APPENDIX 12.3: FLOOD RISK ASSESSMENT

LT379 Greens 400kV Substation

Flood Risk Assessment

GRNS4-LT379-SEBAM-DRAI-ZZ-RPT-C-0003

Scottish & Southern Electricity Networks
TRANSMISSION

SIEMENS energy bam

FAIRHURST

CONTROL SHEET

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1.0 INTRODUCTION

1.1.1 Fairhurst was appointed by Siemens Energy BAM Joint Venture (SEBAM) to carry out a Flood Risk Assessment (FRA) for a proposed substation development at Greens near Turriff in Aberdeenshire. A plan of the location of the proposed development in relation to the local area is provided in **Figure 1**.

1.1.2 This report forms an assessment of flood risk for the development as a whole in accordance with National Planning Framework 4 (NPF4). Flood risk at the site has primarily been assessed in relation to overland flooding; however, other potential sources of flood risk have also been considered.

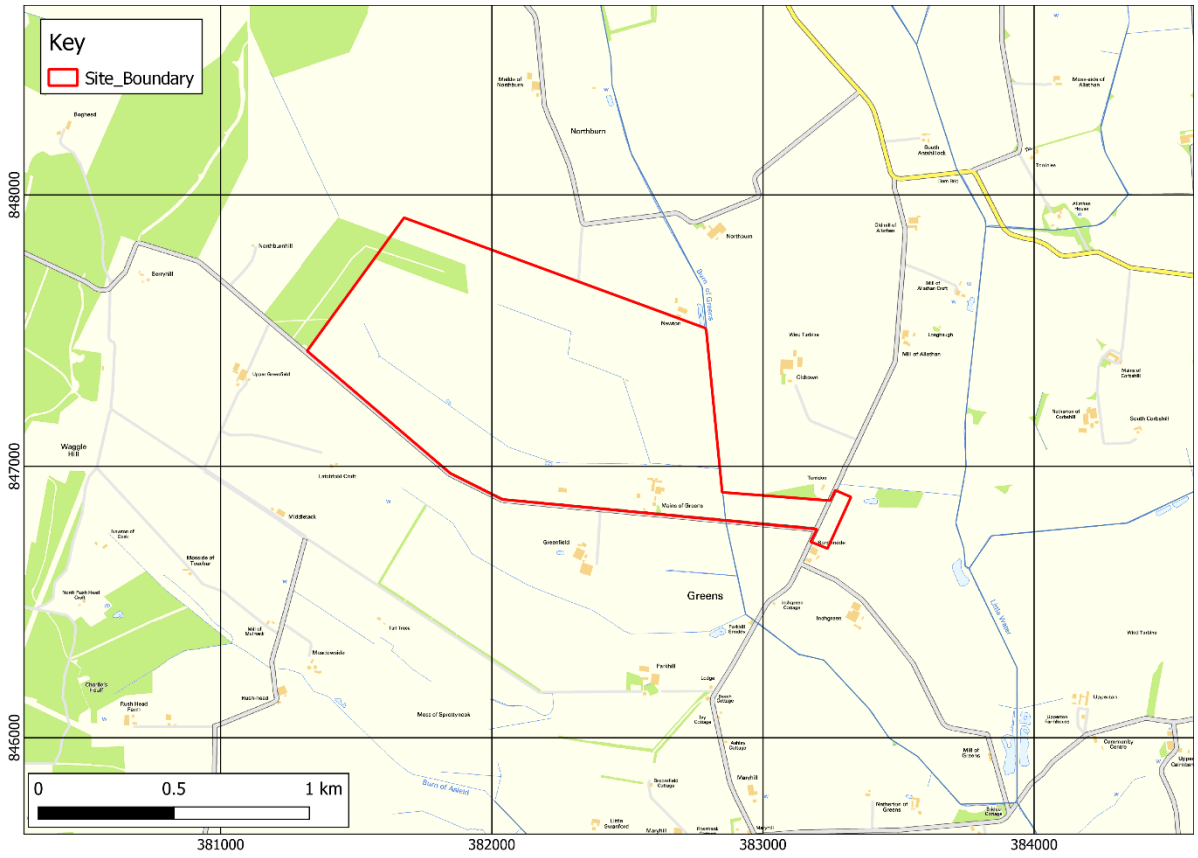

Figure 1: Site Location Plan

2.0 EXISTING SITE DESCRIPTION

2.1 National Planning Framework 4

2.1.1 In consideration of planning applications, planning authorities require to be satisfied that due account has been taken of National Planning Framework 4 (NPF4), and the Scottish necessary to show that adequate protection against flooding exists or can be provided for the proposed development and that the development does not increase flood risk to others.

