Scottish & Southern Electricity Networks

Fanellan Hub 400 kV Substation and Converter Station Environmental Impact Assessment Report Volume 4 | Technical Appendices

Appendix 13.5 – Earthworks Strategy Report

February 2025

Fanellan

400kV Switching Station and HVDC Converter Station

Earthworks Strategy Report

LT459-SWE-XX-XX-T-W-1001

SWECO

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1 Introduction

This report details the outline earthworks strategy to inform the earthworks design proposals as part of the Fanellan 400kV Switching Station and HVDC Convertor Station, on behalf of Scottish and Southern Energy Networks (SSEN) Transmission. The information contained in this report will support the planning application for the Fanellan development and provide the basis for further design development to be undertaken by the detailed designer. The report describes the proposed earthworks design methodology taking into account relevant information obtained from the 2023 ground investigation works.

1.1 Purpose of this Report

This report has been prepared to detail the anticipated methodology for construction of the earthworks platform upon which the switching and convertor stations and associated infrastructure will be constructed, along with the development of site access roads, attenuation basins and landscape bunds required as part of the wider planning design.

This Earthworks Strategy Report (ESR) provide a high-level assessment of the following elements:

- Initial stability assessment of proposed earthworks cut slopes
- Cut & fill volumetric analysis
- Excavatability of bedrock
- Re-use of site won fill for platform construction
- CBR assessment for site access roads

Additionally a status of design matrix has been provided to confirm the scope of works undertaken by Sweco for preliminary (outline planning) design and the items requiring further development by the Contractor at detailed design stage.

The report has been prepared taking into account the requirements and recommendations of the following documents:

- SSEN Earthworks Specification SP-NET-CIV-501
- SSEN Drainage Specification SP-NET-CIV-502
- SSEN Pavements and Roadways Specification SP-NET-CIV-503

1.2 Existing Information

This earthworks strategy report relies on information detailed with the 2023 Ground Investigation Factual Report and the Preliminary Site Layout designs. This ESR should be read in conjunction with the preliminary design drawings noted in Appendix B and the following documents available under separate cover:

- BAM Ritchies Final Factual Report on Ground Investigation (ref. ASTI Substations – LT459 Beauly 400kV: RGN.330E) dated March 2024.
- SSEN Desk Study Report – Beauly 400kV Substation and HVDC Station (ref: LT459-BEAU-GDS-CIV-001 Revision 01) dated April 2023.
- Sweco Ground Investigation Report – Fanellan 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-Z-0000-GIR_Rev1) dated June 2024.
- Sweco Drainage Strategy Report - Fanellan 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-C-0501_P07) dated August 2024.
- Sweco Enabling Works Report – Fanellan 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-C-201_P05) dated August 2024.
- Sweco Flood Risk Assessment – Fanellan 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-W-1002_P02) dated September 2024.

2 Site Setting

2.1 Site Location

The proposed development site lies approximately 5km southwest of Beauly, at Fanellan within the Highland Council local authority. The OS Grid northings and eastings of the site are approximately 248404, 843094 (to the middle of the proposed development site). Access to the site can be taken from the A831 via the A862 and C1106 road from the Black Bridge. Refer to site layout drawing LT459-SWE-XX-XX-D-X-0001 in Appendix A for details and Figure 2-1.

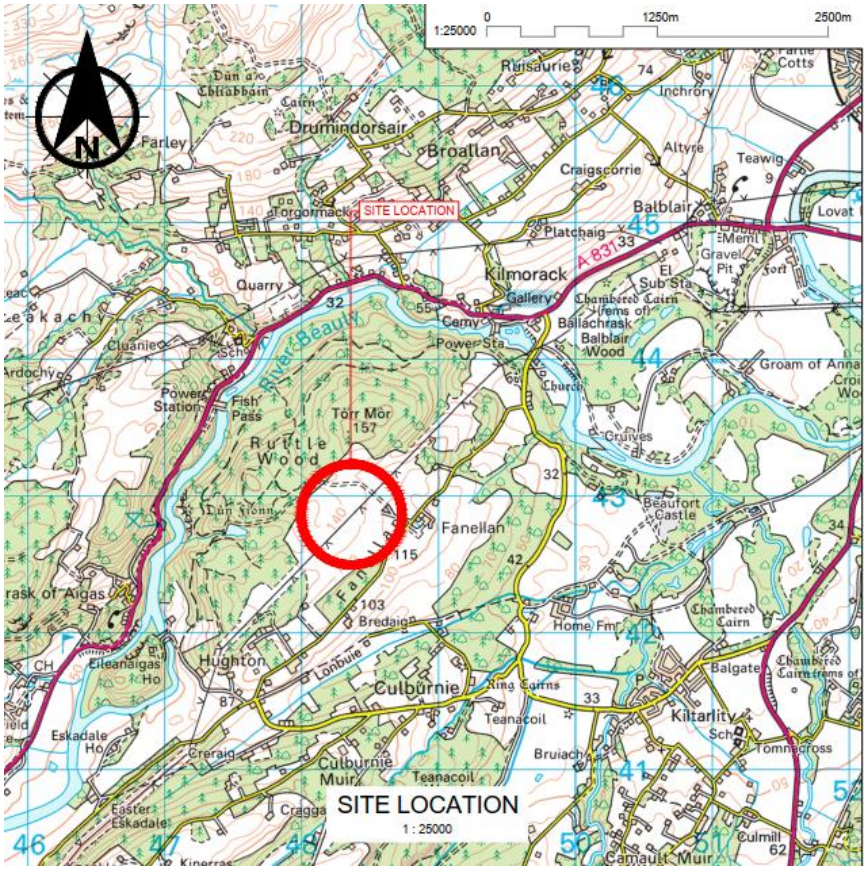


Figure 2-1. Site location to the south of the River Beauly

2.2 Site Description

The proposed Fanellan development site as shown in Figure 2-1 largely comprises open farmland with a number of small buildings located on the site. The existing Beauly to Denny overhead line (OHL) also runs directly through the site. The site is bounded to the north-west and north-east by Ancient woodland (named as 'Ruttle Wood' and Tòrr Mòr). The site is accessed by a single track road (C1106 Fanellen Road), running south-west to north-east, along the south-eastern site boundary. trends south-west to north-east.

The topography of the site generally falls from east to west towards the road, however, there are a number of undulations or 'knowes' and localised 'gully' type features to the north and southwest of the site. Within the proposed site boundary, there are existing dwelling cottages and farm building as well as unbound access tracks providing access to various points around the site.

2.3 Site Topography

A drone survey was carried out of the site by Cyber Hawk in June 2023 which provided a DTM point cloud survey. The current site topography is highly undulating, with elevation varying from approximately 147m AoD at the centre of the site, falling to the lowest point approximately at 90m AOD at the northeast corner.

2.4 Flood Risk

Sweco have prepared a Flood Risk Assessment (FRA), available under separate cover (LT459-SWE-XX-XX-T-W-1002) to support the planning consent of the proposed scheme.

A screening review of flood risk to the site was undertaken as part of the FRA. This review identified that surface water posed a medium risk whereas groundwater posed a high risk of flooding. All other sources of flood risk were considered to be low.

2.5 Unexploded Ordnance (UXO)

Information obtained from the SSEN Desk Study Report, where the included Envirocheck report contains a specialist risk assessment caried out by 6 Alpha Associates Ltd, along with information obtained from Zetica bomb risk mapping, indicates the presence of UXO on site is “low risk”. Where the specialist third party consultant states ‘No further action’ is required.

Therefore, in accordance with guidance in CIRIA C681, a detailed risk assessment is not considered necessary to manage UXO risk at the site.

3 Ground Conditions

An intrusive ground investigation (GI) was specified by SSEN was undertaken by BAM Ritchies between August and October 2023. Sweco provided technical supervision on a full-time basis and follow up reporting.

The scheme Ground Investigation Report (GIR) provides a comprehensive summary of the ground and groundwater conditions encountered during the 2023 GI. This report (LT459-SWE-XX-XX-T-Z-0000-GIR_Rev1) is dated June 2024 is available under separate cover. A brief summary of the ground conditions underlying the site is provided below:

The site generally consists of topsoil over superficial deposits of Glacial Till overlying highly to moderately weathered Conglomerate bedrock.

- Topsoil is generally shallow, however in localised areas towards the north-east is deeper, up to 0.85mbgl.
- Glacial Till is predominantly encountered as granular sands & gravels (and limited localised cohesive deposits) with larger coarser elements throughout, up to 8.40mbgl. Additionally, very localised ‘partially cemented’ areas are identified in the centre and west of the site where standing water was noted prior to exploratory positions commencing.
- The thickness of Glacial Till deposits typically increases towards the south and west of the site where the elevation reduces, which is coincident with an increased depth to rockhead towards the base of the valley.
- Conglomerate bedrock was identified in the majority of exploratory hole locations which extended to depth. Conglomerate was encountered as a highly weathered residual soil at rockhead, generally improving in strength and composition over depth. Conglomerate was proven to a maximum of 20mbgl (borehole termination) and will be the founding stratum for the majority of the platform.

Table 3-1: Summary of ground conditions

Strata	Typical Description	Strata Depth Range (mbgl)	Strata Level Range (mAOD)	Thickness (m)
Topsoil	Turf or Crops over… Dark brown gravelly very rarely slightly silty fine to coarse ('f-c') SAND with low-high cobble content, occasional medium-high boulder content, and frequent roots & rootlets & very rare tree branches, x1 'peat pocket'. Gravel is subangular to subrounded (f-c) of predominantly quartzite and sandstone. Cobbles are subangular to subrounded of predominantly quartzite & sandstone or various lithologies. Boulders (where present) are angular to subrounded of various lithologies.	0.00 to 0.85	94.95 to 146.74	0.15 to 0.85
[Cohesive] Glacial Till	Soft brown / grey (occasionally ('occ') slightly) gravelly (f-c) sandy CLAY/ SILT with occ cobbles. Gravel is subangular to subrounded fine to medium of quartzite (and sandstone) or various lithologies. Cobbles are subangular to subrounded of quartzite.	0.5 to 4.2	117.03 to 131.28	0.25 to 0.70
[Granular] Glacial Till	Medium dense to dense (occ very dense) light brown / dark grey slightly to very gravelly, silty (f-c) SAND w/ frequent various cobble content, rare low to high boulder content & very rare roots. Gravel is angular to subrounded (f-c) quartzite & sandstone or various lithologies (rare granite/ schist & psammite). Cobbles are subangular to subrounded (or occ angular to subrounded or subrounded) of quartzite or various lithologies. Boulders are angular to subrounded of various lithologies. Possible highly weathered conglomerate prior to rockhead. (Rarely described) Medium dense to very dense light brown (occ dark grey and rarely orange) very rarely clayey silty, very (f-c) sandy GRAVEL with frequent low to high cobble content, low to high boulder content. Gravel is quartzite & sandstone or various lithologies (rare granite/ schist & psammite). Cobbles subangular to subrounded of quartzite or various lithologies (rare granite or conglomerate). Boulders are angular to subrounded of various lithologies. Frequent areas of possible highly weathered conglomerate. There are also areas of SAND & GRAVEL containing similar quantities of silt, cobbles and boulders as described above. There is one area denoted as 'medium dense COBBLES" and one area denoted as BOULDERS.	0.0 to 9.0	92.55 to 145.09	0.05[1] to 8.40

Strata	Typical Description	Strata Depth Range (mbgl)	Strata Level Range (mAOD)	Thickness (m)
'Suspected' Peat	Isolated horizon identified with deposits of granular Glacial Till (sand). Black in colour with no odour noted.	0.4- 0.5	136.9- 136.8	0.1
[Cemented] Glacial Till	Localised cemented deposits of granular glacial till [which required coring]… Dense dark grey-brown (rarely very) gravelly (occ slightly) silty (f-c) SAND with rare or frequent cobbles. Gravel (rarely angular) subangular to subrounded (f-c) of predominantly quartzite & sandstone. Rare cobbles of subangular quartzite. OR Dark brownish grey sandy (f-c) gravelly CLAY w/rare cobbles. Gravel subangular to subrounded (f-c) of quartzite. Rare cobbles of subangular to subrounded quartzite.	3.2- 10.0*	131.65- 117.03	1.5- 6.8
Conglomerate	Extremely weak to strong, predominantly described as moderately weak to medium strong, occasionally locally weak or strong. Dark grey/ reddish brown, very thickly bedded, clast supported Conglomerate. Clasts are subangular to sub/rounded fine to coarse gravel (Avg varies from: 2 to 40mm) of predominantly quartzite, sandstone & schist or psammite with rare to occasional subangular to subrounded cobble sized (<75mm to 200mm) quartzite &/ or sandstone in a reddish dark brown sandy matrix (occasionally washed out), very rare white calcite matrix. Slightly to highly weathered based on strength loss/ gain, locally non-intact areas and highly fractured nature in areas. Often two fracture sets 1) 0-10, 0-15 varying spacing, usually closely to medium, stepped striated to undulating rough or to planer rough, silty sand residue 2) usually 25-40 (but can be up to 60-70 and anywhere in-between), varying spacing, usually closely to medium spaced, undulating rough to undulating/ planer rough/ smooth, silty sandy or clayey rock infill. There are limited areas across the site where potentially weathered conglomerate is present, prior to coring commencing, at thicknesses of <0.5m.	0.2- 20.3*	146.4- 85.4	4.5- 20.0*

3.1 Geological Drawings and Models

A series of geological long and cross-section drawings have been produced based on the data contained within the 2023 GI Factual Report and accompanying AGS data. The below drawings are included in Appendix B (latest P02 versions dated September 2024):

- LT459-SWE-XX-XX-D-G-0001 – Geological Section Drawing Series, Sheet 1 of 6
- LT459-SWE-XX-XX-D-G-0002 – Geological Section Drawing Series, Sheet 2 of 6
- LT459-SWE-XX-XX-D-G-0003 – Geological Section Drawing Series, Sheet 3 of 6
- LT459-SWE-XX-XX-D-G-0004 – Geological Section Drawing Series, Sheet 4 of 6
- LT459-SWE-XX-XX-D-G-0005 – Geological Section Drawing Series, Sheet 5 of 6
- LT459-SWE-XX-XX-D-G-0006 – Geological Section Drawing Series, Sheet 6 of 6

Additionally a 3D model of the anticipated rockhead surface has been developed based on interpolation of the digital GI data and topographic survey (using a LandXML surface created for Design Fix 2D dated August 2024). This model has been used to generate preliminary volumetric estimates of the excavation quantities which are discussed in Section 5.3.

