

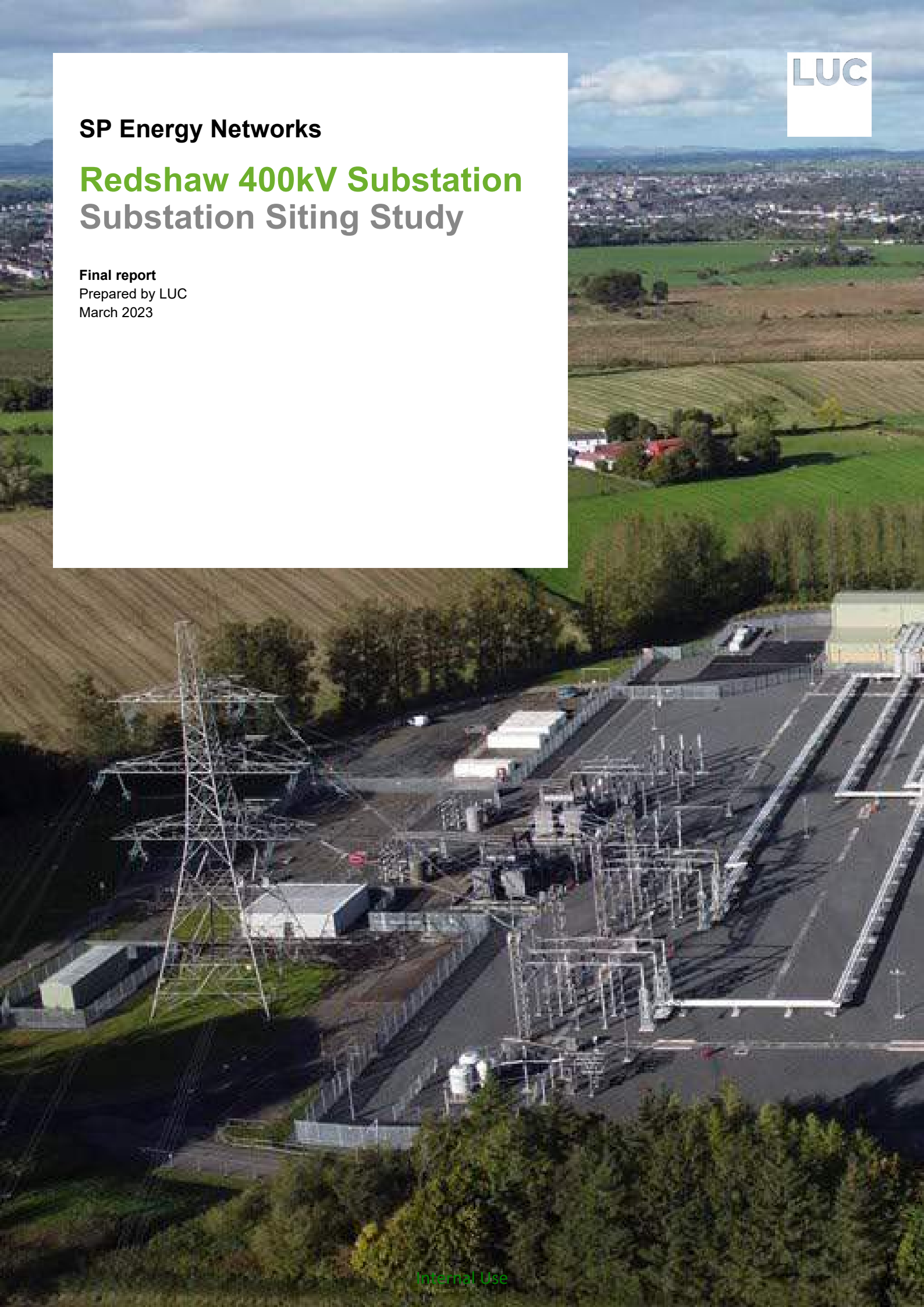
SP Energy Networks

Redshaw 400kV Substation **Substation Siting Study**

Final report

Prepared by LUC

March 2023



SP Energy Networks

Redshaw 400kV Substation Substation Siting Study

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Chapter 1

Introduction

Introduction

1.1 SP Energy Networks (SPEN) is currently proposing a new 400kV/132kV substation at Redshaw (the Proposed Development).

1.2 Owing to the nature of the future renewable energy projects that are planned for the area, the chosen site for the Proposed Development will also have scope for future expansion to meet the need for these renewable energy projects to be connected to the grid. It is anticipated that approximately 2 gigawatts of renewable energy will be generated from these developments.

1.3 The existing transmission grid infrastructure in the South of Scotland will, in the next few years, be operating at full capacity and will therefore no longer be able to accommodate the planned and potential new generation in the area. Therefore, SPEN is required to reinforce the network to facilitate future connections and ensure the network remains fit for purpose. The Proposed Development will provide security to existing supplies as it will create an alternative 'feed' should a catastrophic event occur on the system at Kilmarnock South. This will give more reliability to the network and ensure power continuity.

1.4 To meet the requirement and accommodate the planned and potential generation in the area, SPEN undertook a Strategic Optioneering Study which proposed a new 400kV overhead transmission line to connect a new substation adjacent to the Glenmuckloch Pumped Storage Hydropower (PSH) substation to the existing 'ZV' route (Scotland to England 400kV interconnector), via a new 400/132kV substation located between Coalburn and Elvanfoot (Glenmuckloch to ZV 400kV Over Head Line (OHL) route).

1.5 The proposed Glenmuckloch to ZV 400kV OHL will connect from the proposed Glenmuckloch substation near Kirkconnel (subject of the submitted Section 37 application to the Energy Consents Unit; ECU0001988), to the Proposed Development in proximity to the existing 400kV Scotland to England interconnector (ZV route) at Redshaw. The route from the Glenmuckloch substation to the new substation at Redshaw is subject to a separate routeing and consultation

process, however the key components are annotated in **Figure 1.1**. for ease of reference.

1.6 The existing ZV route will also ‘turn in’ to the proposed 400kV/132kV substation, with the 132kV collector required due to the renewable generation applications received by SPEN to date.

1.7 This report sets out the findings of a high level environmental and technical substation siting study for the Proposed Development, located in an area next to the existing 400kV ZV route.

1.8 The Proposed Development will consist of the following infrastructure:

- A new 400Kv Gas Insulated Switchgear (GIS) substation building which will house gas insulated electrical switchgear and plant (85m x 45m);
- A new Gas Insulated Switchgear (GIS) substation building which will house gas insulated electrical switchgear and plant (30 x 20m);
- A small distribution substation building to provide ancillary power, lighting, heating and ventilation;
- 4 x 360MVA transformers;
- A new permanent access track from local public road to substation compound;
- Internal access roads and parking provision;
- Internal access roads and parking provision;
- A new 3m high steel palisade security fence and internal fencing around the live compound

1.9 An example of the potential layout for the Proposed Development is illustrated in **Figure 1.2**. The photography used in **Figure 1.2** shows the SPEN Kilmarnock South substation location.

1.10 The overall aim of this substation siting study is to identify the most appropriate site for the proposed 400kV/132kV substation, reflecting known environmental considerations and technical considerations identified by SPEN.

Strategic Optioneering Background

1.11 In June 2019, LUC on behalf of SPEN produced an Optioneering Study which sought to identify potential substation siting areas based on technical and environmental considerations and provide advice on the ‘constraints’ and ‘opportunities’ of each option. The Optioneering Study

considered three main components that were required to deliver the proposed electricity network upgrades:

- a new 400kV substation located in the vicinity of the existing ‘ZV’ route (Scotland to England 400kV interconnector) between the existing Coalburn and Elvanfoot substations; and

1.12 It was understood that the Redshaw substation needed to be located on the eastern side and ideally within 500 m of the existing ZV route for technical reasons.

1.13 The Optioneering Study methodology followed these five key stages:

1. Identification of study area and mapping of environmental and technical data;
2. Identification of substation search areas and strategic corridors;
3. Identification of substation siting areas and broad corridor options;
4. Relative appraisal of substation siting areas and broad corridor options; and
5. Summary of strategic optioneering.

1.14 For the purpose of this report, the following text will focus on the substation siting areas only. Full details of the Optioneering Study and its findings can be found in the June 2019 report which is available on the SPEN Redshaw project webpages¹.

1.15 Following completion of Stage 1, three substation search areas were identified based on desk based information (stage 2), as noted in **Table 1.1** below.

Table 1.1: Substation Search Areas (Optioneering Study 2019)

Substation Search Area	Description
A	Substation search area extending east, south-east of the existing Coalburn substation and ZV route, encompassing an area of former open cast mineral extraction at Broken Cross Muir and agricultural land within the Douglas Water Valley east of the M74 corridor in South Lanarkshire.
B	Substation search area extending east of ZV route between Douglas to the north and Abington to the south, and encompassing

¹ http://spenergynetworks.co.uk/pages/redshaw_400kv_substation

Substation Search Area	Description
	elevated moorland and rough grazing west of the M74 corridor within South Lanarkshire.
C	Substation search area extending east, north-east of the existing Elvanfoot substation, between Crawford to the north and Elvanfoot to the south, situated in the Upper Clyde Valley in Dumfries and Galloway.

1.16 These three search areas are illustrated in **Figure 1.3**.

1.17 With regards to the substation search areas, stage 3 involved a preliminary landscape and visual amenity review during fieldwork. This in addition to the desk based work of stage 1 confirmed that the three substation search areas where suitable for the identification of substation siting areas.

1.18 Stage 4 required the substation siting areas to be appraised. Based on established practise for transmission substation/infrastructure siting, the following criteria were appraised:

- Biodiversity;
- Landscape and visual amenity;
- Cultural heritage;
- Forestry;
- Land use; and
- Other technical constraints

1.19 Following the appraisal stage, the Optioneering Study provided a strategic summary of the potential constraints and opportunities in relation to the progression of each substation siting area. The study did not identify a preferred substation siting area at that stage.

Post Optioneering Study

1.20 Since the production of the Optioneering Study in 2019, there have been new constraints which have materialised (wind farm proposals, OHL connections) which impact the technical availability of substation siting areas A and C. Substation siting area B was therefore determined to be the most technically viable solution in relation to its proximity to the existing ZV route, its ability to accommodate the proposed

Glenmuckloch to ZV 400kV route from the south west and the proposed OHL connections from local generation applications.