2.1.2 Policy 22 of the NPF4, rements for development proposals at risk of flooding or in a flood risk area. The policy states:

a) Development proposals at risk of flooding or in a flood risk area will only be supported if they are for:

- i. *essential infrastructure where the location is required for operational reasons;*
- ii. *water compatible uses;*
- iii. *redevelopment of an existing building or site for an equal or less vulnerable use; or.*
- iv. *redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long-term safety and resilience can be secured in accordance with relevant SEPA advice.*

The protection offered by an existing formal flood protection scheme or one under construction can be taken into account when determining flood risk.

In such cases, it will be demonstrated by the applicant that:

all risks of flooding are understood and addressed;

there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;

the development remains safe and operational during floods;

flood resistant and resilient materials and construction methods are used; and

future adaptations can be made to accommodate the effects of climate change.

Additionally, for development proposals meeting criteria part iv), where flood risk is managed at the site rather than avoided these will also require:

the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and

that the proposal does not create an island of development and that safe access/ egress can be achieved.

b) Small scale extensions and alterations to existing buildings will only be supported where they will not significantly increase flood risk.

c) Development proposals will:

- i. *not increase the risk of surface water flooding to others, or itself be at risk.*
- ii. *manage all rain and surface water through sustainable urban drainage systems (SUDS), which should form part of and integrate with proposed and existing blue-green infrastructure. All proposals should presume no surface water connection to the combined sewer;*
- iii. *seek to minimise the area of impermeable surface.*

d) *Development proposals will be supported if they can be connected to the public water mains. If connection is not feasible, the applicant will need to demonstrate that water for drinking water purposes will be sourced from a sustainable water source that is resilient to periods of water scarcity.*

e) *Development proposals which create, expand or enhance opportunities for natural flood risk management, including blue and green infrastructure, will be supported.*

2.2 Local Planning Policy

2.2.1

development within the Aberdeenshire Council area over the course of the next 5 years. The LDP was developed prior to the release of NPF4, and therefore still makes reference to SPP.

2.2.2

C4.1 Flood Risk Assessments should be undertaken in accordance with SEPA Technical Flood Risk Guidance and will be required for development in the indicative medium to high category of flood risk of 0.5% or greater annual probability (1 in 200 years or more frequent). Assessments may also be required in areas of lower annual probability (0.1%-0.5% annual probability) in circumstances where other factors indicate a potentially heightened risk or there are multiple sources of potential flooding. Assessments should include an allowance for freeboard and climate change. Development should not increase flood risk vulnerability and should avoid areas of medium to high risk, functional floodplain or other areas where the risks are otherwise assessed as heightened or unacceptable except where:

It is a development to alleviate flooding or erosion of riverbanks or the coast;

It is consistent with the flood storage and conveyance function of a floodplain;

It would otherwise be less affected by flooding (such as a play area or car park);

It is essential infrastructure. The location is essential for operational reasons for example for water-based navigation, agriculture, transport or utilities infrastructure and an alternative lower risk location is not available

C4.2 If development is to be permitted on land assessed as at a medium to high risk of flooding it should be designed to be flood resilient for the lifetime of the development (this is normally a minimum of 100 years for residential development) and use construction methods to assist in the evacuation of people and minimise damage. It must not result in increased severity of flood risk elsewhere through altering flood storage capacity or the pattern and flow of flood waters.

C4.3 Buffer strips, for enhancement of the watercourse and necessary maintenance, must also be provided for any water body.

C4.4 These measures may also be required in areas of potentially lower risk of flooding (annual probability of more than 1:1000 years) or in coastal areas below the 10-metre contour should evidence demonstrate a heightened risk.

C4.5 In such areas land raising and/or excavations will only be permitted if it is for a flood alleviation measure, it is linked to the provision and maintenance of direct or indirect compensatory flood water storage to replace the lost capacity of the functional floodplain, and it will not create any inaccessible islands of development during flood events or result in the need for flood prevention measures elsewhere.

C4.6 We will not approve development that may contribute to flooding issues elsewhere. Sustainable Urban Drainage principles apply to all sites.

