LT407 – Banniskirk Substation

Drainage Impact Assessment

Prepared for

J Murphy & Sons Ltd

Scottish & Southern Electricity Networks (SSEN)

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1. Introduction

J Murphy & Sons (Murphy) has commissioned Tony Gee and Partners LLP (TG) to produce a Drainage Impact Assessment Report to inform the design and planning application for the proposed development 400kV Banniskirk Substation.

The proposed location for the Banniskirk AC 400kV substation and the Banniskirk to Longside HVDC Converter Station is adjacent to the existing Spittal substation, west of the A9. The new substation will facilitate connections for new and renewable onshore and offshore electricity generation.

1.1. Site Location

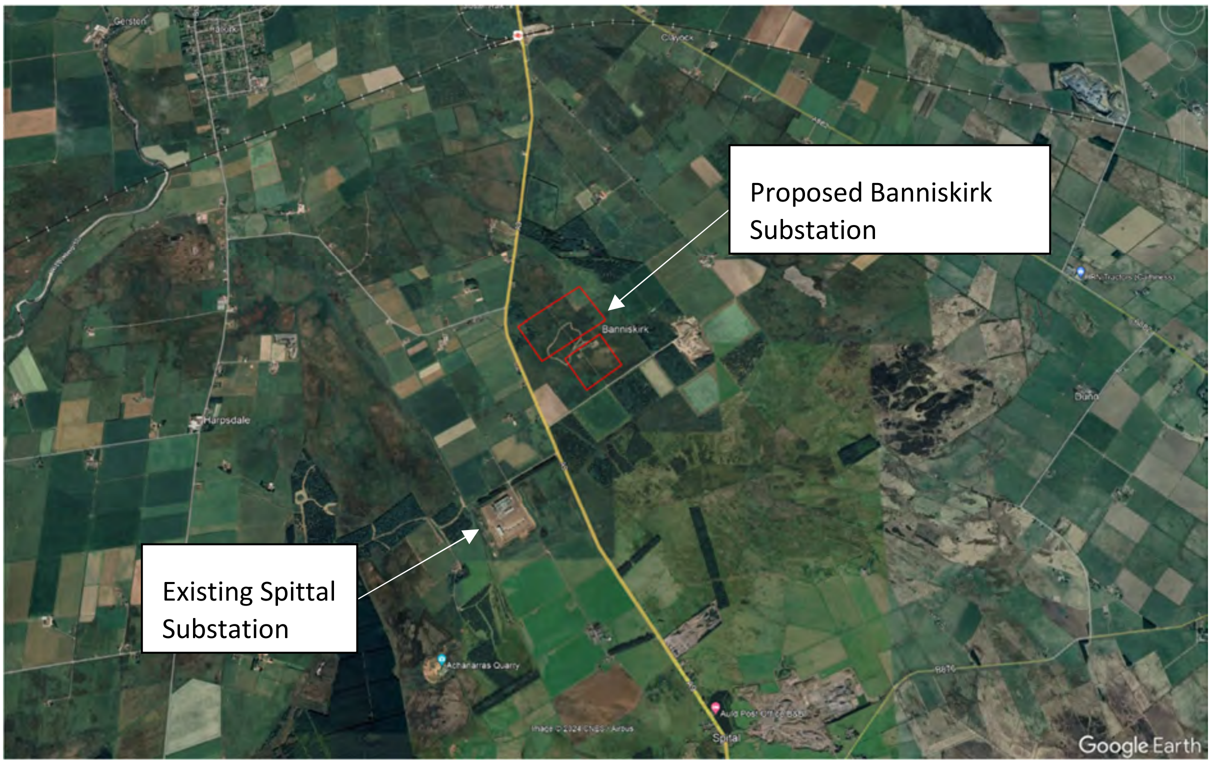


Figure 1: Proposed Site Location

1.2. Background and Aims

This report outlines the proposed drainage strategy to manage surface water runoff and foul water disposal resulting from the proposed development. The report will propose an indicative site area and red line boundary for the Planning Application Notice. The impact of the proposed development on the water environment has been considered.

The aim of the strategy is to develop drainage solutions for the proposed development that comply with current guidance and best management practice. Capacity requirements, discharge, and appropriate sustainable urban drainage systems (SuDS) for the surface water drainage are identified within this report.

This report has been prepared in accordance with "Water Assessment and Drainage Assessment Guide" (SEPA, 2016), The Highlands Council "Flood Risk and Drainage Impact Assessment Supplementary Guidance" (THC, 2016), the CIRIA SuDS Manual (C753) (CIRIA, 2015) and Sewers for Scotland 4th Edition (Scottish Water, 2018).

1.3. Consultation and data source

The following sources have been used in the compilation of this Drainage Assessment:

- Scottish Environment Protection Agency Flood Risk Mapping
- Scottish Water Sewer Record Plans
- CIRIA SuDS Manual C753
- Sewers for Scotland (4th Edition)
- SSEN Specification SP-NET-CIV-502 Rev 1.01
- DMRB CD 521 & CD 522
- The Highland Council Interim Supplementary Guidance: 'Flood Risk and Drainage Impact Assessment'

1.4. Storm and Flood Risk Terminology

Storm events and flood risks will be expressed by the term Annual Exceedance Probability (AEP). AEP will be expressed by the chance of occurrence (1:100, 1:200 etc.).

Where storm or flood events have a climate change factor included the event will be noted as "+CC" for when Climate Change factor has been included i.e., 1:100+CC. (SEPA, 2024).

2. Existing Site Description

2.1. Description of site

The proposed Banniskirk AC Substation and the Longside HVDC Converter Station is centred around grid reference: E: 316777 N: 958319 to the southeast of Georgemas just off Banniskirk Road. This is approximately 2km from Loch Scarmclate which runs parallel to the site. The loch represents the lowest point within the nearby area from where the land increases in elevation surrounding the loch. Clayock is the closest settlement to the site which is located approximately 1.5km to the north.

2.2. Topography

The site is located on a slight slope falling towards the north with elevations ranging from 55mAOD at the site's north extents and up to 90mOAD on the site's southerly extents which was taken from OS Maps (OS Maps, 2024).

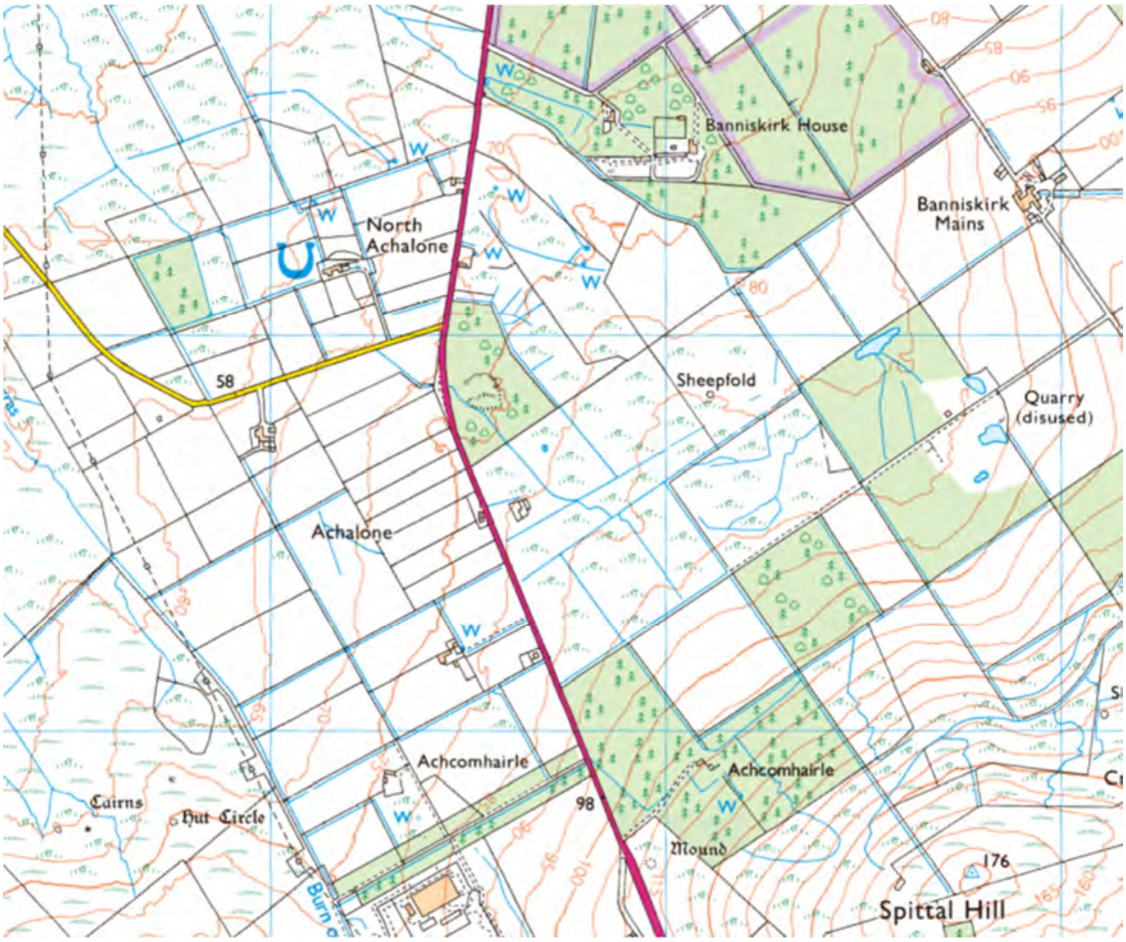


Figure 2: Topographical map (OS Maps, 2024)

2.3. Ground Conditions

2.3.1. Geological and Hydrogeological Features

The BGS website (BGS, 2024) and BGS 1:50,000 series sheet 116 “Wick” map were utilised to better understand the geological conditions on site. The sources provide information relating to the superficial and bedrock geology as well as a brief description of the associated units and geological features in the area.

The geological information associated with the study area is as follows:

Superficial Deposits

BGS shows superficial deposits at the location of the entire site; consisting of Till, Devensian - Diamicton. Sedimentary superficial deposit formed between 116 and 11.8 thousand years ago during the Quaternary period and potentially Peat (Sedimentary superficial deposit formed between 2.588 million years ago and the present during the Quaternary period) to the north of the site.

Solid Geology

BGS depicts the site to be consistent across the entirety of the study area, which is the Spital Flagstone Formation - Siltstone, mudstone and sandstone. Sedimentary bedrock formed between 407.6 and 382.7 million years ago during the Devonian period.

2.3.2. Ground Investigation

SSEN appointed IGNE (IGNE, 2024) in 2023 to undertake a ground investigation (GI) for the proposed Banniskirk substation location. The ground investigation included cable percussion boreholes, sonic boreholes, trial pits, soakaway pits and peat probing. The plan of the GI works is shown in Figure 3. Refer to the ground investigation report document CAAI4-LT470-JMS-EWKS-XX-RPT-G-0005 for further details.

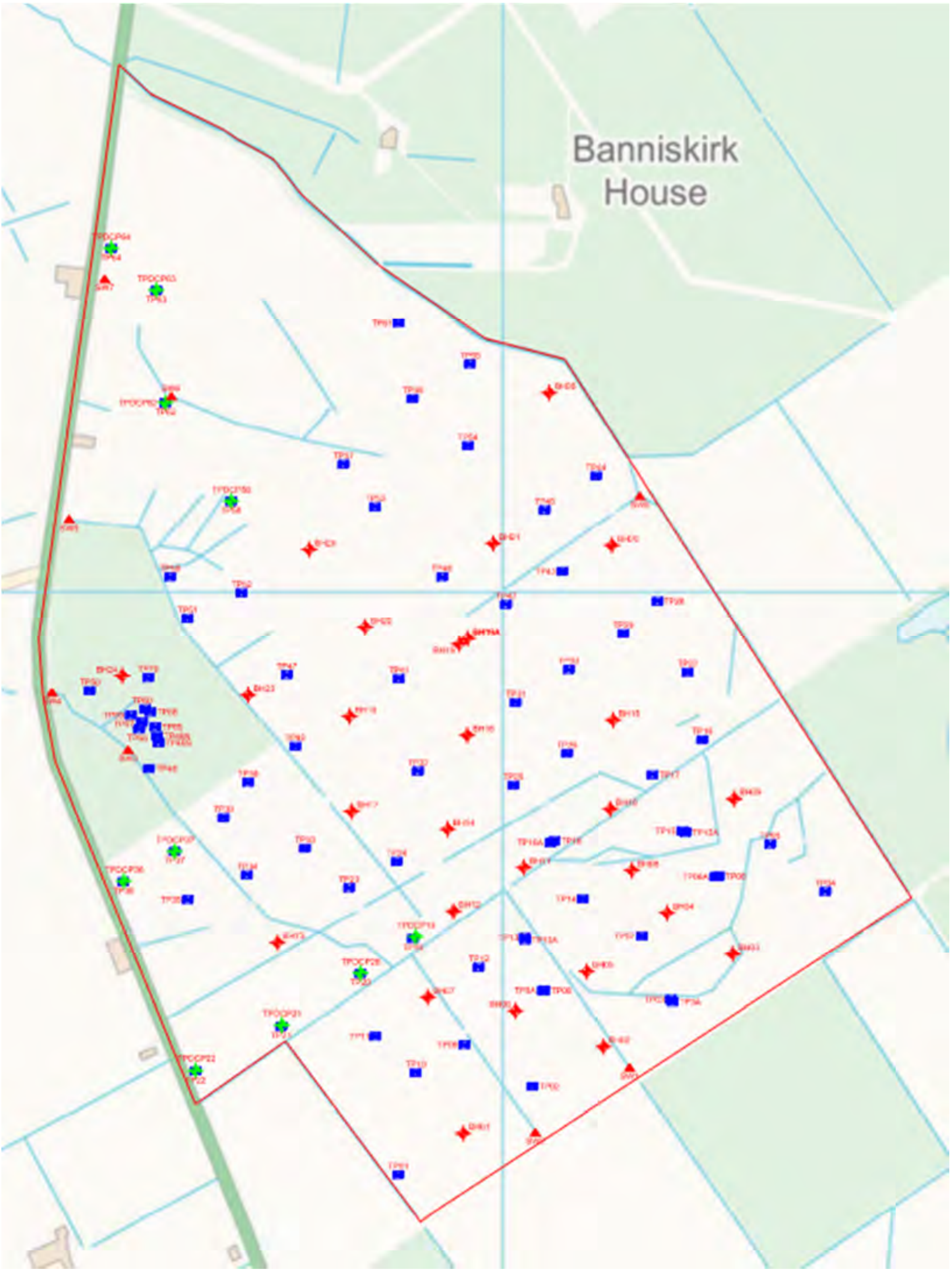


Figure 3: Ground Investigation locations (IGNE, 2024)

Table 1: Sample Ground Profile from BH15 (IGNE, 2024)