SPENs Overall Approach to Substation Siting

1.21 The Government, Ofgem and the electricity industry, including SPEN, have reviewed their positions on OHLs and associated infrastructure. They remain of the view that the need to balance economic, technical and environmental factors, as a result of statutory duties and licence obligations, continues to support an OHL approach in most cases.

1.22 In 2019, SPEN published a summary document outlining the approach taken to routeing transmission infrastructure (including substations); SP Energy Networks, Approach to Routeing and Environmental Impact Assessment (2019)².

1.23 The Approach to Routeing document guides substation siting and design using the Horlock Rules which were devised in 2003 and updated in 2006 by National Grid Company plc.³ The Horlock Rules provide guidelines for the siting and design of new substations, or substation extensions, to avoid or reduce the environmental effects of such developments.

1.24 The Approach to Routeing document was also used to prepare the Optioneering Study.

Substation Search Areas

1.25 As set out above, three substation search areas were defined; A, B and C (**Figure 1.3**) The substation search areas were identified to meet the objectives of being within proximity to the existing ZV 400kV OHL and able to accommodate new proposed OHL connections.

1.26 The substation search areas were subject of a preliminary landscape and visual amenity review (in addition to the desk based assessment work) including site fieldwork working. The initial landscape review included consideration of the following broad criteria:

- Suitability to accommodate required footprint size of proposed substation;
- Localised topography of potential location, including opportunities to integrate substation into existing landform;
- Openness and scale of the landscape;
- Presence of absence of existing screening features;
- Presence of sensitive landscape features;

²

https://www.spenergynetworks.co.uk/userfiles/file/SPEN_Approach_to_Routeing_Document_2nd_version.pdf

³ Copies of these documents can be found on the SPEN Redshaw project website - http://spenergynetworks.co.uk/pages/redshaw_400kv_substation

- Presence of settlements and residential properties;
- Absence of other designated areas of natural and built heritage features;
- Opportunities for implementation of potential mitigation screening; and
- Presence of existing substation and transmission line infrastructure.

1.27 With the route of the new 400kV OHL route from Glenmuckloch substation to Redshaw to be determined, it was considered that Search Area B provided the greatest flexibility to accommodate the new substation in a location which would be more readily accessible by the OHL route. On this basis, search area B was identified as the 'study area' for the new substation siting areas as shown in **Figure 1.4**.

1.28 Search area B is located wholly within the administrative area of South Lanarkshire, approximately 3km south-east of the village of Douglas. The M74 and the B7078 run parallel to the east and west of the search area.

1.29 The search area mainly comprises moorland/grassland, however, there are two disused quarries present in the north and two active quarries present in the east. The existing ZV route runs broadly from south-east to north-west along the western edge of the study area.

Figure 1.1: Location Context

- 400kV OHL (ZV route)
- 132kV OHL
- Existing substation
- Proposed substation

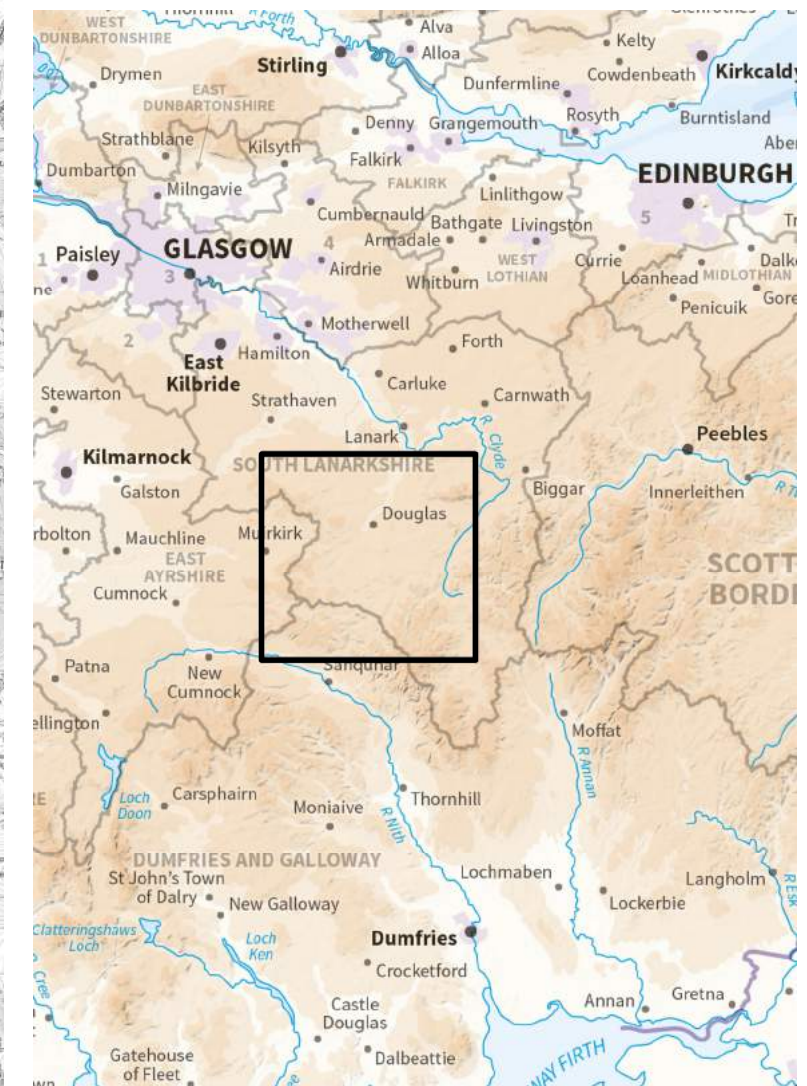
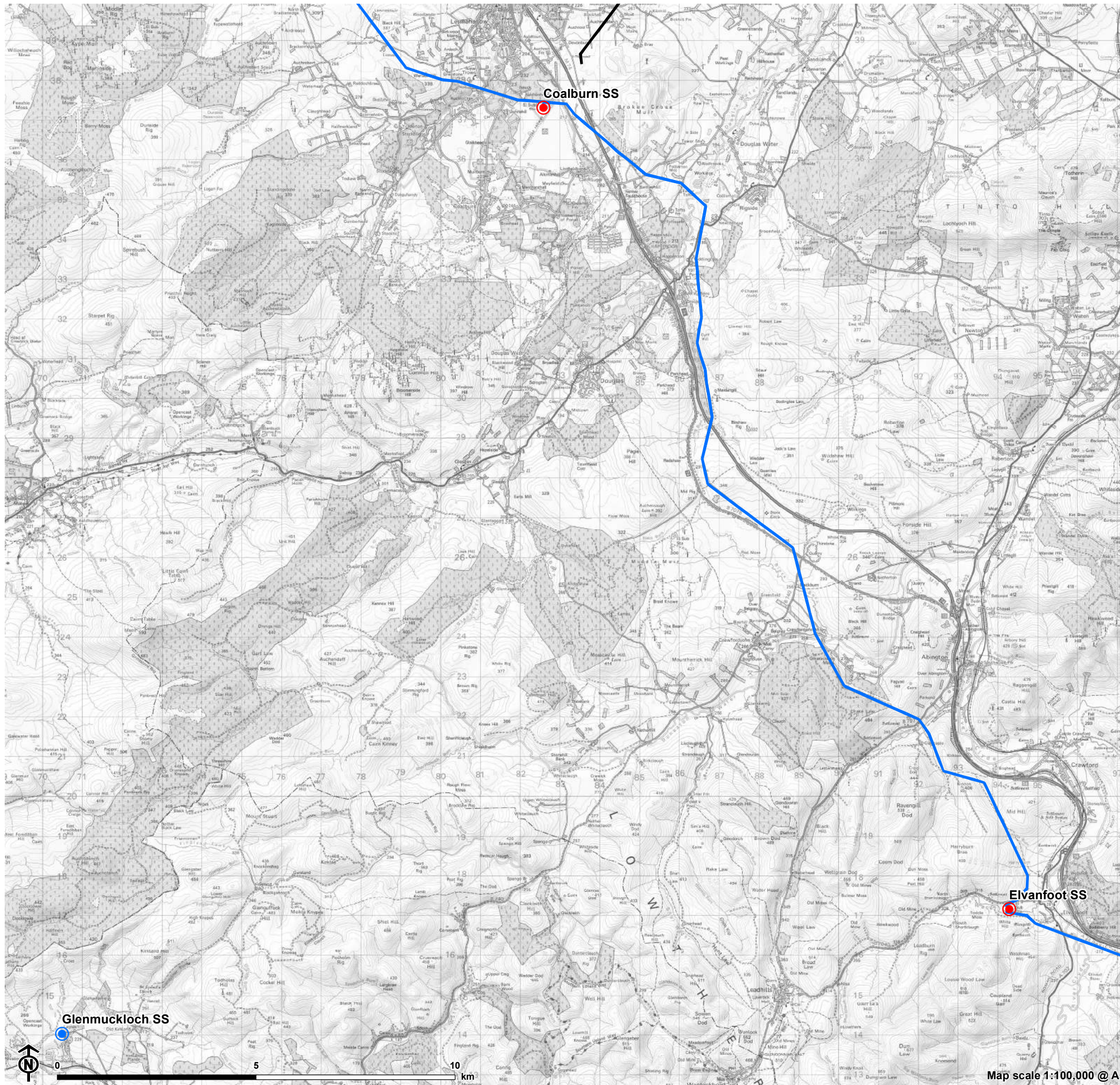