C4.7 We are opposed to the enclosed culverting of watercourses for land gain and will actively seek to discourage such proposals. We encourage the daylighting (or de-

2.2.3 In addition, Planning Advice note PA2023-16 (Aberdeenshire Council, 2023) states the

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side of the watercourse), with the required buffer strip width for individual site dictated by the width of the adjacent watercourse. The guidance also states that buffer strips are also

but for smaller ditches best practice allows some discretion to reduce the buffer strip to a minimum of 3m on both sides of the ditch, depending on requirements for access for maintenance.

3.0 DEVELOPMENT SITE

3.1 Existing Conditions

3.1.1 The proposed development site covers a total area of approximately 114 hectares (ha), comprising agricultural land, as illustrated in **Figure 2**. Site access is from a minor road to the east of the site. A topographical survey was carried out by L&M Survey Services in March 2024 to obtain cross sections of the Burn of Greens and small ditch within the site. The survey included including 15 cross sections of the Burn of Greens (including 3 existing bridge structures) and 3 cross sections of the small ditch, as shown in the drawings in **Appendix 1**.

3.1.2 The site is located above 194 metres Above Ordnance Datum (mAOD) and is bounded to the east, west and north by a mix of forestry and agricultural land. An existing road borders the site immediately to the south, beyond which is more agricultural land.

3.1.3 The Burn of Greens flows southwards along the eastern boundary of the substation site, before being culverted under a minor road bordering the site to the south. Two small ditches where they discharge to the Burn of Greens at the south eastern corner of the site.

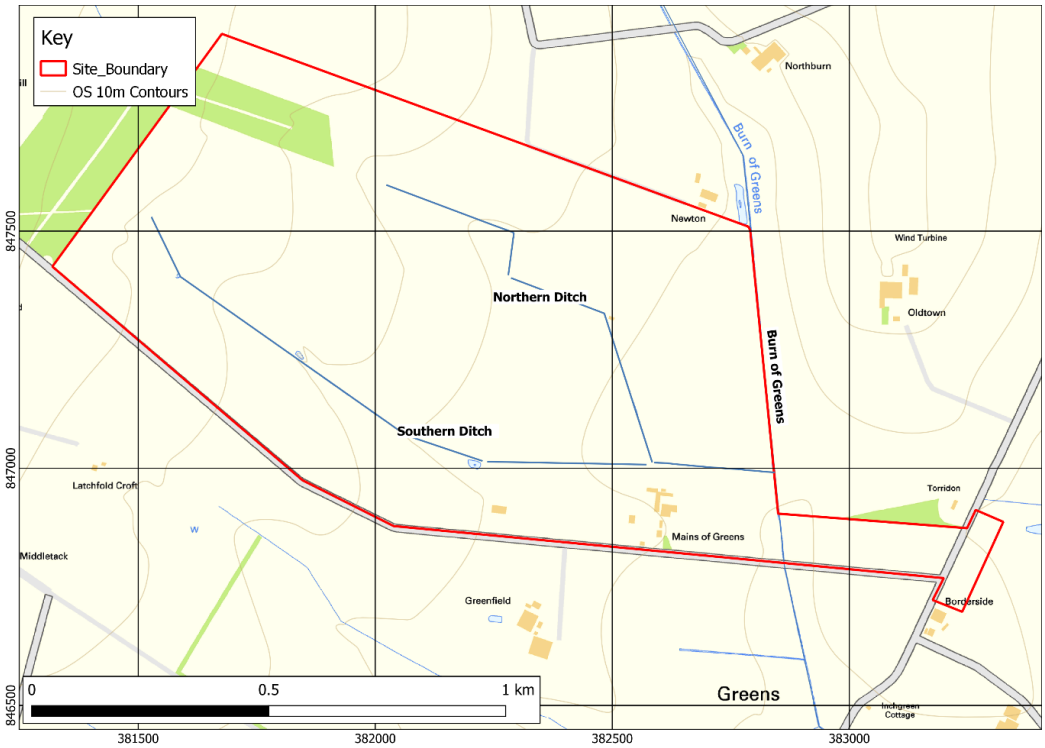

Figure 2: Existing Conditions

3.2 Proposed Development

3.2.1 The proposed development includes the construction of a 400kV substation and associated infrastructure. The proposed layout of the site is shown in Drawing GRNS4-LT379-SEBAM-ZZ-ZZ-D-C-0108 in **Appendix 1**.