3.2 Groundwater

Groundwater monitoring and observations made during the GI indicate that the groundwater level across the site is shallow, with groundwater present in both the superficial Glacial Till (within granular sands and gravels) and the underlying conglomerate bedrock. Groundwater flow within the bedrock is expected to be predominantly within weathered rock and through fractures, evident within the conglomerate. The rate of flow of groundwater will therefore vary depending on the degree of fracturing. Deep excavations into the bedrock for construction of the substation platform will intercept groundwater during construction and appropriate groundwater control measures (e.g. construction dewatering) will be required.

A summary of groundwater levels established over a six-month monitoring period is provided in Section 4.7 and Table 4-3 of the GIR.

4 Proposed Development

The proposed Fanellan development is shown in Figure 4-1 and on the relevant general site development plans included within Appendix A. The development site consists of a 240,000m^2 platform area which is approximately split into two halves to accommodate both the 400kV switching station and HVDC convertor station. The planning boundary area encompasses 233Ha post development. The earthworks platform sits at a level of 127m AOD and incorporates a number of landforms (earthworks screening features) which shield the buildings and associated substation infrastructure from view.

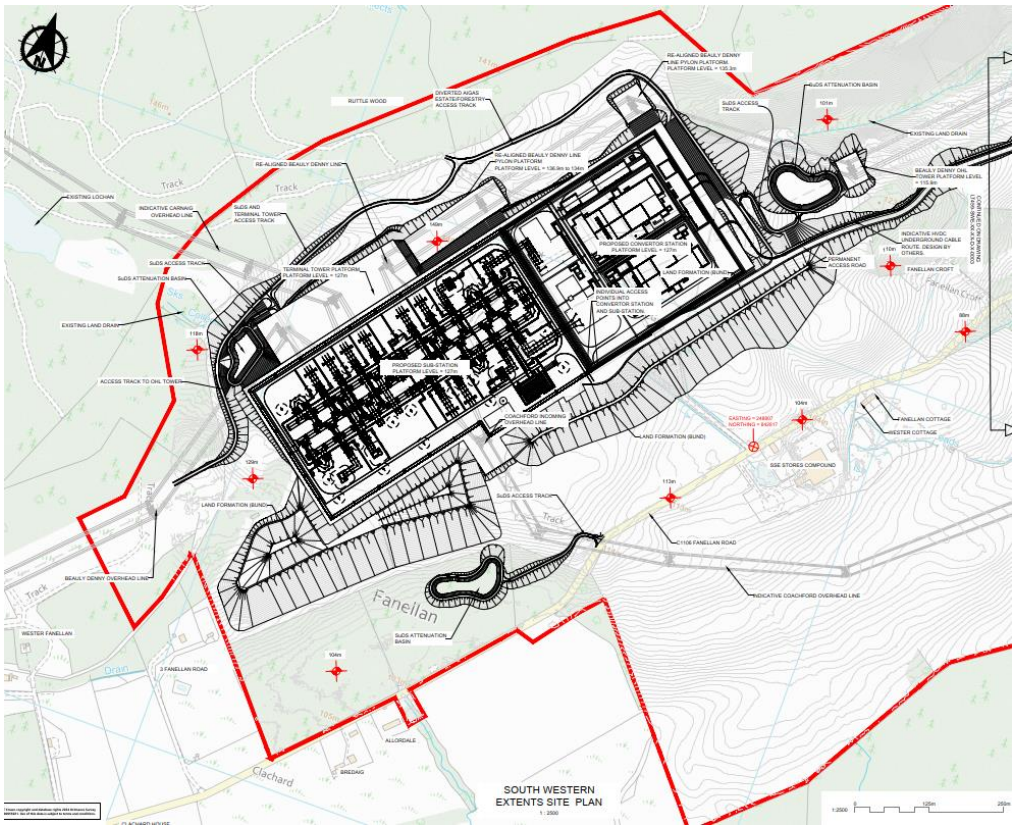


Figure 4-1. Fanellan Site Layout

The current proposed Scheme includes construction and installation of the following plant, buildings and infrastructure at Fanellan.

- Substation:
  - A sub-station on a platform that is approximately 506m x 265m.
  - Control building,
  - Switchgear,
  - Busbar.
- Connections:
  - The site requires to be connected back to the existing Beauly substation, via new 400kV infrastructure (either overhead lines (OHL) or underground cables). This could be achieved by connecting directly onto the existing Beauly – Denny 400kV OHL,
  - Connection with the proposed Spittal – Loch Buidhe – Beauly 400kV OHL,
  - Connection with the proposed Beauly – Blackhillock – Peterhead 400kV OHL.
- High Voltage Direct Current (HVDC) Converter Station:
  - A new 525kV DC 1.8GW Bi-pole HVDC converter station to be located adjacent to the new 400kV AC substation near Beauly. The platform size will be circa 309m x 261m,
  - An AC underground cable connection to the new 400kV substation,
  - HVDC underground cables from the converter station to a landfall on the West Coast at Dundonnell.
- Terminal Tower build-out on a 274m x 77m platform adjacent to the Switching and Convertor stations.
- Site access roads.
- SuDS basins for drainage attenuation.
- Landscape bunds for visual screening purposes (typically 132m to 138m AOD in elevation).

5 Earthworks Strategy

5.1 Platform Design Level

For Design Fix 2D current finished platform level is based on an elevation of 127m AOD, which is largely consistent across the platform extents in order to provide a level surface upon which to construct the HVDC convertor and 400kV switching stations, associated plant, equipment and buildings and facilitate connection to the wider electricity transmission grid.

The current site is topography is highly undulating, with the elevation varying from approximately 90m at the eastern extent and rising to 147m AOD towards the central and northern site extents. Therefore, significant excavation predominantly within bedrock will be required in these areas to reach platform sub-formation level (taken as 126m AOD).

The geological series drawings included in Appendix B presents existing and proposed design levels across the platform from which approximately excavation levels can be inferred. Additionally the 3D design surface model and topographical surface model provided to SEBAM can be interpolated to determine both approximate depth and volume of earthworks cut and fill anticipated.

5.2 Earthworks Design Batters

Given the depth of excavation required to reach platform sub-formation level, earthworks design batters have been set to optimise earthworks volumes and reduce quantities of surplus fill so far as possible. Several large landscape bunds are proposed around the perimeter of the site in order to provide visual screening of the site and provide an opportunity to lose surplus fill.

The preliminary design proposals for the platform assume earthworks cut slope batters of 1V:3H in the superficial deposits (sands and gravel) and highly weathered (disintegrated) bedrock, with a steepened batter up to a maximum of 1V:1.5H to be adopted in the competent bedrock.

A summary of proposed earthworks design batters is provided in **Table 5-1** below:

Table 5-1: Proposed earthworks design batters

Earthworks Feature	Proposed Design Batter V:H (degrees / grade %)
Cut slopes formed in natural strata to reach platform sub-formation level	Soil & highly weathered / disintegrated bedrock: 1V:3H (18.4 degrees / 33%) Intact / competent bedrock: Maximum 1V:1.5H (33.7 degrees / 66%)
Fill slopes to attenuation basins	Maximum: 1V:3H (18.4 degrees / 33%)
Fill slopes to landscape bunds	Maximum: 1V:3H (18.4 degrees / 33%) Minimum 1V:8H (7.1 degrees / 12.5%)
Fill slopes to main site access road	1V:3H (18.4 degrees / 33%)

5.3 Earthworks Volumes

A summary of the outline bulk earthworks quantities are provided in **Table 5-2** below:

Table 5-2: Preliminary earthworks volumes from cut / fill assessment

Earthworks Feature	Cut Volume (m^3)	Fill Volume (m^3)
Earthworks to achieve 126.0m platform formation level	1,829,662	235,517
Earthworks required to for landforms (bunds)	685	1,171,657

Earthworks Feature	Cut Volume (m^3)	Fill Volume (m^3)
Earthworks to form SUDS Basins	15,264	83,822
Earthworks to form OHL tower platforms	7,677	6,355
Earthworks to form access track and roads	9,449	344,428
Total	1,862,737	1,841,779
Surplus (+) / Deficit (-)	**+20,958 (+27,245 with bulking factor of 30%)**	
Topsoil	203,358	99,839
Surplus (+) / Deficit (-)	**+103,519 (+149,551 with bulking factor of 30%)**	

5.4 Preliminary Slope Stability Assessment

For the upper portion of cut slopes excavated to platform sub-formation level, given the nature and composition of the superficial deposits, characterised by medium dense to dense granular soils with relatively high friction angles, design batters of 1V:3H in the upper slopes are considered reasonable and no formal stability assessment has been undertaken for these slopes at this preliminary design stage.

For earthworks fill slopes formed of selected granular fill used in construction of the development platform and slackened fill slopes used in construction of the attenuation basins and landscape / environmental bunds (formed of Class 1 granular or Class 2 cohesive fill); based on engineering judgement and assuming adequate compaction of fills in accordance with the SSEN Earthworks Specification, these fill slopes are considered to be adequate to provide long-term stability and no formal slope stability assessment has been undertaken.

For Design Fix 2D where the fill slopes to some landscape bunds and attenuation basins have been steepened to 1V:3H to increase the HVDC available platform area, no stability assessment has been undertaken at this stage, with global stability analysis of these landforms and specification of acceptable fill to be undertaken by the detailed designer.

Preliminary slope stability assessment of the rock cuttings has been undertaken based on the findings of the 2023 GI and published guidance relating to the stability of cut-slopes in rock. This assessment considers GI data relevant to the location of the larger excavations, predominantly at the north-western extent of the site.

In order to make an initial assessment of the strength and stability of the Conglomerate bedrock, a Geological Strength Index (GSI) approach has been used. GSI is qualitative index that takes into account various geological factors such as rock type, structure, weathering, and discontinuities.

Whilst GSI is typically determined through field mapping and observation of rock outcrops to provide an indication of the rock mass strength and its response to engineering activities such as excavation and tunnelling, the GSI approach has been used here to infer the assumed characteristics of the rock mass from visual observations of the recovered rock core both in terms of structure (disintegrated, blocky, very blocky, intact) and surface quality (weathering, staining, infilling).

Records of the relevant exploratory holes have been reviewed with respect to determining GSI, based on published guidance within Marinos and Hoek (2000), (2005) and (2007); and Wille and Mah (2004). Based on this the conglomerate bedrock has been broadly characterised into four GSI zones based on visual observations of the rock core:

- Zone 1: disintegrated, poor
- Zone 2: disintegrated, fair to good
- Zone 3: very blocky, fair to good
- Zone 4: blocky, good.

Figure 5-1 provides a graphical presentation of the GSI Zones 1 to 4 assigned to bedrock strata, whereby the GSI zones typically increase in competency with depth. **Table 5-3** provides further detail and example core photos from the typical GSI zones.

It is anticipated that the bulk of excavation is likely to be within more intact bedrock (Zones 3 & 4), and for these conditions preliminary design batters of 1V:1.5H are considered reasonable. Where localised areas of weathered and partially disintegrated bedrock (Zones 1 & 2) are encountered at depth and where highly weathered Conglomerate (Zone 1) is encountered near rockhead; cut slopes formed in these deposits are likely to require local slope slackening to a safe angle to provide long-term stability.

Additionally, the use of stabilisation measures to mitigate the potential for rockfall and address possible kinematic rock slope instability during both temporary and permanent works may be required. These mitigation measures should be determined at detailed design. Rockfall prevention measures may include catch-nets, face nets, hanging nets and fences. A minimum offset of 7m has been allowed in preliminary design between the toe of the rock cuts and the platform boundary fence which is considered sufficient to allow for provision of rockfall traps if deemed necessary. Measures to address more significant kinematic failures may include rock bolts, anchors and/or slackening of the slope. Additional stabilisation measures may be required where it is impractical or where there is insufficient space to achieve design batters.

Figure 5-1. Fanellan GSI assessment

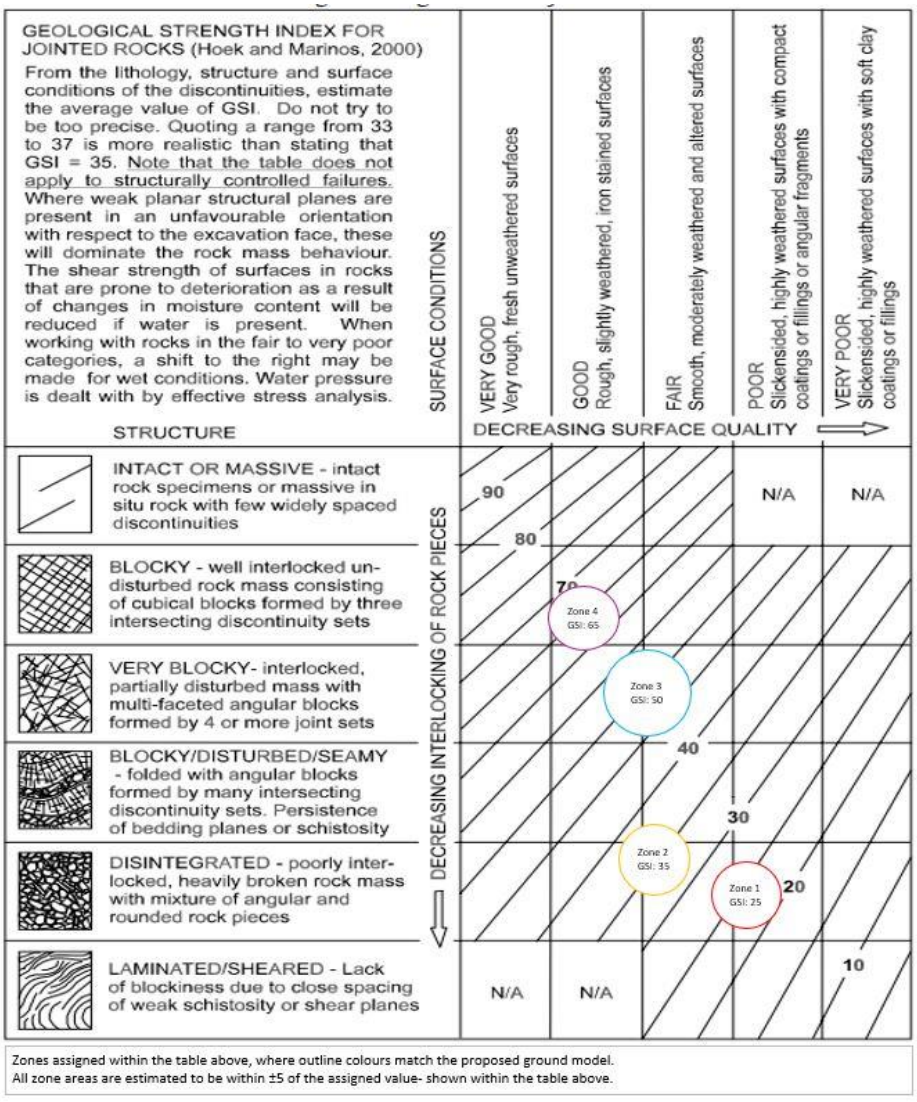


Table 5-3: Bedrock zones based on GSI classification

Zone	Structure Description[1]	Surface Quality Description	Example Photo	Preliminary GSI
Zone 1	Disintegrated – poorly inter-locked, heavily broken rock mass [predominantly recovered as gravel]	Poor – highly weathered surfaces with compact fillings or angular fragments	 BH23 - 1.20 to 2.70m	**GSI = 25 (+/-5)**
Zone 2	Disintegrated – poorly inter-locked, heavily broken rock mass [predominantly recovered as gravel]	Fair to Good – Smooth to rough and moderately to slightly weathered surfaces	 BH20 - 6.50 to 8.00m	**GSI = 35 (+/-5)**

Zone	Structure Description[1]	Surface Quality Description	Example Photo	Preliminary GSI
Zone 3	Very Blocky – interlocked partially disturbed rock mass…	Fair to Good – Smooth to rough and moderately to slightly weathered surfaces	 BH19 - 4.90 to 6.40m	**GSI = 50 (+/-5)**
Zone 4	Blocky – well interlocked undisturbed rock mass…	Good – Rough, slightly weathered iron-stained surfaces	 BH21 - 13.00 to 14.50m	**GSI = 65 (+/-5)**

1. Structure descriptive terms modified from published texts to align with descriptions of recovered rock core that may be a proxy for wider rock mass characteristics.