Depth to base of strata (m)	Thickness (m)	Description
0.3	0.3	Topsoil – Dark brown very sandy topsoil with rootlets and pockets of Spongy pseudofibrous peat. Sand is fine to coarse. Gravel is fine to coarse subangular to rounded of various including siltstone, sandstone and mudstone
0.9	0.6	Sand - Orange brown and grey gravelly very silty fine to coarse SAND. Gravel is fine to coarse subangular to rounded of various lithologies including sandstone, mudstone and siltstone.
1.4	0.8	Siltstone - Medium strong, locally very weak to moderately weak locally thinly laminated greenish grey SILTSTONE. Moderately weathered evident as significant loss of strength, frequent penetrative orangeish brown iron staining on fracture surfaces (up to 5mm) and clay smearing on fracture surfaces. Three fracture sets; No.1: 0°-10° extremely and very closely spaced, planar and undulating, rough bedding fractures with frequent penetrative orangeish brown iron staining up to 5mm. No.2: 15°-45° extremely closely spaced, becoming very close and closely spaced below 1.20m, undulating, rough joints with frequent penetrative orangeish brown iron staining (up to 5mm) and clay smearing. No.3: singular 80° planar and rough joints with penetrative rangeish brown iron staining (up to 5mm) and clay smearing.
2.05	0.65	Siltstone - Strong, locally medium strong locally thinly laminated grey and greenish grey SILTSTONE. Slightly weathered evident as slight loss of strength and frequent penetrative orangeish brown iron staining on fracture surfaces (up to 5mm) and occasional clay smearing on fracture surfaces. Three fracture sets; No.1: 0°-10° very closely spaced, locally extremely closely spaced, planar and undulating, rough bedding fractures with frequent penetrative orangeish brown iron staining (up to 5mm). No.2: 70°-90° very closely spaced, planar and undulating joints with frequent penetrative orangeish brown iron staining (up to 5mm). No.3: 15°-30° close and medium spaced, locally extremely closely spaced, undulating and rough joints with frequent penetrative orangeish brown iron staining (up to 5mm) ....between 2.05m and 2.25m: frequent parallel 90° planar white calcite veins (up to 3mm thick) and is cut off suddenly at 2.05m; possible displacement by microfaulting.
10	7.95	Siltstone - Strong and very strong grey SILTSTONE with frequent very thin and thin bands of thinly laminated dark grey siltstone, locally with lighter grey thin undulating sandy laminae, frequently slightly disturbed due to soft sediment deformation. Mostly fresh, locally slightly weathered evident as occasional surface and penetrative orangeish brown iron staining on fracture surfaces (up to 2mm). Three fracture sets; No.1: 0°-10° close and medium spaced, locally very closely

Depth to base of strata (m)	Thickness (m)	Description
		spaced, planar and undulating, smooth and rough bedding fractures with rare surface and penetrative orangeish brown iron staining (up to 2mm). No.2: 15°-30° medium and widely spaced, locally very closely spaced above 3.85m, undulating and rough joints with occasional surface and penetrative orangeish brown iron staining (up to 2mm). No.3: 70°-90° very widely spaced, undulating and rough joints ....between 4.00m and 4.35m: frequent 10°-45° slightly undulating white calcite veins (up to 5mm thick) ....at 4.30m: 25° slightly undulating white calcite vein displaced by 30mm by 20° micro fault

The groundwater level has been recorded throughout the ground investigation works and continues to be recorded at the time of writing this report. The water level measurements taken from the ground level if found to be varied throughout the site. Table 2 shows the highest depth to water recorded across water monitoring stations from 07th August 2023 to 08th November 2023.

Table 2: Depth to water (groundwater) (IGNE, 2024)

Borehole	Date recorded	Depth to Water (m)	Depth (mOD)
BH01	12/08/2023	1.47	88.72
BH02	29/07/2023	1.54	89.49
BH03	10/08/2023	1.15	88.50
BH04	31/07/2023	1.20	87.56
BH05	03/08/2023	0.95	87.54
BH06	31/07/2023	1.27	86.58
BH07	12/08/2023	0.71	84.81
BH09	11/08/2023	1.00	85.79
BH10	09/08/2023	2.34	84.66
BH11	12/08/2023	1.32	85.11
BH13	12/08/2023	0.74	81.19
BH15	09/08/2023	2.17	82.99
BH16	10/08/2023	0.54	83.25
BH17	09/08/2023	0.54	82.66
BH18	09/08/2023	1.24	79.44

Borehole	Date recorded	Depth to Water (m)	Depth (mOD)
BH20	12/08/2023	1.29	77.98
BH21	12/08/2023	0.95	77.45
BH24	11/08/2023	1.52	72.15
BH26	11/08/2023	1.33	73.80

2.3.3. Historic Land Use

An assessment of the historic land use of the on-site features and off site featured has been undertaken and a summary can be found in the desktop study, document number BANN4-LT407-JMS-ZZ-ZZ-RPT-C-0001. The key findings were the quarries scattered around the site boundary, which either remain operational or have become discussed. Other findings from the assessment include the existing watercourses and tracks around the proposed development boundary.

2.4. Existing Hydrological Features

2.4.1. Water bodies

The ‘Loch Watten’ and ‘Loch Calder’ are waterbodies that could be classified as lochs and are located nearby the proposed substation. The ‘Loch Watten’ is located 5km to the east and ‘Loch Calder’ is located 7.4km to the west of the proposed substation. ‘Loch Watten’ and ‘Loch Calder’ are sited at 15m AOD and 65m AOD respectively which, are lower than the proposed substation platform which is sited at 81.5m AOD (Scotland Topographical, 2024).

2.4.2. Surface Water Network

A walkover survey, to observe and record the surface water network draining the site, was undertaken by Jacobs on the 15th and 16th of November 2023. The observations documented by Jacobs were later confirmed by a site walkover undertaken by Tony Gee and Murphys on the 31st of January 2024. The walkover survey identified key hydraulic structures and catchment features which are documented in the subsequent paragraphs.

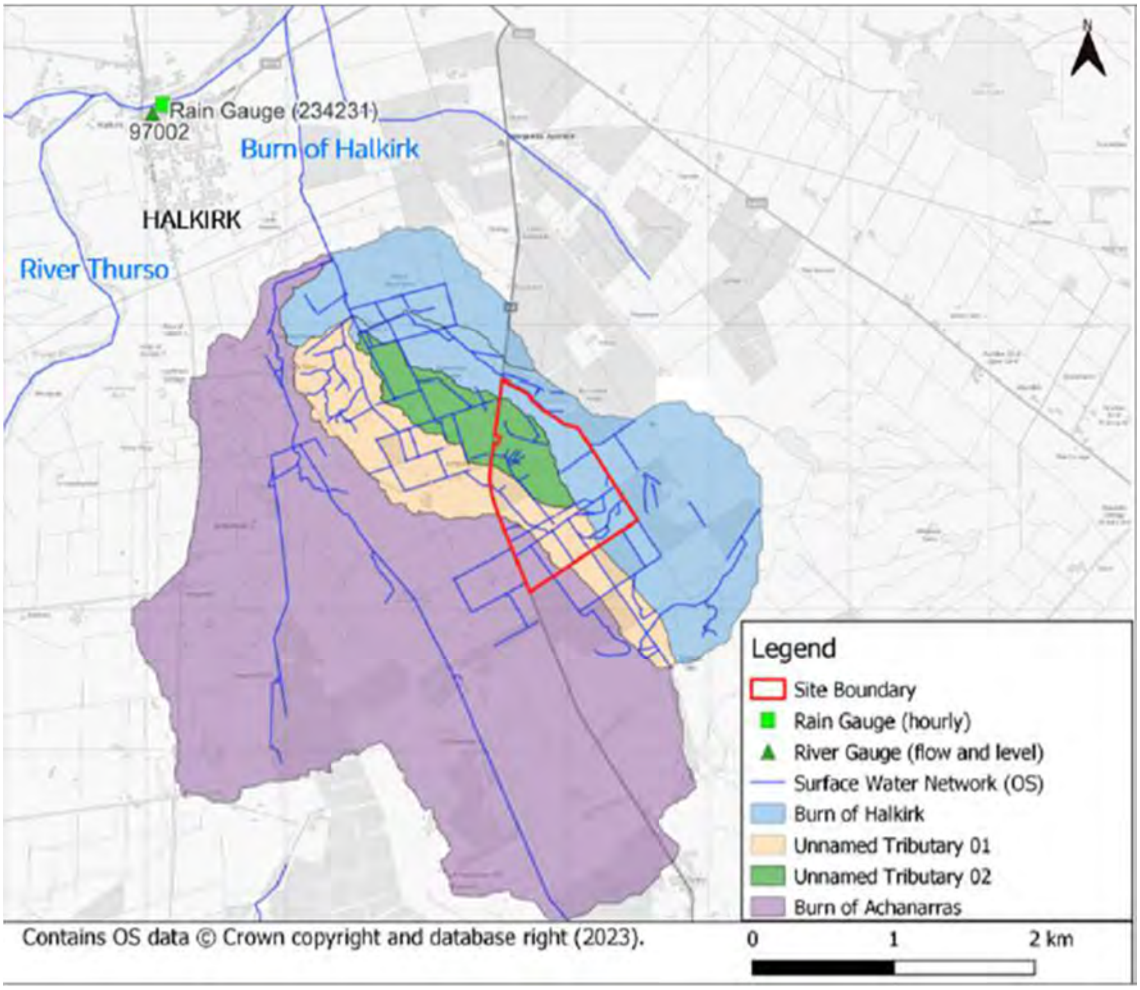


Figure 4: Location plan showing surface water network, contributing catchments and local hydrometric monitoring points

The eastern site boundary is located adjacent to the Burn of Halkirk, and the wider area proposed for development is crossed by a historic system of field drains. These are piped or culverted along their course and augment to form two notable sub-catchment inflows to the Burn of Halkirk, referenced here as Unnamed Tributary 01 and Unnamed Tributary 02.

Most of the 0.87 km² site drains naturally to the Burn of Halkirk (34%) with ~28% draining to Unnamed Tributary 01. Approximately 27% of the northern portion of the site drains naturally to a further unnamed tributary of the Burn of Halkirk, Unnamed Tributary 02. In the most south-westerly reaches of the site, ~11% of the total site area drains (indirectly via a system of field drains) to the Burn of Achanarras.

The sub-catchment flows join at approximately NGR ND 14467 58061, some 1.8 km downstream of the proposed development at its northern boundary. The watercourse then continues for a further ~1.8 km as the Burn of Halkirk before joining with the much larger River Thurso at NGR ND 14003 60224.

The surface water network is described in the subsequent paragraphs from upstream to downstream. Photos which reference is made to, are included under Additional Information to conserve page space.

Burn of Halkirk

The Burn of Halkirk drains from the slopes of Spittal Hill (Photo 1.1) and is culverted under the Quarry access road at NGR ND 16497 56628 via a 450 mm pre-cast concrete pipe (Photo 1.2). The minor burn continues its course along the eastern site boundary until it is diverted 90 degrees east at NGR ND 16342 56874, towards Banniskirk Mains (Photo 1.3). At this location the diverted channel receives additional flow from a drainage ditch via a 150 mm pipe. Downstream of the channel diversion, i.e., along the eastern site boundary, following a period of wet weather, the channel was observed to be dry until approximately, NGR ND 16186 57106 (Photo 1.4).

The diverted channel continues towards Banniskirk Mains to the pond, located at NGR ND 16522 56967. The outflow from the pond joins with the diverted channel here (Photo 1.5) and is conveyed north-west via a 600 mm pre-cast concrete culvert (Photo 1.6). The watercourse continues north-west (Photo 1.7) and is again diverted 90 degrees at NGR ND 16331 57230 (Photo 1.8), flowing for approximately 120 m south- west before diverting its course again at NGR ND 16154 57161 (Photo 1.9) at which point wrack marks indicating a recent water level of 0.85 m above bed level were observed. The watercourse again flows adjacent to the site boundary and is culverted under a masonry box culvert 800 mm wide and 600 mm height with sheet metal top (Photo 1.10) at NGR ND 16005 57300. The watercourse continues, again flowing adjacent to the site boundary, before entering a masonry box culvert measuring 1000 mm wide by 750 mm height (Photo 1.11) and continuing its course along the access track to Banniskirk House (Photo 1.12). The watercourse at this point is augmented by lateral flow and groundwater contributions and was observed to have significantly more flow than observed upstream. At NGR ND 15533 57641 the watercourse is culverted under the A9 via two 750 mm pre-cast concrete pipe culverts (Photo 1.13 and Photo 1.14).

Unnamed Tributary 01

Unnamed Tributary 01 also drains from the slopes of Spittal Hill (Photo 2.1) and is culverted under the Quarry access road at NGR ND 16159 56411 via two 250 mm corrugated PVC pipes (Photo 2.2), referenced as channel one to aid in discussion. It is also culverted under the Quarry access road at NGR ND 16045 56336, referenced here as channel two, via a single steel pipe of 250 mm diameter (Photo 2.3), however no obvious upstream source could be identified.

The two channels were observed to be heavily vegetated and whilst wet, contained no significant flow at least in the upper reaches (Photo 2.4 and Photo 2.5). Channel two was observed to be more readily flowing, particularly with distance downstream. Whilst counterintuitive given the culvert configurations (i.e., channel one has two 250 mm pipes out falling to it and an observable upstream source whereas there was no evidence of an upstream channel at channel two); this is possibly explained by the presence of a drain located on channel one, as indicated on OS Mapping at NGR ND 16084 56535. The walkover survey did not observe this feature but if a drain (culvert) is present, it may be diverting water from the upper reach of channel one to the Burn of Halkirk catchment, however this is unconfirmed. The walkover survey did observe a 150 mm pipe at NGR ND 16009 56640, located at the junction of channel one before it flows south-west to join channel two. This pipe is thought to divert water from channel one to the Burn of Halkirk catchment.

Channel two is further culverted at NGR ND 15955 56459 via a 300 mm corrugated PVC pipe and continues to flow north-west some 115 m to converge with channel one (Photo 2.7). Downstream of this confluence, the watercourse becomes more substantial, with an increased flow and defined channel (Photo 2.8 and Photo 2.9).

Unnamed Tributary 01 continues its course north-west, crossing the western area of the site and is again culverted at NGR ND 15698 56618 via a 500 mm pre-cast concrete pipe (Photo 2.10). At NGR ND 15450 56875 the watercourse is culverted under the A9 via a 500 mm pre-cast concrete pipe culvert (Photo 2.11 and Photo 2.12). The Unnamed Tributary 01 feeds into the Burn of Halkirk at NGR ND 14467 58062, at which point draining a catchment area of ~1.3 km².

Unnamed Tributary 02

A further watercourse, Unnamed Tributary 02, drains the central northern area of the proposed site. Unnamed Tributary 02 is thought to emerge from a 300 mm corrugated PVC pipe culvert (Photo 3.1) located at ND 15782 56750. Upstream of the culvert, no obvious flow was observed within the channel. Downstream of the culvert, the channel was observed to contain little flow and was heavily vegetated. The watercourse flows north-west through the site (Photo 3.3) and is augmented by lateral flow contributions (Photo 3.4). The watercourse diverts its course due west at ND 15467 57088 (Photo 3.5) and flows in a straight, narrow channel (Photo 3.6) before being conveyed under the A9 via a 300 mm corrugated PVC pipe (Photo 3.7 and Photo 3.8).

Surface water flows from the Unnamed Tributary 02 catchment are additionally conveyed under the A9 at NGR ND 15496 57291 and ND 15504 57384 via masonry/stone culverts built into the wall. Where measured this was observed as 250 mm wide by 600 mm height.

The Unnamed Tributary 02 joins the Burn of Halkirk at NGR ND 14527 57942. At its confluence with the Burn of Halkirk, Unnamed Tributary 02 drains an area of just ~0.63 km².

Burn of Achannaras

A small proportion of the south-west area of the site drains indirectly to the Burn of Achanarras. The branch of the Burn of Achanarras drains from the slopes of Spittal Hill and is culverted under the Quarry access road at NGR ND 15894 56235 via two 250 mm clay pipes (Photo 4.1). Flow is conveyed north-west via a heavily vegetated ditch (Photo 4.2) until it is diverted 90 degrees south-west at NGR ND 15734 56447 (Photo 4.3), towards the A9 where it is culverted under the carriageway via a 300 mm pre-cast concrete pipe culvert (Photo 4.4).

Surface water flows from the Burn of Achanarras catchment, are additionally conveyed under the A9 at NGR ND 15591 56477 via a 150 mm clay pipe (Photo 4.5) and again at NGR ND 15558 56566 via a 150 mm concrete pipe (Photo 4.6) which was observed to be approximately 50% blocked.

1.1.2. Hydrometric Monitoring Points

The locations of known hydrometric monitoring points are shown in Figure 3. There are no river gauges nor rain gauges within the Burn of Halkirk catchment itself. There is a SEPA maintained rain gauge, Station number 234231, located at Halkirk at NGR ND 13123 59561, recording hourly rainfall totals. A peak flow rated river gauge, Station 97002, is located on the River Thurso at Halkirk. The river gauge and rain gauge are located some 1 km upstream of the River Thurso's confluence with the Burn of Halkirk.