Figure 1.2: SPEN Kilmarnock South substation

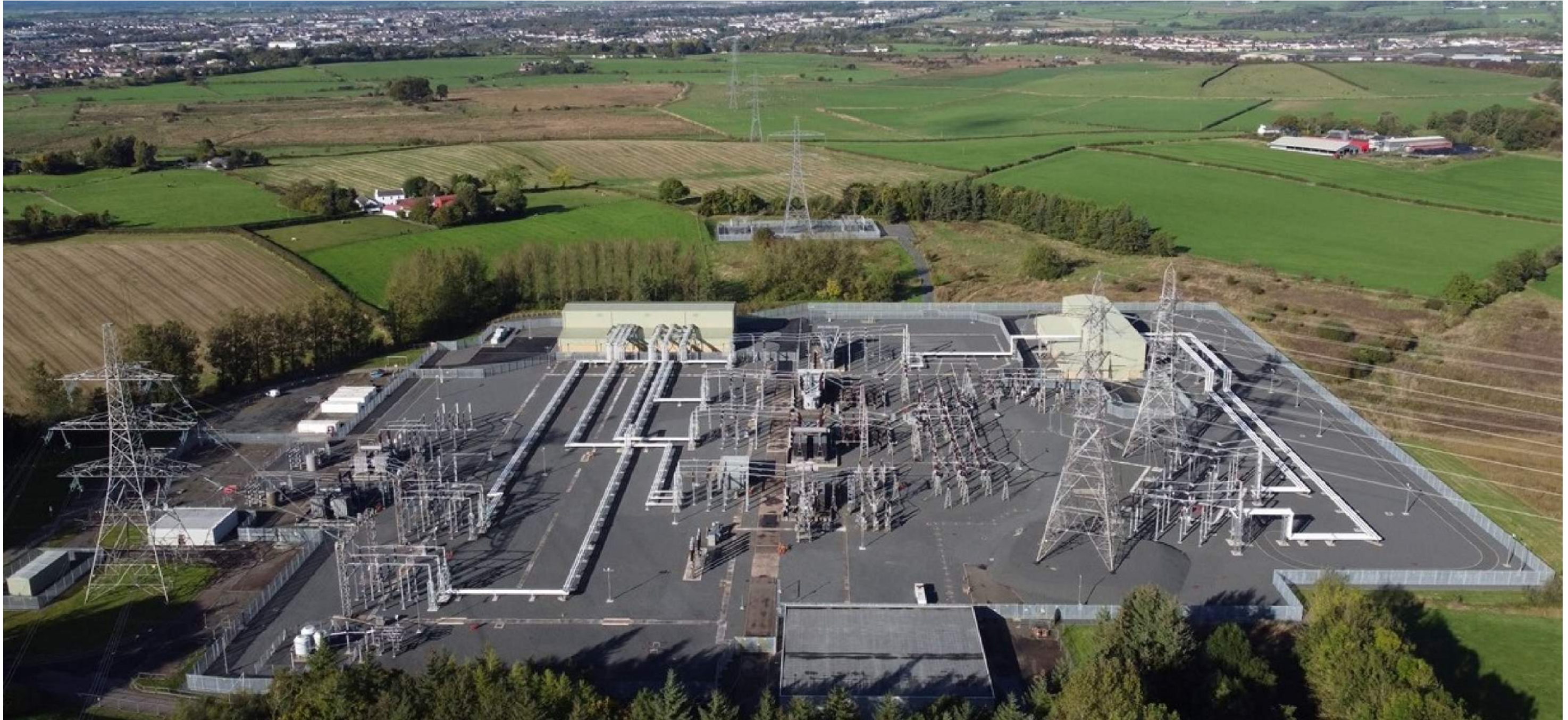
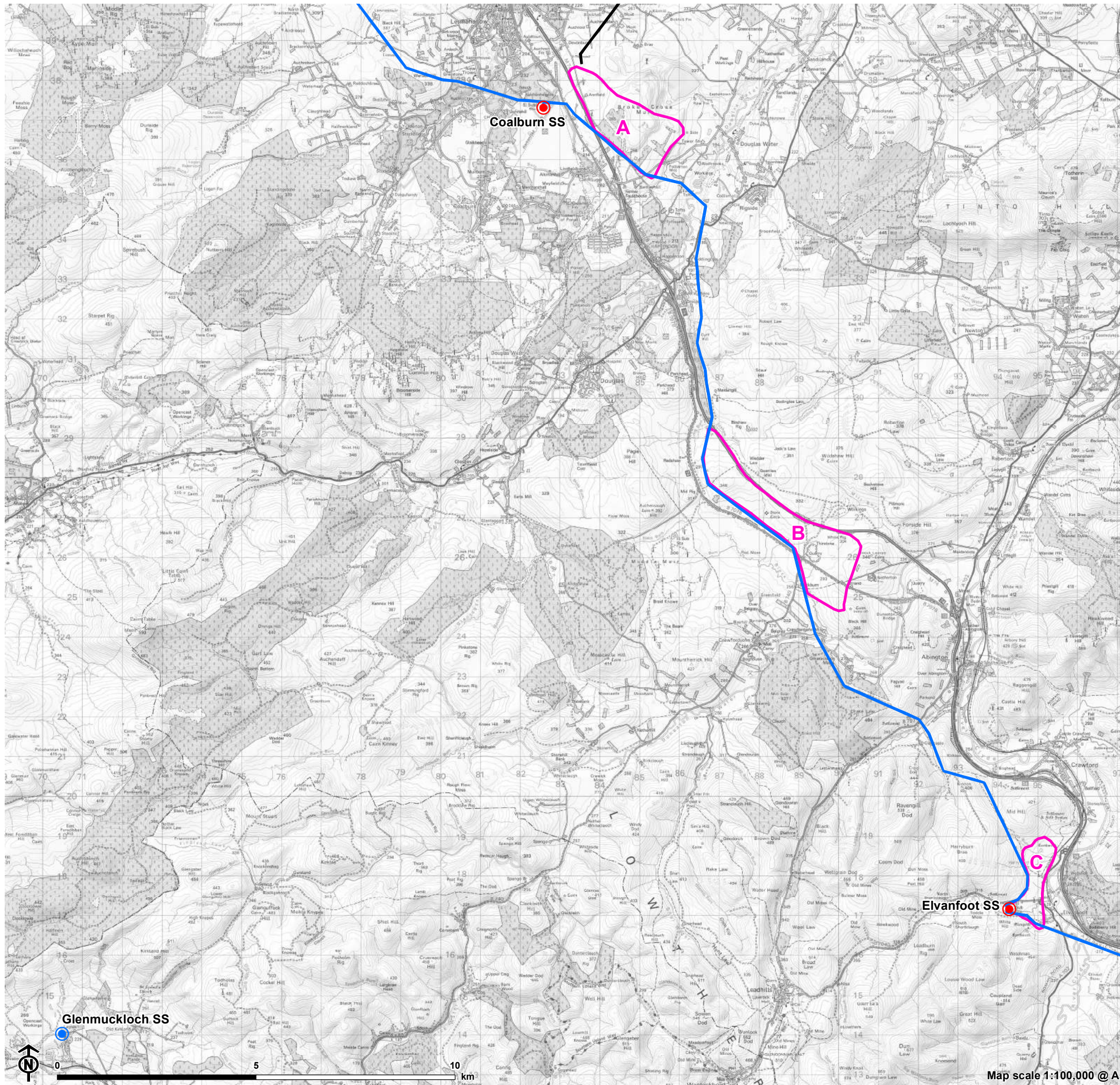


Figure 1.3: Substation Search Areas







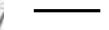
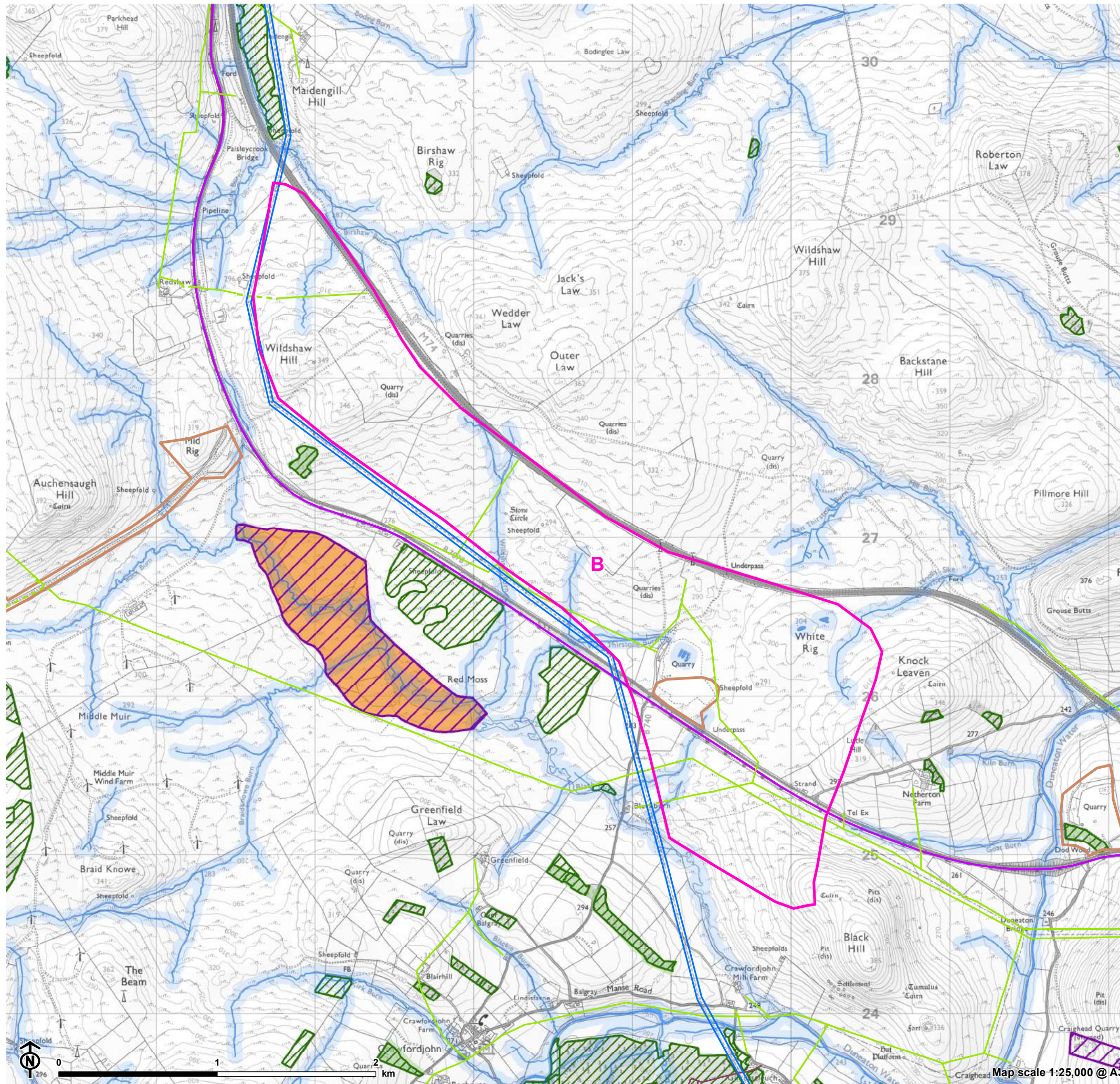
-  Substation search area
-  Existing substation
-  Proposed substation
-  400kV OHL
-  132kV OHL

Figure 1.4: Study Area



- Substation search area
- 400kV OHL
- 11kV OHL
- 11kV UGC
- Mineral Development Sites (Indicative)
- Site of Special Scientific Interest (SSSI)
- Special Area of Conservation (SAC)
- Ancient Woodland Inventory (AWI)
- National Forest Inventory
- National Cycle Network
- Core path
- Watercourse
- 50m watercourse buffer

Notes:

The Mineral Development Sites have been digitised from the South Lanarkshire Local Development Plan 2 proposed plan: Minerals map.

