

Project No: LT486

Project: Hurlie 400 kV Substation

Title:

Site Location and Hydrology Features

Drawn by: IB

Date: 21/10/2024

Figure: 12.1.1

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380

790

785000m.N

375000m.E

380

Scale @ A3: in 1:27,000

0 1 2 km

Hurlie red line boundary

Electrical layout and fence line

Surface water

1m LiDAR digital terrain model data (partial coverage)

Elevation (m AOD)

511.601

-4.811

Project No: LT486

Project: Hurlie 400 kV Substation

Title:

Site Topography (based on OS 1:25K map and Phase 1 LiDAR)

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Date: 21/10/2024

Figure: 12.1.2

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Hurlie red line boundary

Electrical layout and fence line

Surface water

200-year + climate change Burn of Day flood extent

Hare Bog

Hurlie Bog

Hill of Baulk

210m

209m

225m

222m

Elf Hill

The Steading

174m

170m

Fords

FB

Track

Drain

Iss

Sks

Path

Burn of Day

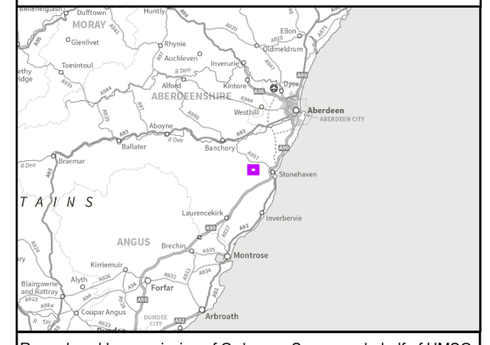
El Dist Sta

Scale @ A3: 1:8,000

0 0.25 0.5 km

N

380000m.E



Project No: LT486

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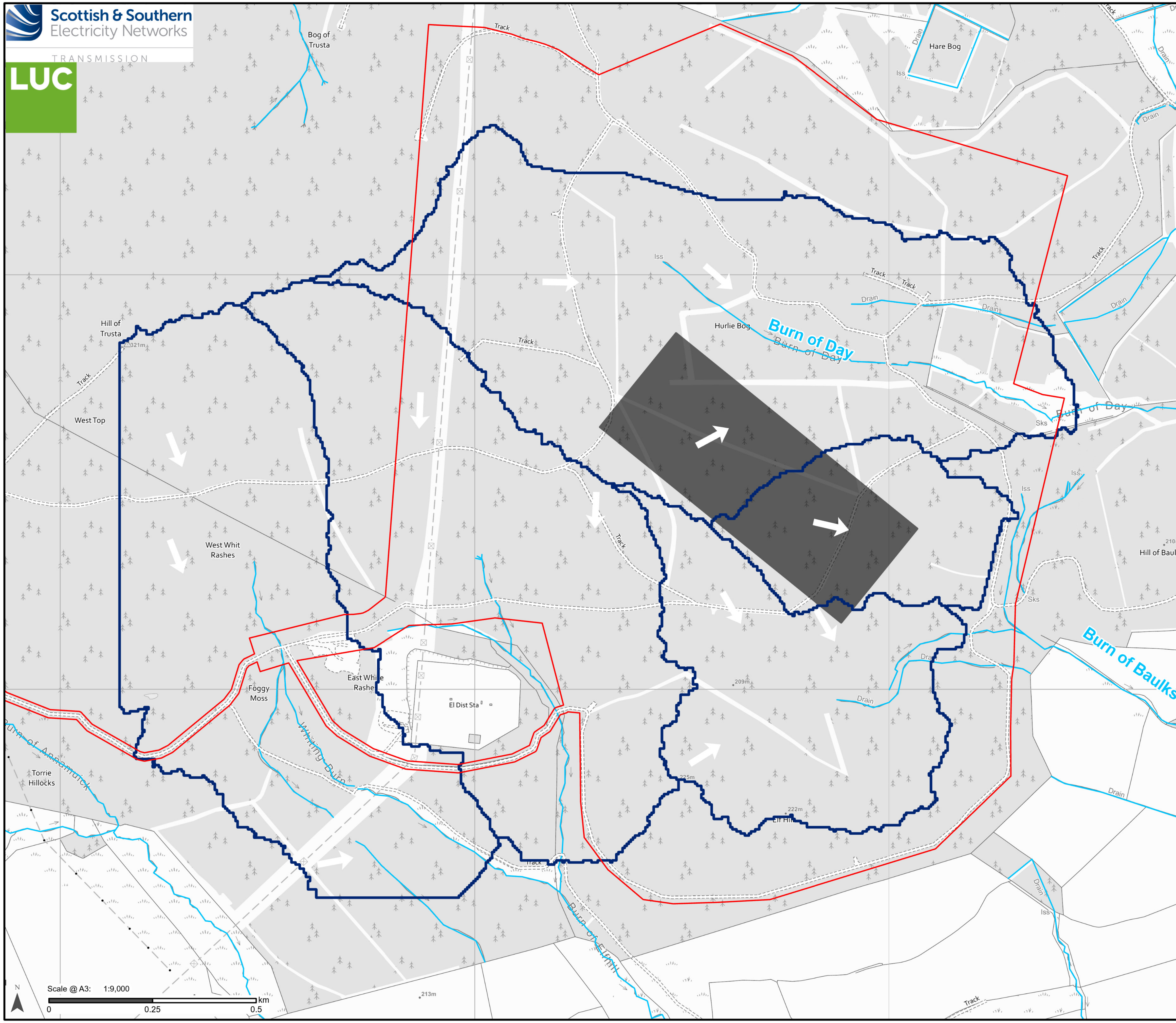
200-year + Climate Change Flood Map of the Burn of Day

Drawn by: IB

Date: 21/10/2024

Figure: 12.1.3



Hurlie Proposal of Application Notice boundary
Indicative platform
Surface water
Watershed
Indicative surface water flow pathways

Project No: LT486

Project: Hurlie 400 kV Substation

Title:

Surface Water Flow Pathways

Drawn by: IB

Date: 14/08/2024

Figure: 12.1.4