A Wastewater Treatment Plant (WWTP) operated by Scottish Water is located at NGR ND 13982 59751, Hoy, Halkirk. Scottish Water were contacted to understand whether they hold any gauged data (flow or level) which could be made available for the study. Scottish Water responded on 15 November 2023 to confirm Scottish Water "have no data logged or available from our site regarding the burn[5]". Hence, for the purpose of assessment, the Burn of Halkirk is considered ungauged.

2.5. Existing Drainage Arrangement

No Scottish Water services were found in the search area of interest.

3. Reference Sources

3.1. SEPA

SEPA flooding maps (SEPA, 2024) have been used to identify the flooding potential for pluvial, fluvial and coastal sources, shown in Figure 5 below. The maps have identified that there is a low risk of surface water flooding and negligible risk of river and coastal water flooding within the site extents. The information shown in Figure 5 contains public sector information licensed under the Open Government Licence v3.0. It must be noted that there are limitations with the accuracy of the SEPA flooding maps as it does not account for existing flooding protection.

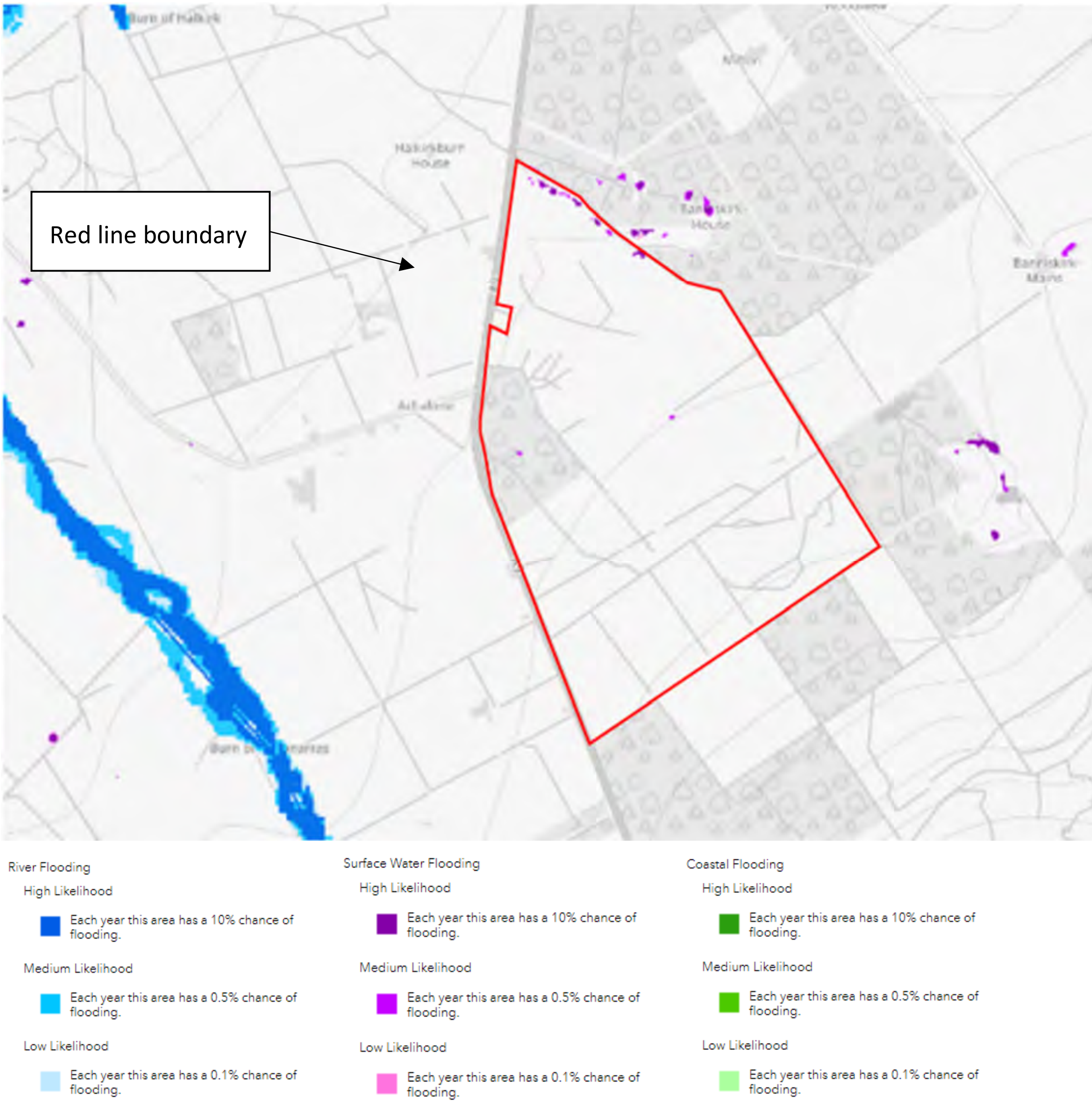


Figure 5: SEPA Flooding Maps for River, Surface water and Coastal

3.2. Site walkover

A walkover to observe and record the surface water network draining the site was undertaken by Tony Gee and Murphy's Group on the 31st of January 2024. The walkover survey identified key hydraulic structures and surface water flows, which allowed for further understanding of the flooding potential for pluvial, fluvial and coastal sources.

The walkover identified the existing hydrological features which are described in heading 2.4.2. The flooding risks within the proposed site are captured in the Flooding Risk Assessment, Document No. BANN4-LT407-JMS-DRAI-XX-RPT-C-0003.

4. Proposed Development

4.1. Description

The proposed development will consist of permeable platforms which will house the AC and HVDC components and designed to the requirements outlined in Drainage Specification SP-NET-CIV-502 and Earthworks Specifications SP-NET-CIV-501. Access roads, junctions, OHL tower platform, areas for SuDs, landscaping/screening and habitat enhancement. The proposed development is shown on drawing BANN4-LT407-JMS-ZZ-ZZ-GA-C-0010.

The proposed permanent AC substation development is 0.167km^2 (16.74 ha) and will consist of free draining stone with a nominal finished platform level as stated on BANN4-LT407-JMS-EWKS-XX-GA-G-0020 which will accommodate the substation. The platform make-up is reproduced from SSEN specification SP-NET-CIV-501 and shown in Figure 6.

The permanent AC development will contain a new outdoor, AIS, 400kV substation complete with 400kV double busbar arrangement and all associated ancillary works. Installation of new super grid transformers (SGT) and reactive compensation equipment which will be contained in a watertight secondary containment system. A new substation control building with provision of a toilet and basin, and synchronous condenser buildings.

The proposed permanent HVDC Converted Station development is 0.086km^2 (8.62 ha) and will consist of free draining stone with a nominal finished platform level as stated on BANN4-LT407-JMS-ZZ-ZZ-GA-C-0010 which will accommodate the substation. This report will cover the drainage impact assessment for the HVDC substation, but the platform drainage design is not covered as it is being designed by others.

The permanent substation access will be provided via a permanent bound access road off the A9 to the west of the proposed platform. The proposed access road will allow permanent access to the AC and HVDC substation platforms.

Maintenance access for the detention basin 01 and 02 will be provided via two permanent unbound access roads, basin 01 will be provided off the permanent substation access track and basin 02 will be provided off the access track from basin 01. The proposed access road will allow permanent access to the SuDs features.

Maintenance access for the OHL tower will be provided via a permanent unbound access road off the permanent substation access track. The proposed access road will allow permanent access to the OHL tower platform.

Screening of the AC substation and the HVDV converter station will be provided in the form of bunds which will be constructed from excess material during construction of the station platforms.

The requirements for the platform make-up taken from SP-NET-CIV-501 (SSEN, 2023) are described here: Layer 1 is to be single sized durable aggregate used for the surfacing material out of the area of the concrete and asphalt bound aggregate surfaces. This layer is required to mitigate step and touch electrical earthing potentials and shall be a minimum of 75mm thick with 20mm single-sized washed aggregate. Layer 2 is to be 200mm type 3 granular material as defined in Series 800 of the SHW. This layer is to be free draining. Layer 3 is to be minimum of 725mm well graded selected granular material. Class 6F2 as defined in Series 600 of the SHW is pre-approved by the employer for this layer. This layer is also to be free draining.

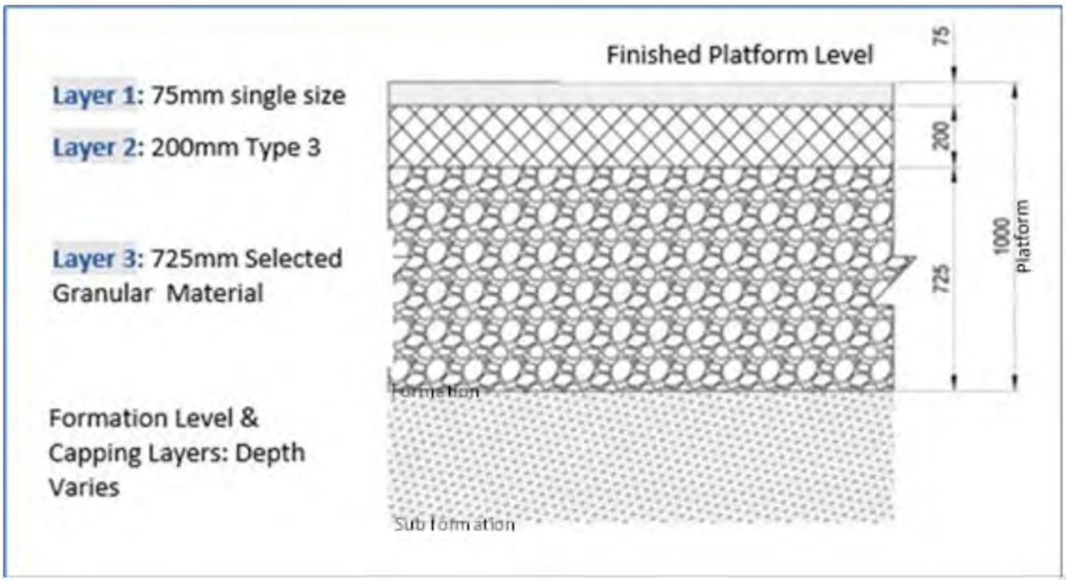


Figure 6: Substation platform formation

5. Surface Water Drainage Strategy

5.1. Sustainable (urban) Drainage System

The drainage design will incorporate SuDs, as recommended by the SuDs Manual (CIRIA, 2015).

CIRIA C753 SuDS Manual identifies a hierarchy for managing surface water, commonly known as the management train as outlined below:-

- Prevention – The use of good site design and housekeeping to prevent run-off and pollution (e.g. minimise hardstanding areas.)
- Source Control – Control of run-off at or very near to its source (e.g. rainwater harvesting)
- Site Control – Control of run off from several sub-catchments to a centralised SuDS system.
- Regional Control – Management of run-off from several sites (typically in a wet land or retention pond.)

The implementation of SuDS measures within a development as opposed to conventional drainage systems provides several benefits including the following:-

- Reducing peak flows to watercourses or sewers and potentially reducing the risk of flooding downstream.
- Reducing the volumes and frequency of water flowing directly into watercourses or sewers from developed sites.
- Improving water quality over conventional surface water sewers by removing pollutants from diffuse pollutant sources.
- Improving amenity through the provision of public open spaces and wildlife habitat; replicating natural drainage patters, including the recharge of groundwater so baseflows are maintained.

5.2. Proposed Discharge Method

In line with the recommendations of the SuDS manual (CIRIA, 2015), the hierarchy of preferred drainage discharge methods set out below has been considered: -

Table 3: Hierarchy of Surface Water Drainage Option

Discharge method	Preferred option	Rationale
Reuse on site	N	It is anticipated that only 8 people will be on site at any one time and visits will be occasional rather than full time. Therefore, the demand is not great enough for form part of the drainage design.
Infiltration to ground	N	The GI completed by IGNE (IGNE, 2024) confirmed that

Discharge method	Preferred option	Rationale
		infiltration to ground is not possible.
Discharge to surface waters	Y	At least three watercourses have been identified from the desk study to take the discharge from the site. Discharge to the nearest watercourse is the preferred option.
Discharge to Sewer	N	The utility search found no sewers in the area, so a sewer connection is not possible.

To control the discharge rate to the watercourse, attenuation will be incorporated into the drainage design. In accordance with 6.2.6 of the SSEN Drainage Specification SP-NET-CIV-502 (SSEN, 2020).

Table 4: Hierarchy of the Attenuation Methods

Attenuation Type	Preferred option	Rationale
Swales	Y	Swales will be located close to the source of the runoff from the platforms and will link the substation drainage system to the detention basins.
Detention Basins	Y	Detention basins will be incorporated into the drainage design to provide the majority of the attenuation volume.
Soakaways	N	The GI completed by IGNE (IGNE, 2024) confirmed that infiltration to ground is not possible.
Ponds	N	Swales and detention basins are the desirable option.
Underground storage pipes and tanks, including cellular systems	N	Swales and detention basins are the desirable option.

5.3. Proposed Surface Water Drainage Strategy

It is proposed to capture and attenuate the runoff from the hardstanding surfaces, including roads, buildings, transformers bunds and concrete refuelling areas and let the water permeate through the remaining surfaces, including the free draining fill making up the substation platform. Detention basins are proposed to attenuate and provide treatment to the runoff from the hardstanding surfaces within the platforms, which is to be discharged into the existing watercourses. As the proposed platform areas are currently divided in four catchments, shown in the Flood Risk Assessment - BANN4-LT407-JMS-DRAI-XX-RPT-C-0003, the discharge will be limited to the greenfield runoff rate from only the catchment feeding into the chosen watercourses.

Free Draining Surface

The subbase layer beneath the platform will be graded at 1 in 500, which is shallower than the existing gradient, so it won't increase offsite flood risk. The subbase will be graded south to north as such that the runoff catchments will be as existing topography and flow paths. The runoff from the formation level (capping layer) will runoff into the existing catchments as shown in the Flood Risk Assessment - BANN4-LT407-JMS-DRAI-XX-RPT-C-0003.

Within the proposed development the existing topsoil has found to have low water infiltration and therefore contains areas of perched water (IGNE, 2024). In the proposed permanent development of the substation platforms, the rainwater will permeate through the granular platform and runoff the capping layer which will have similar characteristics as the existing topsoil and therefore mimic the existing drainage arrangement. The area to the north of the platform where the runoff is being conveyed, falls away from the platform into the existing watercourses. In the proposed permanent works, this area will be graded to mimic the existing arrangement which will ensure that the runoff from the formation layer will drain freely away from the platform.

Figure 7: Location plan showing permanent drainage strategy.

Hardstanding surfaces

The drainage strategy anticipates the use of either filter drains, combined kerb drains or linear drainage channels to capture the runoff from the hardstanding road surfaces and guttering systems to capture runoff from the building roofs. It is proposed either carrier pipes or swales will convey the runoff from the substation platform to the detention basins where the runoff will receive its primary treatment.

The SuDs basins have been sized to accommodate the total hardstanding surfaces within proposed development, including the proposed HVDC platform and the depot which are not covered within this planning submission. Detention basin 01 is to attenuate the runoff from the hardstanding surfaces from the HVDC substation and the depot platform. Detention basin 02 is to attenuate the runoff from the hardstanding surfaces within the AC substation.

The detailed design of the detention basins will be in accordance with The CIRIA SuDs Manual C537 (CIRIA, 2015). The detention basins have been sized to show the approximate dimensions to achieve the desired storage are shown below.

Detention Basin 1

- Depth: 1m
- Slope: 1 in 4
- Top of bank area: 4500m^2 (0.45 ha)
- Volume: 3750m^3
- Allowable discharge rate, Qbar: 38 l/s

Detention Basin 2

- Depth: 1m
- Slope: 1 in 4
- Top of bank area: 3200m^2 (0.32 ha)
- Volume: 2780m^3
- Allowable discharge rate, Qbar: 7.3 l/s

The proposed SuDs Strategy is shown in Figure 7 which incorporates the surface water management elements as described in Table 5.

