LT521 Bingally 400kV Substation

Drainage Impact Assessment: Access Track

BING4-LT521-SEBAM-DRAI-ZZ-RPT-C-0005

Scottish & Southern Electricity Networks
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1.0 INTRODUCTION

1.1 General

1.1.1 Fairhurst have been appointed by Siemens Energy BAM Joint Venture (SEBAM) to prepare a Drainage Impact Assessment (DIA) to assess the proposed access track serving the proposed Bingally 400kV Substation in the Scottish Highlands (the development).

1.1.2 This report will assess potential impacts of existing watercourses / channels and their required realignments. This report will also assess surface water drainage across the proposed access track to Bingally substation. This report considers any relevant information from the Drainage Strategy report compiled for the proposed access track at Bingally.

1.1.3 For the associated Drainage Strategy report see document no. BING-LT521-SEBAM-DRAI-ZZ-RPT-C-0004.

1.1.4 The site is part of Scottish and Southern Electricity Networks (SSEN) £7bn upgrade of their onshore electricity transmission infrastructure.

1.1.5 The development forms part of a proposed 400kV upgrade from the existing 275kV network between Beauly and Denny. The proposed substation and access track at Bingally forms part of this network route.

1.1.6 This DIA has been compiled to outline the potential drainage impacts for the substation access track to support the planning application for the proposed electrical substation at Bingally. A previous DIA has been issued outlining any potential drainage impacts at the substation platform area. See document no. BING-LT521-SEBAM-DRAI-ZZ-RPT-C-0002. While both reports take into account relevant information from ground investigation reports and flood risk assessments, they will be issued separately to the client due to the discreet requirements of the two parts of the overall development.

1.2 Site Location

1.2.1 The proposed Bingally substation site is situated approximately 2.5km south of the village of Tomich. An access track of approximately 9.5km in length will provide access to the platform area from the A831. The entrance to the site can be found at 1.5km east of the town of Cannich within the Highland Council Area. A plan of the location of the proposed development in relation to the local area is provided in *Figure 1*.

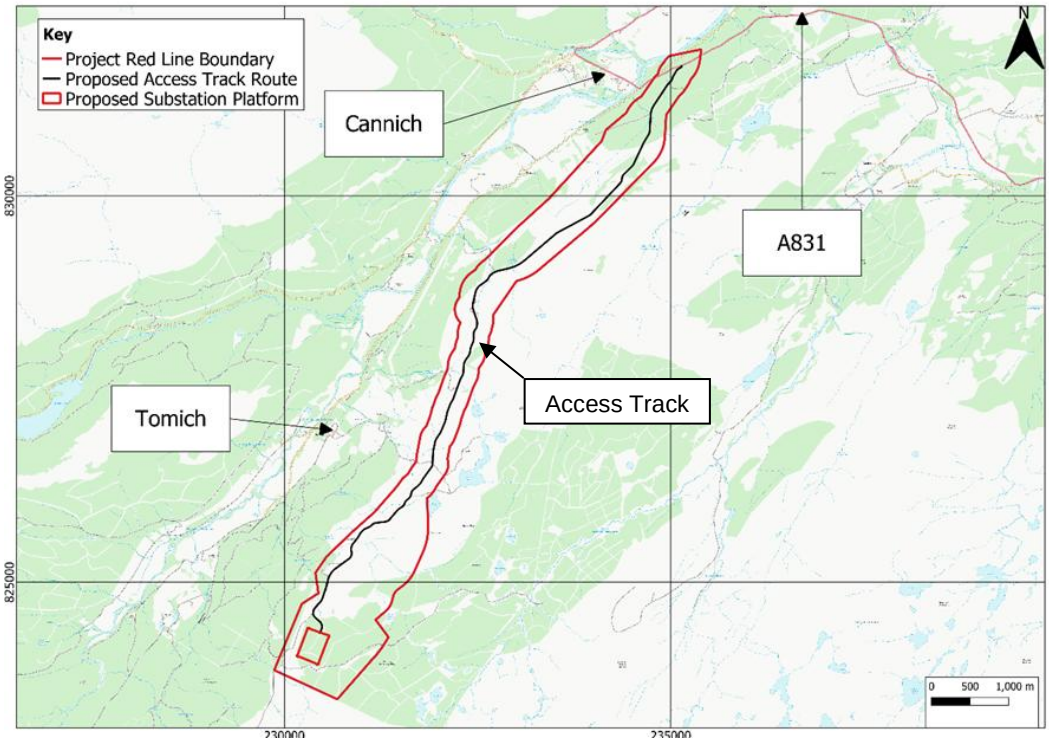


Figure 1: Indicative Site Location

1.2.1 The site area within the red line boundary is approximately 619 Ha. The proposed access track will extend approximately 9.5km in length from the proposed entrance to the site (A831) to the proposed substation. The proposed substation will cover an area of approximately 11.5 Ha.

1.3 Design Considerations

1.3.1 The DIA has been prepared to address the proposed access track drainage arrangements for the site. This also includes the proposed watercourse and drainage crossings, and associated channel realignments required by the design of the access track.

1.3.2 The DIA will assess the surface water run-off from the proposed access track and overland flow from the surrounding area. This report will also detail the management of existing ground water and temporary drainage during the construction, and the maintenance of the

completed network. The drainage design has been prepared to the requirements and recommendations of the following documents:

- SEPA - *Water Assessment and Drainage Assessment Guide*
- The Highland Council (THC) - *Flood Risk and Drainage Impact Assessment Supplementary Guidance*
- CIRIA – *The SuDS Manual (C753)*
- CIRIA – *Culvert Design and Operation Guide (C689F)*
- SSEN Earthworks Specification SP-NET-CIV-501
- SSEN Drainage Specification SP-NET-CIV-502
- Forestry and Land Scotland Civil Engineering Handbook 3rd Edition.
- Sewers for Scotland v4.0 (note this document was considered as a reference for design although not applicable as the drainage will not be vested by Scottish Water)

1.3.3 Further to the above documentation this DIA also relies on information provided in the previously issued Drainage Strategy Report BING4-LT521-SEBAM-DRAI-ZZ-RPT-C-0004.

2.0 EXISTING SITE DESCRIPTION

2.1 Existing Site Description

2.1.1 The current site is located in an area of moor and woodland with areas of boggy land and peat. In June 2023 a wildfire burned through an estimated 80km² of the surrounding area. This resulted in a large section of woodland being burned down or the charred remains being felled. The remnants of the fire can still be seen on site as scorched earth and burnt wooden embers.

2.1.2 There is existing access to the proposed substation area via forestry tracks originating from the village of Tomich. The access track can be reached directly from an entrance on the A831 just prior to reaching the village of Cannich.

2.1.3 A number of unbound access tracks are situated throughout the red line boundary of the overall site, extending in numerous different directions. However, currently there are no uninterrupted access provisions to the proposed substation site access track from the A831.

2.1.4 There are no existing residential dwellings or farm buildings within the site boundary.

2.1.5 For details on the proposed red line boundary and existing site, refer to **Appendix 1**.

2.2 Site Topography

2.2.1 The topography along the access track within the redline boundary varies in direction and gradient. The existing level of the entrance to the access track on the A831 sits at approximately 91mAOD, and the existing level at the end of the access track where it is proposed to join the substation platform increases to 323mAOD. The existing ground levels generally rise from north to south with a varying range of heights from the natural landscape over the approximate 9.5km extent of proposed access track.

2.3 Ground Conditions

2.3.1 Ground investigation information has been taken from the *Fairhurst – Geo-environmental Desk Study Report* (Doc no. *BING4-LT521-SEBAM-EWKS-ZZ-RPT-G-0601*). The present site is a mixture of woodland area, boggy land, numerous watercourses, peat, and rock.

2.3.2 It should be noted that ground investigations are ongoing for the proposed access track. Additional information will be available before detailed design, which will be reviewed when available.

Peat

2.3.3 Peat can be found over a large percentage of the proposed site. Recent ground investigations have shown that the peat reaches thicknesses of up to 7m at the north-west area of the site. Further investigation is required but, it is likely that the peat areas will require some removal and replacement with suitable fill below structures. During the construction phase and post-construction, management of the peat environment will be required.

2.3.4 Areas where peat does not require removal should be left in-tact. Due to the possibility of removal leading to the release carbon into the atmosphere, peat should only be removed if there are no suitable alternatives.

2.3.5 A Peat Management Plan shall address the peat encountered across the site.

Groundwater

2.3.6 Ground investigations along the proposed access track area are still ongoing. Additional information on groundwater will be available before detailed design, which will be reviewed when available.

2.4 Flood Risk

2.4.1 A review of *SEPA Flood Maps* shows no fluvial flood risk within the location of the proposed substation development.

2.4.2 The SEPA Flood Maps also show a risk of surface water (pluvial) flooding at the entrance to the access track at the A831 and directly along the existing access track. There are other localised areas alongside the proposed track at risk of pluvial flooding.

2.4.3 A Flood Risk Assessment (FRA) has been undertaken for the scheme, which provides full details of the flood risk across the site, and the corresponding impact. Please refer to this document, BING4-LT521-SEBAM-DRAI-ZZ-RPT-C-0006, for further details.

2.5 Utilities

2.5.1 There are no private water supplies or foul water systems noted along the line of the proposed access track and surrounding area within the redline boundary. It is also assumed that any underground cables associated with the transmission line will run in parallel with the transmission overhead structures.

2.5.2 The proposed main access track will cross underneath the existing transmission lines at chainages of approximately 8750m and 7550m.

2.5.3 A proposed electrical and fibre optic cable will be buried below the proposed access track from Fasnakyle Electricity Distribution Station. Construction of this utility will be managed by the project manager and construction manager. *Figure 2* below shows the pathway of the transmission overhead line and its location in comparison to the proposed access track.