5.5 Rock Excavatability Assessment

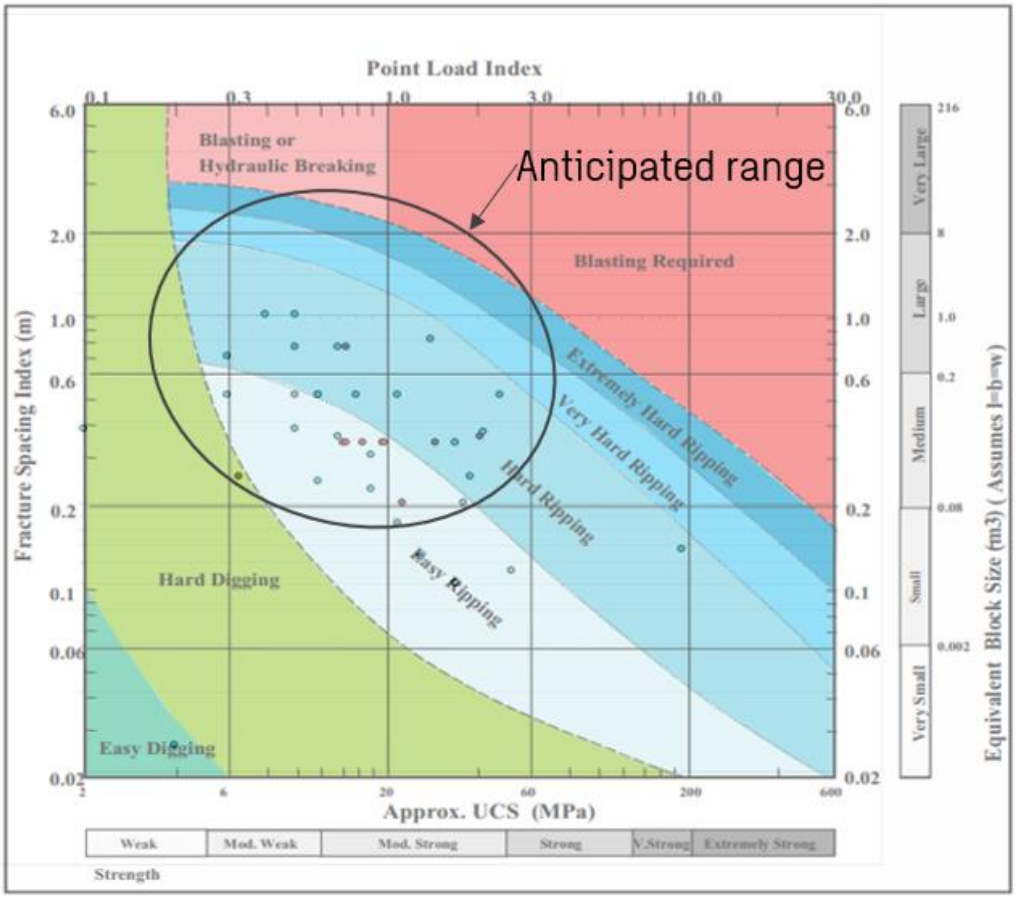
An initial assessment of the excavatability of the Conglomerate bedrock has been undertaken in accordance with guidance outlined in TRL Published Project Report 556 using the approach developed by Pettifer & Fookes (1994). The fracture index included on exploratory hole logs has been used to determine likely Fracture Spacing index, with the results of geotechnical laboratory testing on samples of rock core used to determine a characteristic range of Unconfined Compressive Strength (UCS).

Rock strength typically ranged between 5MN/m^2 and 40MN/m^2 with a number of results above 50MN/m^2. Average fracture spacing index typically ranged between 0.15 and 1.00 but it must be noted that the in-situ fracture spacing of the rock mass may be higher (i.e. greater spacing between fractures and discontinuities) as exploratory hole records used in this assessment are likely to include drilling-induced fractures.

This high-level assessment suggests a wide range of classifications dependant on the weathering state, fracture spacing and rock strength. It is anticipated that near-surface highly weathered rock will likely classify as hard digging to easy ripping, and that partially weathered rock will likely classify as hard to very hard ripping. Where fresh unweathered bedrock with a high fracture spacing is encountered at depth this may not be rippable and may potentially require hydraulic breaking. **Figure 5-2** presents a summary of the anticipated excavatability classes.

Additionally, due the nature and composition of Conglomerate (hard gravel sized clasts in a sandy cemented matrix) there is a risk of overbreak upon excavation to platform sub-formation levels which may result in additional quantities of surplus rock fill.

Figure 5-2: Anticipated excavatability classifications



5.6 Preliminary Foundation Assessment

Given that significant excavation is required across the site to reach proposed sub-formation level for the platform and based on the interpolated levels shown on the geological section drawings (included within **Appendix B**), it is assumed that the sub-formation level for the platform will largely be within Conglomerate bedrock.

Towards the northern extent of the convertor station platform and the north-eastern and south-eastern periphery of the switching station platform, design levels are above existing ground level and filling with selected granular fills processed from the site-won primary aggregate will be required to reach sub-formation level. The SSEN Earthworks Specification (Document ref: SP-NET-CIV-501) provides details of acceptable fill classes for this purpose and Section 8.2 of the Sweco GIR provides high-level commentary on the geotechnical suitability of site-won aggregate for use as selected granular fill in platform construction.

It is anticipated that the earthworks platform will be a minimum of 1000mm thick and will act to provide an adequate bearing capacity for the overlying buildings, plant and equipment (to be verified by others during detailed design), provide ease of future excavation and regulate potential differential stiffness from the bedrock strata below.

Where platform sub-formation level is within competent bedrock it is expected that this will provide a suitable founding stratum for construction of the overlying granular earthworks platform. Dimensions and loading of proposed platform infrastructure are not available at the time of writing, however guidance within Annex G of BS EN 1997-1:2004+A1:2013 suggests lower-bound values of presumed bearing resistance in excess of 250kN/m^2 for weak rocks with closely spaced discontinuities is likely to be provided. It is considered that settlement is likely to be within tolerable limits, assuming internal settlement of the granular platform is complete prior to construction of overlying buildings, equipment and associated infrastructure.

Where platform sub-formation level overlies superficial deposits and / or highly weathered bedrock, with the strata below the earthworks platform presumed to comprise medium-dense sand and gravels, it is assumed that sufficient bearing capacity will be provided from the platform construction and underlying strata. However, it is recommended that the detailed designer undertake all necessary ULS and SLS calculations to verify the foundation requirements for all structures, plant and equipment proposed to be constructed upon the platform once details of the loads and dimensions are available.

It is recommended that all sub-formation levels are inspected by a suitably qualified Geotechnical Engineer, with any soft or loose areas to be excavated and replaced with clean, well-compacted fill meeting the acceptability requirement defined in SP-NET-CIV-501. Where water-filled depressions are encountered, these should be drained, over-excavated and replaced with an appropriate backfill for below water filling (such as Class 6A in accordance with Specification for Highway Works (SHW) Series 0600). The sub-formation should be blinded on completion (where acceptable) or sealed with well compacted acceptable fill to prevent deterioration and enable a sound surface for placement of platform fill.

5.7 Ground Improvement

Based on the anticipated ground conditions and the founding level for the platform falling predominantly within Conglomerate, at this stage it is envisaged that no major ground improvement or piling works will be required. However localised dig and replace of any soft / loose superficial deposits or highly weathered bedrock at platform sub-formation level may be required. These requirements are to be determined and specified by the Detailed Designer prior to construction.

5.8 Retaining Structures

No requirements for retaining structures have been identified by the Civils team based on the Design Fix 2D site design.

5.9 Earthworks Material Acceptability

This section provides a high-level preliminary assessment of the likely geotechnical acceptability of site-won fills derived from bulk excavation to proposed platform founding level. For further details of the testing undertaken and assessment of results please refer to Section 8.2 of the GIR.

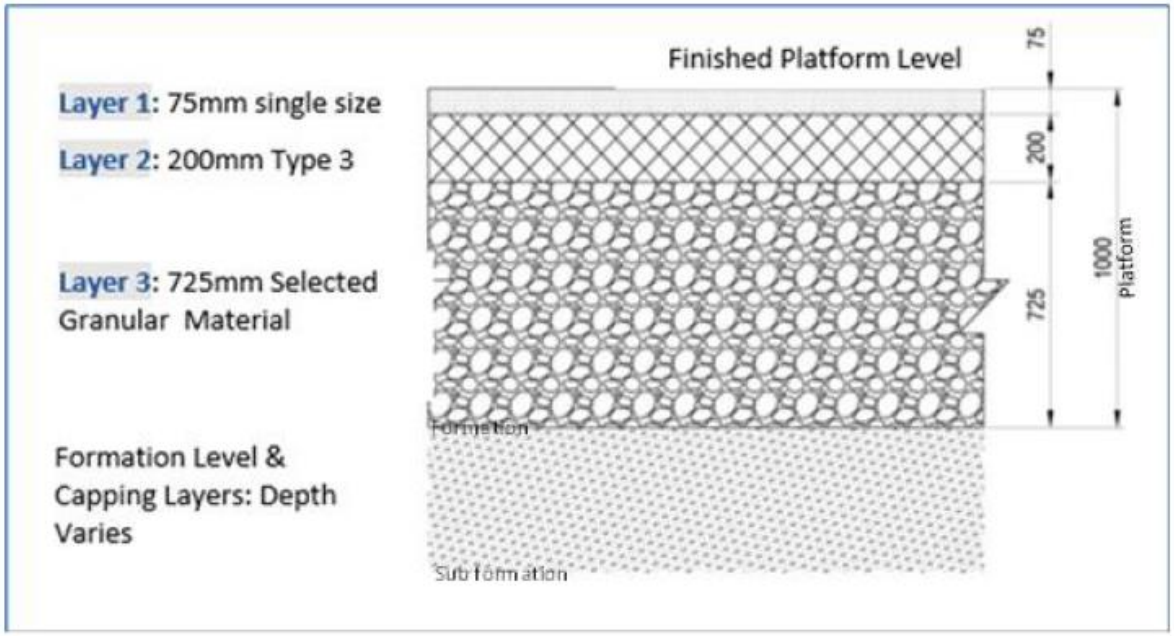
It is proposed that the Fanellan Hub will be constructed on an earthworks platform comprised of various layers of granular acceptable fill. SSEN has provided an Earthworks Specification (Document ref: SP-NET-CIV-501) which details their requirements for construction of engineered earthworks platforms used to provide the foundation to substations and all associated mechanical and electrical equipment, as well as providing a suitable founding stratum for roads, hardstanding areas and electrical earthing. This specification (and the associated earthworks acceptability criteria) is largely developed from the MCHW Specification for Highway Works (SHW) Series 0600 and Series 0800. Additionally, reference has been made to BS EN 13285:2010 and BS EN 13242:2002+A1:2007, which have been used to identify requirements outlined within Series 800, with regards to Type 1 & Type 3 materials.

It is anticipated that the platform will be approximately 1000mm thick and will act to provide an adequate bearing capacity for all proposed buildings, plant and equipment (to be verified by others during detailed design) provide ease of future excavation and regulate potential differential stiffness from the bedrock strata below. **Figure 5-3** provides details of SSEN's typical platform composition.

Appendix A of the SSEN Earthworks Specification SP-NET-CIV-501 defines the acceptable fill class for each platform layer as below:

- Layer 1 – 75mm Platform Finish, comprised of 20mm single sized washed aggregate.
- Layer 2 – 200mm Sub Platform Fill, typically comprised of SHW Series 0800 Type 3 granular material.
- Layer 3 – minimum 725mm Sub Platform Capping Fills, typically comprised of SHW Series 0600 Class 6F2 acceptable fill.
- Sub-formation capping to be used below platform layers where required. Typically comprises SHW Series 0600 Class 6N acceptable fill. SSEN's specification allows a modified grading (30mm max, with 95% passing <125mm sieve and a maximum fines content of 15%).

Figure 5-3: SSEN Typical earthworks platform construction



Based on an assumed platform sub-formation level of 126m AOD, much of the founding strata is likely to comprise Conglomerate and it is anticipated that significant excavation within rock will be required for the majority of the platform area.

Preliminary material re-use assessment has primarily been undertaken on the superficial Glacial Till deposits, where sufficient PSD data has been obtained from post-fieldwork laboratory testing to determine acceptability for re-use as selected granular material in accordance with the 'Layer 3' allowable fill classes defined in the SSEN Earthworks Specification (Doc ref SP-NET-CIV-501).