Table 5: Surface Water Management Strategy SuDS Option Summary

SuDS Management Train Element	Application	SuDS Features to be used
Source Control	For the interception of surface water run off at source from surfaced roads, foundations and buildings. Provides the required surface water attenuation / storage and first level of treatment.	Gullies or Combined Kerb Drains and Filter Drains
Conveyance	Convey surface water runoff from Source Control measures to Site Control	Carrier pipes, Filter Drains or Swales
Site Control	To provide attenuation storage in order to restrict the peak discharge rate to the permissible rate, in addition to	Detention Basin

SuDS Management Train Element	Application	SuDS Features to be used
	providing the primary treatment.	
Surface Water Flows	For the interception and diversion of surface water flows	Cut-off Ditch

The design proposed in this strategy document incorporates cut-off drains around the site perimeter, where there is a risk of off-site runoff encroaching on the platform, and toe drainage at the base of all the cutting slopes. These features will prevent any runoff from adjacent land from entering the platform. The runoff from trafficked areas, including the access roads and the concrete refuelling areas, will be collected in a separate system. As well as the runoff from the building roofs and the transformer bunds. Therefore, there is a low risk of fines and silts entering the platform make up and it is not envisaged that the platform will require to be maintained to operate.

5.4. Design return events and Climate Change

The drainage system will be designed to attenuate surface water generated during rainfall events with a return period of up to 1 in 200 year rainfall including a 42% uplift to account for climate change (SEPA, 2024).

A further assessment has been undertaken for the 1 in 1000-year event to verify the extents of any surface water flooding for critical equipment, which the top of platform level is classed critical equipment level. This assessment is captured in the Flood Risk Assessment report - BANN4-LT407-JMS-DRAI-XX-RPT-C-0003.

5.5. Greenfield Runoff Flow

In line with THC's guidelines (THC, 2016) for development, it is anticipated that the allowable discharge for the site would match that of the existing 1-in-2-year greenfield runoff rate. As per HR Wallingford, the existing 1-in-2-year greenfield runoff rate is stated in section 5.3 for the entire area catchment within the platform. This will ensure the catchment area for the surface water is discharge into the network similar to existing arrangement to avoid increasing peak flows to watercourses and the risk of downstream flooding.

5.6. Attenuation

The outline network and the attenuation systems have been designed in accordance with Sewers for Scotland (Scottish Water, 2018). The network has been designed to provide attenuation for impermeable areas ensuring no flooding up to and including the 200 year event + 42% Climate Change to satisfy SEPA and Scottish Water criteria (SEPA, 2022). The free boarding allowance shall be 300mm as per the CIRIA SuDs Manual (CIRIA, 2015) for larger attenuation features. Where risks are particularly high a further allowance shall be agreed with SEPA.

In accordance with the "Water Assessment and Drainage Assessment Guide" (SEPA, 2016), the network design calculations allow for events up to the 200-year storm event plus 42% allowance for Climate Change with potential exceedance to be accommodated within the application boundaries and without detriment to properties. A further check has been carried out to consider a 1 in 1000-year event +42% to consider the impact on the surrounding area.

5.7. Water Quality Treatment

5.7.1. Surface Water

CIRIA C753 The SUDS Manual (CIRIA, 2015) outlines guidance for designing SUDS to achieve the appropriate level of water treatment.

The post development surface water runoff generated from the impermeable areas of the site are considered to have a 'high' pollution Hazard Level as set out within Table 6 below: -

Table 6: Pollution Hazard Indices for Land Use Classification

Land Use	Pollution Hazard Level	Pollution Hazard Indices		
		Total Suspended Solids (TSS)	Metals	Hydrocarbons
Industrial Roofs (Medium potential do metal leaching)	Low	0.3	0.2	0.05
Low trafficked Access Roads	Low	0.5	0.4	0.4
Site where chemicals and fuels (other than domestic fuel oil) are to be delivered, handled, stored, used or manufactured	High	0.8	0.8	0.9

The transformer bund area will be captured in a separate system as per SP-NET-CIV-502 (SSEN, 2020) and SP-NET-CIV-509 (SSEN, 2020), the runoff from the transformer bund will flow through an oil full retention separator before being discharged into the main drainage system. The water being discharged into the main substation drainage network from the oil retention separator will be free from oil contaminates. The oily water network will have a manhole and sampling point before entering the main drainage system where the water can be tested.

The hardstanding refuelling area will be captured in a separate network, which will pass through an oil separator before being discharged to the detention basin. The type of oil separator will be selected at detailed design stage.

The Simple Index Approach Tool (HR Wallingford, 2024) has been used for the development of the water quality treatment strategy for the development. The Simple Index Approach Tool checks that the proposed SUDS will provide the required level of treatment for the relevant pollution source.

As described in section 4, the maintenance access roads will be unbound and free draining. The runoff with permeate through the unbound material onto the existing ground, mimicking the existing drainage arrangement. As the proposed arrangement mimics the existing drainage arrangement, there is no requirement for additional treatment and restricting the discharge rate.

The Simple Index Approach Tool accounts for where two or more SUDS features are used to exceed the pollution hazard indices and applies the following formula.

Total SUDS mitigation index = mitigation index 1 + 0.5 (mitigation index 2)

Table 7: SuDS Mitigation Indices

SuDS Component	Mitigation Indices		
	TSS	Metals	Hydrocarbons
Filter Drain	0.4	0.4	0.4
Swale	0.5	0.6	0.6
Detention Basins	0.5	0.5	0.6
Total SUDS mitigation Index Achieved	0.9	0.95	>0.95
Acceptable	Y	Y	Y

Table 7 shows the Simple Index Approach pollution hazard index is satisfied through the three detention basin compartments.

A full retention oil separator will be incorporated into the compound drainage system to prevent the risk of oil discharging the system and contaminating surrounding ecosystem.

5.7.2. Foul Water

There are no existing public sewers in the vicinity of the proposed site therefore a connection to the existing sewer network was not a feasible option; in accordance with the relevant guidance (SEPA, 2022) (SSEN, 2020), an on-site treatment and discharge option will be designed for the development.

As highlighted within Section 4, the substation control building will include the provision of a toilet and basin. The usage is anticipated to be very low <15.ep. The foul water drainage system will be designed to suitably treat all foul water to SEPA regulations WAT-RM-03 (SEPA, 2022) prior to discharge. There are no existing public sewers in the vicinity of the proposed development, therefore a connection to the existing sewer network was not a feasible option, in accordance with relevant guidance, it is proposed an on-site treatment and discharge option will be designed for the development.

To calculate the population equivalent (p.e) for non-domestic sewage effluent, the BOD load should be multiplied by the number of people using the system and divided by 60 (SEPA, 2022). It is assumed at this stage that there would be 5No. operations engineers and 3No. maintenance crew at any one time. Considering this, the calculation for the p.e for this sewage system is shown below:

$$Population\ Equilalent\ (p.e) = \frac{BOD\ load\ \left(\frac{g}{day}\right) x\ no. people\ using\ system}{60} = \frac{25\ x\ 8}{60} = 3.33$$

Since the p.e of the proposed development is less than 50, a private wastewater treatment plant and/or septic tank should be designed, constructed, and installed in accordance with BS EN 12566 – 'Small wastewater treatment system up to 50 PT'. Part 1 of BS EN 12566 specifies the requirements for prefabricated septic tank units, where discharge of the effluent is to a drainage field which then infiltrates into the ground. A septic tank requires additional land take-up for the leaching field which is beyond any environmental exclusion zones and have acceptable infiltration rates to the ground. Therefore, due to the space constraint on the site and the limited infiltration to ground, it is recommended that package treatment plants are the preferred option for treating foul drainage. A package treatment plan treats the wastewater to a much higher standard than a septic tanks prior to release, hence the treated effluent can be discharged to a watercourse.

Package treatment plants should be designed, constructed and installed in accordance with Part 3 of BS EN 12566, which specifies the level to which the effluent must be treated before it is discharged. Such designs shall include a chamber downstream of the plant, for inspection, sampling in accordance with SEPA guidance.

It is anticipated that the foul water will be treated by a package treatment plant (PTP) prior to discharge. Three sources of foul water are anticipated on the proposed development, including the control building on the AC platform, the operating building on the HVDC platform. Figure 8 and Figure 9 show the proposed package treatment plants for the foul water system, as well as the pipework between the devices. The package treatment plant will treat the effluent to the sufficient level, as per BS EN 12566-1, before being discharged to the proposed watercourse diversion. The detailed design will be subject to agreement with SEPA and authorised in accordance with the Controlled Activity Regulations (CAR).

The watercourses receiving the discharge from the PTP are shown on a 1:25,000 watercourse map (NGR Tool, 2024). Therefore, registry approval will be required, and it is advised that a PTP and partial soakaway will be sufficient to issue to the registration (SEPA, 2022).

Figure 8: Foul Water Treatment System for AC Platform

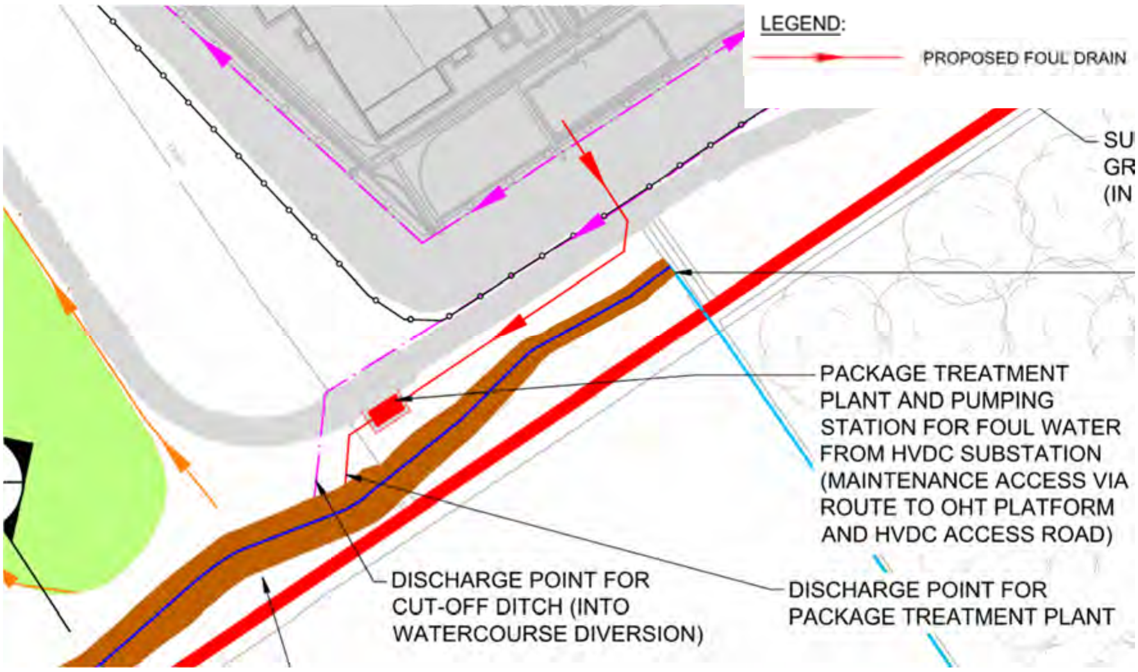


Figure 9: Foul Water Treatment System for HVDC Platform

5.7.3. Oil Filled Equipment

As highlighted in Section 4, oil-filled equipment such as the transformers shall be installed in a watertight secondary containment system, which as a minimum will comprise of an above ground bund to retain the oil. The bund design is reproduced from SSEN Specification for Substation Bunds SP-NET-CIV-509 and shown in Figure 10.

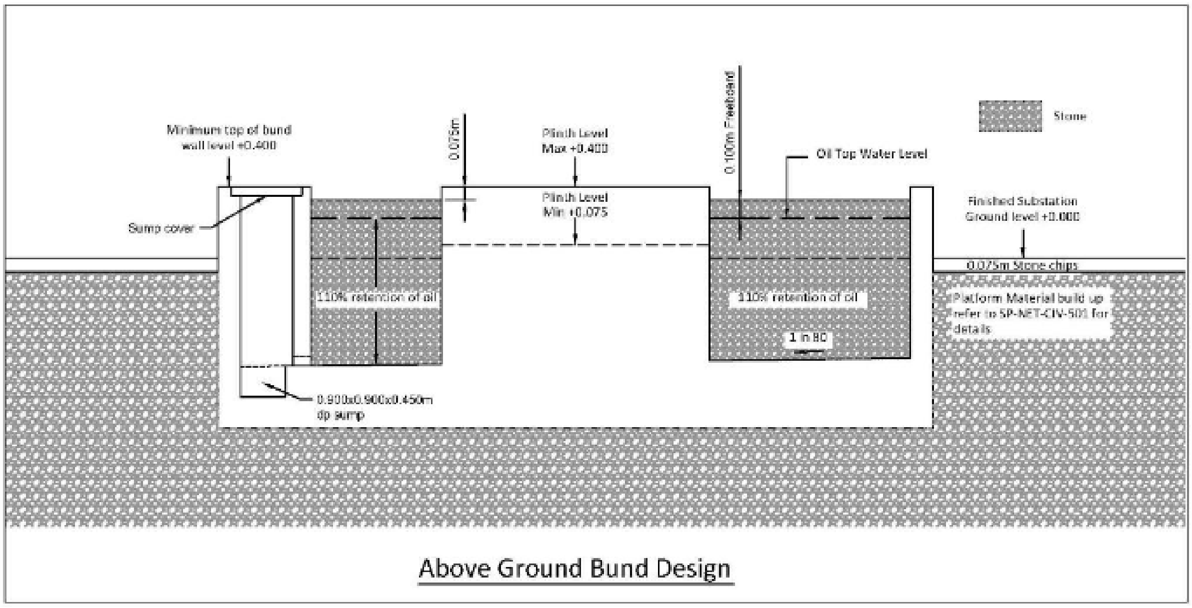


Figure 10: Above ground bund design for oil filled equipment.

The bund water control unit (BWCU) shall be discharged to the surface water drainage system via an approved above ground oily water mitigation system. The BWCU will be sized to accommodate 110% of the oil capacity of the equipment and the BCWU has an oil discriminating pump. The oily water drainage system will be suitable designed and discharged into the first level of treatment area as per SP-NET-CIV-502 Figure 6.1, also shown in Figure 11 below. The oily water will have the same treatment facility as the surface water system and is accounted for in the attenuation area.

Sampling points shall be incorporated at the downstream ends of the attenuation ponds prior to their discharge to the receiving watercourses, to test the quality of the surface water runoff from the site is sufficient for it to be safely discharged to the environment.