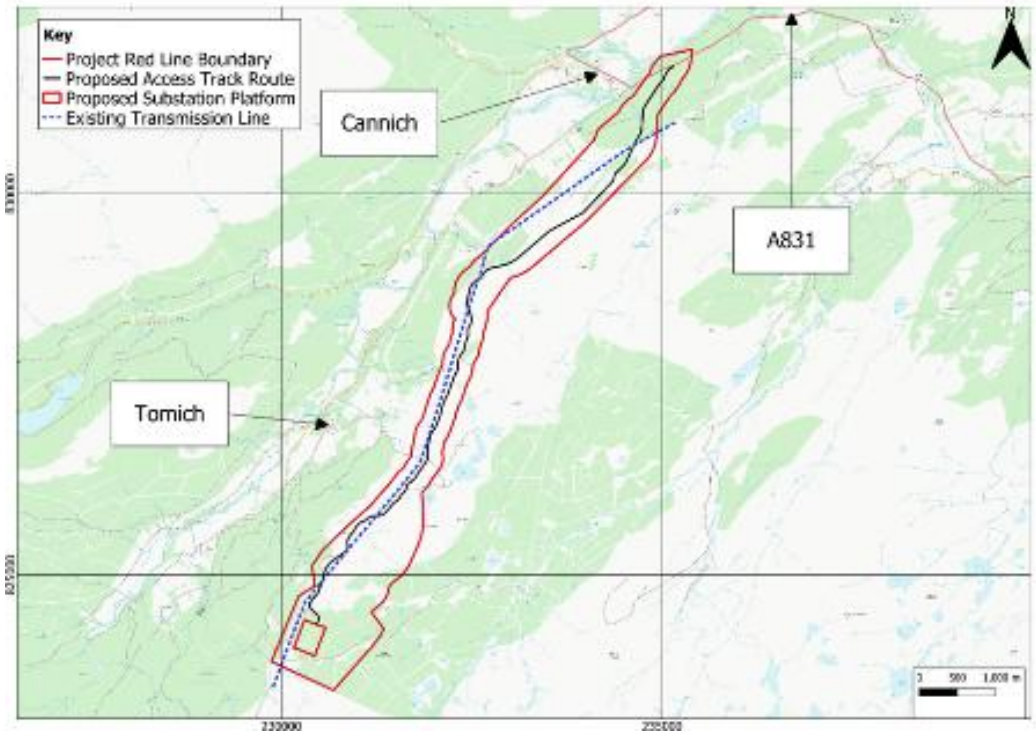


Figure 2: Plan of Existing Transmission Line

2.5.4 During both the planning and construction phases, the proximity of the overhead lines to the access track must be taken into consideration. *Health and Safety Executive guidance note GS6: Avoiding danger from overhead power lines* must be followed during the planning and construction phases.

3.0 EXISTING WATERCOURSES AND DRAINAGE FEATURES

3.1 Watercourses

3.1.1 While numerous watercourses, small tributaries, naturally formed ditches and channels exist within the site boundary, nine main watercourse channels have been impacted, necessitating designed water crossings for the proposed road design.

3.1.2 Due to the extensive area of the site and numerous informal surface water drainage channels in the locality, there may be further drainage paths which may not have been identified using OS maps or visual inspection. It also should be noted that a range of tributaries are not visible on the 1:50,000 scale OS maps. A detailed investigation of the site is required before detailed design.

3.1.3 The nearest major watercourse is the north-east flowing River Glass which is 1.5km from the main site boundary and runs parallel to the proposed access track. It is fed by Abhain Deabhag which receives tributaries draining from the main site and the southern end of the access track.

3.1.4 The proposed access track runs to the west of several lochans with outlets which flow into nearby watercourses. These watercourses drain predominantly in a north-west, west and north-easterly direction before ultimately draining to Abhain Deabhag and the River Glass. The proposed access track crosses a number of mostly north-westerly flowing watercourses which drain towards both aforementioned rivers.

3.1.5 The watercourses identified from the OS mapping impacted by the proposed access track are included in *Table 1*.

Table 1: Existing Watercourses Crossing the Proposed Access Track

Approximate Chainage	Watercourse Name
0360	Unnamed channel
0850	Kerrow Burn
3580	Allt Baile na h-Aibhne
3870	Unnamed Tributary of Allt Baile na h-Aibhne
5370	Allt Currachan
6350	Unnamed Tributary of Abhainn Deabhag
7200	Allt an Fhasaich Mhoir
8000	Allt Bail a' Chladaich
8070	Allt a' Bhuachaille
9020	Unnamed Tributary of Allt a' Bhuachaille

3.1.6 An existing hydroelectric scheme and public water abstraction is located on Allt Currachan, downstream of the location of where the channel crosses the proposed access track. A further existing hydroelectric scheme can be found downstream of the track crossing point at the Allt Baile na h-Aibhne.

3.1.7 Due to the extensive area and numerous informal surface water drainage channels in the locality, there may be further drainage paths within the access track area which have not been identified using OS maps or visual inspection. It should be noted that a range of tributaries are not visible on the 1:50,000 scale OS maps and some which are noted at a 1:50,000 scale may be smaller than anticipated. A detailed investigation of the site is required prior to detailed design.

3.2 Drainage Features

3.2.1 Throughout the site there are numerous visible land ditches that are naturally formed. These ditches have been piped below the existing forestry tracks on their natural route. Outfalls from these ditches could not be located whilst on site.

3.2.2 Due to the extensiveness of the site, further investigation would be required to confirm the location and details of all existing and proposed crossings on site prior to detailed design.

4.0 PROPOSED DEVELOPMENT

4.1 Proposed Access Track

4.1.1 To upgrade the existing Beauly to Denny overhead line from 275kV to 400kV, additional substations are required for the line to be able to connect to the upgraded circuit. This includes the proposed Bingally 400kV substation.

4.1.2 The site will be accessed from the A831, north-east of the village of Cannich. The proposed access track is approximately 9.5km in length from the proposed entrance (A831) to the proposed substation.

4.1.3 The proposed access track will incorporate new junctions along its length with existing intersecting tracks to provide access around the site.

4.1.4 It is assumed that where the gradient exceeds 8%, the access track will have a bound surface in accordance with SSEN Specification. Gradients < 8% will have an unbound surface. SSEN specifications state that unbound material Type 2 sub-base is used. This will be confirmed by the contractor.

4.1.5 The proposed access track is to be predominantly adoptable by Forestry and Land (FLS).

4.1.6 The access track will consist of a bound pavement from chainage 0 to chainage 0300. The physical make-up of all bound sections of track will follow SSEN specifications for bound pavement. Details of the makeup can be found in *Table 2* below.

Table 2: Physical Make Up of Bound Section of Track

Layer	SSEN Specification	
	Standard Details (Bellmouth)	Standard Details (Widening)
Surface Course	40mm close graded Surface Course (AC14 to BS EN 13108-010)	40mm Surface Course
Binder Course	60mm Dense Binder Course (AC20 Dense Binder 100/150 Des to BS EN 13108-01)	60mm Binder
Base		140mm Base
Sub-Base	150mm type 1 Unbound Material to CL 803	Geogrid and 410mm Type 1 CBR 2.5 to 5% 460mm sub base only
Capping	As required	

4.1.7 The remainder of the proposed access track will be unbound. The formation of the track will be finalised upon completion of the ground investigations on site.

4.1.8 *Table 3* below summarises the options that will be used for proposed access track design.

Table 3: Unbound Track Design Options

Anticipated CBR	Formation Material	Extension of FC Access Track (Type 2 Sub Base)	Forestry Tracks	Permanent Access Track	Capping Thickness (mm)	Potential Sacrificial Additional Thickness (mm)
		Assumed Pavement thickness for 0.5 MSA	Assumed Pavement thickness for 1.0 MSA	Assumed Pavement thickness 3.5 to 4.0 MSA		
<5	Clay	200+ Capping	300+ Capping	350+ Capping	Min 600mm to achieve >15% CPR	100mm
<10	Sand (poorly Graded)	200+ Capping	300+ Capping	350+ Capping	Min to achieve >15% CPR	
>15	Sand (Well Graded)	250	300	300	N/A	
>20	Sandy Gravel	150	200	200	N/A	
>100	Rock	100	200	200	N/A	

5.0 PROPOSED DRAINAGE: STRATEGY

5.1 Drainage Principles

5.1.1 The principles of the Drainage Impact Assessment for the Bingally Substation access track drainage design is to replicate the existing quality and quantities of run-off presently at the site wherever it is reasonable and practicable to do so. Post development run-off shall also be dispersed in accordance with:

- CIRIA – *The SuDS Manual (C753)*.
- CIRIA – *Culvert Design and Operation Guide (C689F)*.
- The Highland Council – *Flood Risk and Drainage Impact Assessment Supplementary Guidance*.
- SEPA guidelines.
- SSEN Specifications (SSEN Drainage Specifications: Document SP-NET-CIV-502).
- Forestry and Land Scotland Civil Engineering Handbook 3rd Edition.

5.2 Design Philosophy

5.2.1 In addition to complying with SSEN drainage specification and Local Authority guidelines, the proposed surface water design has been developed in accordance with the principles outlined in *CIRIA: The SuDS Manual (C753)*, as far as practicable. The manual states:

- Wherever possible, run-off should be managed at source (i.e., close to where the rain falls) with residual flows then conveyed downstream to further storage or treatment components where required.
- The passage of water between individual components should be through the use of above ground conveyance systems (e.g., swales and rills).
- Pipework may be a more suitable option depending on the specific scheme, especially where space is limited.
- Pre-treatment (the removal of litter and sediment) and maintenance are vital to ensure the long-term and sustained effectiveness of all SuDS components.
- Overland flow routes may also be required to convey and control floodwater safely during extreme events.

5.2.2 All drainage generated within the site will be drained using Sustainable Drainage Systems (SuDS) principles and will be adhered to during the design with the following:

- Natural run-off collection and diversion (where required).
- Access Track surface water run-off drainage collection and routing.
- Cut-off drains, swales and ditches for treatment and attenuation.

5.4 Design Assumptions

5.4.1 Design assumptions for the proposed access track include:

- All drainage features have been designed to accommodate the 1 in 200-year return period, including a sensitivity check for the 1 in 200-year event plus an allowance for climate change.
- Overland flow flowing east to west will be collected via drainage ditches at the eastern side of the access track.
- Overland flow flowing west to east will be collected via a swale before discharging to one of a series of drainage crossings or existing water features.
- Surface water run-off from the road will flow via proposed swales for treatment.
- Cut-off and roadside ditches will be sized using Manning's formula for open channel flow.

5.5 Design Parameters

5.5.1 SSEN drainage specification document SP-NET-CIV-502, states the following parameters are to be considered during design as a minimum:

- *1 in 200-year rainfall period protection for operational areas;*
- *1 in 1000-year rainfall return period protection for critical equipment;*
- *1 in 200-year rainfall return period for off-site flooding.*

5.5.2 SSEN specifications state that the access track should be considered an operational area.

5.5.3 The Highland Council flood risk and drainage guidance states that "formal on-site storage should be provided up to the 1 in 30-year return period event and attenuation measures should be designed such that SuDS features will not surcharge during a 30-year return period rainfall event." However, the drainage design has accommodated on-site storage of up to and including the 1 in 200-year return period storm with a discharge rate equivalent to the 1 in 2-year return period, to accommodate SSEN Specifications.