3.2.2 A new access track will be created off the minor road which runs north to south to the east of the site. A new crossing will be required to allow the access track to cross the Burn of Greens just upstream of where the burn is currently culverted under the existing road to the south of the site. The proposed crossing will be a box culvert with 300mm bed material and a low flow channel. The internal span of the culvert will be 3.9m and there will be a clear rise of 0.9m above bed material, as shown in Drawing GRNS4-LT379_SEBAM-DRAI-ZZ-D-C-0161. The impacts on flood risk associated with the proposed Burn of Greens crossing have been investigated as part of this study.

3.2.3 Two crossings structures will be provided for the drainage ditch, one being a new crossing and another upgrading an existing crossing. The culverts for these crossings will be designed during the detailed design phase of the project.

3.2.4 Two additional access roads will also be provided as part of the development, and will extend northwards into the

will be formed at the centre of the southern site boundary.

3.2.5 The existing drainage ditches will be re-routed around the proposed substation platform. The northern ditch will be re-aligned along the northern boundary of the site before extending southwards parallel to the eastern site boundary and tying in to the existing outflow to the Burn of Greens. The southern ditch will be diverted southwards of its current position and will tie back into the current route of the ditch downstream (Drawing GRNS4-LT379-SEBAM-DRAI-ZZ-D-C-0170, **Appendix 1**).

3.2.6 Drainage from the substation platform will be collected in a filter drain and conveyed to two SuDS basins at the north eastern part of the site for attenuation before being discharged to the Burn of Greens. The access track will also be positively drained to a number of small SuDS basins prior to discharge to the Burn of Greens (Drawing GRNS4-LT379-SEBAM-DRAI-ZZ-D-C-0171, **Appendix 1**)

3.3 Sources of Flood Risk Information

SEPA Flood Maps

3.3.1 l, coastal and pluvial flooding, alongside various associated information. These maps are a strategic planning tool, the resolution of

which does not take account of individual hydraulic structures or drainage infrastructure. These provide indicative flood risk information, rather than site-specific detail.

3.3.2 The fluvial flood map indicates out-of-bank flooding along the Burn of Greens in a 1 in 200 year plus climate change event, although floodwater is confined to a relatively narrow corridor along the watercourse.

3.3.3 The surface water flood maps show small isolated pockets at risk of flooding in the vicinity of the site in a 1 in 200 year event, although none of these are located within the site itself.

3.3.4 Whilst the flood maps can be a useful tool for initially considering whether a site may be at risk of flooding, the following caveat is attached to their use:

has been made to ensure that the Flood Maps are accurate for their intended

3.3.5 More detailed analysis is required to fully understand the flood risk to any development site and is provided in **Section 5** of this report.

SEPA Reservoir Map

3.3.6 In order to implement the Reservoirs (Scotland) Act 2011, SEPA produced reservoir inundation maps (RIMs). These maps illustrate the areas likely to be flooded by an uncontrolled release of water from a reservoir with storage volume of 25,000 m^3 or more. The RIMs indicate that the site is not at risk of flooding from reservoir failure.

4.0 POTENTIAL SOURCES OF FLOOD RISK

4.1.1 There are several potential sources of flooding that require consideration:

- **Coastal flooding**: Extreme sea levels and coastal waves have the potential to cause rapid inundation of a development, posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure.
- **Fluvial flows**: Extreme fluvial flood events have the potential to cause rapid inundation of a development, posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure.
- **Overland flow**: Overland flow occurs when the infiltration capacity of the ground is exceeded in a storm event. This could result in water travelling as sheet flow overland or excess water being conveyed from one location to another via local road networks.
- **Infrastructure failure**: The failure of conveyance infrastructure such as culverts or bridges, or the failure of any man-made water storage or conveyance infrastructure that could increase the risk of flooding at the site.
- **Sewer flooding**: If the capacity of sewers is exceeded in an extreme event, or a blockage occurs, surcharging of the network can result in surface flooding. The local drainage network should be considered with a view to assessing flood risk to the site.
- **Groundwater**: High groundwater levels could exacerbate flooding occurring at low points on any given site, potentially contributing to flood risk from other sources.