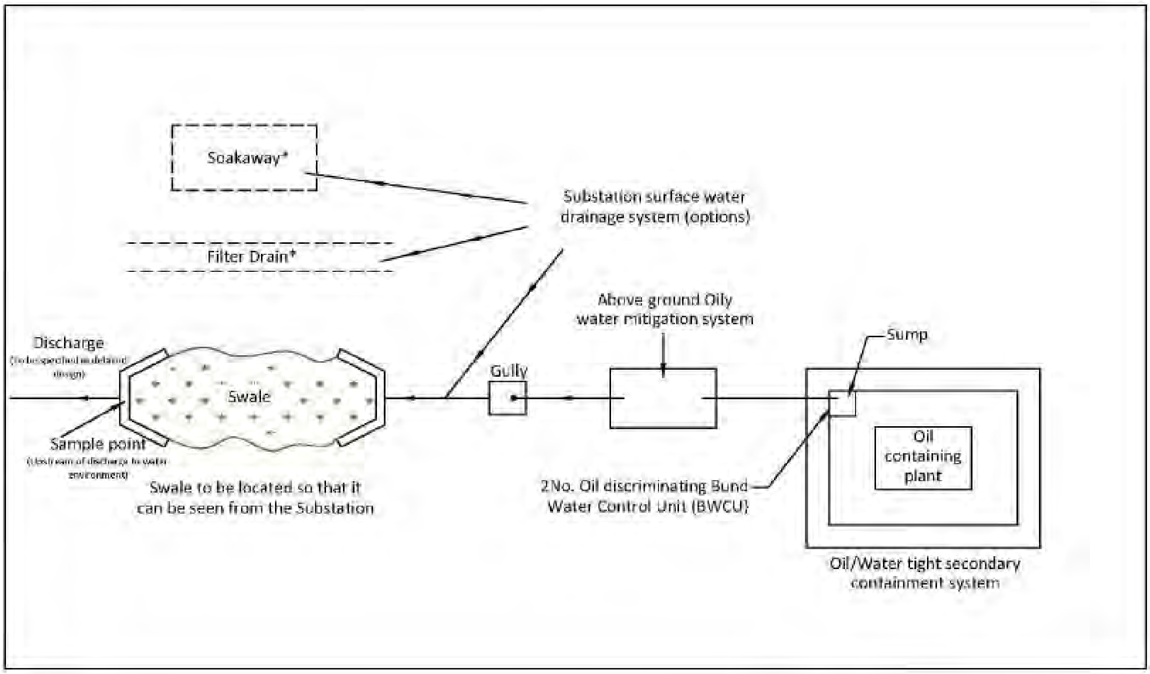


Figure 11: Surface water and oily water drainage system.

6. Operation and Maintenance

All surface water drainage and pollution control features associated with the development will remain as private assets and will be maintained by SSEN. The following section outlines the recommended maintenance requirements as detailed in The SuDs Manual (CIRIA, 2015) for the various aspects of the drainage system for the development. An operation and maintenance plan should be developed by SSEN for the site once operational.

6.1. Permeable Platform

As described in section 5.3, the platform does not require to be maintained.

6.2. Filter Drains

A recommended operation and maintenance plan for filter drains is summarised in Table 8 below: -

Table 8 Filter Drain Operation and Maintenance Requirements (CIRIA, 2015)

Maintenance Schedule	Required Action	Suggested minimum frequency
Routine Maintenance	Inspect filter drain surface, inlet / outlet pipework and flow control systems for blockage, standing water or damage	Biannually (or as required)
	Inspect pre-treatment systems, inlets, pipework, chambers for silt accumulation and undertake silt removal as required	Biannually (or as required)
	Remove sediment from pre-treatment devices	Annually
	Remove litter, including leaf build up and debris from filter drain surface, access chambers and pre-treatment devices.	Annually
Occasional Maintenance	Remove or control tree roots that are encroaching the filter drainage network. Recommended methods to be utilised as NJUG, 2007 or BS3998:2010.	As required
	At locations with high pollutant load, remove surface geotextile and replace, and wash or replace overlying filter media.	5 yearly or as required

6.3. Swale

A recommended operation and maintenance plan for the swale is summarised in Table 9 below: -

Table 9: Swale Operation and Maintenance Requirements (CIRIA, 2015)

Maintenance Schedule	Required Action	Suggested minimum frequency
Routine Maintenance	Remove litter, debris and trash	Annually
	Inspect inlets, outlets and overflows for blockages and clear as required.	Biannually (or as required)
	Remove sediment from inlets, outlets and bed	Annually
	Cut grass – to retain grass height within specified design range	Monthly during growing season (or as required)
Occasional Maintenance	Reseed any areas of poor vegetation growth	As required
	Repair erosion or other damage by re-seeding or re-turfing.	As required.

6.4. Detention Basins

A recommended operation and maintenance plan for the detention basins is summarised in Table 10 below: -

Table 10: Detention Basin Operation and Maintenance Requirements (CIRIA, 2015)

Maintenance Schedule	Required Action	Suggested minimum frequency
Routine Maintenance	Remove litter, debris and trash	Biannually (or as required)
	Inspect inlets, outlets and overflows for blockages and clear as required.	Biannually (or as required)
	Inspect inlets and facility surface for silt accumulation.	Biannually (or as required)
	Inspect banksides, structures. Pipework etc for evidence of physical damage	Biannually (or as required)
	Remove sediment from inlets, outlets and bed	Annually
	Check mechanical devices e.g. penstocks	Biannually (or as required)

Maintenance Schedule	Required Action	Suggested minimum frequency
	Remove sediment from inlets, outlets and borebays	Every 1 to 5 years (or as required)
	Cut the meadow grass	Biannually (or as required)
Occasional Maintenance	Remove sediment from inlets, outlets forebays and main basin when required	Every 5 years (or as required)

6.5. Package Treatment Plant

A recommended operation and maintenance plan for the package treatment plant is summarised in Table 11 below: -

Table 11: Septic Tank Operational and Maintenance Requirements (CIRIA, 2015)

Maintenance Schedule	Required Action	Suggested minimum frequency
Occasional Maintenance	Pump and clean package treatment plant	Annually
	Inspection of treatment plant	Annually

6.6. Full Retention Separator

A recommended operation and maintenance plan for the full retention separator is summarised in Table 12 below: -

Table 12: Full Retention Separator Operational and Maintenance Requirements (CIRIA, 2015)

Maintenance Schedule	Required Action	Suggested minimum frequency
Occasional Maintenance	Inspected	Bi-annually (or as required)
	Checking and cleaning the coalescer assembly	Annually or following major incident
	Alarm probes where fitted, should be removed and cleaned	Annually or following major incident

7. Construction Stage Water Management

Construction stage water management proposals will be developed separately in a Pollution Prevention Plan and agreed with SEPA as part of the CAR Construction License submission and agreement.

8. References

BGS. (2024). *Geology Viewer*. Retrieved from British Geology Viewer: https://geologyviewer.bgs.ac.uk/?_ga=2.191039149.646962443.1695043941-500996651.1695043941

CIRIA. (2015). The SuDs Manual (C753).

HR Wallingford. (1980). Winter rain acceptable potential. London.

HR Wallingford. (2024, March). *Water quality assessment for SuDS developments (SuDS manual).* Retrieved from HR Wallingford: https://www.uksuds.com/tools/water-quality-assessment-suds-developments-suds-manual

IGNE. (2024). *Spittal Hub Site Ground Investigation Report.* Jacobs.

Maps, Ordnance Survey. (2024). *Ordnance Survey Maps*. Retrieved from National Library of Scotland: https://maps.nls.uk/geo/find/#zoom=13.1&lat=58.48634&lon=-3.42251&layers=298&b=10&z=0&point=58.49763,-3.41902

NGR Tool. (2024). Retrieved from SEPA: https://map.sepa.org.uk/ngrtool/

OS Maps. (2024, March). *OS Maps*. Retrieved from OS Maps: https://explore.osmaps.com/?lat=53.478537&lon=-2.233954&zoom=14.1091&style=Standard&type=2d

Scotland Topographical. (2024). *Scotland topographic map*. Retrieved from Scotland Topographical: https://en-gb.topographic-map.com/map-75t6/Scotland/?center=57.19887%2C-3.03302&zoom=14&popup=57.19585%2C-3.03877

Scotland's Soil. (2024). *Soil Maps*. Retrieved from Scotland's Soil: https://map.environment.gov.scot/Soil_maps/?layer=1

Scottish Water. (2018, October). Sewers for Scotland - A technical specification.

SEPA. (2016). Water Assessment and Drainage Assessment Guide.

SEPA. (2021, September). Supporting Guidance (WAT-SG-75) Water Run-Off from Construction Sites.

SEPA. (2022, April). Regulatory Method (WAT-RM-03) - Sewage Discharges to Surface Waters. Strathallan House, The Castle Business Park, Stirling, FK9 4TZ. Retrieved from Sewage Discharges to Surface Waters: https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Fwww.sepa.org.uk%2Fmedia%2F594196%2Fwat-rm-03-regulation-of-sewage-discharges-to-surface-waters.docx&wdOrigin=BROWSELINK

SEPA. (2022, July). Supporting Guidance (WAT-SG-12) General Binding Rules for Water.

SEPA. (2022, June). Technical Flood Risk Guidance for Stakeholders.

SEPA. (2023, June). The Water Environment (Controlled.

SEPA. (2024, March). *Climate change allowance for flood risk assessment in land use planning*. Retrieved from SEPA.MAP.ARCGIS: https://scottishepa.maps.arcgis.com/apps/webappviewer/index.html?id=2ddf84e295334f6b93bd0dbbb9ad7417

SEPA. (2024). *Flood Maps*. Retrieved from SEPA: https://beta.sepa.scot/flooding/flood-maps/

SSEN. (2020). *Drainage Specification - SP-NET-CIV-502.*

SSEN. (2020). *Specification of Substation Bunds.* SSEN.

SSEN. (2023). *Earthworks Specification - SP-NET-CIV-501.*

THC. (2016). Flood Risk & Drainage Impact Assessment: Supplementary Guidance.

THC. (2016). Local Flood Risk Management Plan.

Appendix A – Surface Water Network Record

400kV Banniskirk Substation and HVDC Converter Station –

Surface Water Network Record

<u>Burn of Halkirk</u>

Photo 1.1 Looking Upstream Towards Spittal Hill

Photo 1.2 450mm Concrete Pipe Inlet

Photo 1.3 Channel Diversion Looking Upstream 150mm pipe enters from left bank.

Photo 1.4 Downstream of Diversion Looking Upstream

Photo 1.5 Confluence of Pond Outflow and Diverted Channel

Photo 1.6 600mm Concrete Pipe Outlet


Photo 1.7 Looking Downstream of Photo 6


Photo 1.8 Channel Diversion


Photo 1.9 Channel Diversion and Wrack Marks


Photo 1.10 Masonry box culvert with sheet metal top


Photo 1.11 Masonry box culvert Upstream of Banniskirk House Access Road


Photo 1.12 Burn of Halkirk at Banniskirk House Access Road


Photo 1.13 Burn of Halkirk Upstream of A9


Photo 1.14 Burn of Halkirk Downstream of A9

Unnamed Tributary 01


Photo 2.1 Looking Upstream Towards Spittal Hill


Photo 2.2 2 x 250mm PVC Pipe Outlet


Photo 2.3 250mm Steel Pipe Outlet


Photo 2.4 Channel One Looking Downstream


Photo 2.5 Channel Two Looking Upstream


Photo 2.6 Channel Two at Culvert Crossing


Photo 2.7 Confluence of Channel One and Two


Photo 2.8 Downstream of Confluence


Photo 2.9 Downstream of Confluence


Photo 2.10 500mm Pre-Cast Concrete Pipe


Photo 2.11 Upstream of A9


Photo 2.12 500mm Pre-Cast Concrete Pipe at A9

Unnamed Tributary 02


Photo 3.1 300mm Corrugated PVC Pipe.


Photo 3.2 Channel – Upper Catchment.


Photo 3.3 Channel – Upper Catchment.


Photo 3.4 Channel – Lateral Flow Contributions.


Photo 3.5 Channel Diverts Course.


Photo 3.6 Channel – Upstream of A9.


Photo 3.7 Upstream of A9, Looking Downstream.


Photo 3.8 300mm Corrugated PVC Pipe at A9.


Photo 3.9 Masonry/stone box built into wall. 250mm wide, 600mm high.


Photo 3.10 Unknown. Unable to access.

Burn of Achanarras


Photo 4.1 2 x 250mm Clay Pipes.

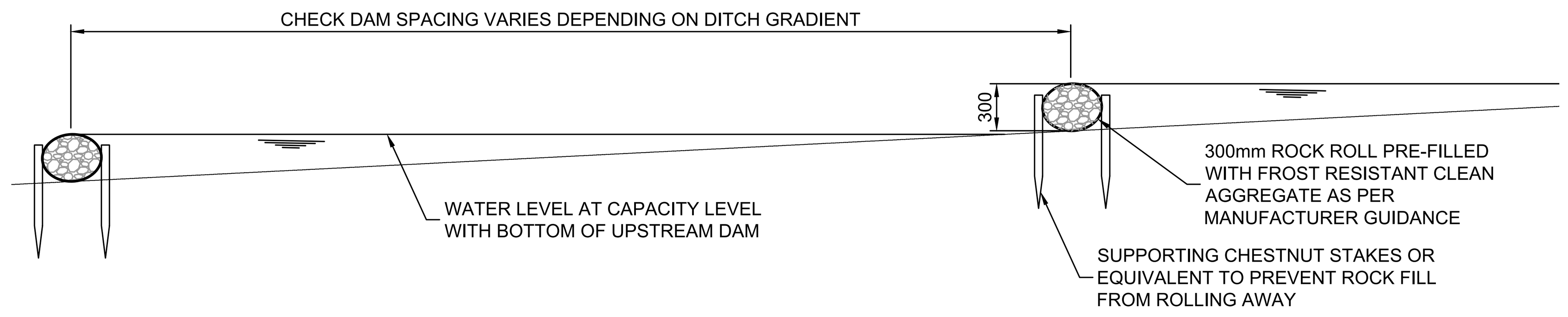

Photo 4.2 Downstream of Quarry Access.


Photo 4.3 Receiving Channel Upstream of A9.


Photo 4.4 300mm Pre-Cast Concrete Pipe at A9.

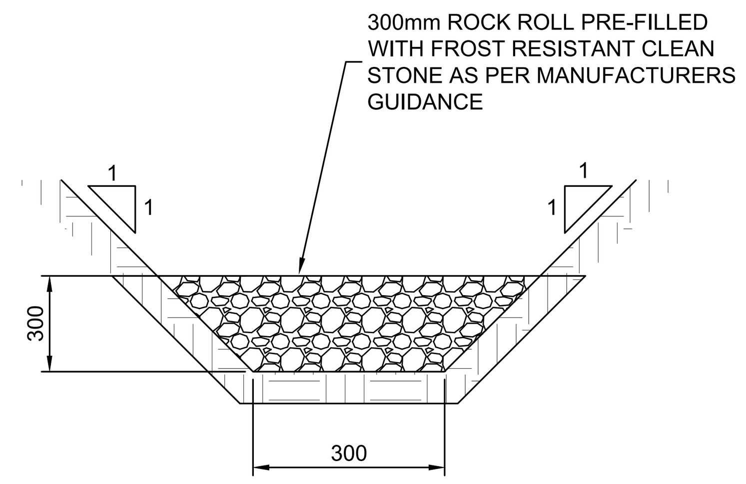

Photo 4.5 150mm Clay Pipe.


Photo 4.6 150mm Stone/Concrete Pipe. 50% Blocked.