5.5.4 Climate Change (CC) allowances have been included when considering the proposed surface water drainage design within the development site. The SEPA: *Climate Change Allowances for Flood Risk Assessment in Land Use Planning, Version 5, Table 2,* recommends a 42% uplift to rainfall data for the North Highland basin region where Bingally is located. This climate change allowance shall be considered during surface water drainage design as required by SEPA guidelines.

5.5.5 Modelling of drainage features has been analysed by using FEH 22 rainfall data for storm events from the 1 in 2-year storm event up to the 1 in 200-year return period, including a sensitivity check for the 1 in 200-year event plus an allowance for climate change.

5.5.6 Modelling of watercourse crossing and drainage crossing capacities has been analysed using the following software, methods and data:

- Flood Estimation Handbook (FEH) method to determine the rainfall data for the region;
- ReFH2 software to model flows in the region to the appropriate storm events;
- LIDAR data to show rainfall flow paths;
- QGIS software to determine the catchment area size in km² for each crossing;

- HY8 culvert analysis software to determine capacities of crossings with freeboard limits applied.

5.5.7 SSEN specifications state that crossings should be sized to convey flow up to a 1:200-year event. A sensitivity check for the 1:200-year plus 42% climate change event has also been carried out.

5.5.8 CIRIA*: Culvert Design and Operational Guide (C689F),* states crossings should have an allowable bed material depth and freeboard allowance. The depths of both vary depending on the diameter/height of the proposed crossing.

5.6 Drainage Outfalls

5.6.1 The options available for discharging surface water are recommended by *CIRIA: The SuDS Manual C753* hierarchy. The hierarchy with relevant site considerations are summarised in *Table* 4 below:

Table 4: CIRIA: The SuDS Manual C753 Outfall Hierarchy

Outfall Method	Suitability	Comments
Infiltrate run-off back into the ground.	Suitability is not known at this time as no infiltration test have been completed.	Conclusive infiltration tests are required prior to confirming if this option is available at the Bingally development site.
Discharge run-off to watercourse	There are a number of watercourses located across the site. Based on the proposed surface water design and development levels, outfalls can be achieved to nearby watercourses following suitable approvals.	A number of outfalls may be required to allow for this option, along with confirmation of levels at detailed design stages.
Discharge run-off to surface or combined sewers.	There are no known Scottish Water sewers at the site location so there could be no discharge to a sewer network.	Not feasible.
Discharge run-off into existing water features such as ponds.	Further investigations and agreements would be required to consider this outfall option.	Not feasible.

6.0 PROPOSED DRAINAGE: ACCESS TRACK

6.1 Proposed Track Drainage

6.1.1 The surface water run-off from the access track will be attenuated and treated using sustainable drainage systems (SuDS), prior to discharge to the local environment. This is to ensure that the run-off from the site will not result in flooding of the site or increase flooding elsewhere.

6.1.2 The proposed drainage will comprise of cut-off trenches on the high side of the track to intercept overland flow and convey it to drainage culverts. The culverts have been spaced, where possible, a maximum of 100m apart to comply with Forestry and Land Scotland requirements. When in fill, surface water from the proposed access track will shed down the fill slope to the proposed swale to receive suitable treatment before discharge to the natural environment. When the access track is in cut, surface water will be collected by roadside ditches. This will then be conveyed to the proposed cut-off trench or swale to receive treatment before discharge to the natural environment.

6.1.3 The proposed access track run-off shall be discharged to greenfield rates. Please refer to **Appendix 2** for initial discharge rate calculations for the proposed ditches and swales across the proposed track.

6.1.4 The proposed track drainage has been designed to convey the 1 in 200-year storm event. Sensitivity checks have also been carried out for the 1 in 200-year + 42% CC storm event.

6.1.5 The proposed access track drainage layouts are presented in **Appendix 3**.

6.2 Proposed Drainage Crossings

6.2.1 Drainage culverts have been designed along the access tracks to convey surface water run-off from the high side of the track to the low side. These have been spaced, where possible, a maximum of 100m apart to comply with Forestry and Land Scotland Requirements. They have been sized to accommodate the 1 in 200-year storm event. Sensitivity checks have also been carried out for the 1 in 200-year + 42% CC storm event. Initial calculations to size the proposed drainage culverts are presented in **Appendix 4**.

6.3 Proposed Watercourse Crossings

6.3.1 Where watercourse channels have been identified to be impacted by the proposed access track design, and are also visible on the OS 1:50,000 scale map, crossing designs are required (see *Table 1*). In addition to these 10 crossings, a further access track crossing is proposed for the western side of the track at the Kerrow Burn.

6.3.2 See **Appendix 3** for the proposed watercourse crossing and realignment location plan. This highlights each crossing location, and identifies the proposed crossing type. The watercourse crossings design is to be finalised during the detailed design stage when additional survey information is available.

6.3.3 Where culverts have been proposed, the design has been progressed to minimise culvert length and maximise open channel length.

6.3.4 A summary table of initial watercourse crossing sizing details is presented in **Appendix 4**.

6.3.5 Please also refer to **Section 9** for additional design details for the proposed watercourse crossings.

7.0 PROPOSED DRAINAGE: SuDS & ATTENUATION

7.1 Simple Index Analysis (SIA) Tool

7.1.1 All proposed SuDS schemes are designed to comply with CIRIA C753: *The SuDS Manual (2015)*, and the *Simple Index Analysis (SIA) Tool*. This document has been developed by SEPA to assess the suitability of proposed SuDS components at a development and to minimise any risks to the water quality of any receiving waterbodies.

7.1.2 Outputs from the SIA study are detailed below for the proposed access track.

7.1.3 For the purposes of utilising the SIA tool for pollution management, the proposed track has been identified as a 'low traffic road (e.g. residential roads and general access roads, <300 traffic movements/day).

7.1.4 The proposed swale which is to run adjacent to the access track has been included as mitigation measures in the SIA.

Table 5: SIA Tool Summary Table

Run-off area land-use description	Access Track: Low Trafficked Road			
Pollution hazard indices:	Hazard Level	Suspended Solids	Metals	Hydrocarbons
	Low	0.5	0.4	0.4
Pollution mitigation indices (Swale):		0.5	0.6	0.6
Total mitigation Index:		0.5	0.6	0.6
Sufficiency:		Sufficient	Sufficient	Sufficient

7.1.5 *Table 5* above shows that sufficient treatment has been proposed for the proposed access track based on the *SEPA – Pollution Mitigation Index Tool*.

7.2 Cut-Off Ditches

7.2.1 Cut-off ditches along the eastern side of the track have been designed to allow for the management of overland flows from land adjacent to the track. Ditches will be designed in line with the natural topography of the site providing channel capacity for up to and including the 1 in 200-year return period rainfall event. The ditches will outfall to either a proposed watercourse or drainage crossing, dependant on the proximity of crossing type to the ditch.

7.3 Swales

7.3.1 Swales have been designed in line with the natural topography of the site and sized to convey the 1 in 200-year storm event. Sensitivity checks have also been carried out for the 1 in 200-year + 42% CC storm event. Check dams will be spaced appropriately depending

on the swale bed gradient to control flow rates, which will improve the surface water quality and control flows to mimic greenfield rates.

7.3.2 Initial sizing for the proposed access track drainage features is summarise in **Appendix 5**.

8.0 DRAINAGE IMPACT: TEMPORARY DRAINAGE

8.1 Temporary Access Track Drainage

8.1.1 The temporary drainage design shall accommodate the proposed temporary track arrangement. This consists of a widened arrangement of the proposed permanent access track. Therefore, the temporary drainage of the access track will utilise the permanent drainage design for surface water run-off treatment during the track construction.

8.1.2 The permanent access track width has been designed to be 5m in width. Prior to the construction of the permanent access track, the access track shall be 7m in width to allow for two-way construction traffic.

8.1.3 When in fill, the temporary access track falls towards the proposed treatment swales. Open drainage ditches are also provided to collect adjacent overland flows where required.

8.1.4 When in cut, the temporary access track has been designed with open drainage ditches adjacent to the track, which will then be directed to adjacent treatment swales before discharging to a proposed drainage or watercourse crossing which accommodates an existing channel crossing the proposed track. Cut off ditches at the top of the cut slopes are also provided to convey adjacent run-off away from the proposed track.

8.1.5 Refer to **Appendix 3** for temporary drainage design details.

9.0 PROPOSED DRAINAGE: CHANNEL CROSSINGS AND REALIGNMENTS

9.1 Channel Crossings

9.1.1 In 10 no. locations along the extent of the proposed access track, watercourses visible on the OS 1:50,000 scale map will be impacted by the proposed access track design. In these locations, suitably designed crossings will be required.

9.1.2 Where possible, bridge crossings will be provided to provide a clear span over the existing watercourse channel. Where this is not possible, culvert crossings and watercourse realignments will be proposed, whilst still aiming to provide the least impactful solution to the existing site and water environment by minimising culvert length and maximising open channel length.

9.1.3 Refer to the proposed watercourse crossing realignment location plan in **Appendix 3** for details on these crossings, along with the proposed crossing type.

9.1.4 The modelling of watercourse crossing and drainage crossing capacities has been produced and analysed using the following software, methods and data:

- Flood Estimation Handbook (FEH) method to determine the rainfall data for the region.
- ReFH2 software to model flows in the region to the appropriate storm events.
- LIDAR data to determine rainfall flow paths (where available).
- QGIS software to determine the catchment area size in km² for each crossing.
- HY8 culvert analysis software to determine capacities of crossings with freeboard limits applied.

9.1.5 Where culvert crossings and realignments are considered as required under the Bingally access track, the channel crossings have been sized to convey the 1 in 200-year return period peak flow with an allowance for freeboard through the culvert in accordance with *CIRIA Report C786: Culvert, screen and outfall manual*. A sensitivity check has been undertaken to assess the culvert against the 1 in 200-year flow peak flow plus an allowance for climate change to check the freeboard of the inlet headwater level to the finished access track level to make sure that the access track is not overtopped and remains accessible as an 'operational' area.