The Central Southern Uplands Environmentally Sensitive Area (ESA) covers the entirety of the study area and is not illustrated on this figure.

For data licencing reasons, the SEPA 1:200 year flood risk zones are not shown on this figure. These can be viewed at the following link: <https://www.sepa.org.uk/environment/water/flooding/flood-maps/>

Chapter 2

Substation Siting Areas

Identification of Substation Siting Areas

2.1 The substation siting areas were identified within substation search area B based on the desk-based information within the following technical requirements provided by SPEN:

- located on the eastern side of the ZV route;
- Ideally, located within 500m of the existing ZV route; and
- Minimum footprint area of 500m x 350m required to accommodate 4 x 400/132kV transformers.

2.2 Informed by site visits to the study area undertaken in 2022 and a high-level review technical constraints, one substation siting area was identified by SPEN. An additional two substation sitting areas were identified by LUC within which to locate the Proposed Development. The identification of these additional two LUC substation siting areas has been landscape led, seeking to be located close to the existing ZV route. These proposed substation siting areas have been numbered 1, 2 and 3, and are illustrated on **Figure 2.1** and described below.

Substation Siting Area 1

2.3 Substation Siting Area 1 was identified by SPEN based solely on optimum technical requirements (i.e. ability to be able to turn in the ZV route, proximity to existing and proposed wind farms, avoidance of Glenmuckloch to ZV route running alongside with the existing ZV route over a long distance). The location was identified as a site which is located between towers ZV106 and ZV108, where it is considered that the existing tension towers would give the ability to divert the existing OHL circuits, whilst two new terminal towers would be constructed in place of tower ZV107 to turn both circuits into the new site. Siting Area 1 is located to the east of tower ZV107 to satisfy these technical requirements. Environmental considerations were not initially factored into the identification of this siting area.

Substation Siting Area 2

2.4 Substation Siting Area 2 was identified by LUC based on technical requirements as well as known environmental considerations. The location was identified as a site which is located between towers ZV109 and ZV111, where it is considered that the existing tension towers would give the

ability to divert the existing OHL circuits, whilst two new terminal towers would be constructed in place of tower ZV110 to turn both circuits into the new site. Siting Area 2 is located to the east of tower ZV110 to satisfy these technical requirements. Landscape fit and the presence of existing features to integrate and where possible screen the substation infrastructure was also taken into consideration.

Substation Siting Area 3

2.5 Substation Siting Area 3 was identified by LUC based on technical requirements as well as known environmental considerations. The location was identified as a site which is located between towers ZV113 and ZV115, where it is considered that the existing tension towers would give the ability to divert the existing OHL circuits, whilst two new terminal towers would be constructed in place of tower ZV114 in order to turn both circuits into the new site. Siting Area 3 is located to the east of tower ZV114 to satisfy these technical requirements. Landscape fit and the presence of existing features to integrate and where possible screen the substation infrastructure was also taken into consideration.

Identification and Mapping of Environmental and Technical Considerations

2.6 Following the identification of the substation siting areas environmental and technical considerations have been mapped and reviewed by competent experts at LUC and CFA Archaeology. These considerations were used in the comparative appraisal of the Substation Siting Areas to identify a preferred Area. The environmental considerations used in the appraisal are set out below and can be viewed in **Figure 2.1**.

Environmental Considerations for Appraisal of Siting Areas

2.7 The following environmental considerations have been mapped for consideration in the appraisal to identify the preferred substation siting area.

2.8 The findings and conclusions of the appraisal of the substation siting areas are presented within **Chapter 3** and accompanying **Appendix A**.

Landscape and Visual

2.9 In respect to landscape and visual amenity, a 3km radius study area (L&V study area) from the centre of each substation siting area was employed. Local landscape designations within South Lanarkshire (Special Landscape Areas (SLAs)) and Landscape Character Types (LCTs) have been mapped within the study area and are illustrated on **Figure 2.2**.

2.10 In terms of landscape designations, there are no national level landscape designations across the L&V study area. The north-western extent of the L&V study area includes a small proportion of the locally designated Douglas Valley Special Landscape Area (SLA)⁴ and the southern extent includes a small proportion of the Leadhills and Lowther Hills SLA.⁵

2.11 The NatureScot (formerly SNH) digital map-based National Landscape Character Assessment (published in 2019)⁶ has been used as the basis for determining the susceptibility of LCTs across the L&V study area. This identifies the L&V study area as being largely contained within the Plateau Moorland – Glasgow and Clyde Valley LCT.⁷ This is a large-scale landscape, with relatively simple terrain and landcover that is considered to be of lower susceptibility to the type and scale of development proposed. A small proportion of the northern and southern extents of the L&V study area are within the Upland River Valley – Glasgow and Clyde Valley LCT.⁸ This LCT is considered to be of higher susceptibility to the type and scale of development proposed, with a more complex, smaller scale landform and settled pastoral land use (see **Figure 2.2**).

2.12 The terrain, landscape and land use across the L&V study area has also been analysed, to help inform the preferred substation siting area. In terms of terrain the majority of the L&V study area is formed by undulating plateau and rounded hill summits including Wildshaw Hill (378m AOD) in the eastern extent of the L&V study area and Auchensaugh Hill (392 AOD) in the western extent. In the southern extent of the L&V study area, the landform drops towards the river valley of the Duneaton Water.

2.13 Landcover across the L&V study area is predominantly rough unimproved moorland grazing (see aerial mapping within **Figure 2.3**). The moorland landcover is interspersed with occasional coniferous forestry blocks and a more extensive plantation in the north-western extent of the L&V study area. There are two mineral extraction sites located in

⁴https://www.southlanarkshire.gov.uk/download/downloads/id/4147/landscape_designations_report_november_2010.pdf

⁵https://www.southlanarkshire.gov.uk/download/downloads/id/4147/landscape_designations_report_november_2010.pdf

⁶ <https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/scottish-landscape-character-types-map-and-descriptions>

⁷ <https://www.nature.scot/sites/default/files/LCA/LCT%20213%20-%20Plateau%20Moorlands%20-%20Glasgow%20&%20Clyde%20Valley%20-%20Final%20pdf.pdf>

⁸ <https://www.nature.scot/sites/default/files/LCA/LCT%20207%20-%20Upland%20River%20Valley%20-%20Glasgow%20&%20Clyde%20Valley%20-%20Final%20pdf.pdf>

the south-eastern extent of the L&V study area, adjacent to the B7078 (see **Figure 2.1**) while Middle Muir and Andershaw Wind Farms occupies moorland in the western extent. In contrast to the plateau, landcover towards the Duneaton Water Valley is predominantly agricultural with pasture fields, rough grazing and blocks of coniferous and broadleaved woodland. There are a number of small tributaries across the study area which take various routes to drain south into the Duneaton Water Valley or north into the Douglas Water Valley, beyond the L&V study area (see **Figure 2.2**).

2.14 The L&V study area is sparsely populated aside from scattered properties in the vicinity of the B7078 and the small settlement of Crawfordjohn in the southern extent of the L&V study area (see **Figure 2.2**). The M74 runs through the eastern half of the L&V study area broadly parallel to the B7078, providing a major north-south transport corridor across the plateau.

2.15 The landscape and visual siting appraisal also considers potential key viewpoints and visual receptors, with a focus on the likely visual considerations in relation to the siting of the proposed substation infrastructure. Though the L&V study area is largely unpopulated, there are a small number of isolated residential properties located within 1km of the substation siting areas. These are Redshaw approximately 650m north-west of Substation Siting Area 1 (grid ref 286029, 628525) and at Thirstone approximately 750m south-east of Substation Siting Area 3 (grid ref 289176, 626316). The Red Moss Hotel and Truck Stop is located approximately 340m to the south of Substation Siting Area 2 (grid ref 287414, 627043) though it is currently unoccupied. These properties are shown on **Figure 2.1** along with a 150m radius trigger zone for consideration in respect to residential visual amenity.

2.16 Potential visual receptors include local residents, road users on limited stretches of the M74 to the east of the substation siting areas and road users on the B7078 to the west, from which views towards the substation siting areas are more open and extensive. Recreational receptors include users of National Cycle Network (NCN) Route 74 and the adjacent SLC core path (CL/3464/1) which run alongside the B7078 along a dedicated shared cycle path and walkway.

Ecology and Ornithology

2.17 Ecological and ornithological constraints have been mapped across the study area where relevant (**Figure 1.4**).

2.18 Whilst there are no statutory designated sites located within the study area, Red Moss Special Area of Conservation (SAC) and Site of Special Scientific Interest (SSSI) is located approximately 250m away. The SAC qualifying interests for which the site is designated for, is active raised bogs and is a priority habitat.

2.19 The Central Southern Uplands Environmentally Sensitive Area (ESA) covers the entirety of the study area. The ESA is designated for the purpose of conserving, protecting and enhancing environmental features of the area by the maintenance or adoption of agricultural methods.