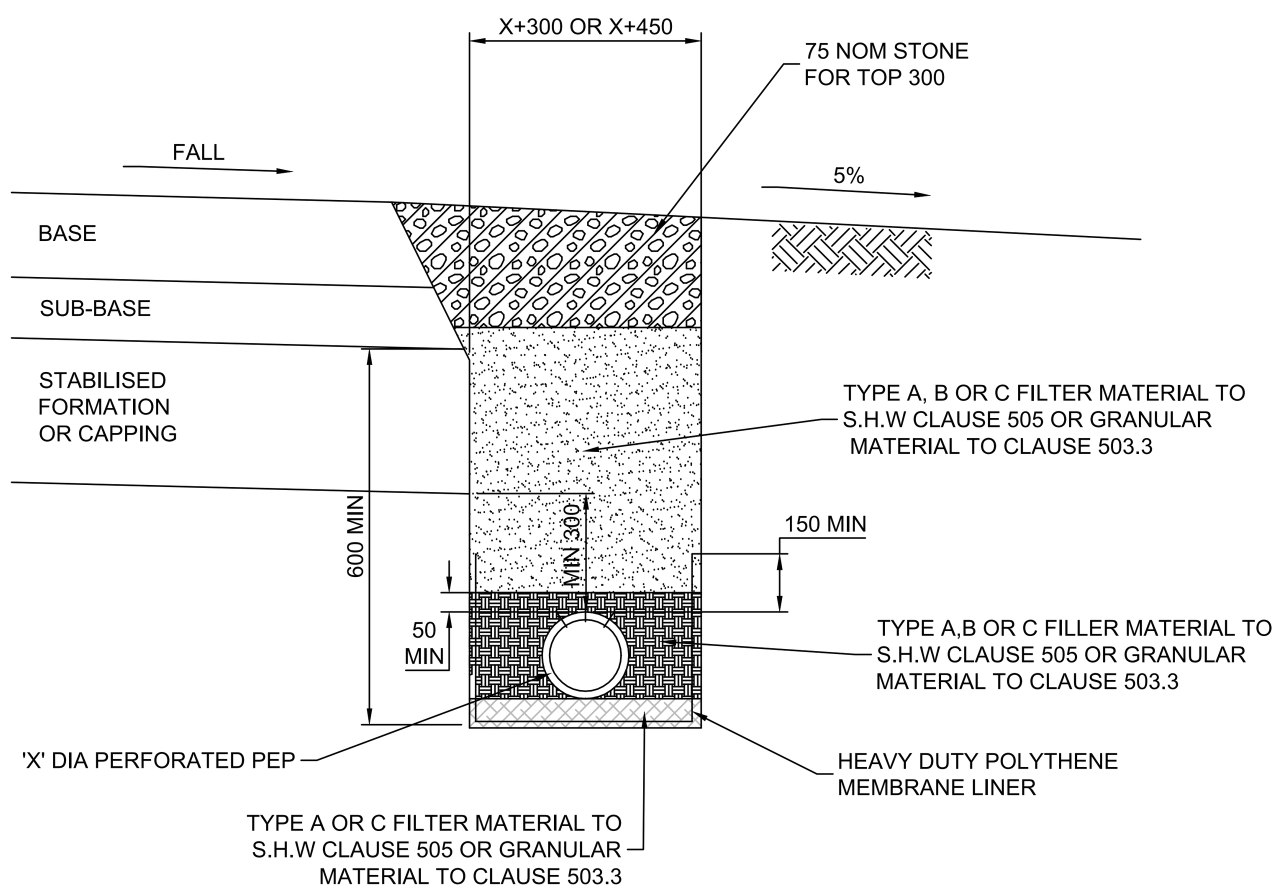
TYPICAL CHECK DAM PROFILE

SCALE 1:20



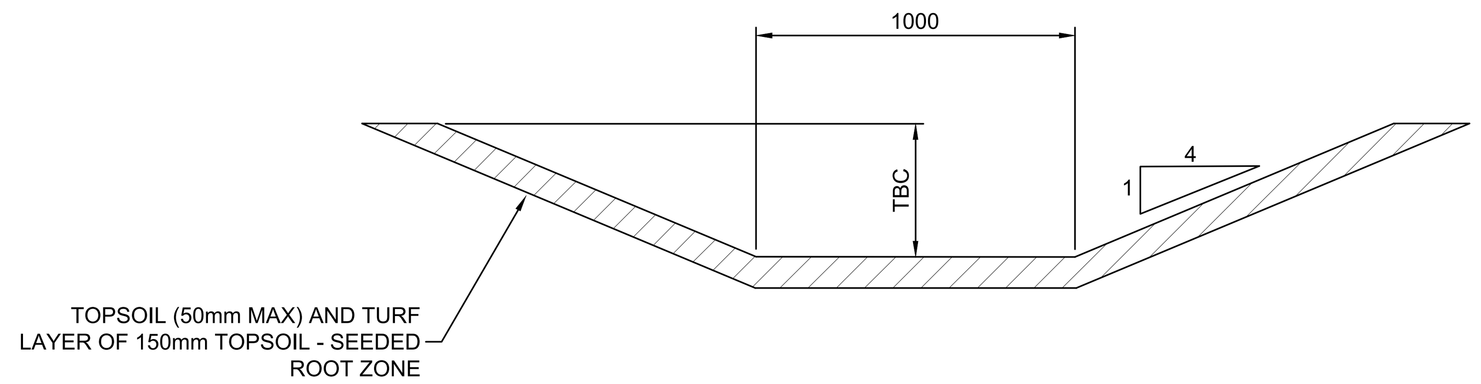
TYPICAL CHECK DAM SECTION

SCALE 1:20



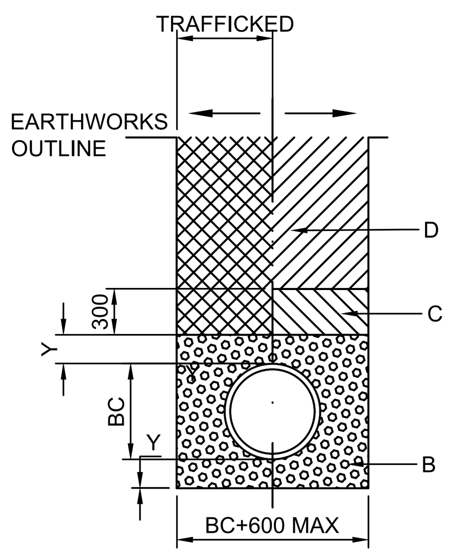
TYPICAL DETAIL FOR FILTER DRAINS ON EMBANKMENT

SCALE 1:20



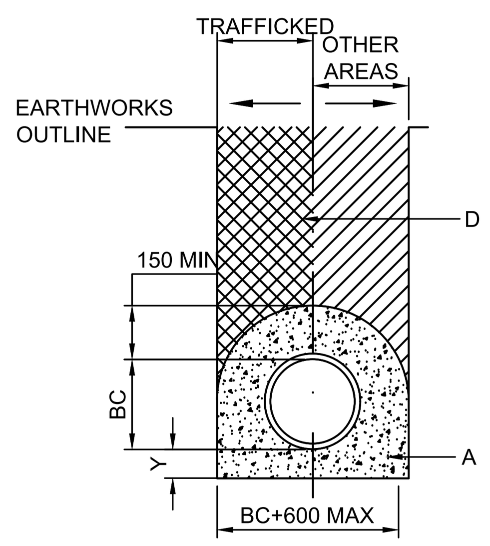
TYPICAL SWALE DETAIL

SCALE 1:20



GRANULAR BED AND SURROUND (CLASS 'S')

SCALE 1:10



CONCRETE BED AND SURROUND (CLASS 'Z')

SCALE 1:10

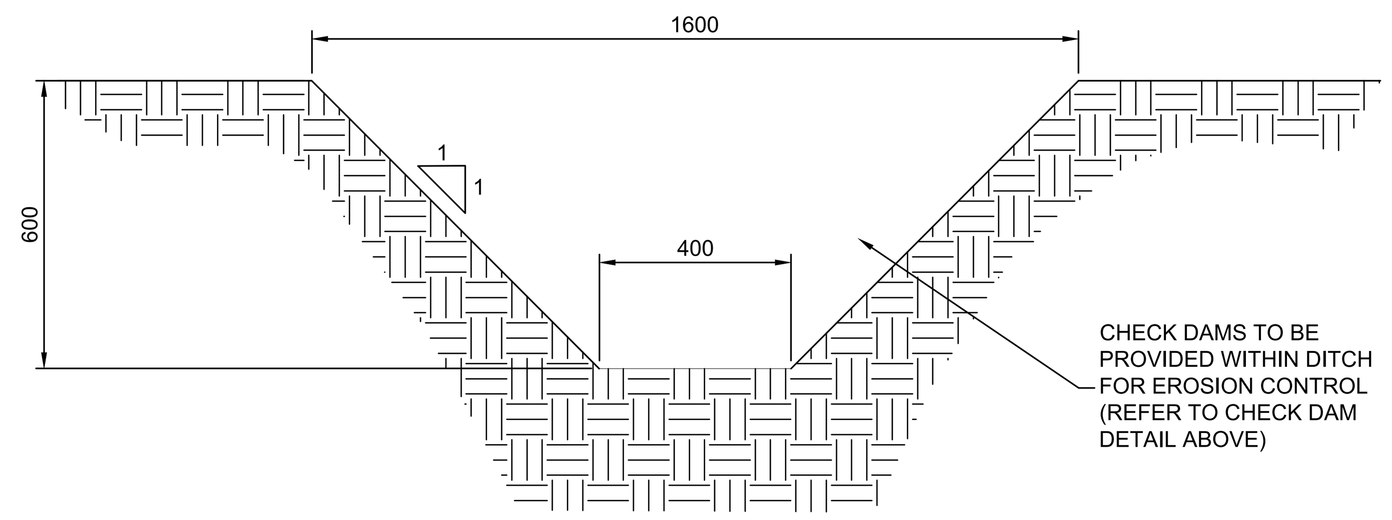
CLASS	MACHINE DUG UNIFORM SOIL	ROCK OR MIXED SOILS
S	NOTE (i)	NOTE (ii)
Z	NOTE (ii)	NOTE (ii)

(i) Y=BC/6, WITH MIN 100 UNDER BARRELS (50 FOR SLEEVE JOINTED) AND MIN 50 UNDER SOCKETS, WHICHEVER IS THE GREATER, WITHMAX OF 400
(ii) Y=BC/4, WITH MIN 200 UNDER BARRELS (150 FOR SLEEVE JOINTED) AND MIN 150 UNDER SOCKETS, WHICHEVER IS GREATER, WITH A MAX OF 400

A. CONCRETE MIX ST4 TO BE BS EN 206 WITH 25mm JOINT FILLERBOARD (FLEXCELL) AT JOINT POSITIONS
B. PIPE BEDDING MATERIAL TO CLAUSE 503.3(i)(SHW) EVENLY COMPACTED
C. CLASS 8 LOWER TRENCH FILL TO CLAUSE(iv)(SHW) COMPACTED BY HAND
D. TRENCH BACKFILL WITHIN THE HIGHWAY TO BE GRANULAR TYPE 1 MATERIAL TO CLAUSE 803(SHW). CARRIED OUT IN ACCORDANCE WITH CLAUSE 505(SHW) TRENCH BACKFILL IN OTHER AREAS TO BE ACCEPTABLE MATERIAL (CLASS 1,2 OR 3) COMPACTED TO CLAUSE 505(SHW

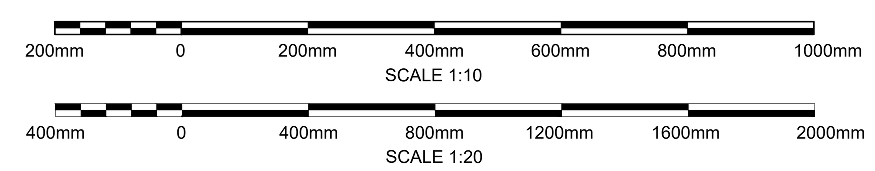
FOR CARRIER DRAINS, WHERE DEPTH OF COVER TO PIPE SOFFIT IS GREATER THAN 900mm IN HIGHWAYS AND 600mm IN LANDSCAPED/PEDESTRIAN AREAS

FOR CARRIER DRAINS, WHERE DEPTH OF COVER TO PIPE SOFFIT IS LESS THAN 900mm IN TRAFFICKED AREAS SUCH AS HIGHWAYS AND 600mm IN LANDSCAPED/PEDESTRIAN AREAS



TYPICAL DRAINAGE DITCH - CROSS SECTION

SCALE 1:10



GENERAL NOTES

1. ALL DIMENSIONS ARE IN MILLIMETERS. DO NOT SCALE.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING BANN4-LT407-JMS-DRAI-XX-LAY-C-0110 AND BANN4-LT407-JMS-DRAI-XX-DET-C-0112
3. BURIED SERVICES SEARCH TO BE COMPLETED PRIOR TO BREAKING GROUND.
4. ALL DISTURBED AREAS OF GROUND ARE TO BE FULLY RESTORED TO THEIR ORIGINAL CONDITION. RE-SEEDING SHALL BE CARRIED OUT USING APPROVED NATURAL SEED MIXTURES.
5. WHERE THE WORKS CROSS EXISTING LAND DRAINS THEY SHALL BE MAINTAINED IN ACCORDANCE WITH THEIR ORIGINAL INTENT.

REV	DRAWN	CHECKED	APPROVED	DATE
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
UPDATED FOR COMMENTS				
P03	SK	AGF	RP	02/08/24
UPDATED FOR COMMENTS				
P02	TS	AGF	TCC	17/05/24
FOR PHASE 2B PLANNING				
P01	TS	AGF	TCC	15/04/24

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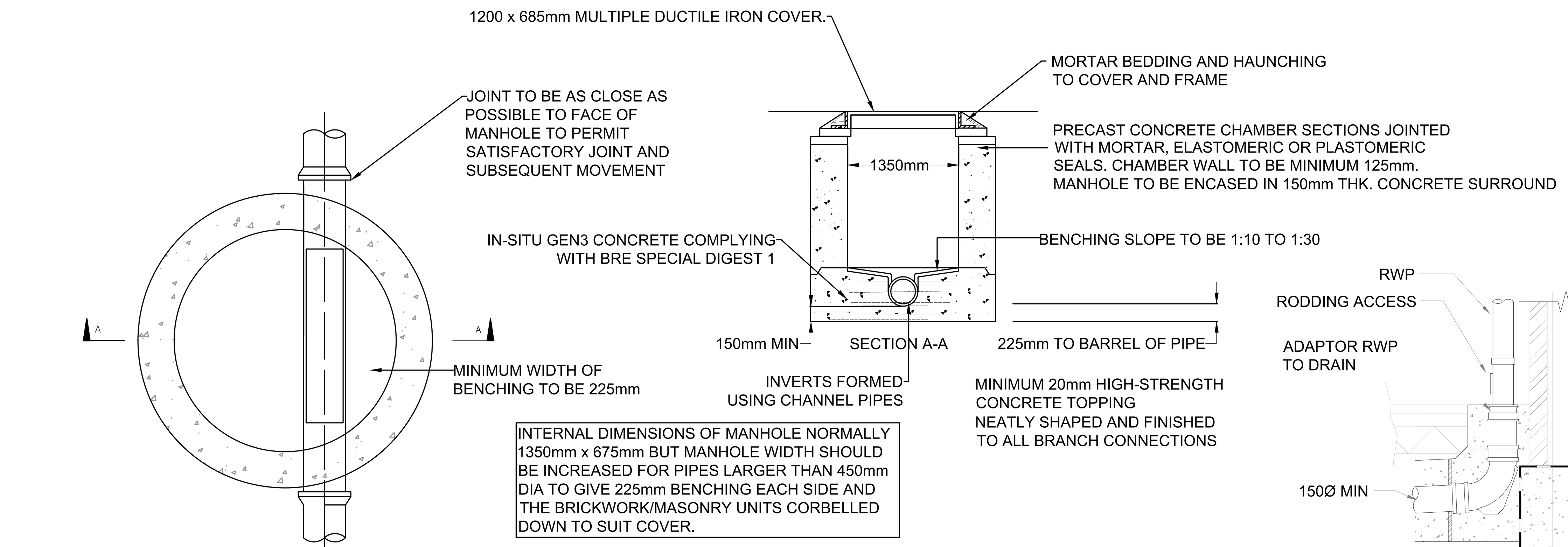
4TH FLOOR, ARTHUR HOUSE, MANCHESTER M1 3FH

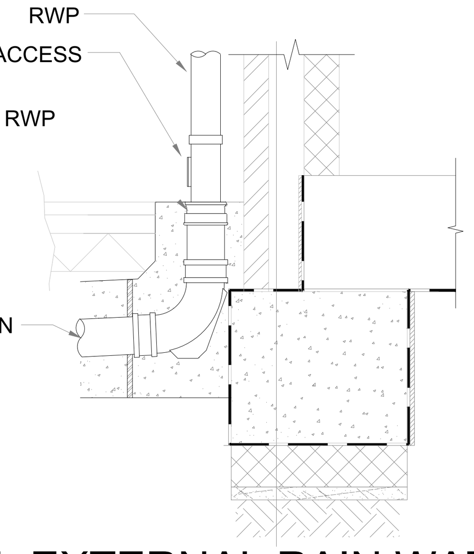
Scottish & Southern Electricity Networks
SCOTTISH AND SOUTHERN ELECTRICITY NETWORK
1 WATERLOO ST, GLASGOW G2 6AY