5.0 FLOOD RISK ANALYSIS

5.1.1 Potential sources of flood risk identified for consideration in **Section 4** are discussed below.

5.2 Coastal Flooding

5.2.1 The proposed development is located over 18km from the nearest coast and at over 195mAOD. The inland location and elevation of the site mean it is not at risk from tidal inundation or coastal waves.

5.3 Fluvial Flows

Pre-Development

5.3.1 Hydraulic modelling indicates that out-of-bank flow will occur along both banks of the Burn of Greens in a 1 in 200 year plus climate change flood event. The flood map in **Appendix 1** provides the baseline 1 in 200 year plus climate change flood extents.

5.3.2 The Burn of Greens is located in a shallow valley feature along much of the modelled reach, and therefore out-of-bank flooding is constrained within a relatively narrow corridor of up to approximately 20m either side of the watercourse.

5.3.3 Constriction caused by the existing road crossing at the south eastern corner of the site results in a significant widening of the floodplain on approach to the bridge, as floodwater backs up behind the structure. The floodplain immediately upstream of the road bridge is approximately 110m wide.

5.3.4 Out-of-bank flooding is also predicted on the drainage ditch although, as with the Burn of Greens, the topography of the site means that flooding will be confined to a relatively narrow corridor around the watercourse.

Post-Development

5.3.5 The presence of the proposed access culvert will create an additional constraint on flood flows from the Burn of Greens compared to existing and, as a result, is predicted to slightly increase flood level by up to 0.02m immediately upstream of the structure in a 1 in 200 year plus climate change event. The impact of this minor increase in flood levels upstream of the proposed structure will however be localised, and will not result in flood risk to the proposed substation platform in the design event. No impact on flood levels outwith the site boundary is predicted.

5.3.6 The proposed access road has been designed to be overtopped in a 1 in 200 year plus climate change flood event. This proposal has been discussed and agreed with Aberdeenshire Council Flood Risk & Coast Protection officers. Spilling over the access road is predicted to last for up to 7 hours in an event of this magnitude with a peak depth of 0.49m. There are two other access roads proposed which extend northwards into the site from the existing road to the south. These will provide alternative access and egress to the substation site in a 1 in 200 year plus climate change flood event, if required.

5.3.7 The proposed access road will also cross the drainage ditch downstream of the confluence between the northern and southern ditches, as shown in GRNS4-LT379-SEBAM-ZZ-ZZ-D-C-0108 (**Appendix 1**). The crossing will be designed during the detailed design phase of the project, and will ensure that any localised increases in flood levels and extents do not impact on proposed infrastructure or result in increased flood risk outwith the site. As with the proposed Burn of Greens crossing, the access road structure will be designed to overtop if

required to reduce any impact on flood levels. All out-of-bank flow will be directed back into the drainage ditch.

5.3.8 The proposed development will be located outwith the areas shown to be at risk of flooding, with the exception of the locations when the proposed access road crosses the Burn of Greens and the ditch. The proposed substation platform formation level is 129.5 mAOD, which is over 20 m higher than the modelled flood levels in Burn of Greens. A flood map showing the predicted post-development flood extents is provided in **Appendix 1**.

5.4 Overland Flow

5.4.1 There is no LiDAR data available for the site or immediate surrounding area, and therefore a combination of OS contour data and site topographic survey data has been used to assess likely overland flow routes within and round the site.