Laboratory test data undertaken on samples of Glacial Till indicate that this material is likely to meet the requirements for as-dug Class 6F2 capping fills used in the construction of Layer 3. For further details and discission of testing please refer to Section 8.2 of the GIR.

The use of as dug soils for incorporation into the platform construction as Layer 1 and Layer 2 (or 2a) fills is prohibited from the SSEN Earthworks Specification, with these fills to be derived from crushed rock.

Given that the majority of excavated material will comprise weathered to intact Conglomerate, it is expected that primary aggregate derived from this strata will be suitable for re-use in the works provided it can be crushed and graded to meet the overall grading requirements and material properties for Layer 1, 2 and 3 fills defined in Appendix A of SP-NET-CIV-501.

The results of circa 20No. aggregate quality tests (comprising LA Coefficient, Aggregate Crushing Value, Slake Durability and Magnesium Sulphate Soundness) undertaken on samples of Conglomerate obtained at a variety of depths are summarised in Table 5-4 of the GIR and presented on Figures B24 to B31 within Appendix B of the GIR. The results indicate that the required aggregate parameters are generally within acceptable limits defined with SP-NET-CIV-501, although it is noted that a number of LA coefficient values obtained were greater than 40, which may preclude the use of crushed conglomerate as both SHW Series 0800 Type 3 material used in Layer 2 and platform finishing material used in Layer 1. Crushed conglomerate is likely to meet the requirements of SHW Series 0800 Type 1 material used in Layer 2a as sub-base fill to road pavements.

Where sub-formation capping may be required below platform layers, the use of Class 6N derived from crushed and graded Conglomerate may require further consideration or relaxation of specification requirements from SSEN. This is because firstly, approximately 50% of samples tested for Magnesium Sulphate Soundness were above the upper-bound acceptability limit of 12%. Secondly, Conglomerate could be considered an argillaceous rock and therefore may be deemed unsuitable for re-use as Class 6N in strict accordance with Table 6/1 SHW Series 0600. However descriptions of the logged core provided on the exploratory hole logs indicate that Conglomerate was mainly described as 'clast-supported' and set in a cemented sandy matrix rather than a clayey or silty matrix, and thus on the basis of the current GI findings is not considered to constitute an argillaceous rock and therefore no derogation from the earthworks specification is anticipated to be required.

Where site won fills (either as dug soils (excluding topsoil) or derived from crushed rock) do not meet the SSEN Earthworks Specification requirements for acceptable fill (e.g. fines content >15% , LA coefficient >40); it is likely that this material will be suitable for re-use as either Class 1 or Class 2 general fill used in the formation of several proposed large environmental screening bunds surrounding the site. Any geotechnically unsuitable material (e.g. low shear strength) that is free from contamination is likely to be suitable for re-use as Class 4 landscape used to dress the surface of bunds (TBC by Detailed Designer).

6 Design Handover - Earthworks

A summary of works completed as part of the preliminary design stage are summarised in **Table 6-1**, with reference to SSEN's Scope of Works.

Table 6-1: Status of Earthworks Design

SSEN Scope of Works	Sweco output / design decision
The *Consultant* shall produce and submit to the Employer earthwork layout drawings and an Autodesk Civil 3D model of the proposed platform, access roads and associated works.	Design Fix 2D civils drawings and 2D/3D models include proposed earthworks layout for site development (including platform, access roads, attenuation basins and landscape bunds). Civil 3D model also contains information on typical profiles / batters for preliminary earthworks design. 2D geological plan and long-section drawings developed by Sweco show site layout and earthworks overlaid with exploratory hole locations. Vertical profiles show existing and proposed design levels superimposed with stratigraphic data based on boreholes. Inferred 3D rockhead surface model developed in Civil 3D produced by Sweco based on GI data and provided to SSEN and BAM to assist in take-offs for excavation by the Contractor.
The *Consultant* is responsible for proposing the final platform level to the Employer for acceptance taking consideration of all technical, geotechnical, environmental, and planning constraints whilst minimising import/export of material.	Platform finished level of 127m AOD adopted for preliminary design.
The *Consultant* shall undertake an initial slope stability assessment for the site(s)/routes which shall consider both the construction and operation phases. The findings of the initial slope assessment will be included in the earthwork's strategy document. The findings of the initial slope stability assessment shall be used to inform the ground investigation requirements.	Preliminary slope stability assessment undertaken based on findings of 2023 GI and assessment of ground conditions. Refer to Section 5.4 of this ESR for details. Assumed at preliminary design that slope face will be netted for rockfall protection, with sufficient clearance for rockfall ditches at toe of cut slopes. Requirement for additional rockfall mitigation and/or stabilisation measures to address potential localised failures during construction and over design life of earthworks to be determined by Detailed Designer. Detailed Designer to determine requirement for global stability analysis for 1V:3H cut & fill slopes and slackened fill slopes for access tracks, attenuation basins and landscape bunds.
The Earthworks Strategy shall be based upon site desktop and physical ground investigation. It shall include narrative on what type and quantity of materials will be excavated (incl. extent of rock cut and extent of any excavations in peat), what depths excavation will occur to and how the earthworks will be undertaken at site. Phasing plans shall also be detailed to highlight any double handling of material etc. This shall include the management of temporary soil storage, including measures for segregating different types of soil and sediment management	This ESR provides details on the preliminary earthworks design considerations at this stage of the project. The GIR contains a comprehensive summary of the ground and groundwater conditions based on the findings of the 2023 GI, broken down into the type of strata and material encountered on site. Depths and thicknesses for each of the principal strata are tabulated in this report. Geological section drawings detail the extent of excavation within rock. Indicative 3D rockhead model produced to assist the Contractor in quantifying the amount of excavation in rock. Additionally Sweco have produced earthworks cut and fill volumetric estimates summarised in Section 5.3. Risk of overbreak within bedrock highlighted which may lead to additional surplus of rockfill.

	Preliminary assessment of the geotechnical suitability of site won fills (soil and rock) undertaken to inform potential for re-use in the platform construction, with reference to the acceptability criteria defined in the SSEN Earthworks Specification, refer to Section 5.9 for details. The Contractor has responsibility for defining *how* the earthworks will be undertaken on site. Additionally the Contractor is responsible for providing details and phasing plans on the movement of materials, temporary soil storage, segregating different types of fill and managing stockpiles.
The Employer would like to explore the possibility of the development of quarries or borrow pits, either within the site boundary or close to the site, such as to reduce the import and potential export distances for materials. The Consultant shall therefore provide detail on any proposed quarries and/or borrow pits (including information regarding location, size (area and depth), nature, and reinstatement) and the relevant planning deliverables if applicable	It is assumed this is generic text included in SSEN's Scope of Works document as the entire platform excavation is essentially a large borrow pit used to generate site-won fill for platform construction, site access roads and screening landforms at Fanellan.
The Earthworks Strategy document shall highlight all proposed ground improvements, piling and retaining wall structures required by the Works.	This ESR contains a preliminary foundation assessment within Section 5.9. Given the platform will largely be founded in rock no deep ground improvement or piling works are envisaged. No requirements for retaining walls have been identified as part of the Design Fix 2D preliminary design, with grade separation between design levels assumed to be achievable using conventional earthworks slopes. Earthworks batters have been designed to be a maximum of 1V:3H in soils and highly weathered bedrock, and can be steepened up to a maximum of 1V:1.5H in competent rock.

7 Conclusions

This ESR provides a summary of the preliminary earthworks design considerations used to inform the site development for planning approval and provides a basis for further design development to be undertaken by SEBAM at detailed design stage.

Based on platform design levels significant cut and fill works are likely to be required, with the majority of excavation across the site to be within glacial sands and gravels and highly to moderately weathered conglomerate bedrock. Preliminary assessment of the in-situ soils and rock suggests the majority of this material can be crushed, graded and processed into acceptable fill for re-use within the works. Cut and fill volumetric estimates produced at this stage suggest a considerable surplus of fill which shall be incorporated into new landforms which shall provide visual screening of the site. Preliminary assessment of the stability of proposed rock cuttings has been undertaken which generally suggests design batters of maximum 1V:3H in highly weathered rock, and up to a maximum of 1V:1.5H in competent bedrock are likely to be feasible. Consideration of both rockfall protection measures and stabilisation measures to address locally poorer zones of rock and localised kinematic failures over the design life of the earthworks should be determined at detailed design, coupled with consideration of the maintenance requirements for such measures.

Sub-formation level for much of the platform and access roads is within medium dense granular soils or weathered bedrock, therefore requirement for deep ground improvement works is not expected. No requirement for retaining walls is anticipated.

8 References

1. LT459 Final Ground Investigation Final Factual Report ASTI Substations: RGN.330E (March 2024). Surrey. BAM Ritchies.
2. SSEN Desk Study Beauly 400kV Substation & HVDC Switching Station (2023): LT459-BEAU-GDS-CIV-001 Revision 1.0. Perth. Scottish & Southern Electricity Networks.
3. SSEN Desk Study Envirocheck Report Beauly 2 400kV (2023): 308265419_1_1. Exeter. Landmark Information Group Service ®.
4. SSEN Specification for Earthworks: SP-NET-CIV-501 (2023). Revision 2.0. Perth. Scottish & Southern Electricity Networks.
5. Sweco Ground Investigation Report - Beauly Hub 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-Z-0000-GIR_Rev1) dated June 2024.
6. Sweco Drainage Strategy Report - Beauly Hub 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-C-0501_P05) dated April 2024.
7. Sweco Enabling Works Report - Beauly Hub 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-C-201_P04) dated June 2024.
8. Sweco Flood Risk Assessment - Beauly Hub 400kV Switching and HVDC Convertor Station (ref: LT459-SWE-XX-XX-T-W-1002_P02) dated June 2024.
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16. National Highways, 2021. Manual of Contract Documents for Highway Works: Specification for Highway Works Series 0800 - Unbound Mixtures for Highway Works. London: HMSO.
17. British Standards Institution, 2007. Aggregates for unbound and hydraulically bound materials for use in civil engineering work and road construction. BS EN 13242:2002+A1:2007. London: BSI.

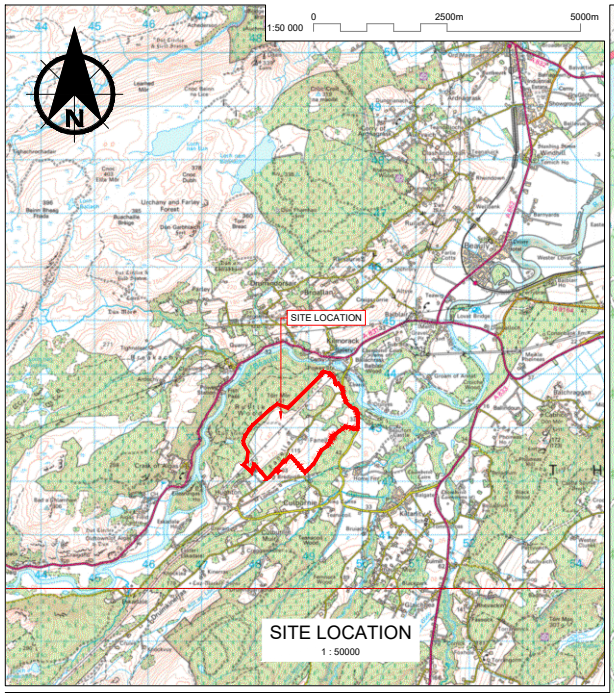
Appendix A

Site Layout Drawings

LT459-SWE-XX-XX-D-X-0001

LT459-SWE-XX-XX-D-X-0002

LT459-SWE-XX-XX-D-X-0003



SITE LOCATION
1 : 50000

SITE LOCATION PLAN
1 : 5000

1:5000 0 250m 500m

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NOTES

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4. REFER TO DRAWINGS LT459-SWE-XX-D-X-0002 AND LT459-SWE-XX-D-X-0003 FOR FURTHER DETAILS OF THE SITE LAYOUT.

KEY TO DRAWING

- PLANNING RED LINE BOUNDARY (223 HA)
- CONIFEROUS TREES
- NON-CONIFEROUS TREES
- BRAKEN, HEATH OR ROUGH GRASSLAND
- WATER
- BUILDINGS
- BOUNDARY WALL OR FENCE
- Iss ISSUES
- o W WELL
- 32m EXISTING GROUND LEVEL
- 400kV OVERHEAD LINE AND TOWER
- EXISTING TRACK
- Collects WATERCOURSE FORMATION
- C CLASS OR UNCLASSIFIED ROAD
- A CLASS ROAD

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P09	28/11/2024	LEGEND ADDED	RL	NG	CB
P08	08/08/2024	TITLE UPDATED	RL	NG	CB
P07	30/04/2024	BOUNDARY UPDATED	RL	NG	CB
P06	19/04/2024	DESIGN FIX 2C	RL	NG	CB
P05	30/01/2024	PAN BOUNDARY UPDATED	RL	NG	CB
P04	19/01/2024	PAN BOUNDARY UPDATED	RL	NG	CB
P03	15/12/2023	DESIGN FIX A	MA	RL	CB
P02	15/11/2023	RLB INCREASED	MA	RL	CB
P01	10/10/2023	FOR COMMENT	MA	RL	CB

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SWECO

Client

Scottish & Southern Electricity Networks TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

SITE LOCATION PLAN
SHEET 1 OF 1

Purpose Of Issue: PRELIMINARY			
Status: S5	Status Description: FOR REVIEW AND ACCEPTANCE		
Drawn: MA	Designed: RL	Checked: RL	Approved: CB
Sheet Size: A1	Scale: AS SHOWN	Sweco Ref: 65209842	Revision: P09