9.1.6 In accordance with *CIRIA Report C786: Culvert, screen and outfall manual* watercourse crossings should have an allowable bed material depth and freeboard allowance. The depths of both vary depending on the diameter/height of the proposed crossing.

9.1.7 For crossing locations CH043 and CH085, where culvert and channel realignments are proposed, please refer to drawings in **Appendix 3** which provide initial design details and arrangements.

9.2 Channel Realignments

9.2.1 The realignment of existing watercourses have been designed to allow for the proposed substation access track realignment, where required.

9.2.2 During the design considerations for channel realignments, any activities proposed within the site that may affect the natural environment, including channels, may require a SEPA – Water Environment (Controlled Activities) (Scotland) Regulations (CAR) application.

9.2.3 Watercourses that require realignment on site have been designed to accommodate a 1 in 200-year +CC flow. The flow has been estimated using the proposed catchment area and point data from FEH 22. The channel capacity has been calculated based on the Manning's equation for a trapezoidal cross-section:

9.2.4 Q = v*A = (1/n)*AR^(2/3)*S^(1/2)

9.2.5 Where:

- Manning's 'n' = 0.05 for a natural stream/stony channel for diverted channels
- S = Average channel slope based on the gradient between the channel tie-in level and the channel bed level
- R = Hydraulic radius (m), which is equal to the Flow Area / Wetted Perimeter
- A = Flow area (m^2)

9.2.6 Channel slope gradients have been proposed as 1 in 3, but geotechnical advice will be needed to confirm this. The bed widths of the channel have been taken as 0.6m. Confirmation on the existing bed width is needed. With confirmation of additional details, the channel can be adjusted to complement the natural settings. The typology of the channels has been taken into consideration during the design, providing sinuosity to the channels to allow for naturalisation of the channels.

9.2.7 The design has implemented the typology for the catchment setting and channel average bed slope based on the table provided in Buffington, J.M. & Montgomery, D.R. (2013) - *Geomorphic Classification of rivers in Scroder J., Wohl E. (eds) Treatise on Geomorphology, Vol9, Academic Press, San Diego CA, pages 730-767*. See extract of the table below.

Table 6: Extract from Buffington and Montgomery (2013)

Type	Slope (%)	Slope (1:X)
Cascade	>7.5%	>1:13
Step pool	3% – 7.5% or, 2% – 3% (>150W/m^2 in 1:2 year event)	1:33 – 1:13 or, 1:50 - 1:33 (>150W/m^2 in 1:2 year event)
Plane bed	1% – 2% or, 2% – 3% (<150W/m^2 in 1:2 year event)	1:100 – 1:50 or, 1:50 – 1:33(<150W/m^2 in 1:2 year event)
Plane riffle	0.5% - 1%	1:200 – 1:100
Pool riffle	0.2% - 0.5%	1:500 – 1:200
Low gradient passive meandering (dune-ripple bed)	<0.2%	<1:500

9.2.8 Channel crossings and realignments have been designed to accommodate a 1 in 200-year return period, as well as additional consideration for climate change. Piped crossings have

been proposed to necessitate the installation of a headwall or a retaining wall at both the inlet and outlet as required. Headwalls are viewed as improvements to the existing baseline conditions.

9.2.9 Geomorphology has been considered during the design. The channel realignments have introduced sinuosity where possible.

9.2.10 Sustainable and ecological material choices shall be specified at detailed design stages where possible, once further investigations of the existing watercourse are carried out.

9.2.11 The proposed indicative channel realignments associated with the proposed watercourse crossings to accommodate the proposed access track can be seen in **Appendix 3**.

10.0 DRAINAGE IMPACT: GROUND WATER

10.1.1 SEPA flood maps indicate areas where groundwater could influence the duration and extent of flooding from other sources. The proposed site is situated out with groundwater influenced flood extent shown on these maps apart from at the northern end of the proposed track where it approaches the A831.

10.1.2 The 1:50,000 British Geological Society (BGS) digital mapping shows that the site is underlain by sedimentary bedrock, comprising the Tarvie Psammite Formation. The BGS 1:625,000 hydrogeology map classifies this as a low productivity aquifer with small amounts of flow occurring predominantly through near surface fractures and discontinuities.

10.1.3 The BGS identifies that superficial deposits across the site, where present, are predominantly Glacial Till. Glacial Till is more prevalent in the southern half of the site. Overlying both bedrock and Glacial Till are pockets and areas of Peat.

10.1.4 It should be noted that ground investigations are ongoing for the proposed access track. Additional information will be available before detailed design, and reviewed when available.

10.1.5 Considerations for groundwater as part of the surface water drainage design are to be finalised upon completion of ground investigations on site. When available, any significant ground water seepage rates from earthworks cut slopes shall be considered as part of the Drainage Strategy if required.

10.1.6 Please refer to Geo-Environmental Report No. BING4-LT521-SEBAM-ZZ-ZZ-RPT-G-0001 for details on potential for groundwater flooding.

10.2 Design Considerations

10.2.1 Groundwater has been observed to be shallow at the proposed substation site and throughout the site. Due to the shallow groundwater depths, careful management will be required to ensure excavation stability during construction and also in the long-term e.g., culvert operation, slope stability and any groundwater changes which may cause flooding or dewatering of localised peat.

10.2.2 Ongoing ground investigation results will be reviewed once available against the proposed design.

11.0 DRAINAGE IMPACT: FOUL WATER MANAGEMENT

11.1.1 The Drainage Impact Assessment Report for Bingally access track has no proposed foul water management at this stage, as the design only incorporates the proposed surface water run-off for the proposed access track.

12.0 MAINTENANCE SCHEDULE

12.1.1 All surface water drainage features will require regular maintenance to ensure the features can maintain their drainage capabilities. The frequency of a maintenance schedule varies depending on the feature and can become less regular over time again, depending on the feature type. The SuDS Manual (C753) provides recommended maintenance requirements, which is summarised below.

12.2 Swales/Ditches

Table 7: Maintenance Schedule, Swales/ Ditches, The SuDS Manual (C753)

Maintenance Schedule	Required Action	Frequency
Regular Maintenance	Inspect inlets/outlets and overflows for blockages and clear if required	Monthly
	Litter and debris removal	Monthly/as required
	Grass cutting – to retain grass height within specified design range.	Monthly (during growing season) or as required
	Manage other vegetation and remove nuisance plants	Monthly at start then as required
	Inspect infiltration surfaces for ponding, compaction & silt accumulation. Record areas where ponding occurs for >48 hours.	Monthly/as required
	Inspect vegetation coverage	Monthly for 6 months then quarterly for 2 years, then half yearly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies	Bi-annually
Occasional Maintenance	Reseed areas of poor vegetation growth and alter plant types to better suit conditions if required	As required of if bare soil is exposed over 10% or more of swale treatment area.
Remedial Maintenance	Repair erosion or other damage by re-turfing or re-seeding.	As required
	Re-level uneven surfaces and reinstate design levels.	As required
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface	As required
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip.	As required

Maintenance Schedule	Required Action	Frequency
	Remove and dispose of oil or petrol residues using safe standard practices	As required

13.0 CONCLUSION

13.1.1 This Drainage Impact Assessment (DIA) report shows the proposed drainage infrastructure and the methodology behind the designs for the proposed access track to the proposed Bingally 400kV Substation. Design parameters have also been included in this report and appropriate guidelines have been observed in order to influence the design process.

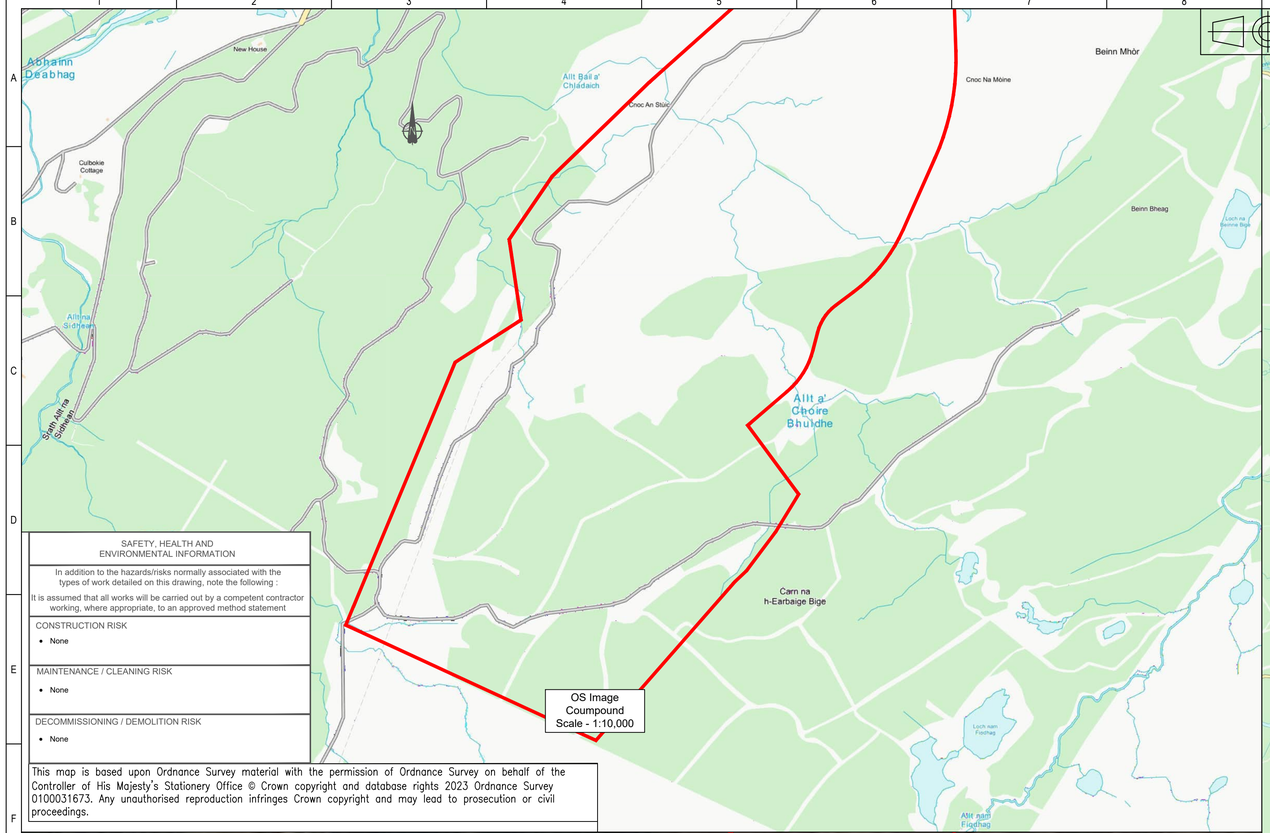
13.1.2 Fairhurst are responsible for the design of surface water drainage proposals at the access track.

