Flood Risk Screening and Drainage Management Plan

Bishops Dal Storage

Ref	05389-8396970

Revision History

Issue	Date	Name	Latest changes
01	05/12/2024	Antonis Poulakis	First Created
02	10/12/2024	Antonis Poulakis	Minor text amendments
03	18/12/2024	Antonis Poulakis	Minor text amendments

Contents

1 Introduction

This report sets out the flood risk screening and drainage management plan for the Bishops Dal BESS which will house battery storage enclosures along with associated infrastructure and electrical equipment.

The battery storage system comprises battery storage enclosures with associated power conversion systems, transformers and grid compliance equipment. All electrical equipment foundation will be determined after site investigation.

Drawing 05389-RES-LAY-DR-PT-001 included in Appendix A, shows the proposed project layout. The compound area within the fence including the DNO substation area measures 2.35 hectares, the total area enclosed by the red line boundary measures 13.20 hectares.

2 Relevant Guidance and Legislation Requirements

This report uses best practice and conforms with the requirements of the relevant regulatory authorities.

The key legislation and guidance adhered to are as follows:

- Scottish Borders Council Local Development Plan (2024).
- Flood Risk Management (Scotland) Act (2009).
- National Planning Framework (NPF) 4.
- Planning Advice Note on Flooding (2015).
- The Sustainable Urban Drainage Scottish Working Party (SUDSWP) Water Assessment and Drainage Assessment Guide.
- Delivering Sustainable Flood Risk Management (Scottish Government) (2019).
- SEPA Guidance for Pollution Prevention (GPPs).
- Control of Water Pollution on Construction Sites, CIRIA C532.
- The SUDS Manual 2015. CIRIA C753.
- Climate Change Allowances for Flood Risk Assessment in Land use Planning, SEPA, Version 5, August 2024.

3 Existing Information

3.1 Site Location

The proposed site sits on an agricultural land, adjacent to the A697 and sits approximately 5 km northwest of Coldstream and opposite Eccles Substation.

Refer to Appendix A for the Site Location Plan.

Access will be taken off A697 to the north of the proposed BESS compound area.

3.2 Existing Land Use and Topography

A walkover survey of the site has been conducted, accompanied by a topographical survey covering the site extents to verify the existing land use and topographical features. The current land use of the site has been confirmed as arable agricultural land, as noted during discussions with the landowner during the site walkover.

The topographical survey indicates that the site exhibits a gentle slope, with an average gradient of approximately 1.5% descending from southeast to northwest. Notably, steeper gradient zones ranging between 5% and 11% are found along the northwest and southwest boundaries. The elevation across the site varies, with the highest point at 55 metres Above Ordnance Datum (AOD) located in the northeast corner, and the lowest point at 45 metres AOD in the southwest corner. The designated area for the proposed BESS compound area features a maximum gradient of approximately 1%.

The commissioned topographical survey also includes the section of the A697 Road and the field extents necessary for the proposed development. The topographical survey is included in Appendix B.

3.3 Ground Conditions

A review of the bedrock geology from the BGS website shows the entire site sits within the Ballagan Formation which consists of sandstone, siltstone and dolomitic limestone as indicated in green colour in Figure 1.

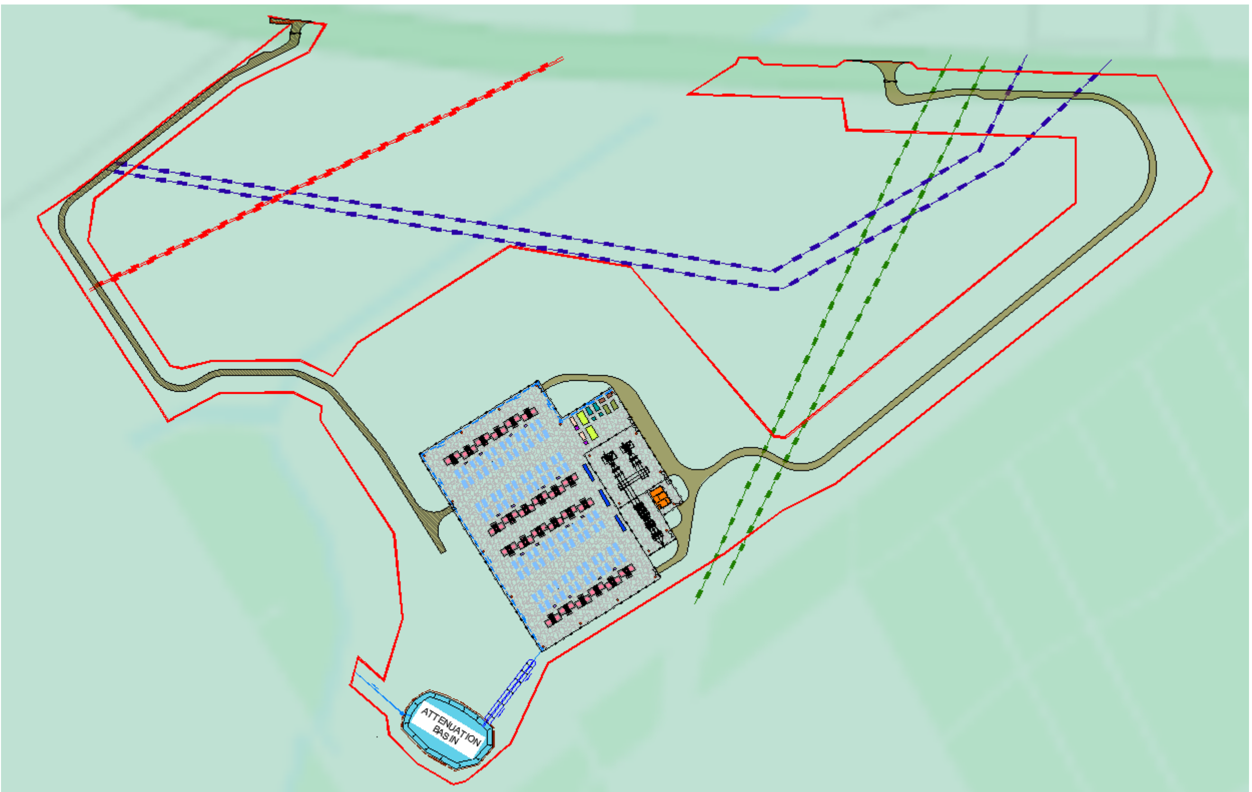


Figure 1: Bedrock geology with proposed development and site boundary overlaid

A review of the superficial deposits from the BGS website shows a Till, Devensian – Diamicton (cyan colour), interspersed with alluvial deposits consist of sands and gravels (brown colour) as indicated in Figure 2.