Project:	BANNISKIRK 400kV SUBSTATION
Scheme:	
Site:	LT407 BANNISKIRK 400kV SUBSTATION
Circuit:	COMMON
Revision: P03	Dwg Title: DRAINAGE TYPICAL DETAILS SHEET 1 OF 2
Suitability: S5	
Scale @ A1: AS SHOWN	Dwg No: BANN4-LT407-JMS-DRAI-XX-DET-C-0111
Sheets: 1 OF 1	Purpose of Issue: ISSUED FOR PLANNING
Internal Proj.Ref: M123015	Client Dwg Number: -



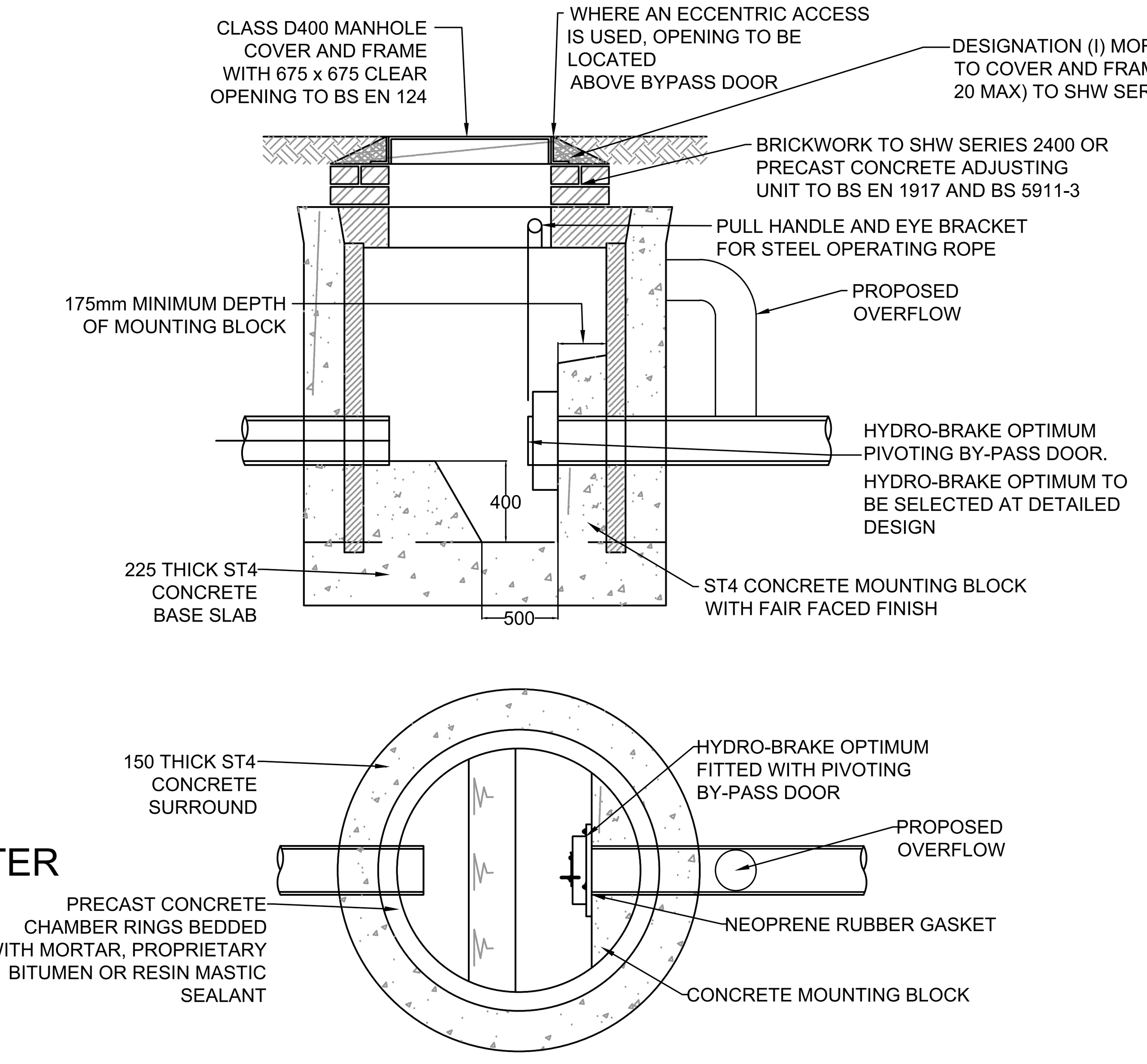
TYPICAL MANHOLE DETAIL - TYPE C

SCALE 1:20



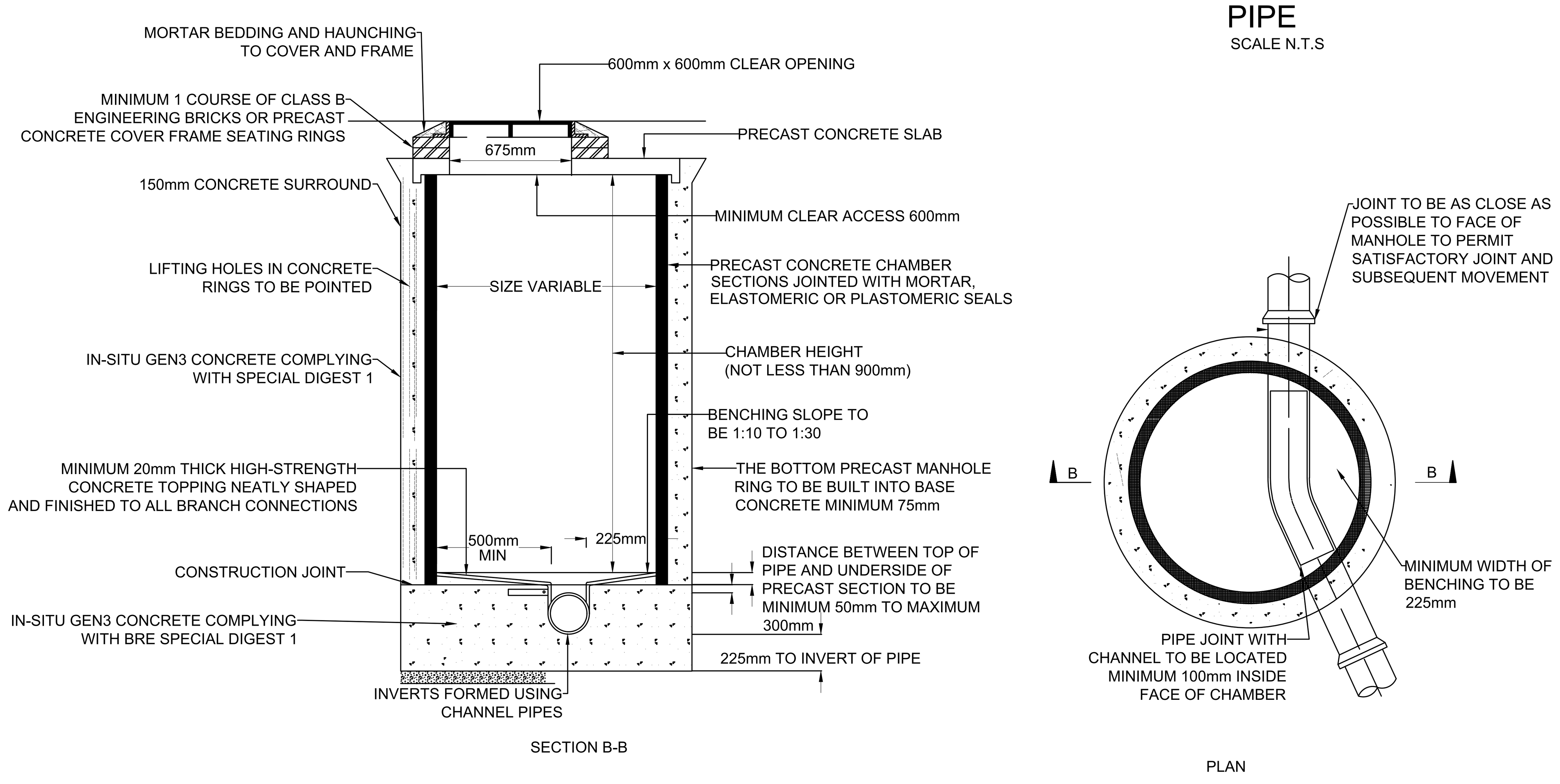
TYPICAL EXTERNAL RAIN WATER PIPE

SCALE N.T.S



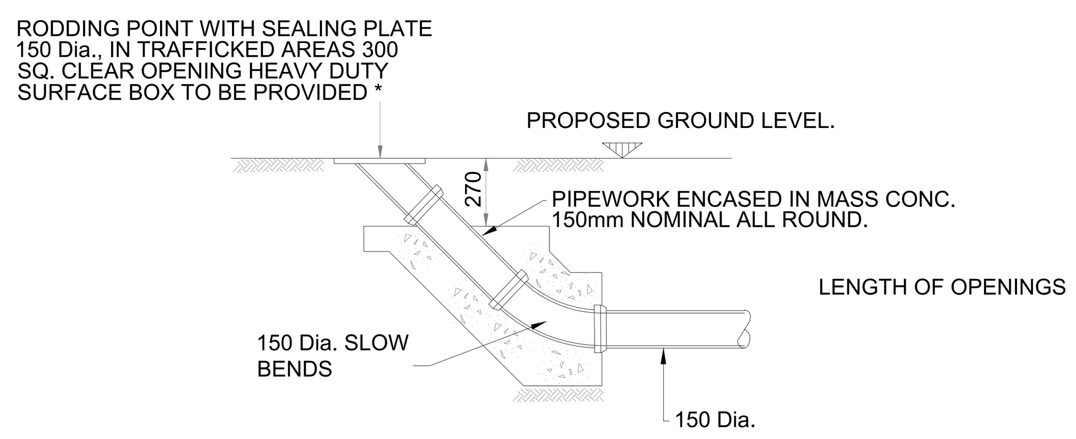
TYPICAL HYDROBRAKE CHAMBER

SCALE 1:20



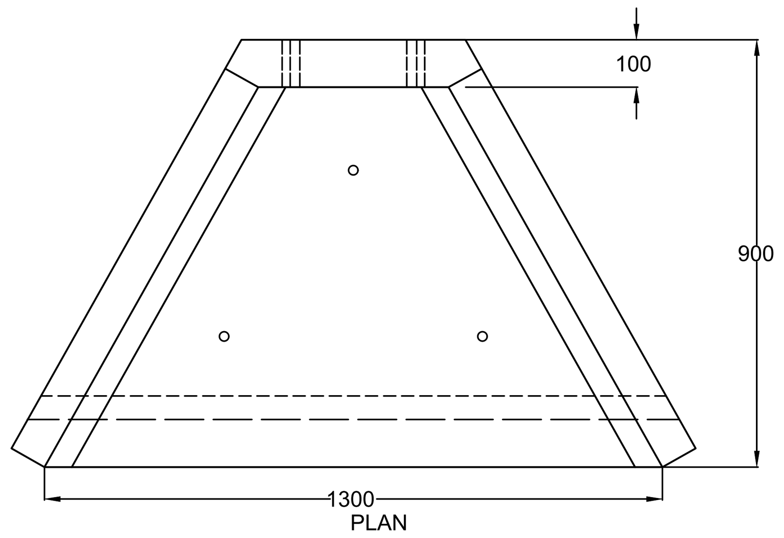
TYPICAL MANHOLE DETAIL - TYPE B

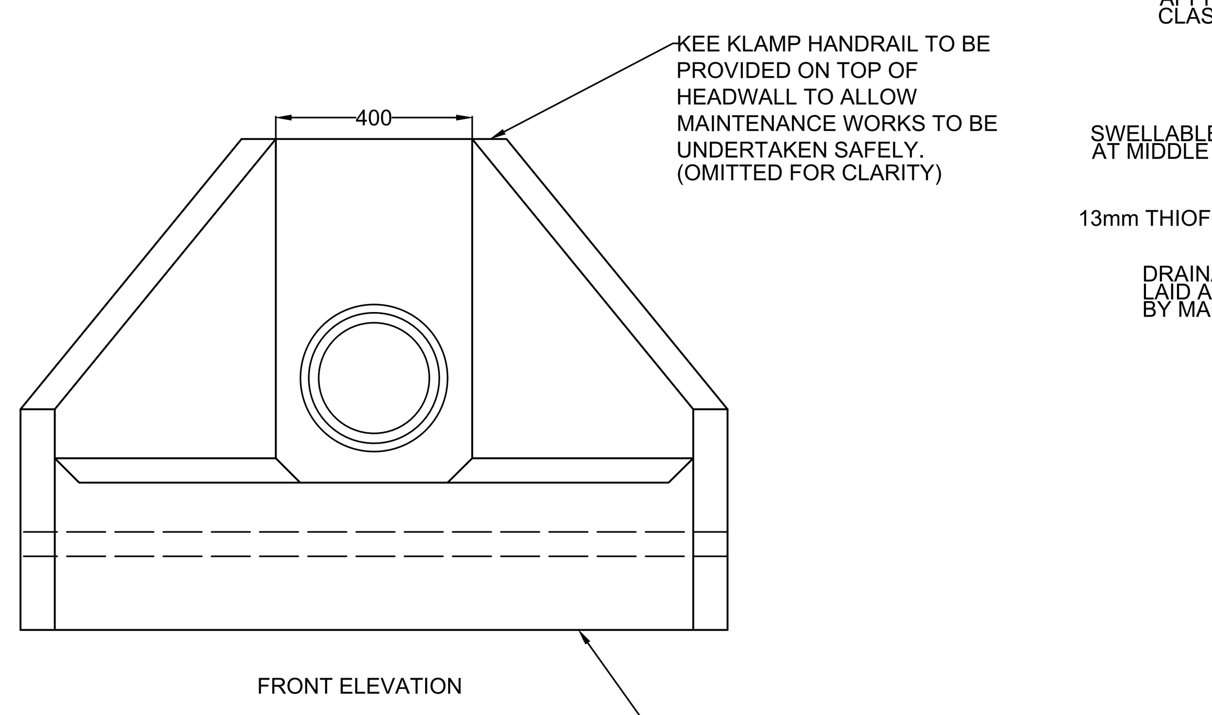
SCALE 1:20



TYPICAL EXTERNAL RODDING EYE (NON-TRAFFICKED AREAS)

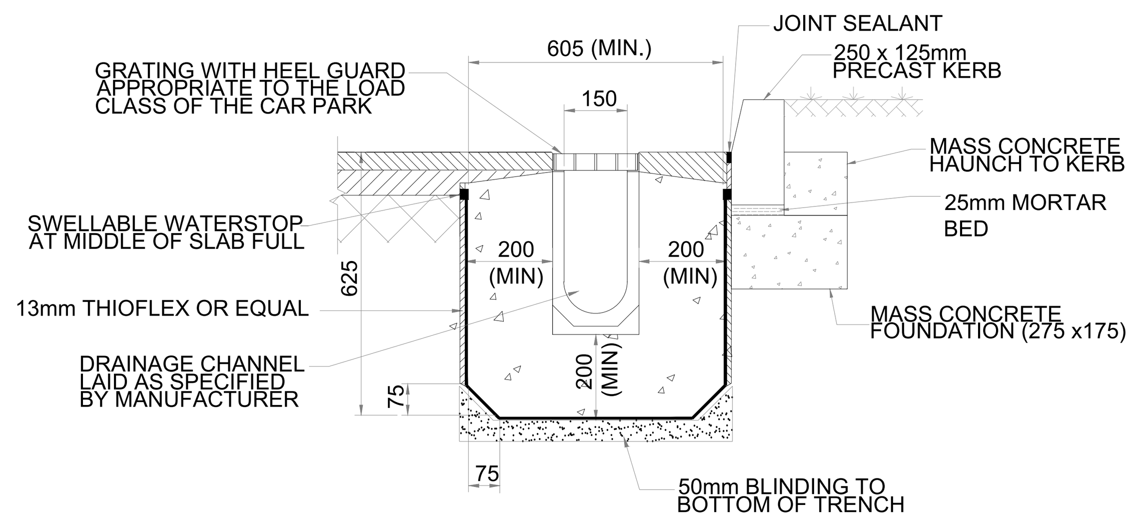
SCALE N.T.S





TYPICAL HEADWALL DETAIL

SCALE N.T.S



TYPICAL SECTION THROUGH 150mm LINEAR DRAINAGE CHANNEL

SCALE N.T.S

400mm 0 400mm 800mm 1200mm 1600mm 2000mm

SCALE 1:20

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN MILLIMETERS. DO NOT SCALE.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWINGS BANN4-LT407-JMS-DRAI-XX-LAY-C-0110 AND BANN4-LT407-JMS-DRAI-XX-DET-C-0111.
3. MANHOLES WITH OUTGOING PIPES GREATER THAN 600mm DIAMETER SHALL BE FITTED WITH GUARD BARS, SAFETY CHAINS OR OTHER SAFETY DEVICES.