2.20 Due to the potential for construction impacts, the SAC, SSSI and ESA are considered in the appraisal.

Cultural Heritage

2.21 Archaeological records, obtained from West of Scotland Archaeology Service (WoSAS) Historic Environment Record (HER), together with designations lists obtained from Historic Environment Scotland (HES), have been used to map known cultural heritage constraints within 200m of each substation siting area and within 3km of the substation search area, as shown on **Figure 2.4**.

2.22 There are six Scheduled Monuments within the 3km study area (see **Figure 2.4**) that are considered further in the appraisal. These are:

- Auchensaugh Hill, cairn (SM 4234);
- Craighead, platform settlement 1200m WNW of (SM 4485);
- Wildshaw Hill, cairn 500m WSW of summit (SM 4511);
- Netherton, cairn 800m SW of (SM 4513);
- Thirstone, stone circle 1300m NNW of (SM 5094); and,
- Thorril Castle, bastle house 450m NNE of Parkhead (SM 5425).

2.23 The closest Scheduled Monument to any of the option areas is Thirstone, stone circle 1300m NNW of (SM 5094). It lies 200m from Substation Siting Area 3, is 670m from Substation Siting Area 2 and is 1500m from Substation Siting Area 1. There are many other Scheduled Monuments within the 3km study area, including several that have settings where wide ranging visibility to and from their locations and intervisibility between them are important aspects of their settings, but these are not considered further in the appraisal as it is not expected that the Proposed Development would negatively impact these assets.

2.24 There are other heritage assets with statutory and non-statutory designations (in this instance, Scheduled Monuments, other archaeological sites recorded in the WoSAS HER as non-statutory register (NSR) sites of potential national importance, Listed Buildings, and Conservation Areas) within the 3km study area.

2.25 In addition to the Scheduled Monuments, there are four NSR sites recorded in the WoSAS HER that are considered to be of national importance (possibly of schedulable quality)

within the 3km study area and these are considered further in the appraisal (**Appendix A**). These are:

- Auchensaugh Hill Enclosure (10054)
- Knock Leaven Cairn (10454);
- Auchensugh Hill; Mound, Shieling Hut (13295); and
- Crawfordjohn Mill/Black Hill Cairn (10535)

2.26 The nearest other designated heritage assets to any of the substation siting areas are a group of Listed Buildings in the Douglas Conservation Area, 4km north-west of the nearest substation siting area (Substation Siting Area 1) and a Category B Listed Estate Complex (New Mains) to the north-east of Douglas. There is no unobstructed view from these Listed Buildings or from any part of the Conservation Area, and their settings would consequently not be adversely affected by any of the three options. There are also Listed Buildings at Crawfordjohn, 3km to the south of the nearest substation siting area (Substation Siting Area 3) and at Robertson, 6km to the east north-east of the nearest substation siting area (Substation Siting Area 3) but these too have no unobstructed intervisibility with any of the substation siting areas, and their settings would consequently not be adversely affected by any of the proposed options. Impacts from the proposed development on Listed Buildings and Conservation Areas, along with other statutory and non-statutory designations will not be considered further in the appraisal.

2.27 The HER records four non-designated heritage assets within 200m of Substation Siting Area 1. These include several small cairns (potentially but not certainly of prehistoric date), remains of buildings (likely of post-medieval date), and indeterminate remains (likely of little or no heritage significance). The small cairns and buildings would be archaeological constraints to micrositing the substation and potentially sensitive to impacts during construction.

Land Use

2.28 There one mineral site located in the eastern portion of the substation search area; which is allocated within the South Lanarkshire Local Development Plan 2 (adopted April 2021) (see **Figure 1.4**). Therefore, this has been considered further in the appraisal.

2.29 There are no committed developments present in the substation search area. As such, this has not been considered further in the appraisal.

2.30 Land Capability for agricultural classes 1, 2, and 3.1 in Scotland are referred to as 'Best and Most Versatile' land (with regards to agricultural productivity) and are afforded protection from development. There are no areas of class 1, 2 or 3.1 within the study area, therefore agricultural land use has not been considered further in the appraisal.

Watercourses and Flood Risk

2.31 Hydrological constraints across the substation search area have been mapped and considered (see **Figure 1.4**). A 50m buffer has been applied to watercourses and siting of the Proposed Development will be located at least 50m set back from the watercourse where possible. The presence of watercourses and 50m buffers are included in the appraisal (**Appendix A**).

2.32 Based on SEPA flood mapping for the study area, there are small pockets of land that are subject to a high likelihood of surface water flooding each year. These are located in the north-west of the study area, associated with Long Burn; in the west of the study area running parallel to the B7078 and in the east near White Rig. The Duneaton Water also crosses through the study area in the east, where there is a high likelihood of river flooding.

2.33 As there is both river and surface water flooding present in the substation search area, flood risk is considered further in the appraisal.

Peatland

2.34 The presence of peat throughout the substation search area, particularly deep peat, was considered using the SNH (now NatureScot) (2016) Carbon and Peatland Map. The SNH (2016) map is a GIS dataset that indicates the likely presence of carbon-rich soils, deep peat and priority peatland habitat at a broad scale across Scotland. Based on the SNH (2016) map, no peat is present within the substation search area and therefore is not considered further in the appraisal.

Forestry and Woodland

2.35 Forest areas within the substation search area have been identified through the use of aerial photography, combined with digital data available from NatureScot and Scottish Forestry sources.

2.36 These forests are divided into three groupings:

1. Conifer Forest from the National Forest Inventory (NFI);
2. Ancient Woodland Inventory (AWI); and
3. Native Woodlands from the Native Woodland Survey of Scotland (NWSS).

2.37 No Areas of NFI, AWI or NWSS woodland located within the substation search area. It is noted however that there is one small area of AWI and NFI woodland located to the south (outside) of the substation search area, approximately 100m from the B7078 (see **Figure 1.4**). Where no forestry or woodland assets are located within the search area, these have not been considered further in the appraisal. It is noted that access options from the B7078 will look to avoid direct

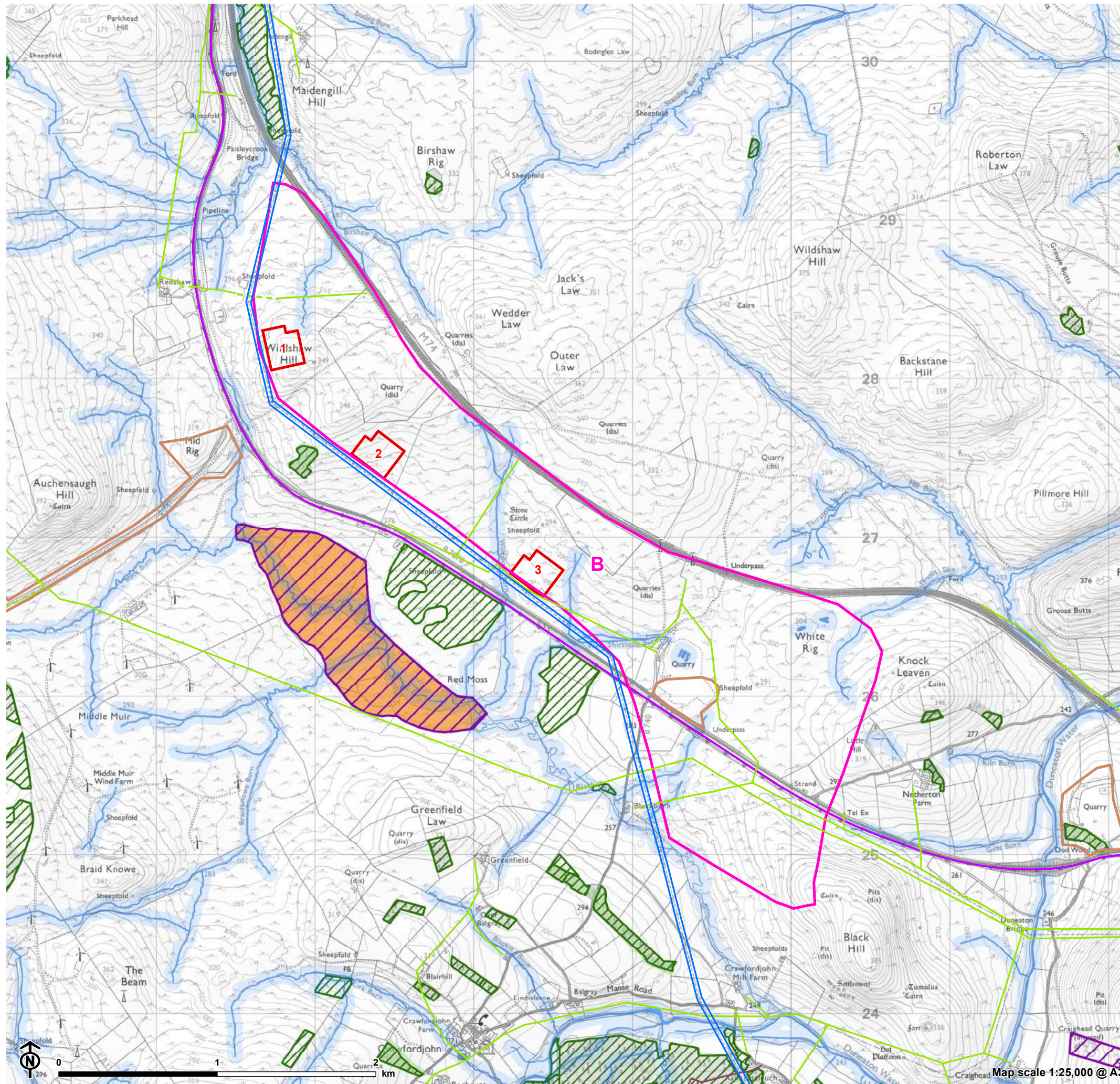
impacts on the AWI and NFI located between the B7078 and the search area boundary.