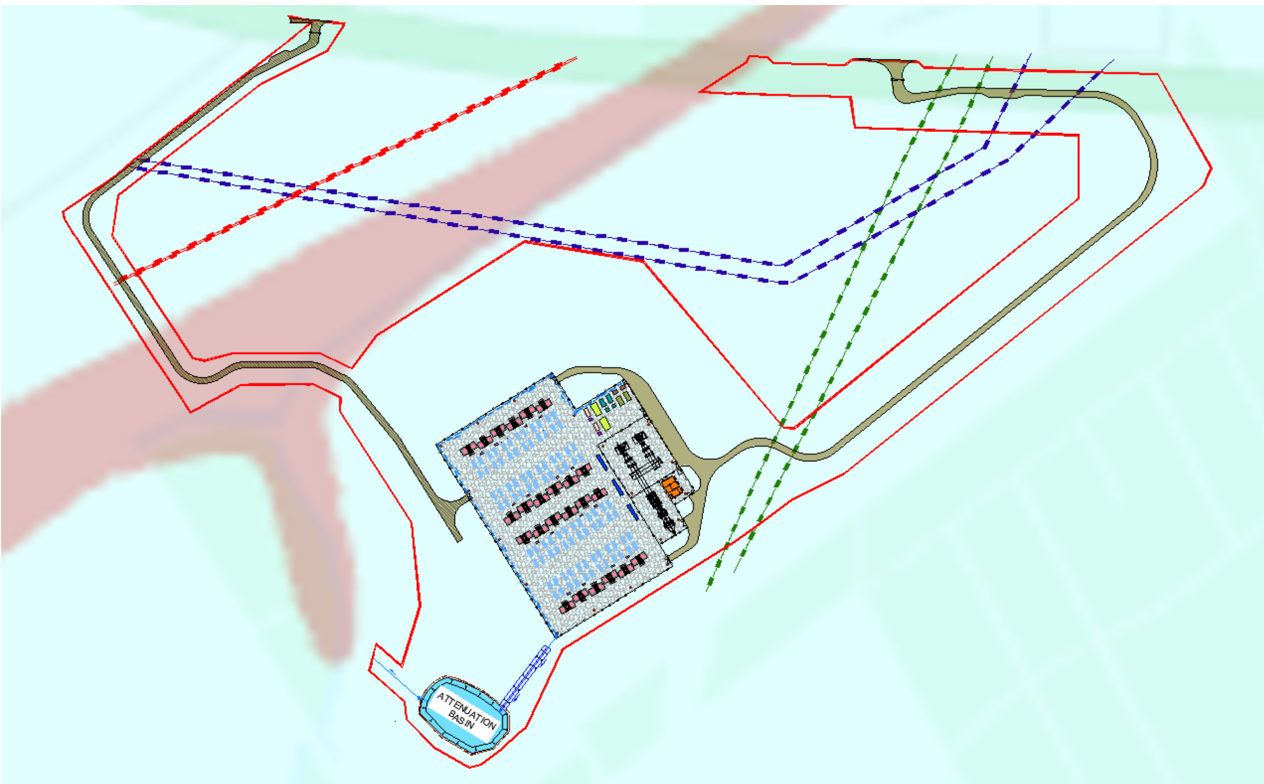


Figure 2: Superficial deposits with proposed development and site boundary overlaid

3.4 Existing Hydrology / Drainage

The field drains into an unnamed ditch which runs alongside the western and northern boundaries. This drainage ditch drains into Wallace's Crook which flows in an easterly direction becoming Liththillum Burn. The Liththillum Burn drains into River Tweed which lies approximately 2.5km south of the site.

The review of British Geological Borehole Survey data was undertaken to better understand groundwater level in the area. However, no boreholes were found within the vicinity of the Site. The nearest borehole data was found 1.3 km from the northwest of the site next to the A697. At this location a 3 m deep borehole was excavated, and no groundwater was encountered.

A site visit was conducted in December 2023. The prior day, a mild rainfall event occurred. There was no water ponding observed in the field, suggesting that the ground on site might have infiltration potential.

The existing drainage strategy of the field includes underground land drains as described through discussions with the landowner.

The existing watercourses are shown in Figure 3 below with blue continuous line.

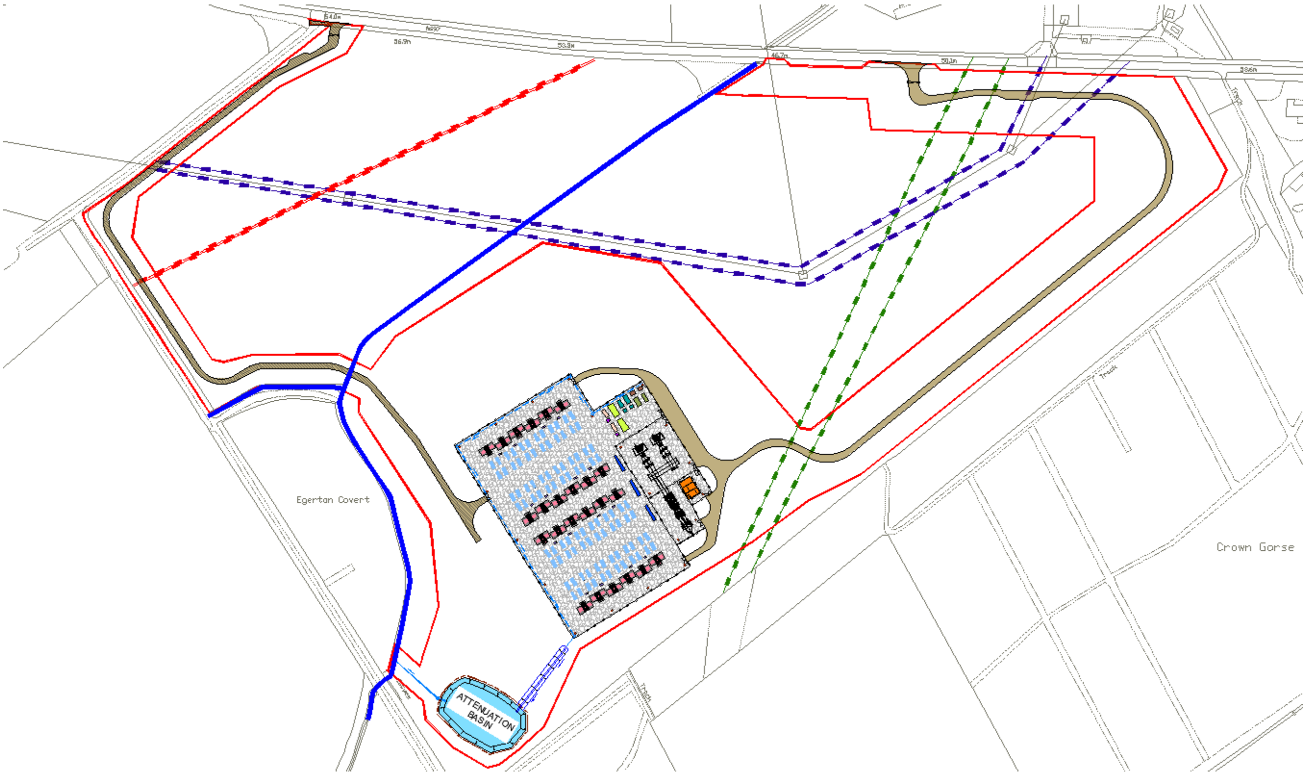


Figure 3: OS mapping including watercourses, with proposed development and site boundary overlaid

4 Flood Risk Screening

4.1 Overview

The proposed development is deemed not to be at risk from flooding with appropriate mitigation measures as set out in this flood screening section.

4.2 Flooding from Fluvial and Surface Water Sources

Figure 4 and Figure 5 below depicts the SEPA flood risk mapping from fluvial and from surface water sources respectively, with the proposed BESS compound and site red line boundary overlaid. As can be observed in Figure 4 and Figure 5 the proposed BESS compound does not lie in an area at risk of flooding from fluvial or from surface water sources (blue zones and purple zones respectively). The proposed secondary access track crosses a small pocket that appears to be in a high flood risk zone associated with an existing watercourse that will require culverting.

Although this small area of flooding has been identified along the secondary access track, access / egress from the site could still be achieved from the primary access track and the likelihood of desiring use of the secondary access at the same time as a flood event is considered very low. Therefore, flooding in this zone is acceptable in high return period events. The proposed culvert will be designed to not increase flood risk. Preliminary sizing for the culvert has been included in Sections 6 and 7 of this report.

There will be some level of track build up to achieve sufficient cover levels for the culvert crossing, so flood alleviation pipes will be used where necessary to avoid surcharge flows against the tracks in extreme flood events.

Flood compensation at the watercourse crossing as a result of the culvert crossing, if required, will be minimal given the extents of track within the flood zone and the partial permeability of the track construction. This provision, if required, will be incorporated at detailed design.

The proposed development is therefore not considered at risk of fluvial and surface water flooding with appropriate mitigations in place at the proposed culvert crossing.