13.1.3 The proposed permanent surface water drainage has been designed using The Highland Council, SEPA, CIRIA and SSEN guidance. The proposed surface water design proposes run-off to be stored up to and including the 1 in 200-year storm event, to the 1 in 2-year greenfield run-off rate. Swales / ditches shall convey surface water, and discharge treated surface water run-off into the existing channels / drainage ditches across the site.

13.1.4 The temporary surface water drainage design has also been considered. It is proposed that the temporary drainage will utilise the swales and ditches proposed in the permanent design where available, whilst accommodating a widened track to allow for two-way construction traffic.

13.1.5 The upgraded forestry track has been designed connecting the A831 to the proposed new substation platform. Along the proposed route of the access track, several crossings and channel realignments to existing channels have been designed to accommodate the proposals. This has been designed with current best practice, and shall include sinuosity where possible, and aim to keep natural gradients as close to the existing channel.

Appendix 1 Proposed Site Boundary and Existing Site Layout



OS Image
Coumpound
Scale - 1:10,000

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :

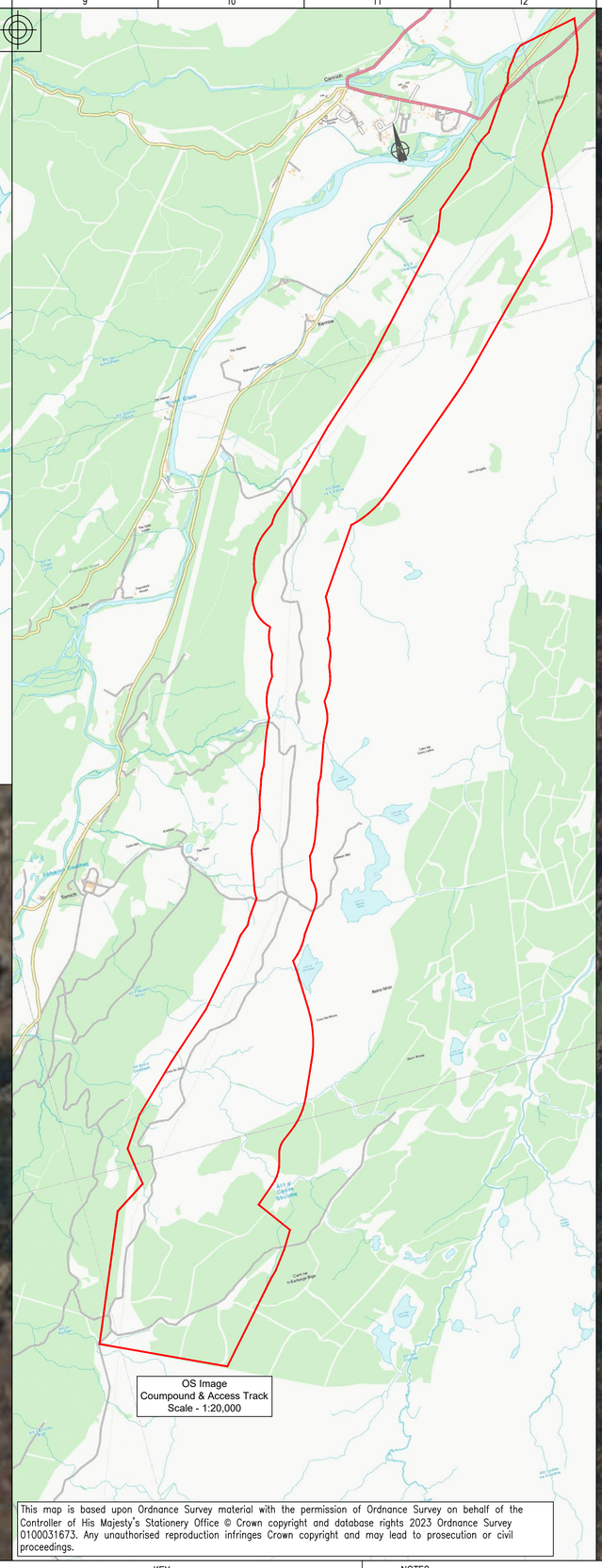
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

CONSTRUCTION RISK
- None

MAINTENANCE / CLEANING RISK
- None

DECOMMISSIONING / DEMOLITION RISK
- None

Aerial View
Coumpound
Scale - 1:10,000



OS Image
Coumpound & Access Track
Scale - 1:20,000

Aerial View
Coumpound & Access Track
Scale - 1:20,000

KEY
PROPOSED RED LINE BOUNDARY

NOTES
1. THE PROPOSALS SHOWN ON THIS DRAWING HAVE BEEN DETERMINED FROM TOPOGRAPHICAL SURVEY INFORMATION PROVIDED BY OTHERS
2. SITE LAYOUT BASED ON DRAWING 231204 SB Layout with additional land take
3. DESIGN PROPOSALS SHOWN ARE PRELIMINARY AND SUBJECT TO DETAILED DESIGN.

DRAWING STATUS: ISSUED	REVISION:	P02
	DRAWN: RG	23/02/24
	CHECKED: GI	23/02/24
	APPROVED: CG	23/02/24

PROJECT REF:
FIRST ISSUE
P02 - 23/02/2024 BOUNDARY AMENDED

Customer: Scottish & Southern Electricity Networks TRANSMISSION

Contractor: SIEMENS energy + bam
Joint Venture
Substation Delivery Framework

Subcon. Drawing No.: LT521-SEBAM-ZZ-ZZ-D-C-0102

Project: BINGALLY 400kv SUBSTATION

Title: LT521 - BINGALLY 400kv SUBSTATION
REFERENCE LOCATION PLAN

Contractor Drawing No.: BING4-LT521-SEBAM-ZZ-ZZ-D-C-0102

Customer Drawing No.: BING4-LT521-SEBAM-ZZ-ZZ-D-C-0102

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
RG	AC	FF	CG	08/01/2024	AS SHOWN	A1	1 of 1	P02

Appendix 2 Initial Track Side Ditch and Swale Greenfield Rates

ICP SUDS Mean Annual Flood

Input

Return Period (years)	200	Soil	0.500
Area (ha)	0.413	Urban	0.000
SAAR (mm)	1475	Region Number	Region 1

Results l/s

QBAR Rural	5.5
QBAR Urban	5.5
Q200 years	15.3
Q1 year	4.6
Q30 years	10.3
Q100 years	13.5

Appendix 3 Proposed Drawings

OUTFALL TO OVERLAND FLOW DISPERSAL
OUTFALL TO WATERCOURSE
DRAINAGE CULVERT
WATERCOURSE BRIDGE
TRACK SIDE DRAINAGE DITCH OUTFALL
TRACKSIDE DRAINAGE DITCH OUTFALL

NOTES
1. DITCH DIMENSIONS ARE PRELIMINARY ONLY AND TO BE FINALISED AT DETAILED DESIGN UPON COORDINATION WITH EARTHWORKS AND CULVERT DESIGNS
2. DITCH SIZES REFER TO CAPACITY REQUIREMENTS ONLY. ADDITIONAL CUT AND FILL MAY BE REQUIRED TO GRADE EXISTING GROUND.
3. SETTLEMENT LAGOONS SHOWN TO NOT INCLUDE EARTHWORKS EXTENTS.
4. DURING CONSTRUCTION PARTICULAR CARE IS TO BE TAKEN BY THE CONTRACTOR TO ENSURE THAT THE MINIMUM AMOUNT OF DAMAGE AND DISTURBANCE TO LAND DRAINS AND DITCHES ARE CAUSED. THE CONTRACTOR WILL INVESTIGATE, DESIGN, INSTALL, REPAIR AND MAINTAIN ALL LAND DRAINS THAT ARE AFFECTED BY THE WORKS AS PER THE CIVIL SCOPE OF WORKS.
5. COORDINATION OF DRAINAGE DESIGN AND CABLE COORDINATES TO BE CONFIRMED.

LEGEND:
- TYPE A OR TYPE B HIGHSIDE DITCH
- SWALE
- DRAINAGE DITCH (PERMANENT TRACK)
- DRAINAGE CULVERT
- WATERCOURSE BRIDGE
- WATERCOURSE CULVERT

METRES @ 1:2500 — 0 20 50 100 250

DRAWING STATUS: S5											
ISSUED FOR FINAL REVIEW	REVISION:	P01		PROJECT REF: BING4-LT521	ISSUED FOR FINAL REVIEW	P02		PROJECT REF: BING4-LT521	ISSUED FOR FINAL REVIEW	P03		PROJECT REF: BING4-LT521	ISSUED FOR FINAL REVIEW
	DRAWN:	J.PETRIE	08/11/2024			J.PETRIE	23/10/2025			J.PETRIE	28/10/2025		
	CHECKED:	R.DUNCAN	08/11/2024			R.DUNCAN	23/10/2025			R.DUNCAN	28/10/2025		
	APPROVED:	R.MINTO	08/11/2024			R.MINTO	23/10/2025			R.MINTO	28/10/2025		

Customer: Scottish & Southern Electricity Networks TRANSMISSION

Contractor: SIEMENS energy + bam — Joint Venture Substation Delivery Framework

Subcon. Drawing No.: FAIRHURST — BING4-LT521-SEBAM-DRAI-ZZ-D-C-0191

Project: BINGALLY 400kV SUBSTATION

Title: LT521 - BINGALLY
ENGINEERING DRAWINGS
PROPOSED TRACK DRAINAGE LAYOUT SHEET 1

Contractor Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0191

Customer Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0191

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
J.PETRIE	S.MITCHELL	J.PETRIE	R.MINTO	03/09/2024	1:2500	A1	1 of 3	P03

OUTFALL TO OVERLAND FLOW DISPERSAL
OUTFALL TO WATERCOURSE
TRACK SIDE DRAINAGE DITCH OUTFALL
DRAINAGE CULVERT
WATERCOURSE BRIDGE

NOTES
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5. COORDINATION OF DRAINAGE DESIGN AND CABLE COORDINATES TO BE CONFIRMED.