Technical Considerations

2.38 The technical considerations have been identified to ensure the substation siting areas are within the technical parameters identified by SPEN. These include the following:

- The ability to accommodate future connectivity for 132kV circuits to access the substation from the north, east and south via wood pole overhead line and/or underground cables;
- Road access from B7078 for construction and operational purposes;
- Connectivity of a new 400kV double circuit line on L8 steel towers from the west of the ZV Route;
- Located to the east of the existing 400kV ZV route;
- Located in an area of approximately 17ha, with a substation compound footprint of approximately 500m x 350m;
- Avoidance of existing/proposed electricity infrastructure within the substation search area; 100m buffer has been applied.

Figure 2.1: Substation Siting Areas



- Substation search area
- Substation siting area
- Mineral Development Sites (Indicative)
- 400kV OHL
- 11kV OHL
- 11kV UGC
- Site of Special Scientific Interest (SSSI)
- Special Area of Conservation (SAC)
- Ancient Woodland Inventory (AWI)
- National Forest Inventory
- National Cycle Network
- Core path
- Watercourse
- 50m watercourse buffer

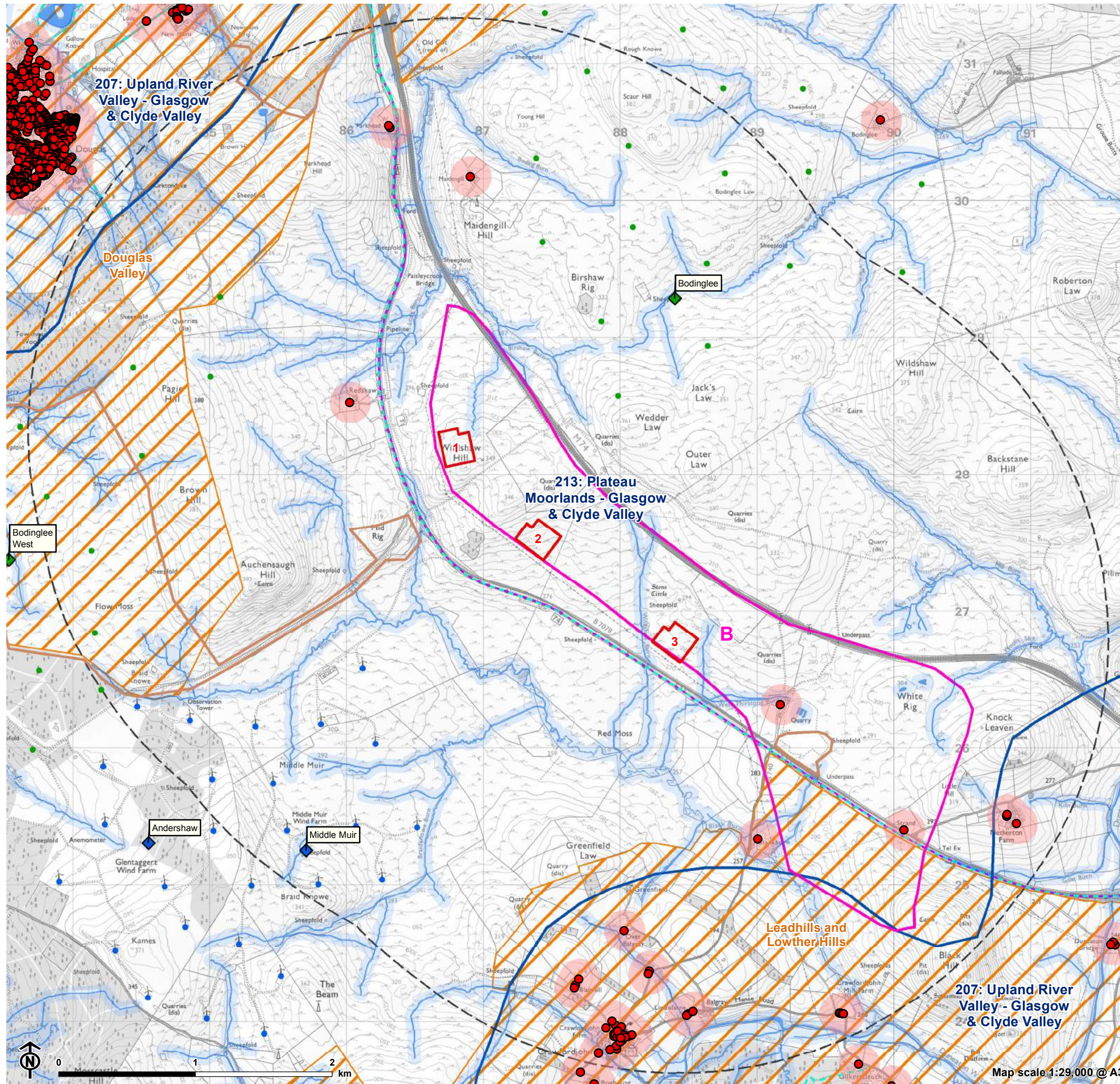
Notes:

The Mineral Development Sites have been digitised from the South Lanarkshire Local Development Plan 2 proposed plan: Minerals map.

The Central Southern Uplands Environmentally Sensitive Area (ESA) covers the entirety of the study area and is not illustrated on this figure.

For data licencing reasons, the SEPA 1:200 year flood risk zones are not shown on this figure. These can be viewed at the following link: <https://www.sepa.org.uk/environment/water/flooding/flood-maps/>

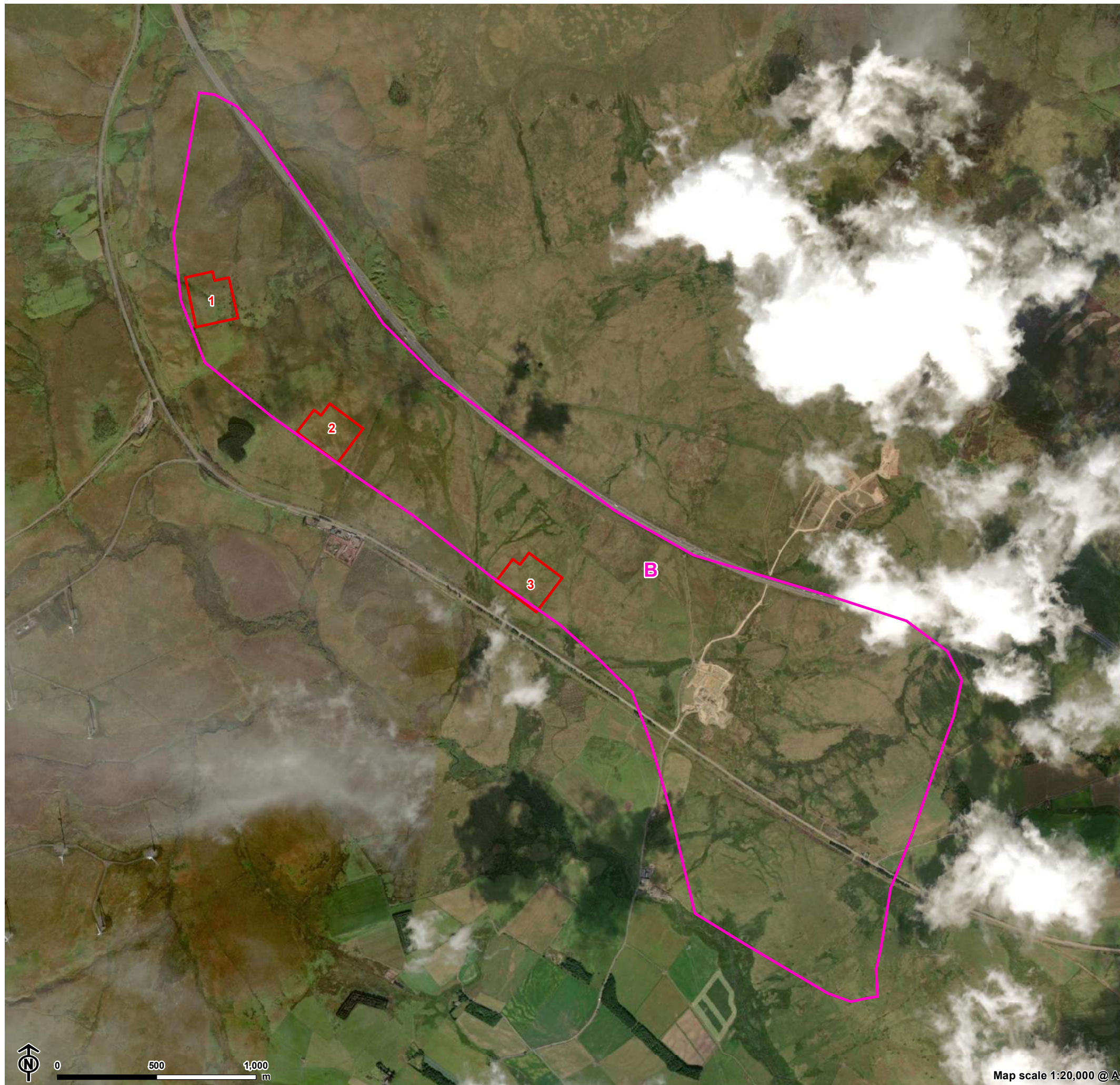
Figure 2.2: Landscape and Visual Study Area



- Substation siting area
- L&V study area (3km buffer)
- Substation search area
- Wind Farm (by status)**
- ◆ Operational
- ◆ Design/Scoping
- Mineral Development Sites (Indicative)
- Watercourse
- 50m watercourse buffer
- National Cycle Network
- Core path
- Residential Property
- 150m property buffer
- Special Landscape Area
- Landscape Character Type

207: Upland River Valley - Glasgow & Clyde Valley
213: Plateau Moorlands - Glasgow & Clyde Valley