Drawing Number: LT459-SWE-XX-XX-D-X-0001

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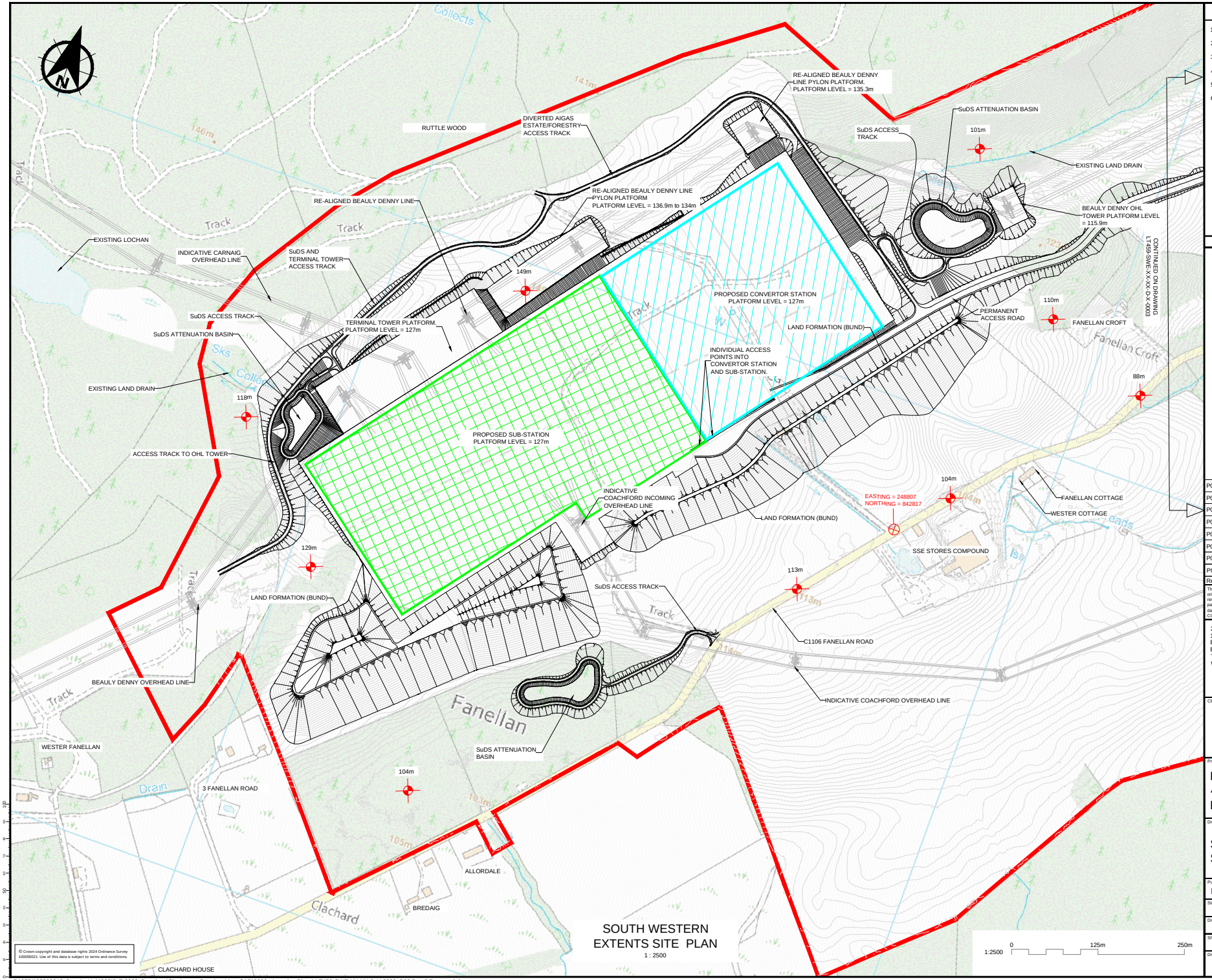

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5. REFER TO DRAWING LT459-SWE-XX-XX-D-X-0003 FOR DETAILS OF THE NORTH EASTERN EXTENTS OF THE SITE.
6. PROPOSED AND EXISTING TOPOGRAPHY CONTOURS ARE SHOWN AT 1m INTERVALS OF HEIGHT DIFFERENCE.

KEY TO DRAWING

- PLANNING BOUNDARY AREA = 223 Ha
- 100m EXISTING TOPOGRAPHY SPOT LEVEL
- CONVERTOR STATION AREA
- SUB-STATION AREA

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P08	28/01/2025	ROAD ALIGNMENTS UPDATED	RL	NG	CB
P07	28/11/2024	CONTOURS ADDED	RL	NG	CB
P06	20/08/2024	FINAL LAYOUT	RL	NG	CB
P05	14/06/2024	COMMENTS ADDRESSED	RL	NG	CB
P04	18/04/2024	DESIGN FIX 2C	RL	NG	CB
P03	29/02/2024	DESIGN FIX 2B	RL	NG	CB
P02	15/12/2023	DESIGN FIX A	MA	RL	CB
P01	10/10/2023	FOR COMMENT	MA	RL	CB

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Client: Scottish & Southern Electricity Networks TRANSMISSION

Project Title: FANELLAN 400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title: SITE PLAN SHEET 1 OF 2

Purpose Of Issue: PRELIMINARY

Status	Status Description
S5	FOR REVIEW AND ACCEPTANCE

Drawn	Designed	Checked	Approved
NG	NG		

Sheet Size	Scale	Sweco Ref	Revision
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Drawing Number: LT459-SWE-XX-XX-D-X-0002

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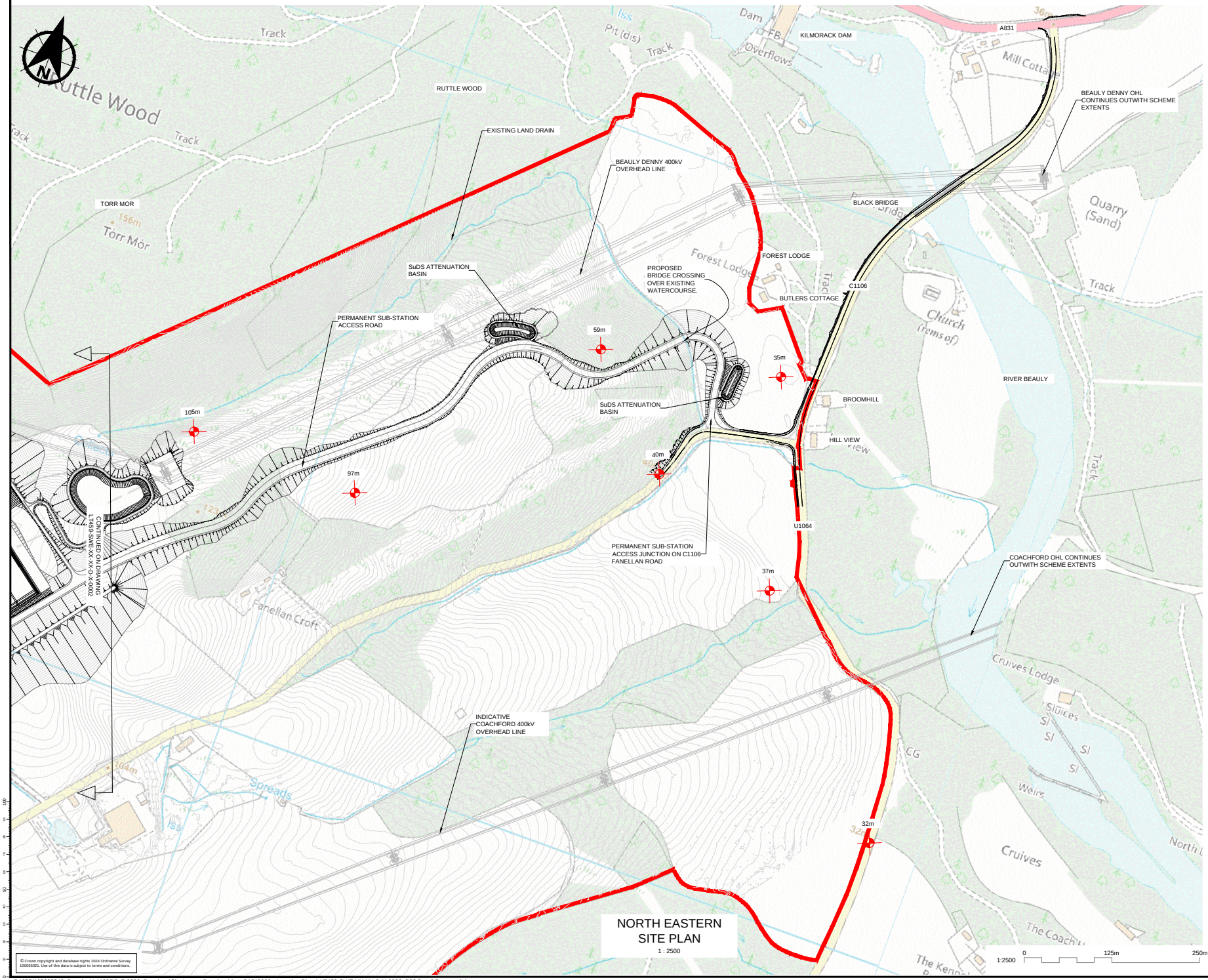

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4. REFER TO DRAWING LT459-SWE-XX-XX-D-X-0001 FOR DETAILS OF THE SITE LOCATION.
5. REFER TO DRAWING LT459-SWE-XX-XX-D-X-0002 FOR DETAILS OF THE SOUTH WESTERN EXTENTS OF THE SITE.
6. PROPOSED AND EXISTING TOPOGRAPHY CONTOURS ARE SHOWN AT 1m INTERVALS OF HEIGHT DIFFERENCE.

KEY TO DRAWING

PLANNING BOUNDARY AREA = 223 Ha

100m EXISTING TOPOGRAPHY SPOT LEVEL

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P08	10/02/2025	ACCESS ROAD AMENDED	RL	NG	CB
P07	28/11/2024	CONTOURS ADDED	RL	NG	CB
P06	20/08/2024	FINAL LAYOUT	RL	NG	CB
P05	14/06/2024	COMMENTS ADDRESSED	RL	NG	CB
P04	18/04/2024	DESIGN FIX 2C	RL	NG	CB
P03	29/02/2024	DESIGN FIX 2B	RL	NG	CB
P02	15/12/2023	DESIGN FIX A	MA	RL	CB
P01	10/10/2023	FOR COMMENT	MA	RL	CB

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Client: Scottish & Southern Electricity Networks TRANSMISSION

Project Title: FANELLAN 400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title: SITE LAYOUT SHEET 2 OF 2

Purpose Of Issue: PRELIMINARY

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S5	FOR REVIEW AND ACCEPTANCE

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RL	NG	NG	CB

Sheet Size	Scale	Sweco Ref	Revision
A1	1:2500	65209842	P08

Drawing Number: LT459-SWE-XX-XX-D-X-0003

Appendix B

Geological Drawings

LT459-SWE-XX-XX-D-G-0001

LT459-SWE-XX-XX-D-G-0002

LT459-SWE-XX-XX-D-G-0003

LT459-SWE-XX-XX-D-G-0004

LT459-SWE-XX-XX-D-G-0005

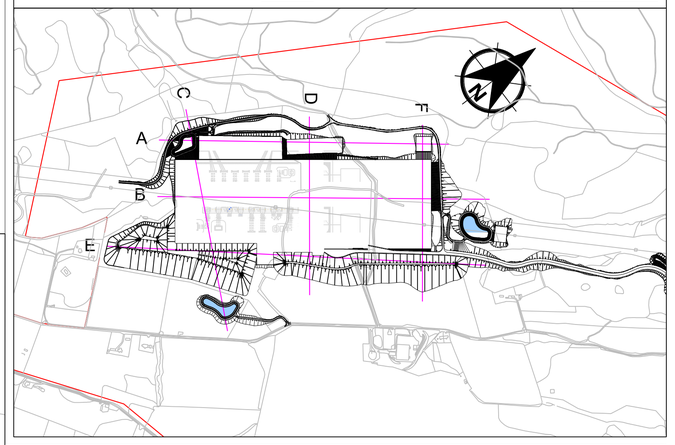
LT459-SWE-XX-XX-D-G-0006

1:1750 0 50 100 150 200m

PLAN LEGEND

- TP — TRIAL PIT (BAM RITCHIES, 2023)
- BH — BOREHOLE (BAM RITCHIES, 2023)
- RED LINE BOUNDARY
- PROPOSED SuDS BASIN
- PROPOSED SUBSTATION
- PROPOSED CONVERTOR STATION

KEY PLAN SCALE 1:10,000

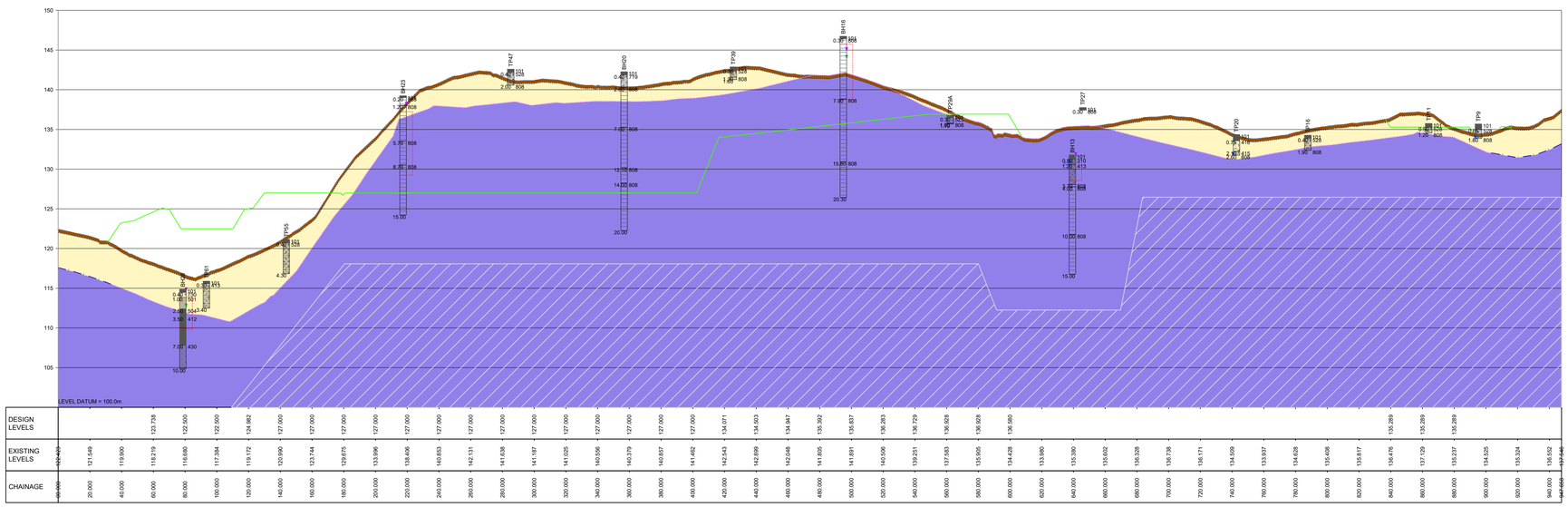


SECTION A

SECTION C

SECTION D

SECTION F



Section A
SCALE: H = 1:1750, V = 1:350

NOTES

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3. ALL LEVELS ARE IN METRES ABOVE ORDNANCE DATUM.
4. DO NOT SCALE FROM THIS DRAWING.
5. WORKS SHOWN ON THIS DRAWING ARE PRELIMINARY AND SUBJECT TO CHANGE.
6. A SCHEME SPECIFIC GROUND INVESTIGATION WAS SPECIFIED BY BAM RITCHIES. THIS INVESTIGATION IS REPORTED IN THE BAM RITCHIES GI FACTUAL REPORT (JANUARY 2024, REF: *RGN:330E*).
7. THE GEOLOGICAL BOUNDARIES SHOWN ON THE SECTIONS HAVE BEEN INTERPRETED BASED ON AVAILABLE GI DATA AND BGS MAPPING INFORMATION. STRATIGRAPHIC BOUNDARIES BETWEEN EXPLORATORY HOLES ARE INDICATIVE ONLY AND ARE EXPECTED TO UNDULATE OR VARY IN THICKNESS BOTH VERTICALLY AND LATERALLY.
8. GROUNDWATER MONITORING DATA SHOWN ON SECTIONS HAS PRIMARILY BEEN RECORDED BETWEEN OCTOBER 2023 AND JANUARY 2024. REFER TO THE PERIODIC GROUNDWATER MONITORING RECORD.
9. ROCKHEAD MODEL CONSTRUCTED BY INTERPOLATING BETWEEN KNOWN AND INFERRED ROCKHEAD LEVELS OBTAINED FROM GROUND INVESTIGATION DATA. MODEL HAS BEEN CONSTRUCTED USING THE LATEST TOPOGRAPHICAL SURVEY DATA AVALABLE (DATED 08/2024).
10. PROPOSED LEVELS BASED ON DESIGN FIX 2D. FINAL LEVELS TO BE CONFIRMED DURING DETAILED DESIGN.