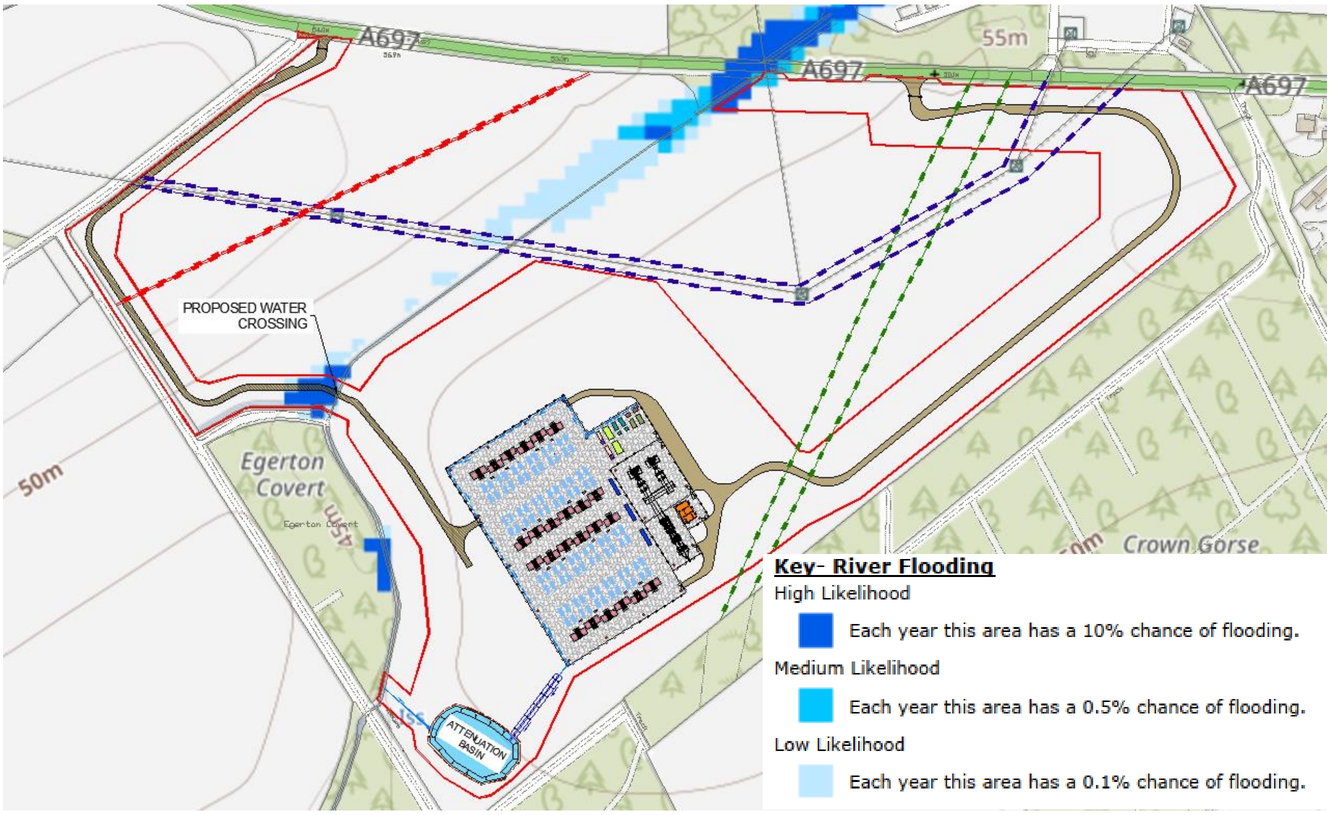


Figure 4 - Excerpt from SEPA fluvial flood risk map, with proposed development and site boundary overlaid.

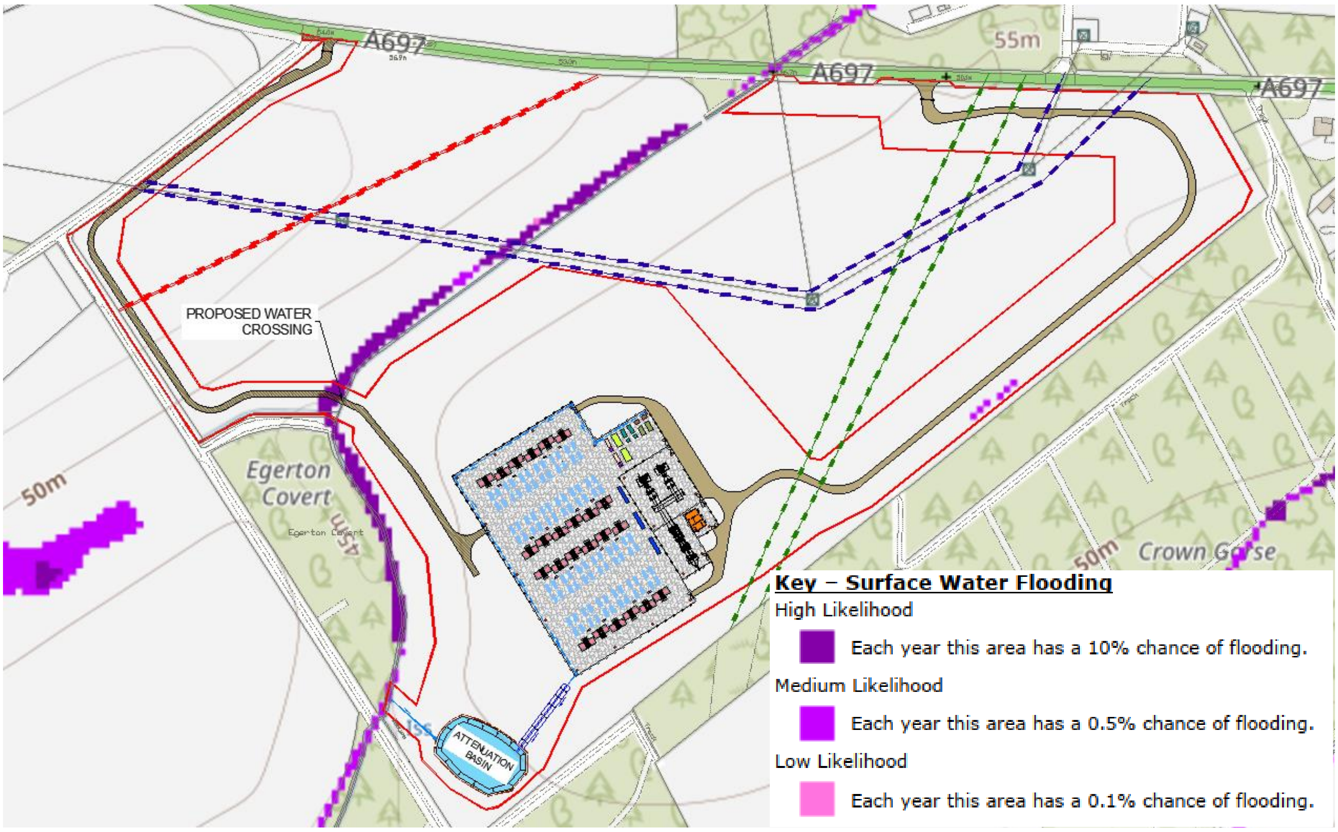


Figure 5 - Excerpt from SEPA surface flood risk map, with proposed development and site boundary overlaid.

4.3 Flooding from Groundwater

As described in section 3.4, the British Geological Borehole Survey data was checked for information relating to previous boreholes discovering shallow groundwater in the area. No boreholes were found within the vicinity of the site; however, the 1m depth pits that were excavated during infiltration test did not encounter any groundwater. The nearest borehole data was found 1.3 km from the northwest of the site next to the A697. At this location a 3 m deep borehole was excavated, and no groundwater was encountered.

Furthermore, SEPA flood maps do not indicate that groundwater will affect flood within site extents. Should any groundwater come to the surface it is expected to following existing flow paths.

Therefore, the proposed development site lies in an area with a low risk of groundwater flooding and is not considered a risk to the project.

4.4 Flooding from Tidal or Sea Flooding

The development site is located outside of any area of tidal influence based on its ground elevation above ordnance datum of >50m AOD. The proposed development is therefore not considered at risk of tidal or sea flooding.

4.5 Flooding from Overland Sheet Flow

An existing watercourse along the northwestern boundary of the site, intercepts any potential sheet flow running off the fields from the higher ground to the west of the site. The proposed development is therefore not considered at risk of flooding from overland sheet flow.

4.6 Flooding from Sewers and Highway Drains

The nearest highway drain is located along the A697 north of the site boundary. The highway is situated lower than the proposed development. Therefore, the highway drains would not pose any flood risk to the proposed development.

4.7 Flooding as a Result of the Development

The proposed BESS compound is not considered to exacerbate the flood risk of the surrounding area as runoff rates and volumes will not exceed the greenfield conditions as discussed in sections 6 & 7.