Figure 2.3: Landcover and Substation Siting Areas

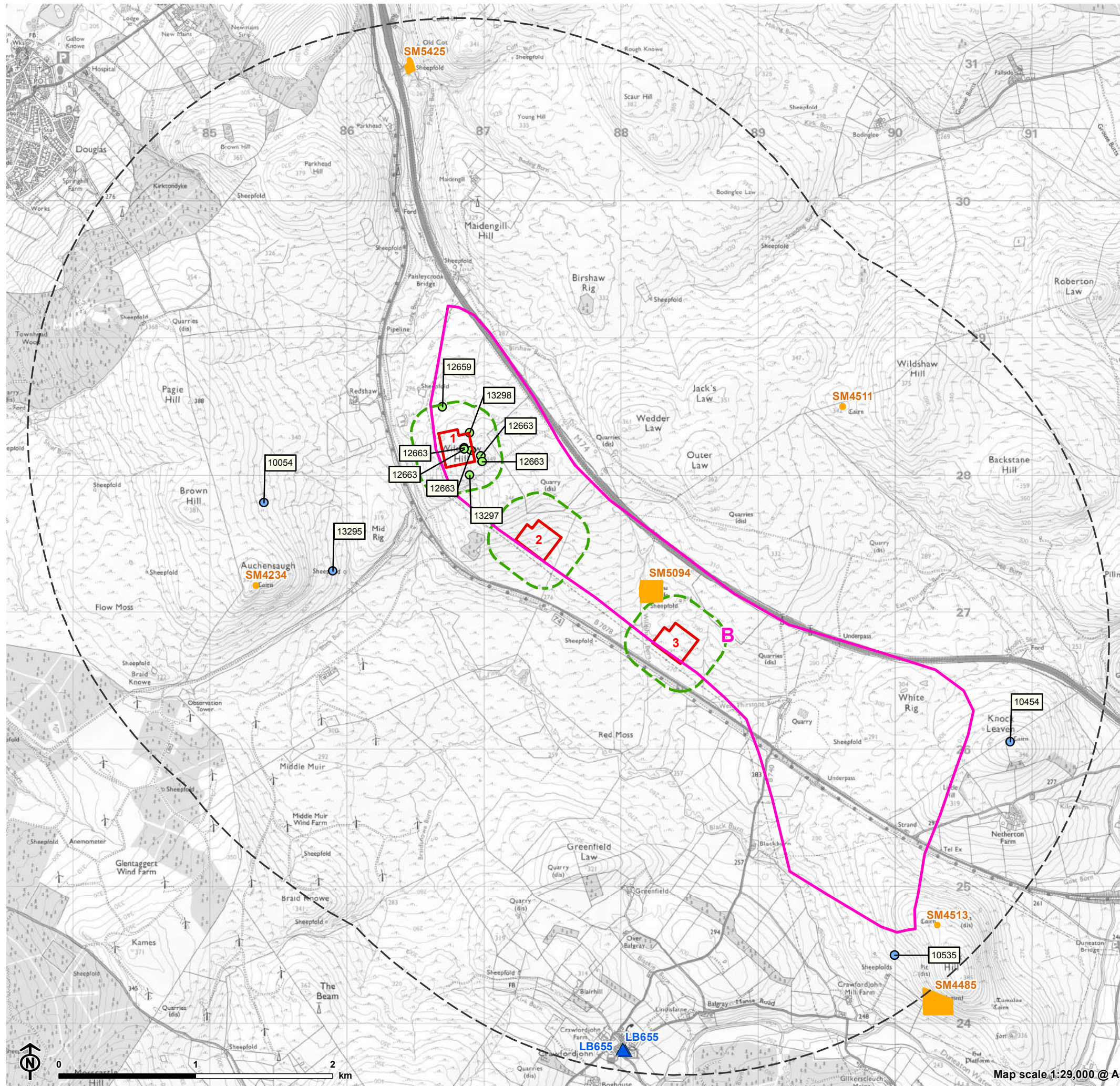


- Substation search area
- Substation siting area



Map scale 1:20,000 @ A3

Figure 2.4: Cultural Heritage Considerations



- Substation search area
- Substation siting area
- L&V study area (3km buffer)
- Archaeological constraint area (200m buffer)
- ▲ Category B Listed Building
- Scheduled Monument
- HER site (archaeological constraint)
- Non-Statutory Register (NSR) site

Chapter 3

Appraisal Findings and Conclusions

3.1 The objective of the appraisal of the substation siting areas was to identify, in a comparable, documented and transparent way, the overall preferred substation siting area for the Proposed Development taking account of environmental and technical considerations.

3.2 The emerging preferred substation siting area for the Proposed Development is **Substation Siting Area 2**. The detailed appraisal findings are included in **Appendix A**.

Technical Review of Emerging Preferred Site Option

3.3 Following the environmental appraisal of the substation siting areas which included consideration of SPEN's technical criteria (as evidence in **Appendix A**), the emerging preferred substation siting area (Substation Siting Area 2) was reviewed by SPEN in relation to design requirements. This technical review was undertaken to ensure that, based on the level of detail available, the preferred substation siting area is within the technical parameters required to construct the proposed 400kV Substation. Substation Siting Area 2 location is the preferred location as it is technically viable and the most economical site in terms of construction due to the topography of the site the level of earthworks required for this site would be 50% less in comparison to SS1 and SS3.

3.4 This site is next to the existing ZV route which runs between Coalburn and Elvanfoot substations. The addition of the Proposed Development will allow for the ZV route to connect to the substation, ensuring greater reliability for the network. Although all three sites identified within this report sit in close proximity to the existing ZV route, Substation Siting Area 2 sits between the existing towers (ZV109 and ZV110) and therefore will minimise disruption with only 1 outage (5 days) required to the ZV route during construction (tower ZV110 will be dismantled), At Substation Siting Areas 1 and 3, the proposed location of the substation would require the relocation of towers, a potential new tower design and longer outages. This site is also in close proximity to the wind farms already developed and proposed in this area which makes connections, especially from the south side more economical. Developers have requested connections to Redshaw substation from the southern side (off the B7078 road). The

route for connecting to these developments is best served by Substation Siting Area 2.

3.5 Overall, from a technical and economical perspective, Substation Siting Area 2 is preferred due to its potential to accommodate future connections due to its location in relation to existing and proposed infrastructure, as well as the least impact on the environment relative to the other two siting areas.

Conclusion

3.6 The preferred substation siting area when considering environmental and technical considerations is confirmed as **Substation Siting Area 2**, as shown in **Figure 2.1**.

Appendix A
Substation Siting Areas
Appraisal Table

Table A1.1: Environmental Appraisal Table for the proposed 132kV/400kV Substation Siting Areas

Criterion	Sub-Criteria	Substation Siting Area 1	Substation Siting Area 2	Substation Siting Area 3	Preference
Landscape and Visual Amenity	Land Use, Landcover, Terrain, Visual Amenity and Potential Opportunities for Additional Mitigation.	<p>Substation Siting Area 1 extends across sloping terrain and moorland land cover near the summit of Wildshaw Hill, between approximately 320m AOD and 340m AOD. It is located directly east of tower ZV107.</p> <p>Substation Siting Area 1 will be evident in views from sections of the M74 to the north and east, and more extensively from the B7078, the National Cycle Network (NCN) Route 74 and core path (CL/3464/1) to the north-west and west. Substation Siting Area 1 will be evident in views from higher ground in the south-eastern periphery of the Douglas Valley SLA approximately 1.8km to the west.</p> <p>The location of Substation Siting Area 1 near the summit of Wildshaw Hill limits opportunities to utilise existing landform to integrate, screen or reduce perceptibility of the substation site in views from the surrounding landscape (embedded mitigation), including from the SLA, and views from the M74 and B7078. Opportunities to incorporate further additional mitigation surrounding the site are also limited.</p> <p>Extensive earthworks (cut and fill) are likely to be required to establish the necessary substation platform(s) with limited opportunity to integrate substation infrastructure into the surrounding terrain, due to the elevated and exposed location near the summit of Wildshaw Hill.</p>	<p>Substation Siting Area 2 extends across low lying and gently sloping terrain north of the B7078, between approximately 295m AOD and 315m AOD. It is located directly east of tower ZV110.</p> <p>Substation Siting Area 2 will be evident in views from M74, B7078 and the National Cycle Network (NCN) Route 74, but views will be limited to short sections of these routes. The visibility of Substation Siting Area 2 from the periphery of the Douglas Valley SLA to the west, north-west will be limited by intervening landform.</p> <p>Existing landform sloping to the north and north-east provides opportunities to integrate the development into the existing landform (embedded mitigation), and screen or reduce perceptibility of the substation site in views from the M74, and opportunities for further additional mitigation to be incorporated around the site.</p> <p>Less extensive earthworks (cut and fill) are likely to be required than for Substation Siting Area 1 to establish platform(s) and cut into slopes to north, north-west, may assist with further integrating substation infrastructure in this location.</p>	<p>Substation Siting Area 3 extends across low lying and gently sloping terrain to the north of the B7078, between approximately 275m AOD and 285m AOD. It is located directly north of tower ZV114.</p> <p>Substation Siting Area 3 will be evident in views from the M74, B7078 and the National Cycle Network (NCN) Route 74, but views will be limited to short sections of these routes. The visibility of Substation Siting Area 3 from the periphery of the Douglas Valley SLA to the north-west will be limited by intervening landform.</p> <p>Existing landform sloping to the north and north-east provides opportunities to screen or reduce perceptibility of the substation site (embedded mitigation) in views from the M74, and opportunities for further additional mitigation to be incorporated around the site.</p> <p>Less extensive earthworks (cut and fill) are likely to be required than for Substation Siting Area 1 to establish platform(s) and cut into slopes to north, north-west of site may assist with further integrating substation infrastructure in this location.</p>	<p>Substation Siting Area 2 the preferred option due to its lower lying location and the potential opportunities for both embedded and additional mitigation provided by the existing landform.</p> <p>Substation Siting Area 3 is on lower-lying terrain but is in closer proximity to the B7078 and properties to the south-east.</p> <p>Substation Siting Area 1 is the least favoured option due to its relatively higher elevation and more exposed location, with limited opportunities for either embedded or additional mitigation.</p>
	Landscape Character Types (LCT)	All three sites are located within the Plateau Moorlands - Glasgow & Clyde Valley LCT. Key characteristics include: <ul style="list-style-type: none"> ■ <i>“Large scale landform;</i> ■ <i>Undulating hills and sloping ridges in the western areas; a more even plateau landform in the east;</i> ■ <i>Distinctive upland character created by the combination of elevation, exposure, smooth plateau landform, moorland vegetation;</i> ■ <i>Predominant lack of modern development;</i> ■ <i>Extensive wind turbine development, including one of the largest wind farms in Scotland, Black Law; and</i> ■ <i>Sense of apparent naturalness and remoteness which contrasts with the farmed and settled lowlands, although this has been reduced in places by wind energy development.”⁹</i> 	Due to the large-scale, relatively simple terrain and landcover of the Plateau Moorlands - Glasgow & Clyde Valley LCT it is considered to be of lower susceptibility to the type and scale of development proposed. As all three sites are located within this LCT, there is no overall preference .		
	Designated Landscapes	None of the substation siting areas are located in any nationally or locally designated landscapes.	Substation Siting Area 2 is the preferred option as visibility from the Douglas Valley SLA will be limited by intervening landform.		