LEGEND:
- TYPE A OR TYPE B HIGHSIDE DITCH
- SWALE
- DRAINAGE DITCH (PERMANENT TRACK)
- DRAINAGE CULVERT
- WATERCOURSE BRIDGE
- WATERCOURSE CULVERT

METRES @ 1:2500 — 0 20 50 100 250

DRAWING STATUS: S5

	P01		P02		P03	
REVISION:	P01		P02		P03	
DRAWN:	J.PETRIE	08/11/2024	J.PETRIE	23/10/2025	J.PETRIE	28/10/2025
CHECKED:	R.DUNCAN	08/11/2024	R.DUNCAN	23/10/2025	R.DUNCAN	28/10/2025
APPROVED:	R.MINTO	08/11/2024	R.MINTO	23/10/2025	R.MINTO	28/10/2025

ISSUED FOR FINAL REVIEW | PROJECT REF: BING4-LT521

Customer: Scottish & Southern Electricity Networks TRANSMISSION
Contractor: SIEMENS energy + bam — Joint Venture Substation Delivery Framework
Subcon. Drawing No.: FAIRHURST — BING4-LT521-SEBAM-DRAI-ZZ-D-C-0192

Project: BINGALLY 400kV SUBSTATION
Title: LT521 - BINGALLY ENGINEERING DRAWINGS PROPOSED TRACK DRAINAGE LAYOUT SHEET 2
Contractor Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0192
Customer Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0192

Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
J.PETRIE	S.MITCHELL	R.DUNCAN	R.MINTO	03/09/2024	1:2500	A1	2 of 3	P03

OUTFALL TO OVERLAND FLOW DISPERSAL
OUTFALL TO WATERCOURSE
TIE INTO EXISTING ROAD SIDE DITCH
OUTFALL TO TRACK SIDE DITCH
TRACK SIDE DRAINAGE DITCH OUTFALL
WATERCOURSE CULVERT
DRAINAGE CULVERT
TEMP DRAINAGE CULVERT (TBC)
TRACK SIDE DRAINAGE DITCH OUTFALL

NOTES
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5. COORDINATION OF DRAINAGE DESIGN AND CABLE COORDINATES TO BE CONFIRMED.

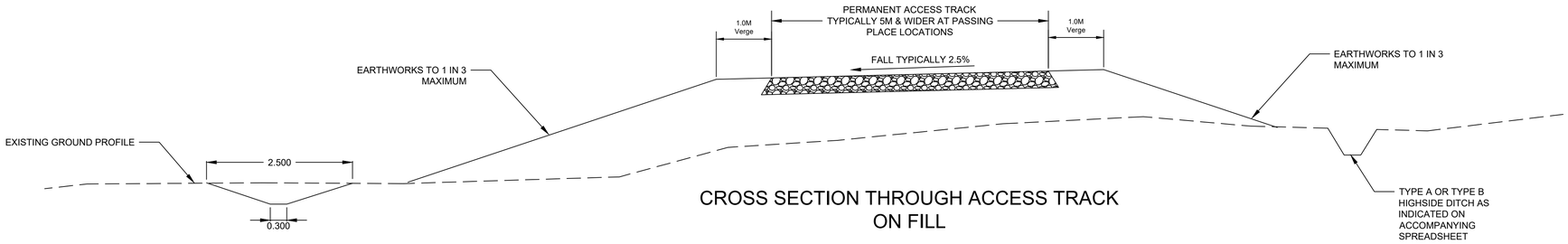
LEGEND:
- TYPE A OR TYPE B HIGHSIDE DITCH
- SWALE
- DRAINAGE DITCH (PERMANENT TRACK)
- DRAINAGE CULVERT
- WATERCOURSE BRIDGE
- WATERCOURSE CULVERT

METRES @ 1:2500 — 0 20 50 100 250

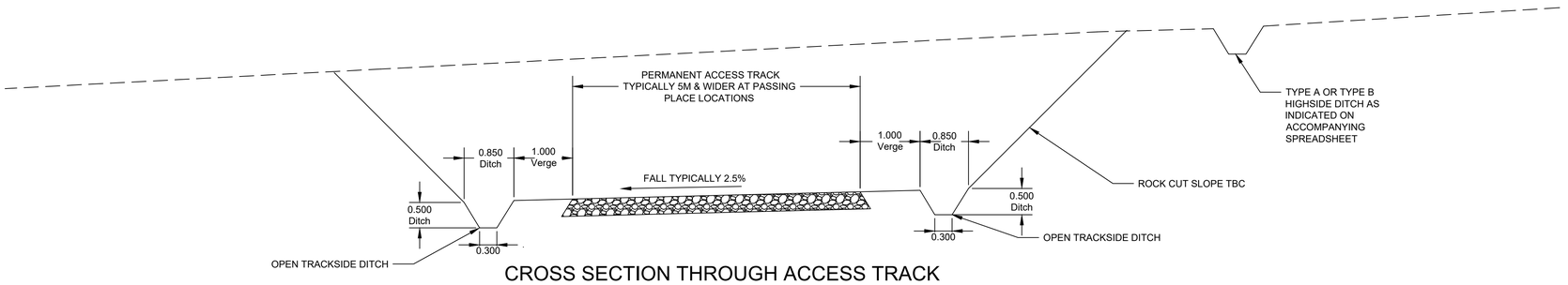
DRAWING STATUS: S5									
ISSUED FOR FINAL REVIEW	REVISION:	P01		P02		P03			
	DRAWN:	J.PETRIE	08/11/2024	J.PETRIE	23/10/2025	J.PETRIE	28/10/2025		
	CHECKED:	R.DUNCAN	08/11/2024	R.DUNCAN	23/10/2025	R.DUNCAN	28/10/2025		
	APPROVED:	R.MINTO	08/11/2024	R.MINTO	23/10/2025	R.MINTO	28/10/2025		
PROJECT REF:	BING4-LT521								

Customer	Scottish & Southern Electricity Networks TRANSMISSION
Contractor	SIEMENS energy + bam Joint Venture Substation Delivery Framework
Subcon. Drawing No.	FAIRHURST BING4-LT521-SEBAM-DRAI-ZZ-D-C-0193
Project	BINGALLY 400kV SUBSTATION
Title	LT521 - BINGALLY ENGINEERING DRAWINGS PROPOSED TRACK DRAINAGE LAYOUT SHEET 3
Contractor Drawing No.	BING4-LT521-SEBAM-DRAI-ZZ-D-C-0193
Customer Drawing No.	BING4-LT521-SEBAM-DRAI-ZZ-D-C-0193

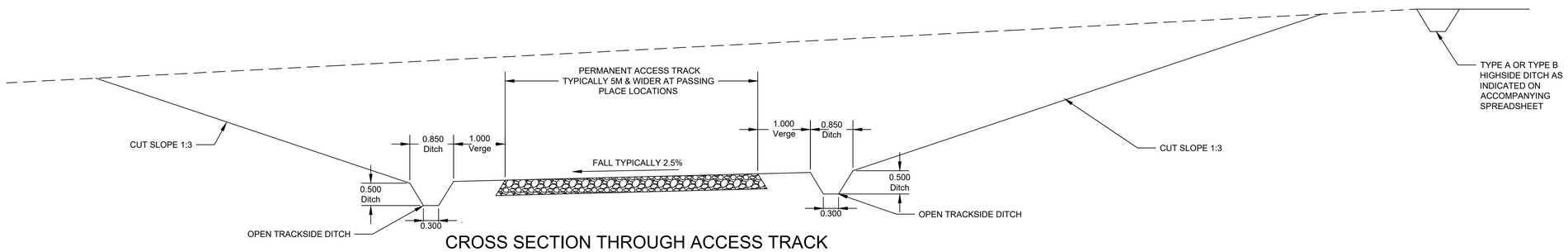
Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
J.PETRIE	S.MITCHELL	J.PETRIE	R.MINTO	03/09/2024	1:2500	A1	3 of 3	P03



CROSS SECTION THROUGH ACCESS TRACK ON FILL



CROSS SECTION THROUGH ACCESS TRACK IN CUT - ROCK



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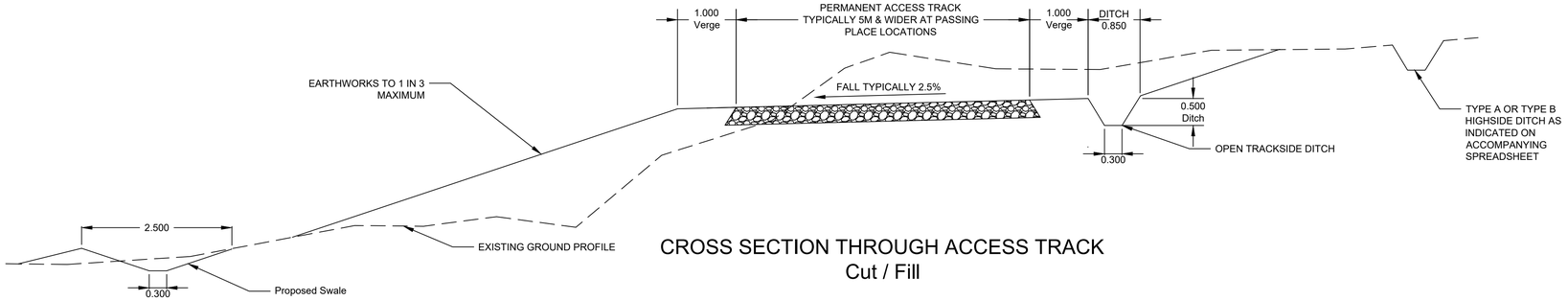
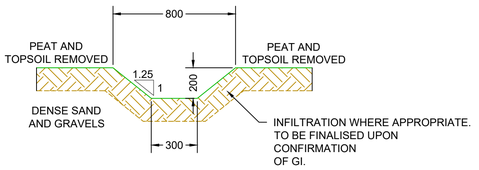
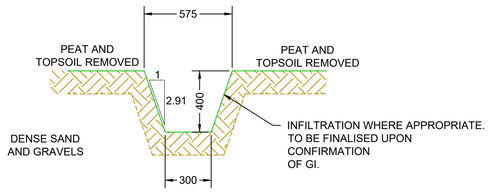