SECTION LEGEND

BOREHOLE LEGEND	
101	TOPSOIL
220	Sandy gravelly CLAY
225	Sandy gravelly bouldery CLAY
310	Sandy gravelly SILT
404	Gravelly SAND
412	Silty gravelly SAND
413	Silty gravelly cobbly SAND
414	Silty gravelly cobbly bouldery SAND
415	Gravelly cobbly SAND
416	Gravelly cobbly bouldery SAND
418	Cobbly bouldery SAND
430	SAND and GRAVEL

BOREHOLE LEGEND CONT...	
501	GRAVEL
504	Sandy GRAVEL
513	Clayey silty sandy GRAVEL
520	Silty sandy GRAVEL
525	Sandy cobbly GRAVEL
528	Silty sandy cobbly GRAVEL
719	Sandy gravelly COBBLES
730	BOULDERS
808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND	
	TOPSOIL
	UNDIFFERENTIATED GLACIAL TILL
	CONGLOMERATE

- PROPOSED LEVELS
- EXISTING LEVELS
- ROCKHEAD MODEL STRATIGRAPHIC BOUNDARY (REFER TO NOTE 9)
- EXTENDED STRATIGRAPHIC BOUNDARY (TBC BEYOND EXTENT OF EXPLORATORY HOLE INFORMATION)
- TOPSOIL BOUNDARY (ASSUMED AT 0.4m SITEWIDE)
- GROUNDWATER STRIKES - STRIKE DEPTH
- GROUNDWATER STRIKES - LEVEL CHANGE AFTER 20 MINUTES
- GROUNDWATER MONITORING - SHALLOWEST READING
- GROUNDWATER MONITORING - DEEPEST READING
- GROUNDWATER MONITORING - STANDPIPE RESPONSE ZONE
- STRATIGRAPHY UNKNOWN (TBC BEYOND EXTENT OF EXPLORATORY HOLE DATA

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P03	25/02/2025	ACCESS TRACK UPDATES	ML	SK	RL
P02	06/09/2024	UPDATED FOR DESIGN FIX 2D	VH	LF	SK
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	29/02/2024	FIRST ISSUE	VH	SK	

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SWECO

Client

Scottish & Southern Electricity Networks
TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

GEOLOGICAL LONG SECTION
SHEET 1 OF 6

Purpose Of Issue

PRELIMINARY

Status	Status Description
S2	FOR INFORMATION

Drawn	Designed	Checked	Approved
VH	VH	LF	SK
Sheet Size	**Scale**	**Sweco Ref**	**Revision**
A1	As Shown	65209842	P03

Drawing Number

LT459-SWE-XX-XX-D-G-0001

\\sweco.se\GB\LDS01\Project\6551\65209842_Beauly_Hub\000\D-Z-0000_Drawings\Geological Sections\Drawings\ GEOLOGICAL LONG SECTIONS SHEET 1 OF 6.dwg

1:1750 0 50 100 150 200m

SECTION A

SECTION B

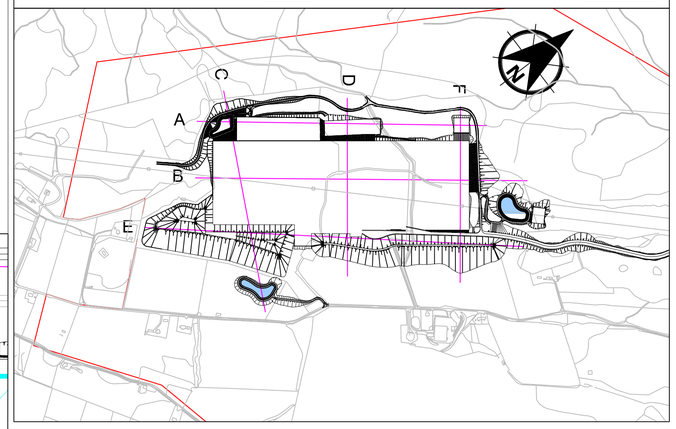
SECTION C

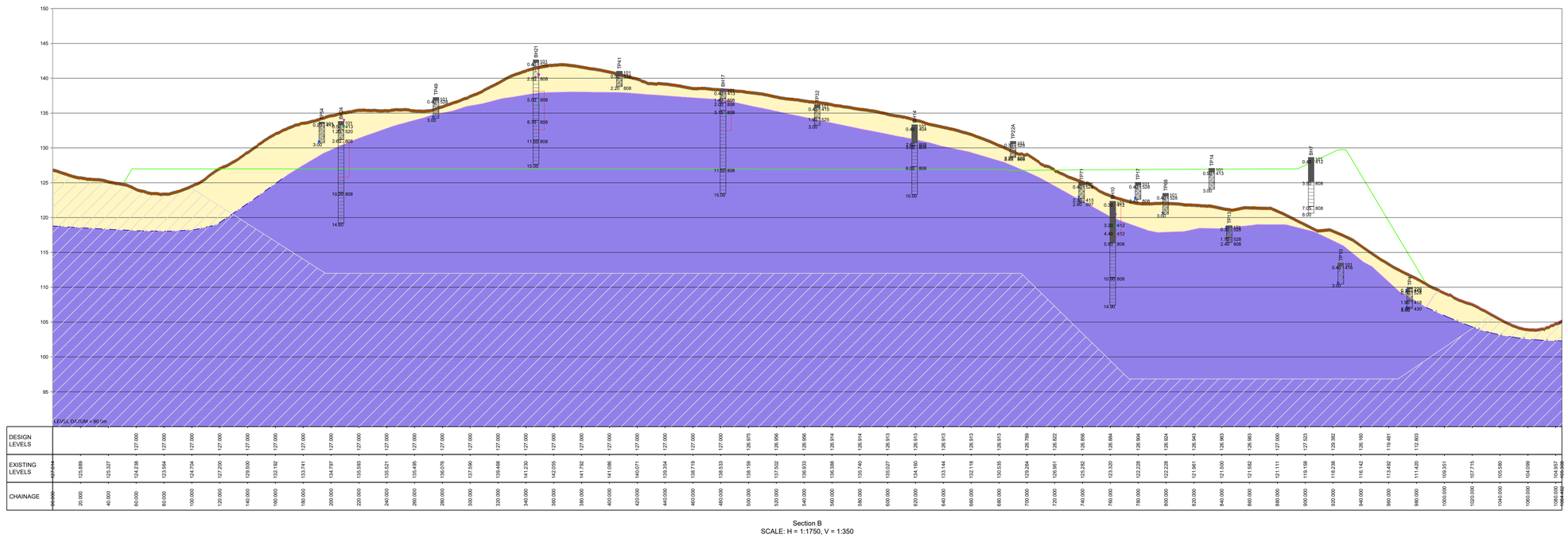
SECTION D

PLAN LEGEND

- TP — TRIAL PIT (BAM RITCHIES, 2023)
- BH — BOREHOLE (BAM RITCHIES, 2023)
- RED LINE BOUNDARY
- PROPOSED SuDS BASIN
- PROPOSED SUBSTATION
- PROPOSED CONVERTOR STATION

KEY PLAN SCALE 1:10,000





Section B
SCALE: H = 1:1750, V = 1:350

NOTES

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7. THE GEOLOGICAL BOUNDARIES SHOWN ON THE SECTIONS HAVE BEEN INTERPRETED BASED ON AVAILABLE GI DATA AND BGS MAPPING INFORMATION. STRATIGRAPHIC BOUNDARIES BETWEEN EXPLORATORY HOLES ARE INDICATIVE ONLY AND ARE EXPECTED TO UNDULATE OR VARY IN THICKNESS BOTH VERTICALLY AND LATERALLY.
8. GROUNDWATER MONITORING DATA SHOWN ON SECTIONS HAS PRIMARILY BEEN RECORDED BETWEEN OCTOBER 2023 AND JANUARY 2024. REFER TO THE PERIODIC GROUNDWATER MONITORING RECORD.
9. ROCKHEAD MODEL CONSTRUCTED BY INTERPOLATING BETWEEN KNOWN AND INFERRED ROCKHEAD LEVELS OBTAINED FROM GROUND INVESTIGATION DATA. MODEL HAS BEEN CONSTRUCTED USING THE LATEST TOPOGRAPHICAL SURVEY DATA AVAILABLE (DATED 08/2024).
10. PROPOSED LEVELS BASED ON DESIGN FIX 2D. FINAL LEVELS TO BE CONFIRMED DURING DETAILED DESIGN.

SECTION LEGEND

BOREHOLE LEGEND	
101	TOPSOIL
220	Sandy gravelly CLAY
225	Sandy gravelly bouldery CLAY
310	Sandy gravelly SILT
404	Gravelly SAND
412	Silty gravelly SAND
413	Silty gravelly cobbly SAND
414	Silty gravelly cobbly bouldery SAND
415	Gravelly cobbly SAND
416	Gravelly cobbly bouldery SAND
418	Cobbly bouldery SAND
430	SAND and GRAVEL

BOREHOLE LEGEND CONT...	
501	GRAVEL
504	Sandy GRAVEL
513	Cobbly silty sandy GRAVEL
520	Silty sandy GRAVEL
525	Sandy cobbly GRAVEL
528	Silty sandy cobbly GRAVEL
719	Sandy gravelly COBBLES
730	BOULDERS
808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND	
	TOPSOIL
	UNDIFFERENTIATED GLACIAL TILL
	CONGLOMERATE

- PROPOSED LEVELS
- EXISTING LEVELS
- ROCKHEAD MODEL STRATIGRAPHIC BOUNDARY (REFER TO NOTE 9)
- EXTENDED STRATIGRAPHIC BOUNDARY (TBC BEYOND EXTENT OF EXPLORATORY HOLE INFORMATION)
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Project Title
FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title
GEOLOGICAL LONG SECTION SHEET 2 OF 6

Purpose Of Issue: PRELIMINARY

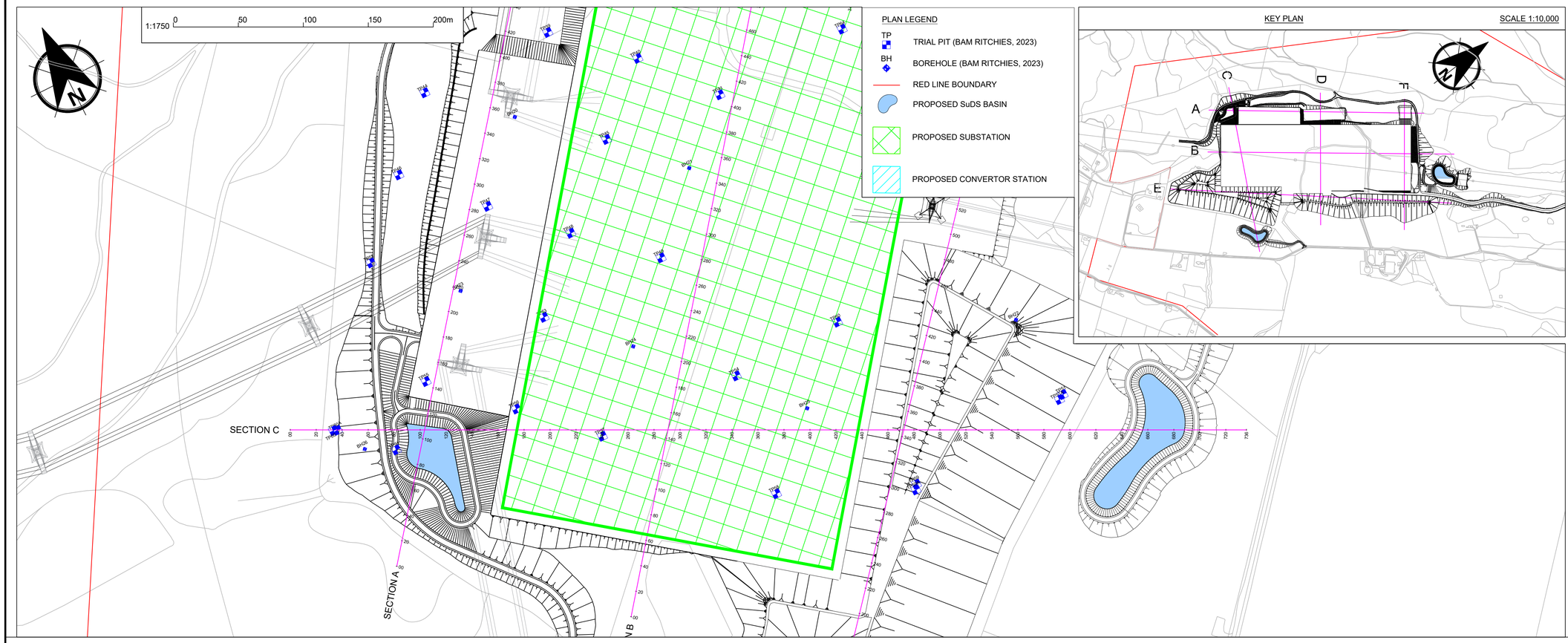
Status	Status Description
S2	FOR INFORMATION