4.8 Historic Flooding

There are no known records of historic flooding to the knowledge of the Landowner.

5 Foul Drainage Strategy

There is no planned permanent foul drainage from the proposed development.

Any foul drainage from the temporary welfare facilities will be self-contained and disposed off-site appropriately.

At the temporary construction compound, welfare facilities will comprise self-contained chemical toilets and additional foul drainage facilities (i.e. sinks). The temporary drainage facilities will be removed on completion of construction.

6 Surface Water Drainage Strategy

6.1 General

The SuDS Hierarchy as included in the SuDS Manual will be applied and is described below:

- Discharge to soakaway or other infiltration system.
- Discharge to existing watercourse.
- Discharge to a surface water sewer, highway drain or another drainage system.
- Discharge to a combined sewer.

The surface water drainage design will ensure that the following requirements of policy for flooding (IS8),Sustainable Urban Drainage (IS9) included in Scottish Borders Council Local Development Plan (2024) and Policy 22 of NPF4 are met.

Policy IS8: Flooding

At all times, avoidance will be the first principle of managing flood risk. In general terms, new developments should therefore be located in areas free from significant flood risk. Development will not be permitted if it would be at significant risk of flooding from any source or would materially increase the probability of flooding elsewhere.

Within certain defined risk categories, particularly where the risk is greater than 0.5% annual flooding probability or 1 in 200 year flood risk, some forms of development will generally not be acceptable.

Developers will be required to provide, including if necessary, at planning permission inf principle stage:

a. A competent flood risk assessment, including all sources of flooding, and taking account of climate change, using the most up to date guidance; and

b. A report of the measures that are proposed to mitigate the flood risk.

The information used to assess the acceptability of development will include:

a. Information and advice from consultation with the Council's Flood Risk and Coastal Management Team and the Scottish Environment Protection Agency;

b. Flood risk maps provided by the Scottish Environment Protection Agency and/or developed by Scottish Borders Council which indicate the extent of the flood plain;

c. Historical records and flood studies/assessments held by the Council and other agencies when possible;

d. The Scottish Environment Protection Agency's Land Use Vulnerability Guidance.

Policy IS9: Sustainable Urban Drainage

Surface water management for new development, for both greenfield and brownfield sites, must comply with current best practice on sustainable urban drainage systems to the satisfaction of the council, Scottish Environment Protection Agency (where required), Scottish Natural Heritage (now NatureScot) and other interested parties where required. Development will be refused unless surface water treatment is dealt with in a sustainable manner that avoids flooding, pollution, extensive canalisation and culverting of watercourses. A drainage strategy should be submitted with planning applications to include treatment and flood attenuation measures and details for long term maintenance of necessary features.

NPF4 - Policy 22

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

i. *essential infrastructure where the location is required for operational reasons;*

ii. *water compatible uses;*

iii. *redevelopment of an existing building or site for an equal or less vulnerable use; or.*

iv. *redevelopment of previously used sites in built up areas where the LDP has identified a need to bring these into positive use and where proposals demonstrate that long-term safety and resilience can be secured in accordance with relevant SEPA advice.*

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

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

- *all risks of flooding are understood and addressed;*
- *there is no reduction in floodplain capacity, increased risk for others, or a need for future flood protection schemes;*
- *the development remains safe and operational during floods;*
- *flood resistant and resilient materials and construction methods are used; and*
- *future adaptations can be made to accommodate the effects of climate change.*

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

- *the first occupied/utilised floor, and the underside of the development if relevant, to be above the flood risk level and have an additional allowance for freeboard; and*
- *that the proposal does not create an island of development and that safe access/egress can be achieved.*

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

c) Development proposals will:

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

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

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

6.2 Surface Water Drainage Options

6.2.1 Infiltration

Based on the hierarchy identified in Section 6.1, the preferred method of surface water discharge is via infiltration to the ground. However, infiltration testing within the site boundaries has been conducted to assess the soil's infiltration capacity and the results demonstrate that the soil's infiltration capacity is poor. Therefore, an infiltration solution strategy will not be suitable for the site.

Refer to Appendix C for infiltration and percolation test results.

6.2.2 Attenuate Rainwater in Basin for Gradual Release

Due to the soil's poor infiltration capacity on site, it appears that attenuation basin is the highest option on the SuDS Hierarchy that is viable for the proposed BESS compound development.

The surface water drainage will be designed in accordance with the guidance in Sections 2 and 6.1. Flows will be restricted to Qbar, and the attenuation basin will be sized to contain the 1 in 200 rainfall event plus a 35% allowance for climate change.

The attenuation basin will discharge via an outfall pipe to the small watercourse the runs along the western boundary of the site.

6.3 Proposed Surface Water Management System

6.3.1 Overview

As set out in Section 6.2, an attenuation basin with gradual release strategy has been chosen as the most appropriate surface water management system.

Without the provision of attenuation features, the proposed development will result in an increase in runoff. To ensure the water quantity and volume are suitably managed back to pre-development rates, attenuation and interception will be provided.

Surface water flows will be collected by a series of filter drains, pipes and a swale before discharging into an above ground attenuation basin. Flows discharging out of the attenuation basin will be restricted by means of a flow control device. Restricted flows will discharge to the watercourse, as per the pre-development hydrological regime.

Typically, the access tracks serving the site will be constructed from unbound granular material. Flows will be partially attenuated at source within the tracks and drain into trackside SuDS features, such as swales and filter drains where necessary. Runoff then will filter onto the adjacent soft landscaped areas. As such, the change in flow regime from the existing scenario will be minimal.

The SuDS will be constructed prior to or at the same time as the access tracks and the site compound. Interim measures include the placement of silt fences across the site around areas likely to have runoff with high silt loads (i.e spoil heaps, excavations and engineered fill). Interim measures will be retained in place until after the completion of high silt generating activities (eg track and hardstanding construction) and until the SuDS are established and providing sufficient silt removal.

Refer to Appendix A for the details and layout of the SuDS proposed across the site.

6.3.2 Design Criteria

A surface water drainage system has been designed in accordance with the guidance in Section 2.

Outflows will be restricted to pre-development runoff rates (Qbar) and an attenuation basin will be sized to contain the 1 in 200 (plus a 35% allowance for climate change) rainfall event. The 35% climate change allowance is based on the SEPA peak rainfall allowances mapping.

6.3.3 Exceedance Flow Design

In accordance with CIRIA Report 753 and (SUDSWP) Water Assessment and Drainage Assessment Guide, an exceedance route should be considered as part of the SuDS design.

The exceedance route will remain as per the existing scenario, over vegetation, westwards towards the watercourse adjacent to the proposed BESS compound.

The attenuation basin will be located downslope of the energy storage facility. The site levels will be such that flows from any extreme events will flow over the banks of the attenuation basin and swale, away from the energy storage facility and then downslope overland away from the site. The edges of the attenuation basin will be vegetated to reduce the risk of scour during an extreme event.

6.3.4 Modification to Land Drainage

Where land drainage is encountered during the works, it will be intercepted / diverted where necessary to facilitate the construction of the development.

6.3.5 Water Quality and Treatment

In line with the requirements noted in the Scottish Borders Council Local Development Plan (2024) document listed in Section 2, a Simple Index Approach is undertaken to ensure the proposed drainage strategy provides adequate water quality treatment, as per Section 26.7.1 of the SuDS Manual.

The proposed development is considered a medium pollution hazard level based on land use definitions provided in Table 26.2 of the SUDS Manual. The corresponding pollution hazard indices are denoted in Table 1.

Surface water within the proposed development will receive treatment before being discharged off site. The main stages are listed below:

1. Filtration of water through filter drain stone upstream of basin; mitigation indices for filter drain: TSS = 0.4, metals = 0.4, hydrocarbons = 0.4.

2. Filtration of water through overland swale; mitigation indices for swale: TSS = 0.5, metals = 0.6, hydrocarbons = 0.6.

3. Settlement in attenuation basin; mitigation indices for detention basin: TSS = 0.5, metals = 0.5, hydrocarbons = 0.6.

Table 1 below demonstrates how the pollution hazard index for each contaminant is satisfied by the three stages of water treatment provided as part of the proposed drainage strategy.