CROSS SECTION THROUGH ACCESS TRACK Cut / Fill



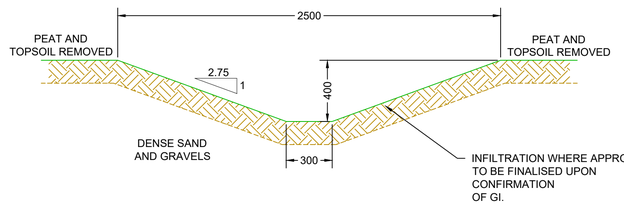
HIGH SIDE CUT-OFF DITCH TYPE A

SCALE 1:20



HIGH SIDE CUT-OFF DITCH TYPE B

SCALE 1:20



LOW SIDE SWALE

SCALE 1:20

DRAWING STATUS: S4 ISSUED FOR REVIEW	REVISION:	P01.1	
	DRAWN:	S.MITCHELL	04/09/24
	CHECKED:	J. PETRIE	04/09/24
	APPROVED:	R.MINTO	04/09/24

PROJECT REF: BING4-LT521
FIRST ISSUE - 04/09/2024

NOTES
1. DITCH DIMENSIONS ARE PRELIMINARY ONLY AND TO BE FINALISED AT DETAILED DESIGN UPON COORDINATION WITH EARTHWORKS AND CULVERT DESIGNS.
2. DITCH SIZES REFER TO CAPACITY REQUIREMENTS ONLY. ADDITIONAL CUT AND FILL MAY BE REQUIRED TO GRADE EXISTING GROUND.
3. SETTLEMENT LAGOON EXTENTS SHOWN TO NOT INCLUDE EARTHWORKS EXTENTS.
4. DURING CONSTRUCTION PARTICULAR CARE IS TO BE TAKEN BY THE CONTRACTOR TO ENSURE THAT THE MINIMUM AMOUNT OF DAMAGE AND DISTURBANCE TO LAND DRAINS AND DITCHES ARE CAUSED. THE CONTRACTOR WILL INVESTIGATE, DESIGN, INSTALL, REPAIR AND MAINTAIN ALL LAND DRAINS THAT ARE AFFECTED BY THE WORKS AS PER THE CIVIL SCOPE OF WORKS.
5. COORDINATION OF DRAINAGE DESIGN AND CABLE COORDINATES TO BE CONFIRMED.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following :

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

CONSTRUCTION RISK
- Working in a sensitive environment - PEAT

MAINTENANCE / CLEANING RISK
- None identified at this design phase

DECOMMISSIONING / DEMOLITION RISK
- None identified at this design phase

Customer: Scottish & Southern Electricity Networks TRANSMISSION

Contractor: SIEMENS energy + bam
Joint Venture
Substation Delivery
Framework

Subcon. Drawing No.: FAIRHURST
BING4-LT521-SEBAM-DRAI-ZZ-D-C-0194

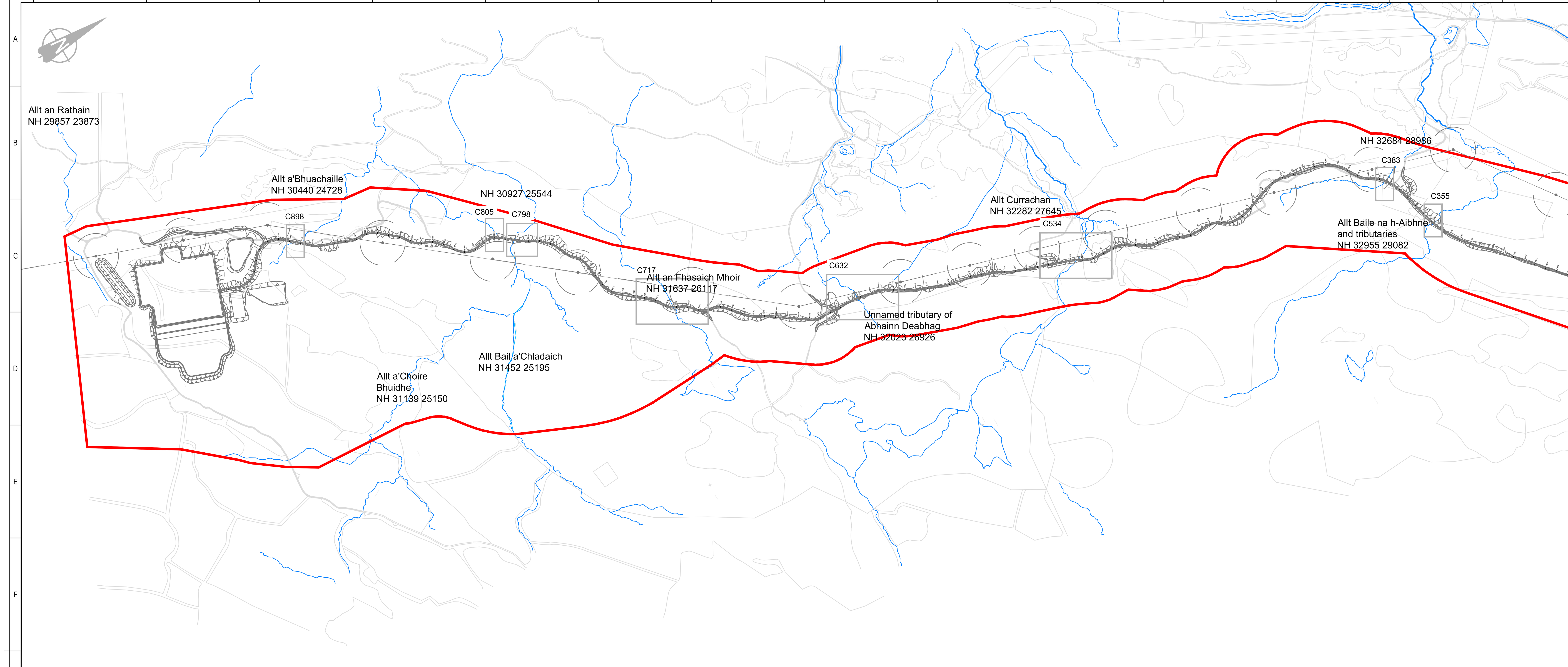
Project: BINGALLY 400kV SUBSTATION

Title:
LT521 - BINGALLY
ENGINEERING DRAWINGS
PROPOSED TRACK DRAINAGE DETAILS

Contractor Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0194

Customer Drawing No.: BING4-LT521-SEBAM-DRAI-ZZ-D-C-0194

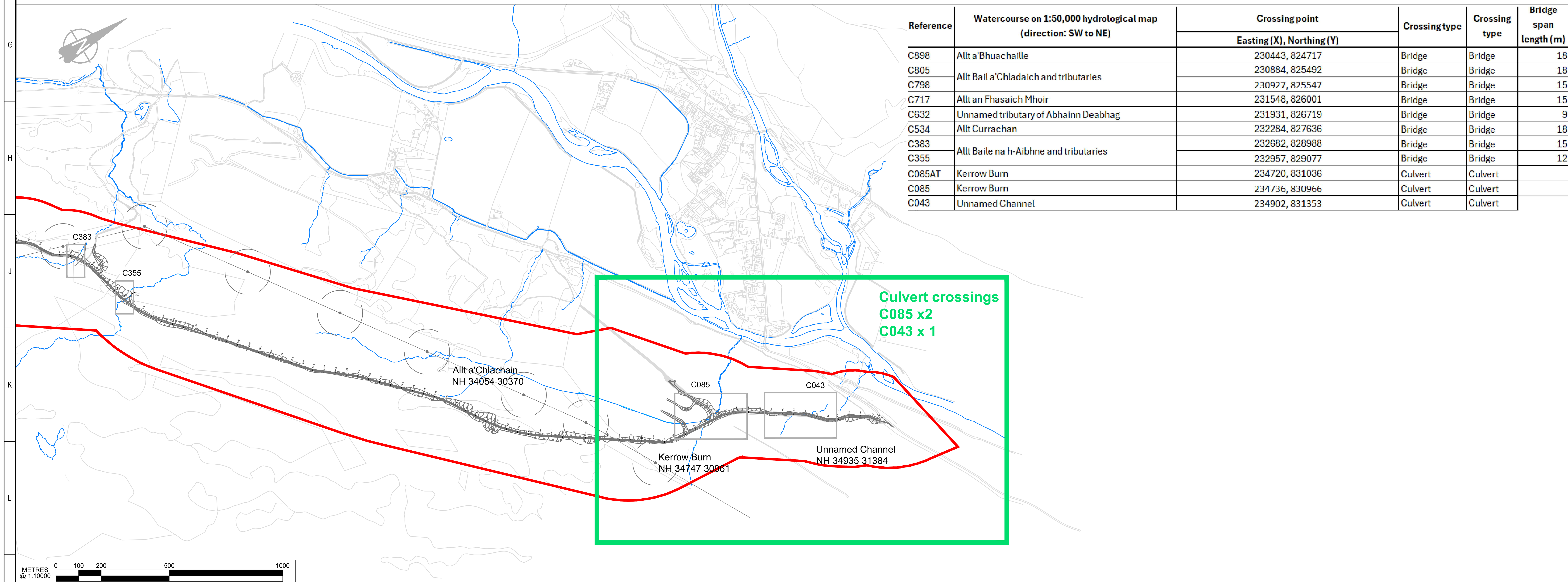
Designed	Drawn	Checked	Approved	Date	Scale	Size	Sheet	Revision
J.PETRIE	S.MITCHELL	J.PETRIE	R.MINTO	04/09/2024	AS SHOWN	A1	1 of 1	P01.1



NOTES:-

1. This drawing shall only be used for the design element stated in the drawing title.
2. Only written dimensions shall be used.
3. All dimensions are in metres unless noted otherwise.
4. This drawing shall only be used for construction of the works when certified as acknowledged by Scottish and Southern Electricity Networks and upon relevant third party consultation certification.
5. All levels in metres (m) above ordnance datum unless stated otherwise
6. Refer to design decision log for assumptions associated with proposed design.
7. Tie-in locations to existing watercourse on hold until topographical survey is received.
8. Proposed channel realignments are designed to coordinate with available topographical contours. This information in some instances is inconsistent with OS information for the existing watercourse. Additional surveys are ongoing and will be reviewed against the design when available.
9. Proposed crossing design to be finalised upon receipt of detailed topographical survey and completed site and ground investigations
10. The contractor shall check all dimensions on site and report and inconsistencies to the designer prior to construction.
11. Refer to BING4-LT521-SEBAM-DRAI-EXT-D-C-0501 - 0514 for proposed access track drainage design.
12. Final setting out of watercourse crossing designs are on hold and will be updated to local grid upon receipt of topographical survey.
13. Channel hydrology details on hold until topographical survey is received.
14. Watercourse crossing culverts and headwalls greater than 1.2m on hold until structural check complete.
15. Watercourse realignments on hold until geotechnical stability assessment complete.
16. Watercourse realignment on hold until scour assessment and erosion protection can be determined.
17. Baffles required in culverts with a gradient greater than 1:67.
18. Baffles are to be included on the headwall apron section on the channel.
19. Refer to drawings BING4-LT521-SEBAM-DRAI-EXT-D-C-0585 - 0586 for watercourse realignment channel bed type details.
20. Culvert bed material to match sediment sizing table.
21. Refer to BING4-LT521-SEBAM-DRAI-ZZ-SCH-C-0002 for proposed Bingally access track watercourse crossings culvert schedule.