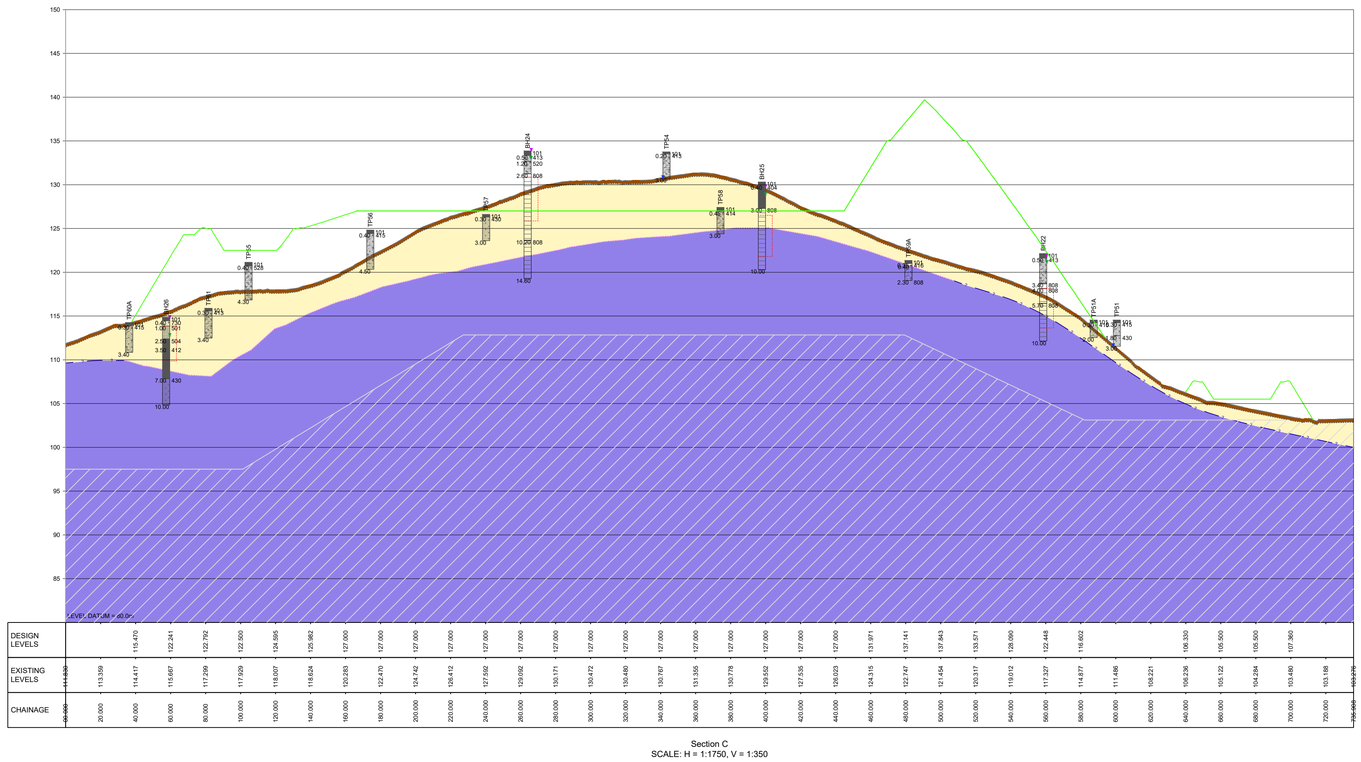
Drawn	Designed	Checked	Approved
VH	VH	LF	SK

Sheet Size	Scale	Sweco Ref	Revision
A1	As Shown	65209842	P03

Drawing Number
LT459-SWE-XX-XX-D-G-0002

\\sweco.se\GB\LDS01\Project\6551\65209842_Beauly_Hub\000\D-Z-0000_Drawings\Geological Sections\Drawings\ GEOLOGICAL LONG SECTIONS SHEET 2 OF 6.dwg





Section C
SCALE: H = 1:1750, V = 1:350

NOTES

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10. PROPOSED LEVELS BASED ON DESIGN FIX 2D. FINAL LEVELS TO BE CONFIRMED DURING DETAILED DESIGN.

SECTION LEGEND

BOREHOLE LEGEND	
101	TOPSOIL
220	Sandy gravelly CLAY
225	Sandy gravelly bouldery CLAY
310	Sandy gravelly SILT
404	Gravelly SAND
412	Silty gravelly SAND
413	Silty gravelly cobbly SAND
414	Silty gravelly cobbly bouldery SAND
415	Gravelly cobbly SAND
416	Gravelly cobbly bouldery SAND
418	Cobbly bouldery SAND
430	SAND and GRAVEL

BOREHOLE LEGEND CONT...	
501	GRAVEL
504	Sandy GRAVEL
513	Clayey silty sandy GRAVEL
520	Silty sandy GRAVEL
525	Sandy cobbly GRAVEL
528	Silty sandy cobbly GRAVEL
719	Sandy gravelly COBBLES
730	BOULDERS
808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND	
	TOPSOIL
	UNDIFFERENTIATED GLACIAL TILL
	CONGLOMERATE

- PROPOSED LEVELS
- EXISTING LEVELS
- ROCKHEAD MODEL STRATIGRAPHIC BOUNDARY (REFER TO NOTE 9)
- EXTENDED STRATIGRAPHIC BOUNDARY (TBC BEYOND EXTENT OF EXPLORATORY HOLE INFORMATION)
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Rev	Date	Amendment Details	Dr'n	Chk'	App'
P03	25/02/2025	ACCESS TRACK UPDATES	ML	SK	RL
P02	06/09/2024	UPDATED FOR DESIGN FIX 2D	VH	LF	SK
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SWECO

Client

Scottish & Southern Electricity Networks
TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

GEOLOGICAL LONG SECTION
SHEET 3 OF 6

Purpose Of Issue

PRELIMINARY

Status	Status Description
S2	FOR INFORMATION

Drawn	Designed	Checked	Approved
VH	VH	LF	SK
Sheet Size	**Scale**	**Sweco Ref**	**Revision**
A1	As Shown	65209842	P03

Drawing Number

LT459-SWE-XX-XX-D-G-0003

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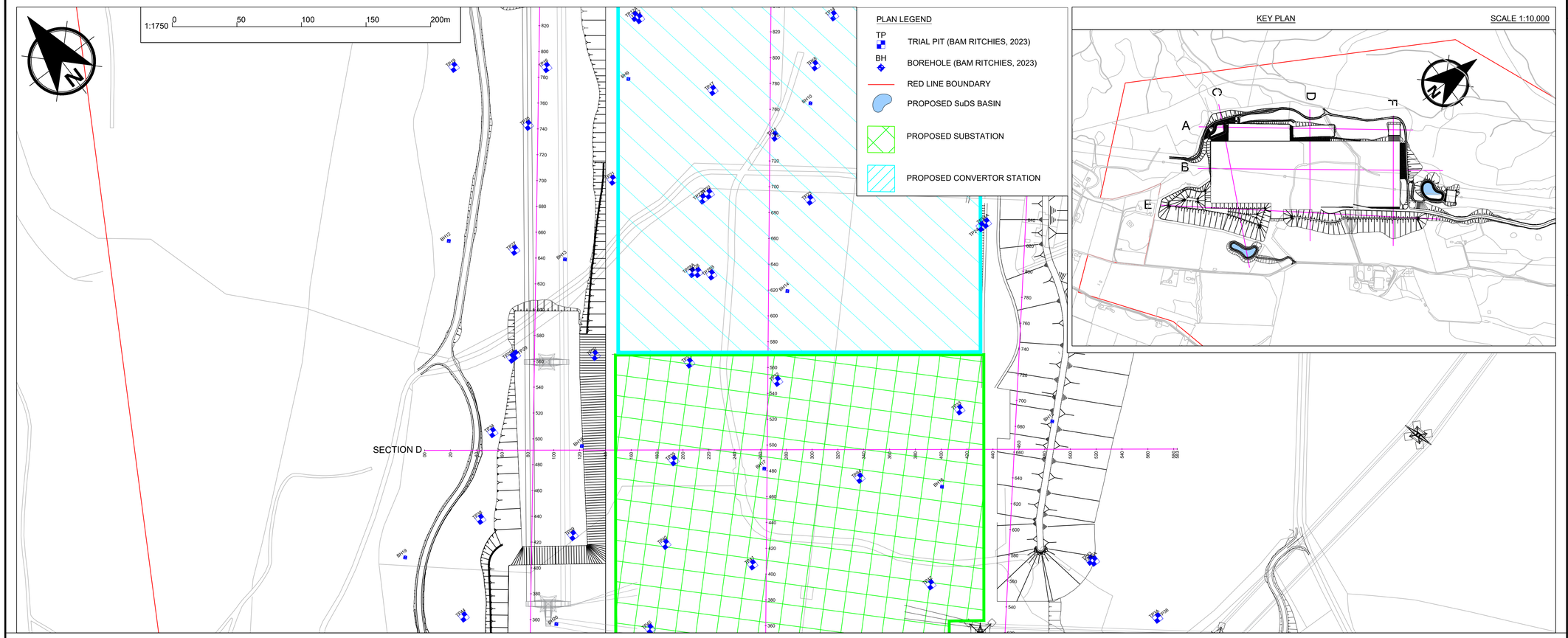

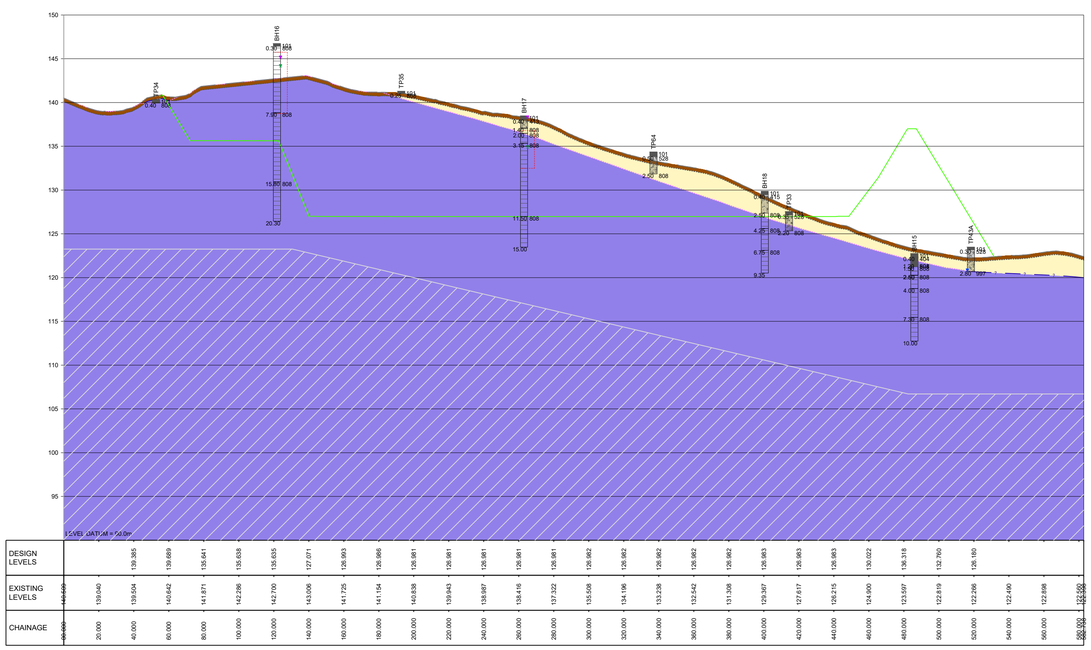

Section D
SCALE: H = 1:1750, V = 1:350

NOTES

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10. PROPOSED LEVELS BASED ON DESIGN FIX 2D. FINAL LEVELS TO BE CONFIRMED DURING DETAILED DESIGN.