Table 1 - Simple Index Calculation

Contaminant Type	Stage 1	Stage 2	Stage 3	Total SUDS Mitigation Index	Pollution Hazard Index	Utilisation (<1 is acceptable)
TSS	0.4	0.5(0.5)=0.25	0.5(0.5)=0.25	0.90	0.70	0.78
Metals	0.4	0.5(0.6)=0.30	0.5(0.5)=0.25	0.95	0.60	0.63
Hydrocarbons	0.4	0.5(0.6)=0.30	0.5(0.6)=0.30	1.00	0.70	0.70

During the construction phase, temporary silts fences will be installed, providing an additional treatment stage of water filtration.

6.3.6 Watercourse Crossing

In accordance with Ciria C786 Culvert Screen and Outfall Manual, a culvert crossing the have been designed beneath the section of secondary access track crossed by an unnamed watercourse. Details on the culvert design can be found in section 7.4.

7 Hydraulic Assessment

7.1 General

Pre-development runoff rates for the development have been estimated using the Flood Estimation Handbook IH124 methodology. The methodology with the lower runoff rate will be used for the design.

Attenuation storage will be provided to accommodate the peak runoff rate calculated up to the critical 1 in 200 year storm event plus a 35% allowance for climate change.

The inputs taken have been assumed as "worst case" and as such has determined the maximum drainage component extents required for the project. This includes assuming all permanent infrastructure (other than the access tracks) has an asphalt surface, and that drainage by infiltration is not possible.

A detailed drainage design will be performed following the ground investigation and compound earthing design (to determine surface finishes).

All methods and inputs are taken in accordance with the relevant guidance documents provided in Section 2.

7.2 Greenfield Peak Runoff Rates from Site

Current and future greenfield runoff rates for the development have been estimated using the lowest run off rate derived by the FEH Statistical Method and IH124 Method. Using the rainfall data from the UK Centre for Ecology & Hydrology and the mapping software within HR Wallingford Design Tool, the site-specific parameters have been established:

- Standard average annual rainfall (SAAR6190): 636mm;
- Standard percentage run-off: 37%;
- M5-60 rainfall depth: 17mm;
- Ratio M5-60 / M5-2day: 0.3.
- Total impermeable area: 2.35ha;

Total drained area is defined as the catchment area for the attenuation basin, which comprises the area inside the compound including the DNO substation area 2.35ha.

The peak runoff rate calculated for a Qbar (1 in 2.3) rainfall event is 6.03 l/s. It is proposed to match this discharge rate through use of a flow control device installed in a manhole positioned immediately downstream of the basin.

Refer to Appendix C for the Qbar calculation summary.

7.3 Attenuation Storage

Attenuation storage will be provided to accommodate the peak runoff rate calculated up to the critical 1 in 200-year event (including 35% allowance for climate change).

As per the calculation described in Section 7.2, allowable discharge from the basin is set to the calculated greenfield runoff rate of 6.03 l/s.

The attenuation volume calculated based on the above criteria is approximately 2,536m^3.

The attenuation basin has been sized to accommodate this volume.

The attenuation volume should be considered a maximum volume, this assumes that the compound has an impermeable asphalt surface and that drainage by infiltration methods is not possible.

Refer to Appendix D for the attenuation storage volume calculation summary.

7.4 Water Channel Crossing Culvert Design

The preliminary water channel crossing culvert design has been designed in accordance with Ciria C786 Culvert Screen and Outfall Manual.

The culvert design criteria uses a 1 in 200 storm with a 35% climate change allowance.

The total upstream catchment area (identified in OS mapping) was defined to inform the peak runoff rates in the watercourse.

A preliminary culvert diameter of 0.75m has been identified, accommodating a peak runoff rate (incl. cc) of 394l/s from a total catchment of 38ha.

Refer to Appendix D for the culvert, catchment area and runoff rate design calculations.

8 Operation and Maintenance Requirements

All surface water drainage and pollution control features associated with the site will remain private and will be maintained by the site operator.

The following section outlines the proposed maintenance for the various aspects of the drainage system. If necessary, these outline maintenance proposals will be refined when the site is operational to suit specific conditions.

8.1 Filter Drain

The anticipated maintenance plan for the filter drains is outlined in Table 2.

Table 2 – Typical Filter Drain Operation and Maintenance Requirements

Filter Drain Maintenance Schedule	
Maintenance Action	**Minimum Frequency**
Inspect manhole / pipe. Where pipe has become clogged with silt, the pipe will be cleared out	Half yearly
Remove litter and debris	Half yearly
Inspect inlets and outlets for blockages, and clear (if required)	Half yearly

8.2 Swale

The anticipated maintenance plan for the swale at the site is outlined in Table 3.

Table 3 - Typical Swale Maintenance Requirements

Swale Maintenance Schedule	
Maintenance Action	**Minimum Frequency**
Inspect swale for silt contamination.	Half yearly
Remove litter and debris.	Half yearly
Cut grass along swale banks.	Half yearly

8.3 Attenuation Basin

The anticipated maintenance plan for the basin at the site is outlined in Table 4.

Table 4 – Typical Basin Operation and Maintenance Requirements

Basin Maintenance Schedule	
Maintenance Action	**Minimum Frequency**
Remove litter and debris	Half yearly
Inspect inlets and outlets for blockages, and clear (if required).	Half yearly
Inspect inlets and outlets for noticeable effects of erosion, suitable erosion protection measures such as reno-mattress or placement of large stones (>150mm) to dissipate water energy levels will be installed at the area affected.	Half yearly
Inspect silt accumulation rates in any forebay and in main body of the pond and establish appropriate removal frequencies	Half yearly
Reseed areas of poor vegetation growth, alter plant types to better suit conditions (if required).	As required, or if bare soil is exposed over 10% or more of the basin treatment area

8.4 Discharge Pipe

The anticipated maintenance plan for the attenuation basin discharge pipe & outfall is outlined in Table 5.

Table 5 – Typical Discharge Pipe Operation and Maintenance Requirements

Discharge Pipe Maintenance Schedule	
Maintenance Action	**Minimum Frequency**
Inspect manhole / pipe. Where pipe has become clogged with silt, the pipe will be cleared out	Half yearly
Remove litter and debris	Half yearly
Inspect inlets and outlets for blockages, and clear (if required)	Half yearly

9 Conclusion

A flood risk assessment has been undertaken across the site. The site has been deemed at low risk of flooding.

An assessment of the drainage options has also been undertaken including infiltration testing and considering that the site soil cannot adequately support an infiltration solution, it has been concluded that drainage by infiltration is not a viable solution. As such, the proposal is to drain the site via an attenuation basin, with a restricted discharge rate to match its existing drainage condition.

The required attenuation volume has been calculated as approximately 2,536m^3. This should be considered a maximum volume, based on the assumption that all permanent infrastructure (other than the access tracks) has an asphalt surface and that drainage by infiltration methods is not possible.

A site investigation, detailed 3D earthworks design, earthing design, and a further assessment of the proposed discharge will be undertaken to inform the detailed design of the site drainage.

A preliminary culvert has also been sized (0.75m) where the secondary access track cross an unnamed watercourse.

The drainage strategy proposed will provide sufficient water quality treatment as demonstrated using the Simple Index Approach.