REV	DRAWN	CHECKED	APPROVED	DATE
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
P03 (UPDATED FOR COMMENTS)	RH	AC	TCC	02/08/24
P02 (UPDATED FOR COMMENTS)	TS	AGF	TCC	17/05/24
P01 (FOR PHASE 2B PLANNING)	TS	AGF	TCC	15/04/24

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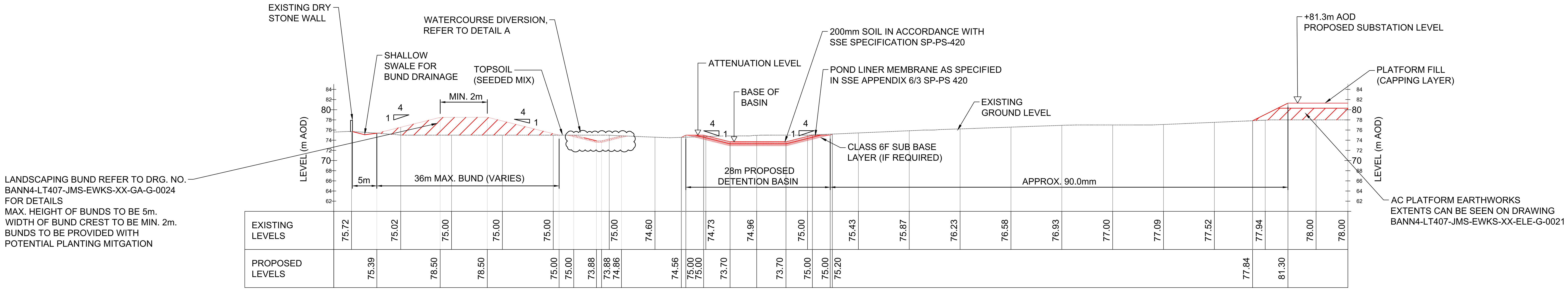
Tony Gee — TONY GEE AND PARTNERS LLP, 4TH FLOOR, ARTHUR HOUSE, MANCHESTER M1 3FH

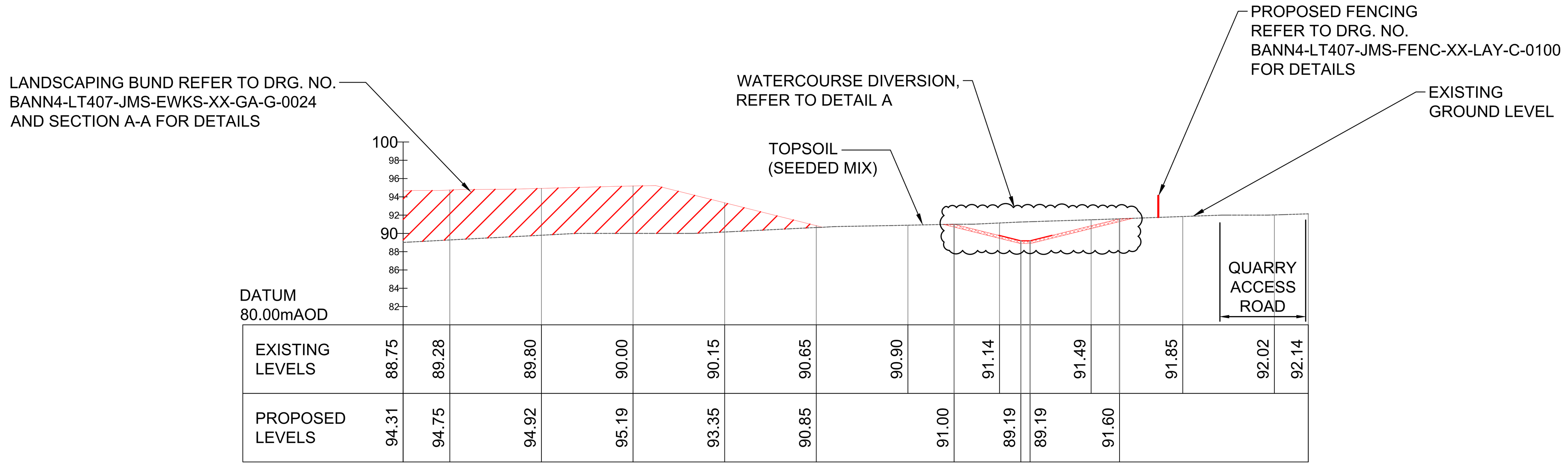
Scottish & Southern Electricity Networks — SCOTTISH AND SOUTHERN ELECTRICITY NETWORK, 1 WATERLOO ST, GLASGOW G2 6AY

Project:	BANNISKIRK 400kV SUBSTATION
Scheme:	
Site:	LT407 BANNISKIRK 400kV SUBSTATION
Circuit:	COMMON
Revision:	P03
Suitability:	S5
Dwg Title:	DRAINAGE TYPICAL DETAILS SHEET 2 OF 2
Scale @ A1:	AS SHOWN
Dwg No:	BANN4-LT407-JMS-DRAI-XX-DET-C-0112
Sheets:	1 OF 1
Purpose of Issue:	ISSUED FOR PLANNING
Internal Proj.Ref:	M123015
Client Dwg Number:	-



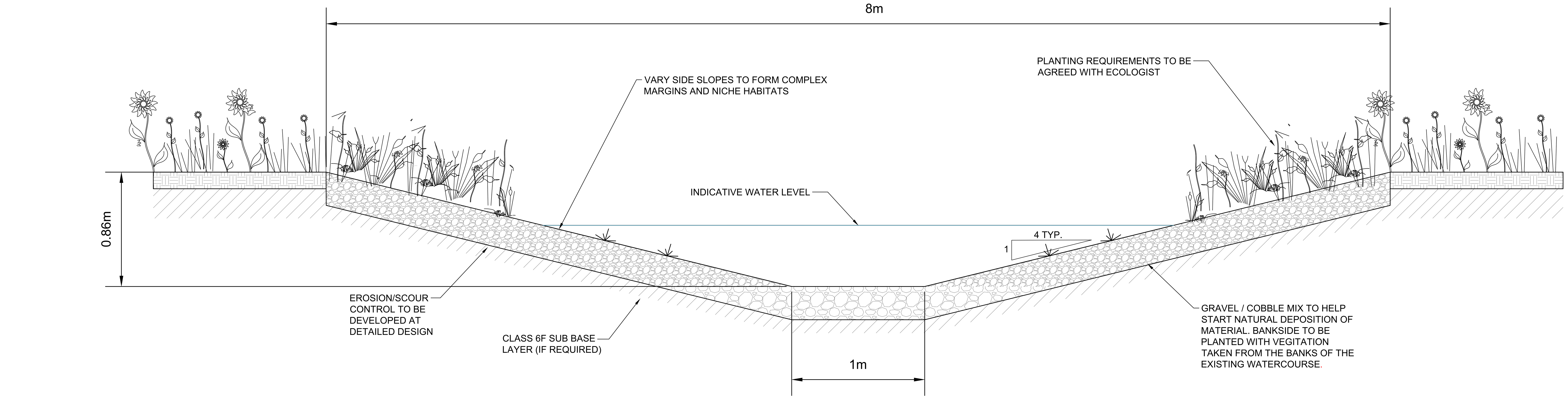
SECTION A - A

SCALE 1:500



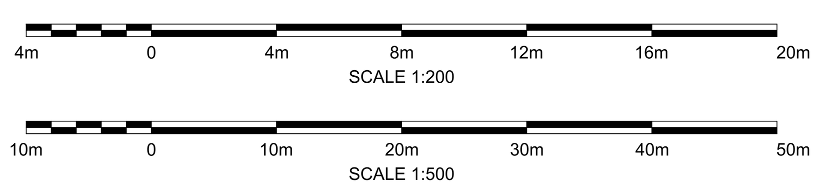
SECTION B - B

SCALE 1:500



DETAIL A - TYPICAL WATERCOURSE SECTION

SCALE 1:200



GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METERS. DO NOT SCALE.
2. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH DRAWING BANN4-LT407-JMS-DRAI-XX-LAY-C-0110.
3. THE WATERCOURSE DIVERSION IS SHOWN INDICATIVELY TO SHOW LOCATION. DETAILS ARE TO BE CONFIRMED BY SSEN AND ERM.
4. ALL LEVELS TO BE CHECKED ON SITE PRIOR TO COMMENCEMENT OF ANY WORKS.
5. DIVERTED FLOOD CHANNEL ALIGNMENT AND SIZE TO BE CONFIRMED AT DETAILED DESIGN STAGE.
6. UPSTREAM FLOOD CHARACTERISTICS TO BE REVIEWED AT DETAILED DESIGN STAGE TAKING CONSIDERATION OF EXISTING CULVERT, FLOOD CONTROL OR RETENTION SYSTEMS.
7. SOFT ENGINEERING SOLUTIONS TO BE CONFIRMED BY ECOLOGICAL CONSULTANT AT DETAILED DESIGN STAGE.

REV	DRAWN	CHECKED	APPROVED	DATE
-	-	-	-	-
P05 (UPDATED FOR PLANNING)	SK	AHC	RP	07/08/24
P04 (UPDATED FOR COMMENTS)	OJ	AHC	TCC	28/06/24
P03 (UPDATED FOR COMMENTS)	AHC	AHC	TCC	14/06/24
P02 (UPDATED FOR COMMENTS)	AGF	AGF	TCC	17/05/24
P01 (FOR PHASE 2B PLANNING)	HT	AC	TCC	17/04/24

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Scottish & Southern Electricity Networks
SCOTTISH AND SOUTHERN ELECTRICITY NETWORK
1 WATERLOO ST, GLASGOW G2 6AY

Project: BANNISKIRK 400kV SUBSTATION
Scheme:
Site: LT407 BANNISKIRK 400kV SUBSTATION
Circuit: COMMON
Revision: P05
Dwg Title: DRAINAGE WATERCOURSE DIVERSION DETAILS
Suitability: S5
Scale @ A1: AS SHOWN
Dwg No: BANN4-LT407-JMS-DRAI-XX-DET-C-0113
Sheets: 1 OF 1
Purpose of Issue: ISSUED FOR PLANNING
Internal Proj.Ref: M123015
Client Dwg Number: -

50m 0 50m 100m 150m 200m 250m
SCALE 1:2500

PLAN
SCALE 1:2500

GENERAL NOTES:

1. ALL DIMENSIONS ARE IN METERS. DO NOT SCALE.
2. THIS DRAWING SHOULD BE READ IN CONJUNCTION WITH DRAWING BANN4-LT407-JMS-DRAI-XX-DET-C-0111, 0112 AND 0113.
3. REFER TO DRG. NO. BANN4-LT407-JMS-ZZ-ZZ-GA-C-0010 FOR SUBSTATION OVERVIEW.
4. THIS SUBMISSION PROVIDES SUITABLE OUTFALL LOCATIONS FOR THE HVDC INTERNAL SUBSTATION DRAINAGE. THE HVDC SUBSTATION OUTFALLS PROVIDED FOR FORMATION RUNOFF AND FOUL WATER ASSUMES THAT THE PLATFORM IS IMPERMEABLE ACROSS ITS EXTENT. THIS PROVIDES A CONSERVATIVE APPROACH TO DRAINAGE DESIGN.
5. DETENTION BASINS TO PROVIDE TREAMENT AND ATTENUATION OF SURFACE RUNOFF FROM SUBSTATION COMPOUND AND ASSOCIATED EARTHWORKS.
6. THE DETENTION BASINS ARE SIZED TO ATTENUATE THE RUNOFF FROM THE PROPOSED PLATFORM CATCHMENT AND ASSOCIATED EARTHWORKS. THE CONTRIBUTING CATCHMENTS FOR EACH DETENTION BASIN ARE:
   DETENTION BASIN 01 = 2.57 ha (HVDC PLATFORM), 0.8 ha (DEPOT) AND.5 ha (ACCESS ROAD)
   DETENTION BASIN 02 = 2.82 ha (AC PLATFORM)
7. DETENTION BASIN SURFACE AREAS ARE APPROXIMATELY:
   DETENTION BASIN 01 = 4500m²
   DETENTION BASIN 02 = 3181m²
8. FOR LANDSCAPED BUNDED AREAS REFER TO DRG. NO.BANN4-LT407-JMS-EWKS-XX-GA-G-0024 FOR DETAILS

LEGEND:

- RED LINE BOUNDARY
- EXISTING WATERCOURSE
- PROPOSED CARRIER DRAIN & MANHOLE
- PROPOSED FILTER DRAIN
- PROPOSED SWALE
- PROPOSED SHALLOW SWALE
- PROPOSED ACO DRAIN
- PROPOSED OILY WATER DRAIN
- PROPOSED FOUL DRAIN
- OHL UTILITY
- DETENTION BASIN
- CONCRETE REFUELLING HARDSTANDING
- AREA OF PROPOSED IMPERMEABLE INFRASTRUCTURE
- PROPOSED DEVELOPMENT
- AREA OF PROPOSED PERMEABLE GRANULAR FORMATION
- BUNDED LANDSCAPED AREAS (REFER TO NOTE 10)
- PROPOSED CLEAN WATER CUT-OFF DITCH
- PROPOSED CARRIER PIPE (NON ATTENUATING)
- PROPOSED CULVERT HEADWALLS
- INDICATIVE WATERCOURSE CHANNEL
- INDICATIVE WATERCOURSE CUT EXTENTS

REV	DRAWN	CHECKED	APPROVED	DATE
-	-	-	-	-
P05 (UPDATED FOR COMMENTS)	RH	AC	RP	13/08/24
P04 (UPDATED FOR COMMENTS)	RH	AC	TCC	28/06/24
P03 (UPDATED FOR COMMENTS)	RH	AC	TCC	14/06/24
P02 (UPDATED FOR COMMENTS)	TS	AGF	TCC	17/05/24
P01 (FOR PHASE 2B PLANNING)	HT	AC	TCC	16/04/24

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Scottish & Southern Electricity Networks
SCOTTISH AND SOUTHERN ELECTRICITY NETWORK
1 WATERLOO ST, GLASGOW G2 6AY

Project:	BANNISKIRK 400kV SUBSTATION
Scheme:	
Site:	LT407 BANNISKIRK 400kV SUBSTATION
Circuit:	COMMON
Revision:	P05
Dwg Title:	OPERATIONAL PHASE DRAINAGE LAYOUT
Suitability:	S5
Scale @ A1:	1:1250
Dwg No:	BANN4-LT407-JMS-DRAI-XX-LAY-C-0110
Sheets:	1 OF 1
Purpose of Issue:	ISSUED FOR PLANNING
Internal Proj.Ref:	M123015
Client Dwg Number:	-