⁹ <https://www.nature.scot/sites/default/files/LCA/LCT%20213%20-%20Plateau%20Moorlands%20-%20Glasgow%20&%20Clyde%20Valley%20-%20Final%20pdf.pdf>

Criterion	Sub-Criteria	Substation Siting Area 1	Substation Siting Area 2	Substation Siting Area 3	Preference
		<p>The north-western extent of the L&V study area includes a small proportion of the locally designated Douglas Valley Special Landscape Area (SLA). Relevant special qualities include “<i>scenic compositional qualities of a meandering river passing through a sheltered, mature pastoral landscape enclosed by moorland hills.</i>”¹⁰</p> <p>The southern extent of the L&V study area includes a small proportion of the Leadhills and Lowther Hills SLA. The special qualities of this SLA relate primarily to the extensive uplands at the core of the designated area.</p> <p>All three substation siting areas will be visible from higher ground at the northern edge of the Leadhills and Lowther Hills SLA (within approximately 1.6k-3km). Substation Siting Area 2 and Substation Siting Area 3 will be less visible than Substation Siting Area 1 from higher ground in the Douglas Valley SLA approximately 2-3km to the north-west due to intervening landform.</p>			<p>Furthermore, views from the Leadhills and Lowther Hills SLA towards Substation Siting Area 2 will be longer distance in comparison to Substation Siting Area 3.</p>
	Residential Visual Amenity	<p>There is a property at Redshaw (grid ref 286029, 628525) approximately 650m to the north-west of Substation Siting Area 1, with potential views towards the site.</p>	<p>The nearest property to Substation Siting Area 2 is Redshaw (grid ref 286029, 628525) approximately 1.5km to the north-west, from which views will be screened by intervening landform. The Red Moss Hotel (grid ref 287414, 627043) located approximately 350m to the south is currently unoccupied.</p>	<p>There is a property at Thirstone (289176, 626316) approximately 750m to the south-east of Substation Siting Area 3, with potential views towards the site.</p>	<p>Substation Siting Area 2 is the preferred option due to the absence of nearby properties, though there is the potential for the Red Moss Hotel to be occupied in the future.</p>
Ecology and Ornithology	Environmentally Sensitive Areas (ESA)	<p>All substation siting areas are located within the Central Southern Uplands ESA. This is designated for the purpose of protecting and enhancing environmental features of the area by the maintenance or adoption of agricultural methods. The ESA is unavoidable for all substation siting areas due to its extent.</p>			<p>No overall preference.</p>
	Designated Sites	<p>There are no designated sites located within Substation Siting Area 1, however, Red Moss SSSI and SAC is located approximately 1km to the south (on the other side of the 400kV OHL and the B7078).</p> <p>The SAC qualifying interests for which the site is designated for, is active raised bogs and is a priority habitat. In this regard, construction impacts such as noise are not considered to result in a development constraint.</p>	<p>There are no designated sites located within Substation Siting Area 2, however, Red Moss SSSI and SAC is located approximately 500m to the south-west (on the other side of the 400kV OHL and the B7078).</p> <p>Construction impacts such as noise can be mitigated through good practise methods and are not considered to result in a development constraint.</p>	<p>There are no designated sites located within Substation Siting Area 3, however, Red Moss SSSI and SAC is located approximately 800m to the west (on the other side of the 400kV OHL and the B7078).</p> <p>Construction impacts such as noise can be mitigated through good practise methods and are not considered to result in a development constraint.</p>	
Cultural Heritage	Scheduled Monuments	<p>There are four Scheduled Monuments within 3km of Substation Siting Area 1.</p>	<p>There are three Scheduled Monuments within 3km of Substation Siting Area 2.</p>	<p>There are five Scheduled Monuments within 3km of Substation Siting Area 3.</p> <p>One of the Scheduled Monuments (Thirstone Stone Circle (SM 5094)) is within 200m of Substation Siting Area 3 as shown on Figure 1.7.</p>	<p>Overall, Substation Siting Area 1 is preferred as it is best sited in relation to nearby Scheduled Monuments: Thirstone Stone Circle (SM 5094); and Auchensaugh Hill Cairn (SM 4234) with regards to setting impacts. Potential direct impacts on non-designated heritage assets can be offset by mitigation including:</p> <ul style="list-style-type: none"> ■ Field survey to identify the positions, character and condition of the sites previously recorded, and any not yet identified. ■ Marking-off sites that should be avoided, such as the building (13298). ■ Excavation of small cairns that cannot be avoided by micro-siting the substation and marking-off the cairns.
	NSR Sites (HER national importance)	<p>There are two HER Sites within 3km of Substation Siting Area 1 and Siting Area 2: an enclosure (possibly of prehistoric date) and a mound (of indeterminate date) (HER references 10054 and 13295 on Figure 1.7).</p>	<p>There are three HER Sites within 3km of Substation Siting Area 3: two cairns (possibly of prehistoric date) and a mound (of indeterminate date) (HER references 10454, 10535 and 13295 on Figure 1.7).</p>		
	Non-designated heritage assets (regional/local importance)	<p>There are four non-designated heritage assets within 200m of Substation Siting Area 1 (NSR references 12659, 13298, 12663 and 13297 on Figure 1.7).</p>	<p>There are no non-designated heritage assets within 200m of Substation Siting Area 2 or Siting Area 3.</p>		

¹⁰ https://www.southlanarkshire.gov.uk/download/downloads/id/4147/landscape_designations_report_november_2010.pdf

Criterion	Sub-Criteria	Substation Siting Area 1	Substation Siting Area 2	Substation Siting Area 3	Preference
					Archaeological evaluation by trial trenching is also likely to be required and a watching brief may also be required during construction works.
Watercourses and Flood Risk	Watercourses	Substation Siting Area 1 is located partially within 50m of a watercourse.	There are no 50m watercourse buffers located within these substation siting areas. Substation Siting Area 3 is located between two watercourse 50m buffers.		Overall, Substation Siting Area 2 is preferred as it is located outwith any areas of flood risk and is the greatest distance from any watercourses.
	Flood Risk	None of the substation siting areas are located within an area associated with flood risk.			
Land Use	Mineral Sites	None of the substation siting areas are located within a mineral site allocated in the South Lanarkshire Local Development Plan 2 (Adopted April 2021).			There is no overall preference as none of the substation siting areas are located within a mineral site.
Technical Considerations	Future Connections	<p>Connectivity of the proposed Glenmuckloch to ZV Route 400kV overhead line likely to be possible from west, north-west around the north of the proposed Bodinglee Wind Farm, or from south-west passing north of, or through, the existing Middle Muir and Andershaw Wind Farms before connecting into substation site (located between ZV106 and ZV108).</p> <p>A number of further connections are required to be accommodated within Redshaw Substation owing to the planned regenerations schemes in the area. Substation Siting Area 1 is located in close proximity to these connections. Both Elvanfoot and Coalburn substations have no capacity to accommodate planned and future connections.</p>	<p>Connectivity of the proposed Glenmuckloch to ZV Route 400kV overhead line likely to be possible from west, passing north of, or through, the existing Middle Muir and Andershaw Wind Farms. Connectivity from further north-west around the north of the proposed Bodinglee Wind Farm would likely require paralleling of existing ZV route alignment and/or the B7080/NCN 74 before connecting into substation site (located between ZV109 and ZV111).</p> <p>A number of further connections are required to be accommodated within Redshaw Substation owing to the planned regenerations schemes in the area. Substation Siting Area 2 is located in close proximity to these connections. Both Elvanfoot and Coalburn substations have no capacity to accommodate planned and future connections.</p> <p>Most economical site in terms of construction and availability of resources from the nearby area. The amount of earthworks required for this site would be 50% less in comparison to Substation Siting Area 1 and Substation Siting Area 3.</p>	<p>Connectivity of the proposed Glenmuckloch to ZV Route 400kV overhead line likely to be possible from south, passing south of, or through, the existing Middle Muir and Andershaw Wind Farms. Connectivity from further west or north-west around the north of the existing Middle Muir and Andershaw Wind Farms or further north around the proposed Bodinglee Wind Farm would likely require paralleling of existing ZV route alignment and/or the B7080/NCN 74 before connecting into substation site (located between ZV113 and ZV115).</p> <p>A number of further connections are required to be accommodated within Redshaw Substation owing to the planned regenerations schemes in the area. Substation Siting Area 3 is located in close proximity to these connections. Both Elvanfoot and Coalburn substations have no capacity to accommodate planned and future connections.</p>	Substation Siting Area 2 is preferred from a technical perspective and will require considerably less earthworks to be carried out.
	Access (motorway, A and B Roads)	These substation siting areas can be accessed directly from the B7078 (between >150m and >350m). Access will be subject to detailed design considerations.			There is no overall preference as all substation siting areas can be accessed directly from B7078.
	Overhead Lines (OHL) / Underground Cables (UGC)	There is an 11kV OHL and UGC located approximately 200m north of Substation Siting Area 1 (Figure 1.4) however this can be avoided through detailed design.	There are no technical constraints effecting Substation Siting Area 2.	There is an 11kV OHL that runs very close to the edge of Substation Siting Area 3 in the south-east (Figure 1.4).	
Overarching Preference	The overall preference when balancing the environmental and technical considerations set out above is for Substation Siting Area 2 as this site is the preferred site from a landscape and visual perspective where it would sit on lower lying terrain and would have the potential for both embedded and additional mitigation provided by the existing landform. The visibility from the Douglas Valley SLA will also be limited by intervening landform at siting area 2 and is not located in close proximity to any existing residential properties. Siting area 2 is also free from flood risk and is not constrained by existing OHL/UGC infrastructure.				