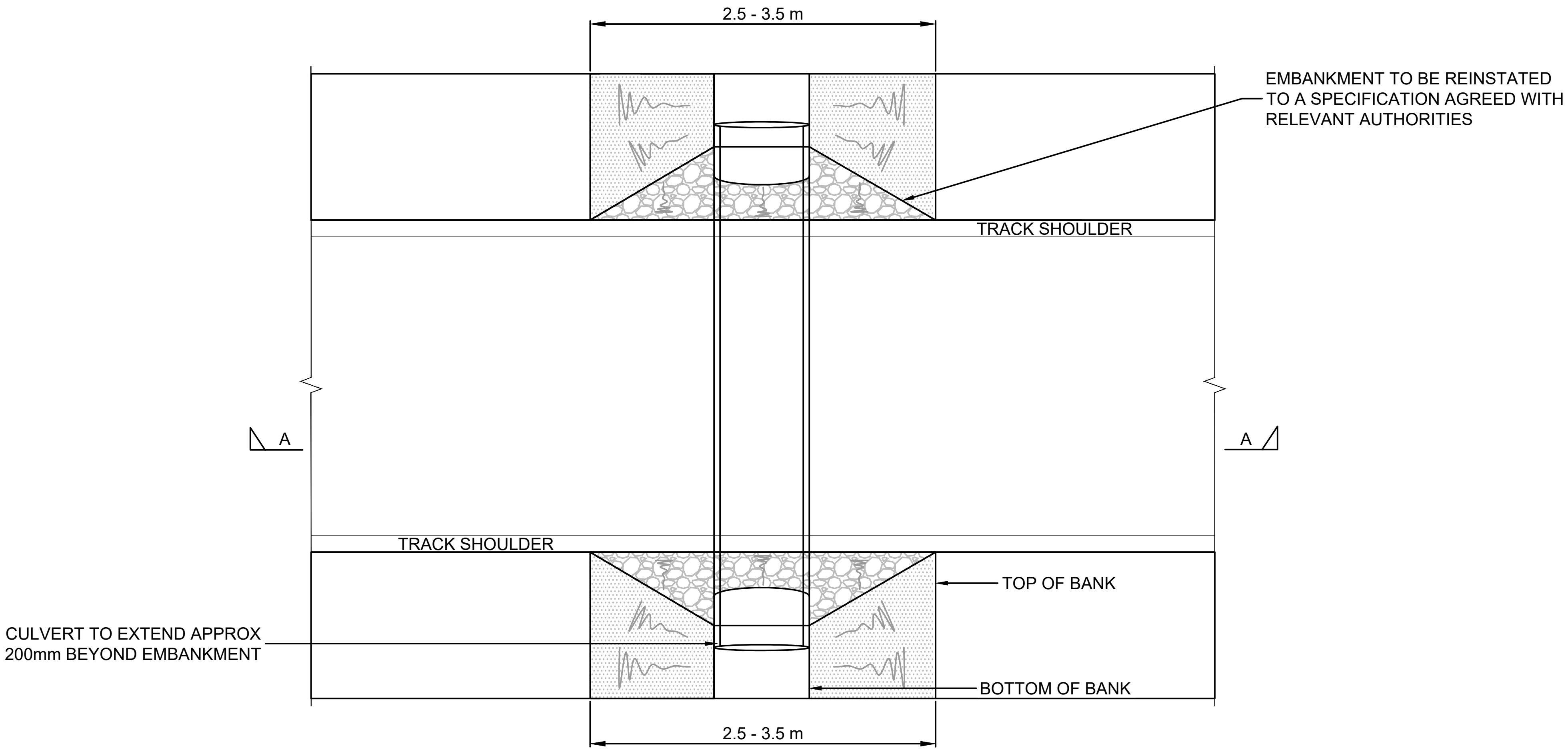
Appendix A Project Drawings

05389-RES-DRN-DR-PT-002.pdf – Typical Water Channel Crossing Culvert

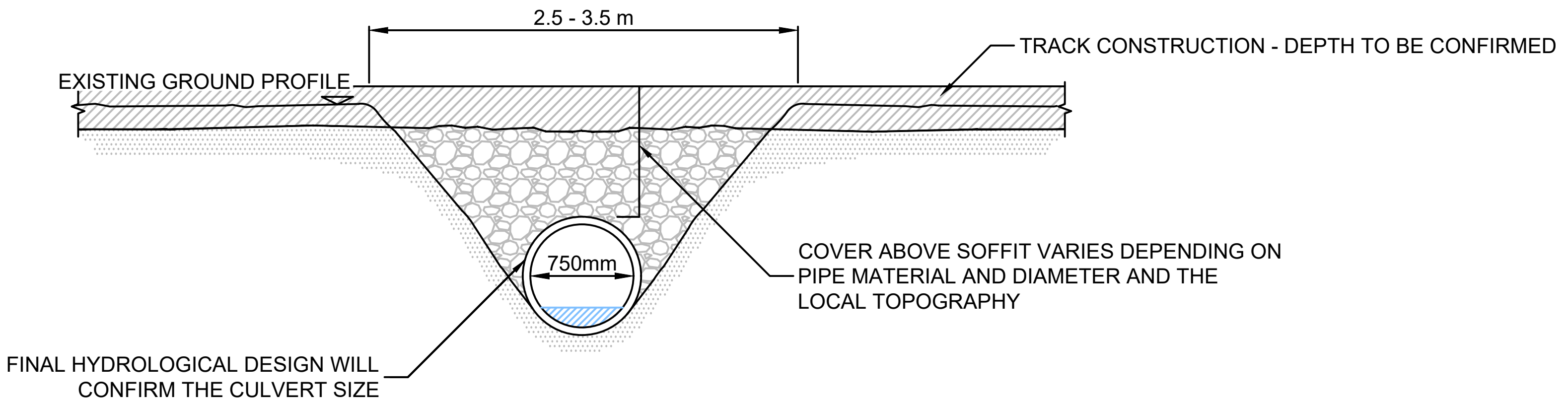
05389-RES-DRN-DR-PT-001.pdf – Typical Drainage Details

05389-RES-LAY-DR-PT-001.pdf – Infrastructure Layout

05389-RES-MAP-DR-XX-002.pdf – Block Plan (Site Boundary)



PLAN



SECTION A-A

NOTES:

1. FINAL SPECIFICATION AND INSTALLATION METHOD TO BE IN ACCORDANCE WITH THE REQUIREMENTS OF THE RELEVANT AUTHORITIES.
2. CULVERT TYPE AND SIZING TO BE CONFIRMED DURING DESIGN OF ON-SITE DRAINAGE SYSTEMS.
3. INFILL MATERIAL TO BE CLEAN CRUSHED ROCK.

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
2	BM	JM	JM	2024-12-12	UPDATED DETAILS AND PURPOSE TO PLANNING
1	BM	AP	VM	2024-06-24	FIRST ISSUE