Reference	Watercourse on 1:50,000 hydrological map (direction: SW to NE)	Crossing point Easting (X), Northing (Y)	Crossing type	Crossing type	Bridge span length (m)
C898	Allt a'Bhuachaille	230443, 824717	Bridge	Bridge	18
C805	Allt Bail a'Chladaich and tributaries	230884, 825492	Bridge	Bridge	18
C798		230927, 825547	Bridge	Bridge	15
C717	Allt an Fhasaich Mhoir	231548, 826001	Bridge	Bridge	15
C632	Unnamed tributary of Abhainn Deabhag	231931, 826719	Bridge	Bridge	9
C534	Allt Currachan	232284, 827636	Bridge	Bridge	18
C383	Allt Baile na h-Aibhne and tributaries	232682, 828988	Bridge	Bridge	15
C355		232957, 829077	Bridge	Bridge	12
C085AT	Kerrow Burn	234720, 831036	Culvert	Culvert	
C085	Kerrow Burn	234736, 830966	Culvert	Culvert	
C043	Unnamed Channel	234902, 831353	Culvert	Culvert	



REV:	DATE:	DRWN:	CHKD:	APPVD:	DESCRIPTION:
P04	27/10/25	JM	RG	SC	UPDATED WITH LATEST DESIGN
P03	07/10/25	JM	RG	SC	UPDATED WITH LATEST DESIGN
P02	12/09/25	JM	RG	SC	BRIDGE SPANS ADDED
P01	14/03/25	CMcL	RD	RJM	FIRST ISSUE

STATUS: S5 ISSUED FOR FINAL REVIEW

CONTRACTOR: SIEMENS energy + bam

Joint Venture Substation Delivery Framework

CLIENT: Scottish & Southern Electricity Networks TRANSMISSION

PROJECT: LT521-BINGALLY 400kV SUBSTATION

PROJECT NUMBER: BING4-LT521 LOCATION: BINGALLY

TITLE: PROPOSED WATERCOURSE CROSSING REALIGNMENT LOCATION PLAN

DRAWN:	C.McLAUGHLIN	ENG CHECK:	R.DUNCAN
DESIGNER:	A.PETERS	COORDINATION:	R.DUNCAN
SCALE:	1:10000	APPROVED:	R.MINTO
DATE OF FIRST ISSUE:	24/01/2025	SECURITY:	

ORIGINATOR DRAWING NUMBER: BING4-LT521-SEBAM-DRAI-EXT-D-C-0584

SHEET No: 1 of 1

CLIENT DRAWING NUMBER: BING4-LT521-SEBAM-DRAI-EXT-D-C-0584

REV. No: P04

Appendix 4 Initial Track Crossings Capacity Results Summary

Drainage Culverts Sizing

Round Culvert - D004	
Flow Required (m3/s)	0.78
Diameter (m)	0.9
Radius (m)	0.45
Area (m2)	0.636172512
Perimeter (m)	2.827433388
Hydraulic radius (m)	0.225
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	1.176702248
Capacity (L/s)	1176.702248
Suitable?	Yes

Round Culvert - D019	
Flow Required (m3/s)	0.45
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D121	
Flow Required (m3/s)	0.39
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D135	
Flow Required (m3/s)	0.06
Diameter (m)	0.45
Radius (m)	0.225
Area (m2)	0.159043128
Perimeter (m)	1.413716694
Hydraulic radius (m)	0.1125
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.185318992
Capacity (L/s)	185.3189915
Suitable?	Yes

Round Culvert - D145	
Flow Required (m3/s)	0.26
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D155	
Flow Required (m3/s)	0.18
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D165	
Flow Required (m3/s)	0.3
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D201	
Flow Required (m3/s)	0.62
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D221	
Flow Required (m3/s)	0.64
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D233	
Flow Required (m3/s)	0.02
Diameter (m)	0.3
Radius (m)	0.15
Area (m2)	0.070685835
Perimeter (m)	0.942477796
Hydraulic radius (m)	0.075
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.062855493
Capacity (L/s)	62.85549305
Suitable?	Yes

Drainage Culverts Sizing

Round Culvert - D245	
Flow Required (m3/s)	0.26
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D267	
Flow Required (m3/s)	0.42
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D289	
Flow Required (m3/s)	0.26
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D297	
Flow Required (m3/s)	0.75
Diameter (m)	0.9
Radius (m)	0.45
Area (m2)	0.636172512
Perimeter (m)	2.827433388
Hydraulic radius (m)	0.225
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	1.176702248
Capacity (L/s)	1176.702248
Suitable?	Yes

Round Culvert - D307	
Flow Required (m3/s)	0.42
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D367	
Flow Required (m3/s)	0.3
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D430	
Flow Required (m3/s)	0.35
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D505	
Flow Required (m3/s)	1.82
Diameter (m)	1.2
Radius (m)	0.6
Area (m2)	1.130973355
Perimeter (m)	3.769911184
Hydraulic radius (m)	0.3
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	2.534174681
Capacity (L/s)	2534.174681
Suitable?	Yes

Round Culvert - D595	
Flow Required (m3/s)	0.42
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D604	
Flow Required (m3/s)	0.23
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Drainage Culverts Sizing

Round Culvert - D625	
Flow Required (m3/s)	0.12
Diameter (m)	0.45
Radius (m)	0.225
Area (m2)	0.159043128
Perimeter (m)	1.413716694
Hydraulic radius (m)	0.1125
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.185318992
Capacity (L/s)	185.3189915
Suitable?	Yes

Round Culvert - D640A	
Flow Required (m3/s)	0.01
Diameter (m)	0.3
Radius (m)	0.15
Area (m2)	0.070685835
Perimeter (m)	0.942477796
Hydraulic radius (m)	0.075
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.062855493
Capacity (L/s)	62.85549305
Suitable?	Yes

Round Culvert - D640B	
Flow Required (m3/s)	0.01
Diameter (m)	0.3
Radius (m)	0.15
Area (m2)	0.070685835
Perimeter (m)	0.942477796
Hydraulic radius (m)	0.075
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.062855493
Capacity (L/s)	62.85549305
Suitable?	Yes

Round Culvert - D674	
Flow Required (m3/s)	0.53
Diameter (m)	0.75
Radius (m)	0.375
Area (m2)	0.441786467
Perimeter (m)	2.35619449
Hydraulic radius (m)	0.1875
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.723630051
Capacity (L/s)	723.6300508
Suitable?	Yes

Round Culvert - D703	
Flow Required (m3/s)	0.16
Diameter (m)	0.45
Radius (m)	0.225
Area (m2)	0.159043128
Perimeter (m)	1.413716694
Hydraulic radius (m)	0.1125
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.185318992
Capacity (L/s)	185.3189915
Suitable?	Yes

Round Culvert - D767	
Flow Required (m3/s)	0.31
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D841	
Flow Required (m3/s)	0.3
Diameter (m)	0.6
Radius (m)	0.3
Area (m2)	0.282743339
Perimeter (m)	1.884955592
Hydraulic radius (m)	0.15
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.399107503
Capacity (L/s)	399.1075031
Suitable?	Yes

Round Culvert - D856	
Flow Required (m3/s)	0.05
Diameter (m)	0.3
Radius (m)	0.15
Area (m2)	0.070685835
Perimeter (m)	0.942477796
Hydraulic radius (m)	0.075
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.062855493
Capacity (L/s)	62.85549305
Suitable?	Yes

Round Culvert - D864	
Flow Required (m3/s)	0.1
Diameter (m)	0.45
Radius (m)	0.225
Area (m2)	0.159043128
Perimeter (m)	1.413716694
Hydraulic radius (m)	0.1125
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	0.185318992
Capacity (L/s)	185.3189915
Suitable?	Yes

Round Culvert - D875	
Flow Required (m3/s)	1.05
Diameter (m)	0.9
Radius (m)	0.45
Area (m2)	0.636172512
Perimeter (m)	2.827433388
Hydraulic radius (m)	0.225
Mannings n	0.02
Slope	0.01
Capacity (m3/s)	1.176702248
Capacity (L/s)	1176.702248
Suitable?	Yes

Appendix 5 Initial Track Side Ditch Sizing

FAIRHURST

CONSULTING CIVIL & STRUCTURAL ENGINEERS
ETIVE HOUSE, BEECHWOOD PARK, INVERNESS, IV2 3BW

JOB No	DRG No.	Sheet No.
156918		1

Calculated By	Checked By	Date
JP	DE	04/09/2024

Project Title Bingally Sub-Station

Section Title Access Track - Initial Track Side Ditch Sizing

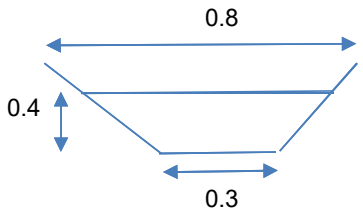
Reference	Calculations	Remarks

Mannings Equation Open Channel Flow

V = (1 / n) * R^2/3 * s^1/2

V = Velocity
n = Manning's roughness coefficient
R = Hydraulic Radius (R = Cross Section Area (A) / Wetted Perimeter(P))
s = Channel Slope

Channel Cross Section



Hypotenuse =	0.447214	
n=	0.035	Grass
A=	0.37	
P=	1.194427	
R=	0.309772	
s=	0.05	
V=	2.924904	m/s
Q=V*A	1.082215	m3/s

Greenfield Runoff Rate for 100m Section of Track = 15.3 l/s
0.015 m3/s

1.082215	>	0.0153	OK