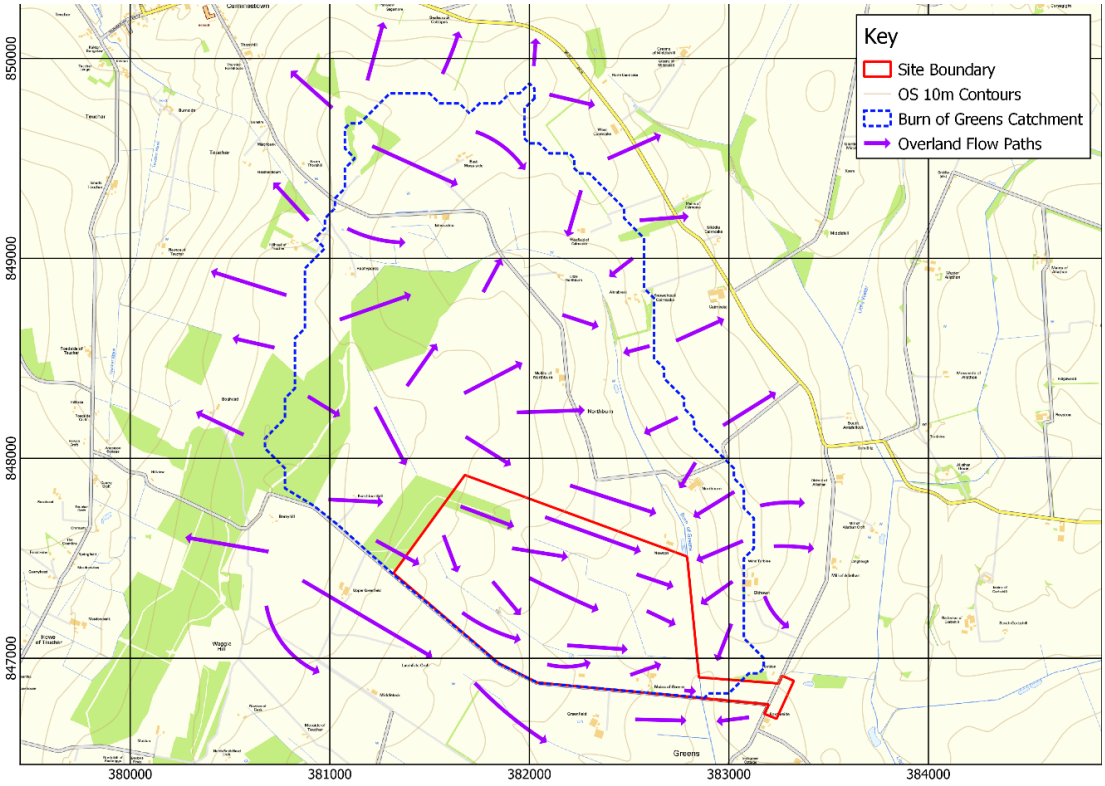

Figure 3: Overland Flow

5.4.2 A small area of land to the north west of the site is located at a higher elevation than the site and therefore runoff generated within this area will flow towards the site. Runoff generated within the site itself will flow south eastwards towards the existing drainage ditches and Burn of Greens. The catchment of the site is relatively small and therefore runoff volumes will be limited.

5.4.3 The site is located on a relatively steep slope and therefore it is unlikely that runoff will pond to significant depths within the site boundary, although there is the potential for limited ponding in localised topographic hollows.

5.4.4 The drainage strategy for the site is shown in Drawing GRNS4-LT379-SEBAM-DRAI-ZZ-D-C-0171 in **Appendix 1**. The proposed development will include SuDS drainage and

therefore the risk of flooding due to overland flow is considered unlikely. Residual risk will be mitigated by profiling ground levels to route flow around and away from sensitive infrastructure.

5.5 Infrastructure Failure

Pre-Development

5.5.1 Additional hydraulic modelling scenarios have been carried out to determine the impact of a partial blockage on both the field access crossing at the north eastern corner of the site and the existing road bridge at the southern boundary of the site

5.5.2 Results indicate that a 50% blockage of these structures results in increases in water levels immediately upstream of the blocked structures of approximately 0.11m at the field access crossing, and a 0.13m at the road bridge. The increase in flood levels also results in minor increases in predicted flood extents in these areas.

5.5.3 Overall, results suggests that potential blockage is unlikely to significantly increase flood risk to the proposed development. The potential increase in flooding associated with structure blockage should be mitigated by the inclusion of a 600 mm freeboard to sensitive equipment and buildings. The substation platform is to be set at 129.5 mAOD, which is over 20 m higher than the modelled flood levels in Burn of Greens.

Post-Development

5.5.4 A hydraulic modelling scenario has also been undertaken to assess the impact of a partial blockage on flood risk in a 1 in 200 year plus climate change flood event. Results indicate that a 50% blockage of the structure will result in an increase in water levels immediately upstream of approximately 0.03m, with no increase in flood levels or extents outwith the site.

5.5.5 Overall, results suggests that potential blockage is unlikely to significantly increase flood risk to the proposed development. The potential increase in flooding associated with culvert blockage should be mitigated by the inclusion of a 600 mm freeboard to sensitive equipment and buildings. The substation platform is to be set at 129.5 mAOD, which is over 20 m higher than the modelled flood levels in Burn of Greens assuming a 50% blockage of the proposed of the proposed structure.