PURPOSE: PLANNING	COORDINATES: N/A
SCALE: 1:100 @A3	DATUM: N/A
LAYOUT DRAWING: N/A	T-LAYOUT NO: N/A

PROJECT TITLE
BISHOPS DAL STORAGE

DRAWING TITLE
TYPICAL WATER CHANNEL CROSSING CULVERT

RES DRAWING NUMBER	REV
05389-RES-DRN-DR-PT-002	2

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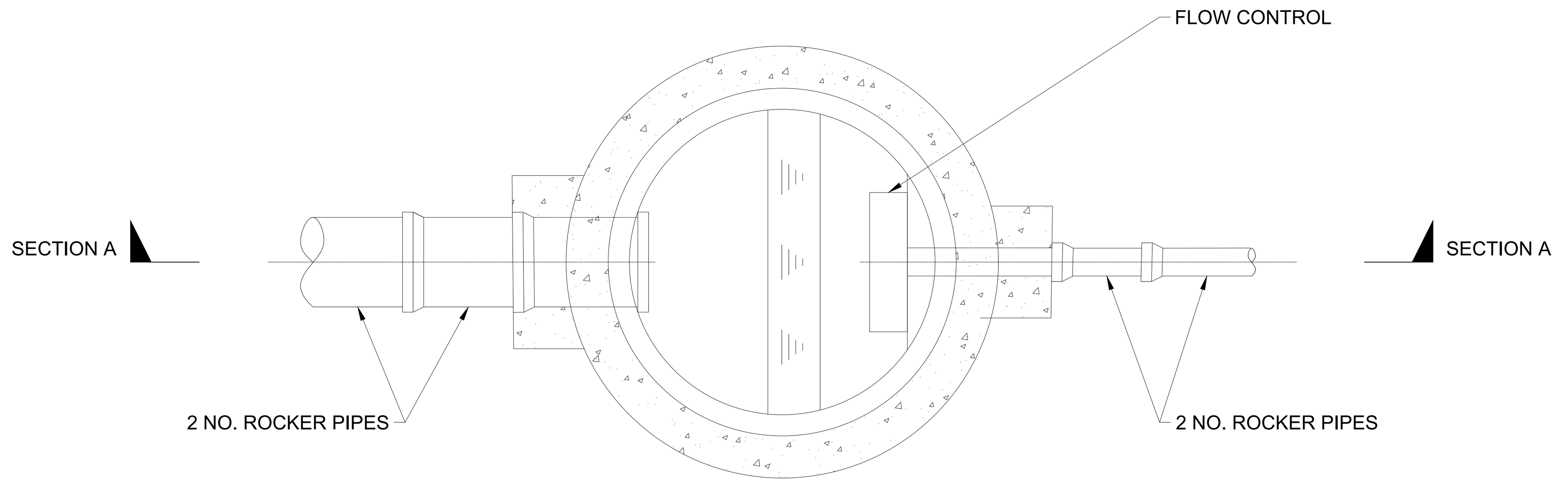
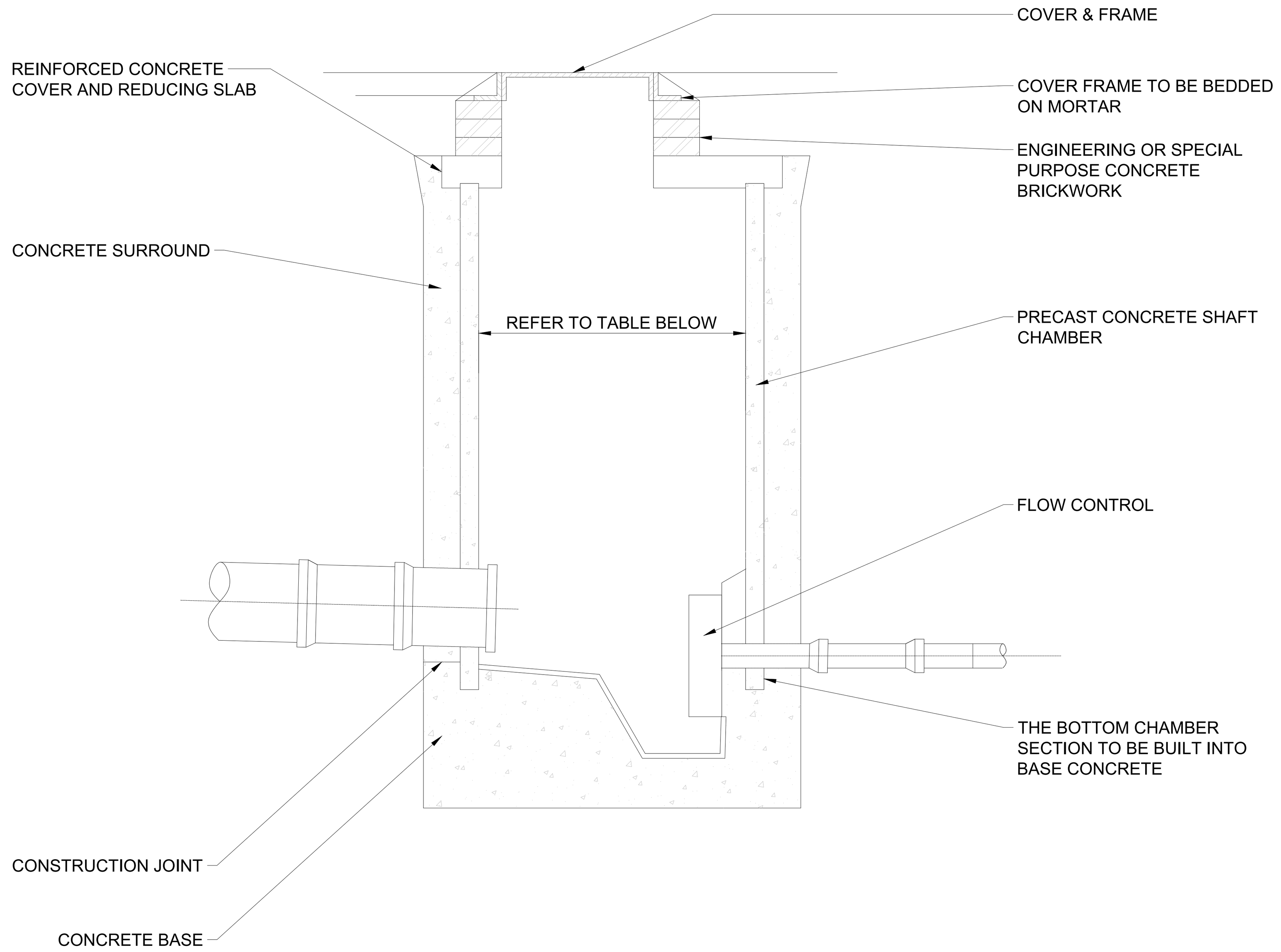
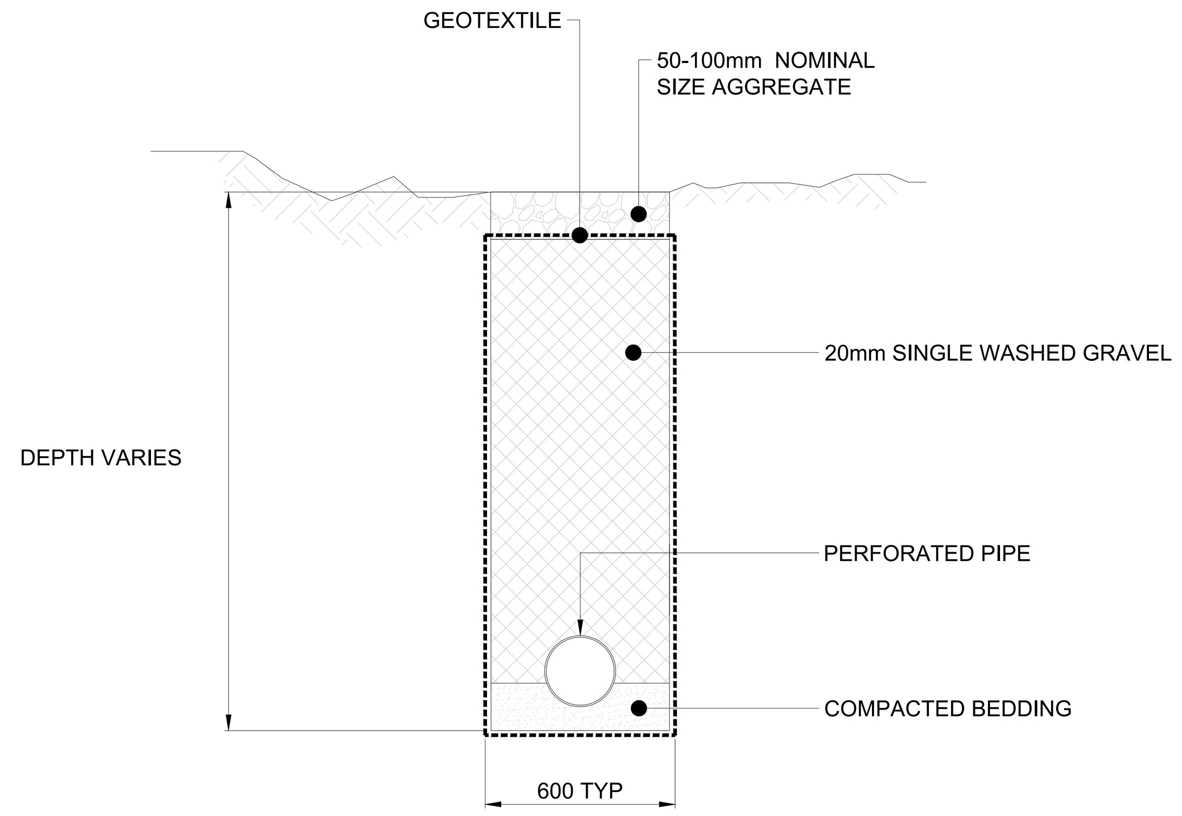