SECTION LEGEND

BOREHOLE LEGEND		
	101	TOPSOIL
	220	Sandy gravelly CLAY
	225	Sandy gravelly boulderly CLAY
	310	Sandy gravelly SILT
	404	Gravelly SAND
	412	Silty gravelly SAND
	413	Silty gravelly cobbly SAND
	414	Silty gravelly cobbly boulderly SAND
	415	Gravelly cobbly SAND
	416	Gravelly cobbly boulderly SAND
	418	Cobbly boulderly SAND
	430	SAND and GRAVEL

BOREHOLE LEGEND CONT...		
	301	GRAVEL
	304	Sandy GRAVEL
	313	Clayey silty sandy GRAVEL
	320	Silty sandy GRAVEL
	325	Sandy cobbly GRAVEL
	328	Silty sandy cobbly GRAVEL
	719	Sandy gravelly COBBLES
	730	BOULDERS
	808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND		
		TOPSOIL
		UNDIFFERENTIATED GLACIAL TILL
		CONGLOMERATE

- PROPOSED LEVELS
- EXISTING LEVELS
- ROCKHEAD MODEL STRATIGRAPHIC BOUNDARY (REFER TO NOTE 9)
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- STRATIGRAPHY UNKNOWN (TBC BEYOND EXTENT OF EXPLORATORY HOLE DATA

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P03	25/02/2025	ACCESS TRACK UPDATES	ML	SK	RL
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SWECO

Client

Scottish & Southern Electricity Networks
TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

GEOLOGICAL LONG SECTION
SHEET 4 OF 6

Purpose Of Issue

PRELIMINARY

Status	Status Description
S2	FOR INFORMATION

Drawn	Designed	Checked	Approved
VH	VH	LF	SK
Sheet Size	**Scale**	**Sweco Ref**	**Revision**
A1	As Shown	65209842	P03

Drawing Number

LT459-SWE-XX-XX-D-G-0004

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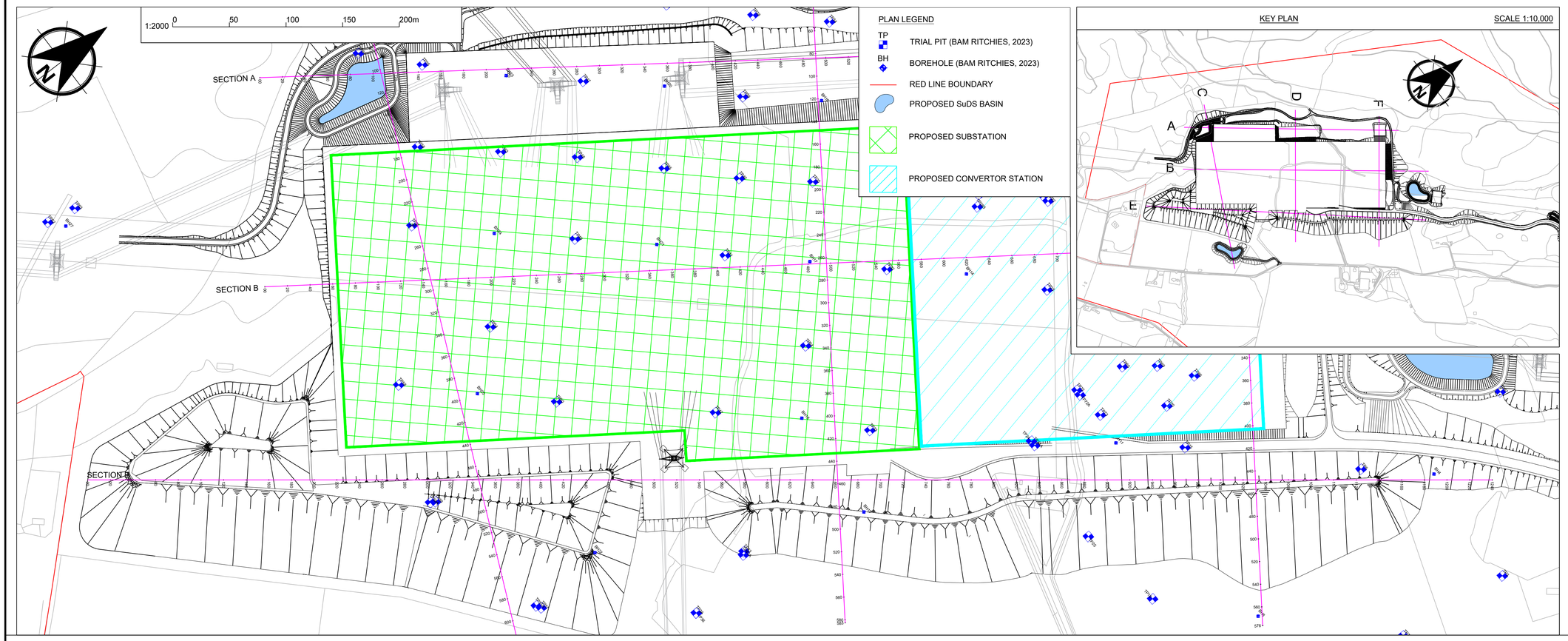

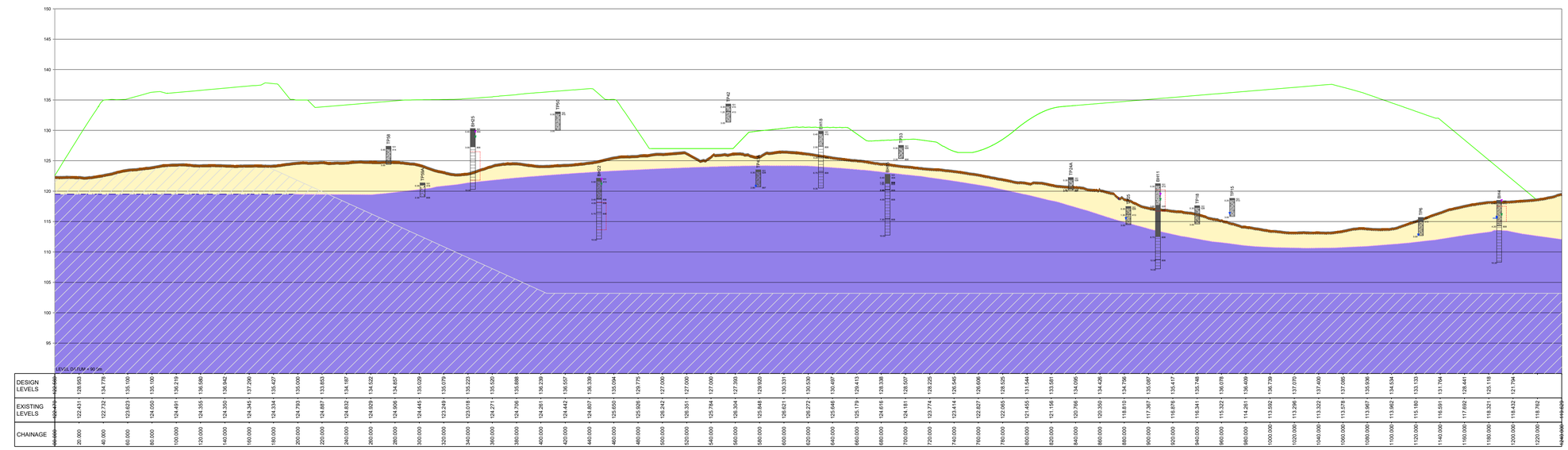

Section E
SCALE: H = 1:2000, V = 1:400

NOTES

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SECTION LEGEND

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	225	Sandy gravelly bouldery CLAY
	310	Sandy gravelly SILT
	404	Gravelly SAND
	412	Silty gravelly SAND
	413	Silty gravelly cobbly SAND
	414	Silty gravelly cobbly bouldery SAND
	415	Gravelly cobbly SAND
	416	Gravelly cobbly bouldery SAND
	418	Cobbly bouldery SAND
	430	SAND and GRAVEL

BOREHOLE LEGEND CONT...		
	501	GRAVEL
	504	Sandy GRAVEL
	513	Clayey silty sandy GRAVEL
	520	Silty sandy GRAVEL
	525	Sandy cobbly GRAVEL
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	719	Sandy gravelly COBBLES
	730	BOULDERS
	808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND		
		TOPSOIL
		UNDIFFERENTIATED GLACIAL TILL
		CONGLOMERATE

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SWECO

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TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

GEOLOGICAL LONG SECTION SHEET 5 OF 6

Purpose Of Issue

PRELIMINARY

Status	Status Description
S2	FOR INFORMATION

Drawn	Designed	Checked	Approved
VH	VH	LF	SK

Sheet Size	Scale	Sweco Ref	Revision
A1	As Shown	65209842	P03

Drawing Number

LT459-SWE-XX-XX-D-G-0005

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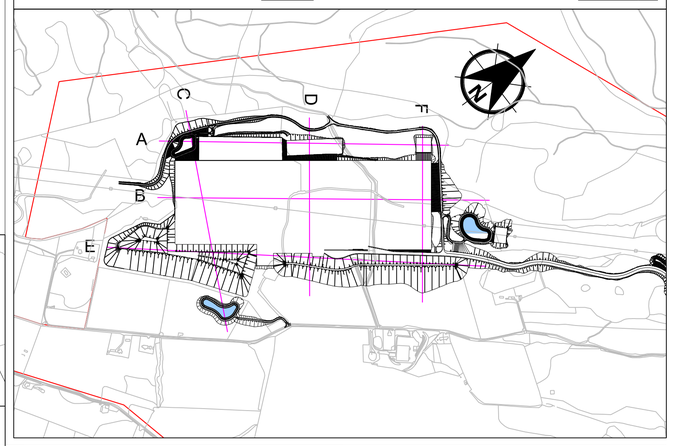
1:1750 0 50 100 150 200m

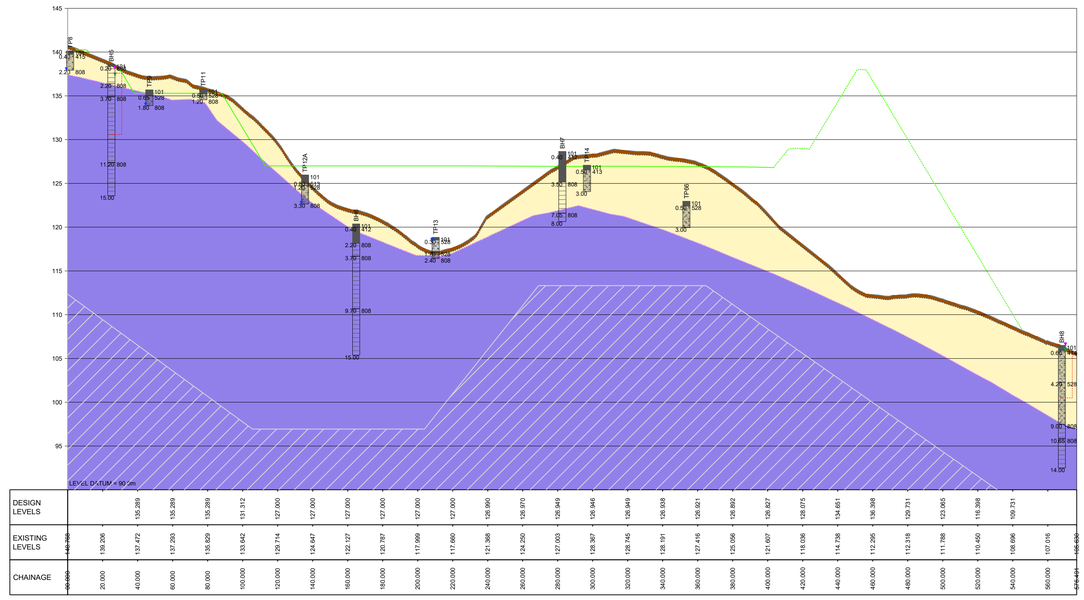
PLAN LEGEND

- TP — TRIAL PIT (BAM RITCHIES, 2023)
- BH — BOREHOLE (BAM RITCHIES, 2023)
- RED LINE BOUNDARY
- PROPOSED SuDS BASIN
- PROPOSED SUBSTATION
- PROPOSED CONVERTOR STATION

KEY PLAN SCALE 1:10,000



SECTION F



Section F
SCALE: H = 1:1750, V = 1:350

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7. THE GEOLOGICAL BOUNDARIES SHOWN ON THE SECTIONS HAVE BEEN INTERPRETED BASED ON AVAILABLE GI DATA AND BGS MAPPING INFORMATION. STRATIGRAPHIC BOUNDARIES BETWEEN EXPLORATORY HOLES ARE INDICATIVE ONLY AND ARE EXPECTED TO UNDULATE OR VARY IN THICKNESS BOTH VERTICALLY AND LATERALLY.
8. GROUNDWATER MONITORING DATA SHOWN ON SECTIONS HAS PRIMARILY BEEN RECORDED BETWEEN OCTOBER 2023 AND JANUARY 2024. REFER TO THE PERIODIC GROUNDWATER MONITORING RECORD.
9. ROCKHEAD MODEL CONSTRUCTED BY INTERPOLATING BETWEEN KNOWN AND INFERRED ROCKHEAD LEVELS OBTAINED FROM GROUND INVESTIGATION DATA. MODEL HAS BEEN CONSTRUCTED USING THE LATEST TOPOGRAPHICAL SURVEY DATA AVALABLE (DATED 08/2024).
10. PROPOSED LEVELS BASED ON DESIGN FIX 2D. FINAL LEVELS TO BE CONFIRMED DURING DETAILED DESIGN.

SECTION LEGEND

BOREHOLE LEGEND		
	101	TOPSOIL
	220	Sandy gravelly CLAY
	225	Sandy gravelly bouldery CLAY
	310	Sandy gravelly SILT
	404	Gravelly SAND
	412	Silty gravelly SAND
	413	Silty gravelly cobbly SAND
	414	Silty gravelly cobbly bouldery SAND
	415	Gravelly cobbly SAND
	416	Gravelly cobbly bouldery SAND
	418	Cobbly bouldery SAND
	430	SAND and GRAVEL

BOREHOLE LEGEND CONT...		
	501	GRAVEL
	504	Sandy GRAVEL
	513	Clayey silty sandy GRAVEL
	520	Silty sandy GRAVEL
	525	Sandy cobbly GRAVEL
	528	Silty sandy cobbly GRAVEL
	719	Sandy gravelly COBBLES
	730	BOULDERS
	808	CONGLOMERATE
INTERPRETED GEOLOGY LEGEND		
		TOPSOIL
		UNDIFFERENTIATED GLACIAL TILL
		CONGLOMERATE

- PROPOSED LEVELS
- EXISTING LEVELS
- ROCKHEAD MODEL STRATIGRAPHIC BOUNDARY (REFER TO NOTE 9)
- EXTENDED STRATIGRAPHIC BOUNDARY (TBC BEYOND EXTENT OF EXPLORATORY HOLE INFORMATION)
- TOPSOIL BOUNDARY (ASSUMED AT 0.4m SITEWIDE)
- GROUNDWATER STRIKES - STRIKE DEPTH
- GROUNDWATER STRIKES - LEVEL CHANGE AFTER 20 MINUTES
- GROUNDWATER MONITORING - SHALLOWEST READING
- GROUNDWATER MONITORING - DEEPEST READING
- GROUNDWATER MONITORING - STANDPIPE RESPONSE ZONE
- STRATIGRAPHY UNKNOWN (TBC BEYOND EXTENT OF EXPLORATORY HOLE DATA

Rev	Date	Amendment Details	Dr'n	Chk'	App'
P03	25/02/2025	ACCESS TRACK UPDATES	ML	SK	RL
P02	06/09/2024	UPDATED FOR DESIGN FIX 2D	VH	LF	SK
P01	19/07/2024	UPDATE TO DRAINAGE BASINS	VH	SK	RL
	29/02/2024	FIRST ISSUE	VH	SK	

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SWECO

Client

Scottish & Southern Electricity Networks
TRANSMISSION

Project Title

FANELLAN
400kV SWITCHING STATION AND HVDC CONVERTOR STATION

Drawing Title

GEOLOGICAL LONG SECTION SHEET 6 OF 6

Purpose Of Issue

PRELIMINARY

Status	Status Description
S2	FOR INFORMATION

Drawn	Designed	Checked	Approved
VH	VH	LF	SK

Sheet Size	Scale	Sweco Ref	Revision
A1	As Shown	65209842	P03

Drawing Number

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