5.6 Sewer Flooding

5.6.1 *Given the rural nature of the site, there is unlikely to be any significant sewer infrastructure present. The risk of sewer flooding is therefore considered to be low.*

5.6.2 *Surface water flow generated within the site will be dealt with by a dedicated drainage system, designed to appropriate standards and incorporating Sustainable Drainage Systems (SuDS) as outlined in the Drainage Statement (Fairhurst, 2024)[1].*

5.6.3 *Residual flood risk should be mitigated by profiling ground levels to route flow around and away from sensitive infrastructure. With this mitigation implemented, the risk of flooding from sewer flooding is considered to be low.*

5.7 Ground Water Flooding

5.7.1 Groundwater is generally a contributing factor to flooding rather than the primary source. SEPA flood maps indicate areas where groundwater could influence the duration and extent

[1] Fairhurst (2024). *LT379 Greens 400kV Substation: Drainage Strategy Report*, Reference: GRNS4-LT379-SEBAM-DRAI-ZZ-RPT-C-0001 (S4)

of flooding from other sources. The proposed site is situated outwith groundwater influenced flood extents shown on these maps. Groundwater below the site is likely to be in hydraulic connectivity with the Burn of Greens. This is expected to limit the potential for emerging above ground on the site, the majority of which is at a significantly higher elevation than the watercourse.

5.7.2 Groundwater monitoring was undertaken fortnightly between August 2023 and February 2024 as part of the pre-construction phase ground investigations. The results indicate that, in the vicinity of the substation platform, groundwater levels are located >2.2 metres below ground level (mbgl). The highest groundwater levels were located towards the eastern boundary of the site where the land slopes steeply down towards the Burn of Greens average groundwater levels in this location indicate that groundwater is approximately 0.3mbgl, with groundwater recorded at ground level during one of the monitoring events. No construction works are proposed in this area. The risk of groundwater flooding to the proposed development is therefore considered unlikely.

5.7.3 In the event groundwater levels exceed the ground levels at the site, the excess water would follow the same flow patterns as for overland flow. Residual risk from this source of flooding can be mitigated and profiling ground levels to route flood water around and away from sensitive infrastructure. With this mitigation implemented, the risk of flooding from groundwater is considered to be low.

6.0 CONCLUSION AND RECOMMENDATIONS

6.1.1 Fairhurst was appointed by Siemens Energy BAM Joint Venture (SEBAM) to carry out a Flood Risk Assessment (FRA) for a proposed 400kV substation development at Greens near Turriff in Aberdeenshire.

6.1.2 Hydraulic modelling indicates that out-of-bank flooding will occur along the banks of the Burn of Greens in a 1 in 200 year plus climate change flood event. The proposed development will be located outwith the areas shown to be at risk of flooding with the exception of the locations when the proposed access road crosses the Burn of Greens and ditch.

6.1.3 Localised increases in flood level and extent associated with the proposed watercourse crossing on the Burn of Greens will not result in a flood risk to the proposed development in a 1 in 200 year event plus climate change. No increase in fluvial flood risk is predicted outwith the site boundary. The residual risk of fluvial flooding should be mitigated by the inclusion of a 600 mm freeboard to sensitive equipment and buildings. The substation platform is to be set at 129.5 mAOD, which is over 20 m higher than the modelled flood levels in Burn of Greens.

6.1.4 Risk of flooding as a result of infrastructure failure, overland flows, sewer flooding, and groundwater flooding are all considered to be low. Residual risk of flooding should be mitigated by profiling ground levels to route flood water around and away from sensitive infrastructure.

Appendix 1 Drawings

Pump
Pond
Burn of Greens
Newton
Wind Turbine
Tank
Mill of Allathan Croft
Well
Pond
Longhaugh
105.5m
Mill of Allathan
Water Mill
Little Water
Oldtown
Drain
Drain
Drain
Pump
Greens
102.4m
103.3m
Pond
Track
Sheep Wash
Ruins
Torrisdon
Drain
100.3m
Pond
Greenford
Parkside of Greens
Mains of Greens
Greenfield
Pond
Tank
Drain
Drain
Burn of Greens
124.5m
Borderside
Pond
Water Mill
103.3m
Inchgreen Cottage
Spring
95.7m
Tank
Parkhill Smiddy
TCB
Track
Inchgreen
Drain
Pond
Greens
Burn of Greens
121.9m
109.1m
113.4m