MANHOLE DETAIL WITH
FLOW CONTROL DEVICE
SCALE 1:20

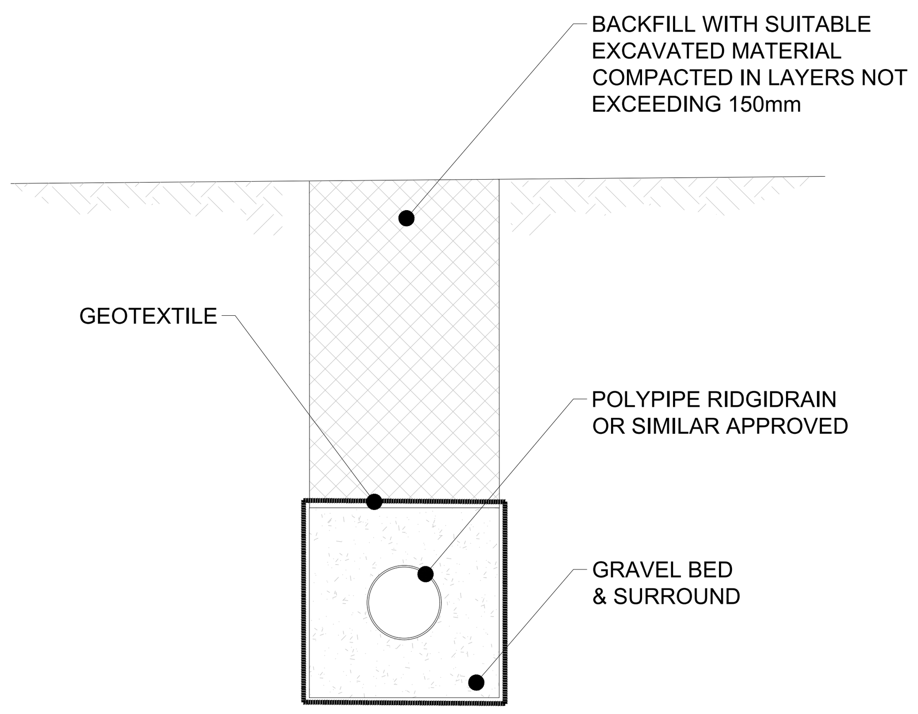
Ø OF LARGEST PIPE IN MANHOLE (mm)	INTERNAL DIAMETER OF MANHOLE (mm)
LESS THAN 375	1200
375 - 700	1500
750 - 900	1800



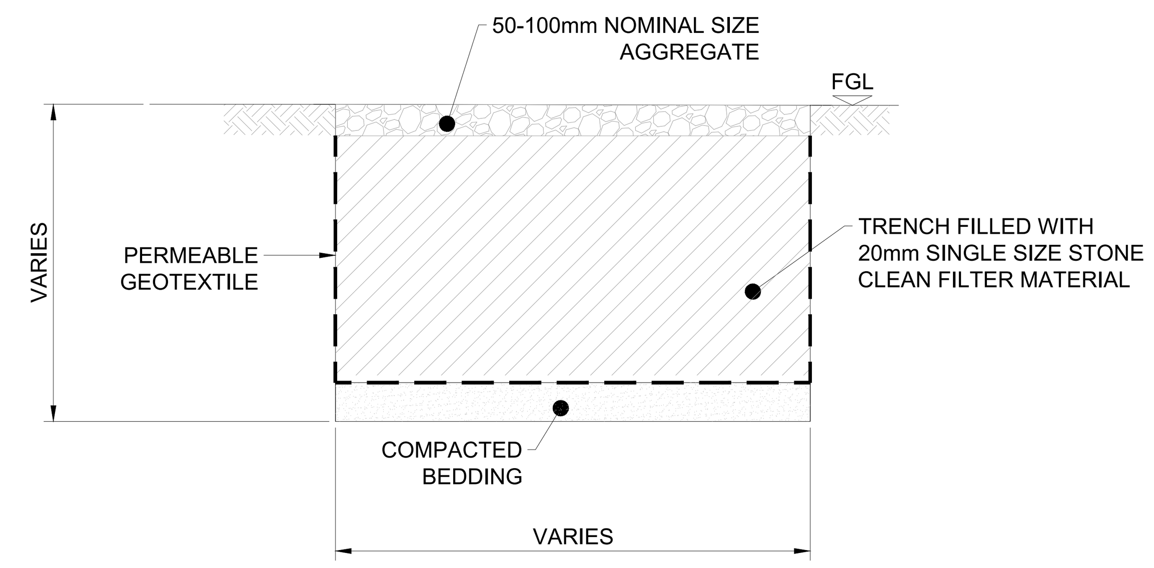
SECTION A-A
SCALE 1:20



FILTER DRAIN DETAIL
SCALE 1:20



OUTFALL PIPE CROSS SECTION
SCALE 1:20



TRENCH DRAIN DETAIL
SCALE 1:20

NOTES:

1. DO NOT SCALE, ANY DISCREPANCIES SHALL BE HIGHLIGHTED TO THE DESIGNER FOR CONFIRMATION.
2. SUDS SYSTEMS TO BE CONSTRUCTED PRIOR TO, OR AT THE SAME TIME AS THE ACCESS TRACK AND COMPOUND. INTERIM MEASURES SUCH AS THE PLACEMENT OF SILT FENCES TO BE USED AROUND WATERCOURSES AND RETAINED IN PLACE UNTIL SUDS ARE ESTABLISHED AND PROVIDING SUFFICIENT SILT REMOVAL.
3. WHERE RESEEDING IS REQUIRED, NATIVE SPECIES SEED MIX SHALL BE USED BASED UPON THE SURROUNDING HABITAT. THE PLANTING SHALL BE CAPABLE OF RESISTING DROUGHT CONDITIONS.
4. AREAS STRIPPED OF VEGETATION SHOULD BE KEPT TO A MINIMUM.
5. SILT LEVELS AT DETENTION BASIN TO BE VISUALLY INSPECTED AS PART OF AN ONGOING MAINTENANCE PROGRAMME DURING THE CONSTRUCTION PHASE. WHERE CHECK DAMS BECOME CLOGGED WITH SILT OR VEGETATION, STONE CHECK DAM TO BE REMOVED AND DISPOSED OF APPROPRIATELY.
6. SUDS DETAILS, DIMENSIONS AND LEVELS MAY BE MODIFIED DURING DETAILED DESIGN. CHANGES WILL ADHERE TO THE REQUIREMENTS AND PHILOSOPHY IN THE SURFACE WATER MANAGEMENT PLAN AND ADDENDUM.

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
2	BM	JM	JM	2024-12-12	ADDED SWALE AND TRENCH DETAIL
1	BM	AP	VM	2024-06-24	FIRST ISSUE

PURPOSE: PLANNING	COORDINATES: N/A
SCALE: AS SHOWN @ A1	DATUM: N/A
LAYOUT DWG: N/A	T-LAYOUT NO.: N/A

PROJECT TITLE
BISHOPS DAL STORAGE

DRAWING TITLE
TYPICAL DRAINAGE
DETAILS

RES DRAWING NUMBER
05389-RES-DRN-DR-PT-001
REV 2

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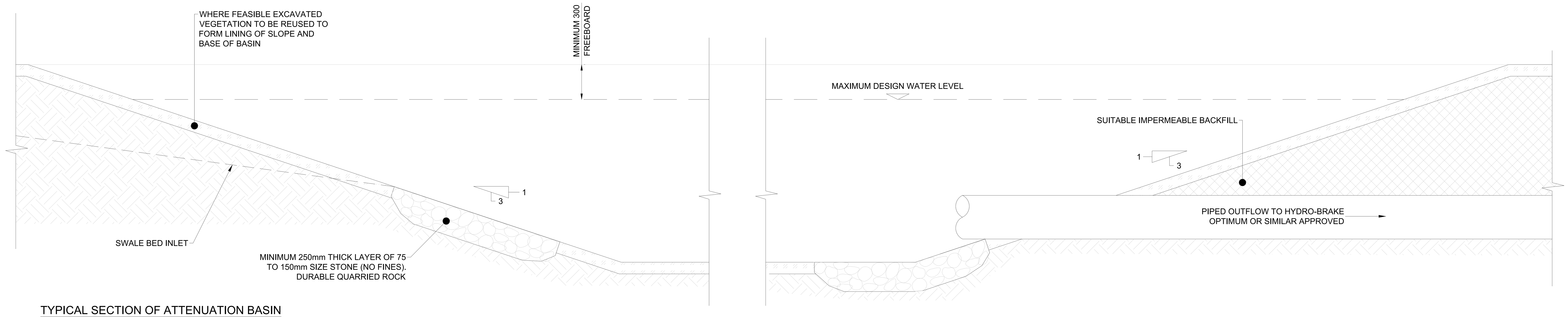
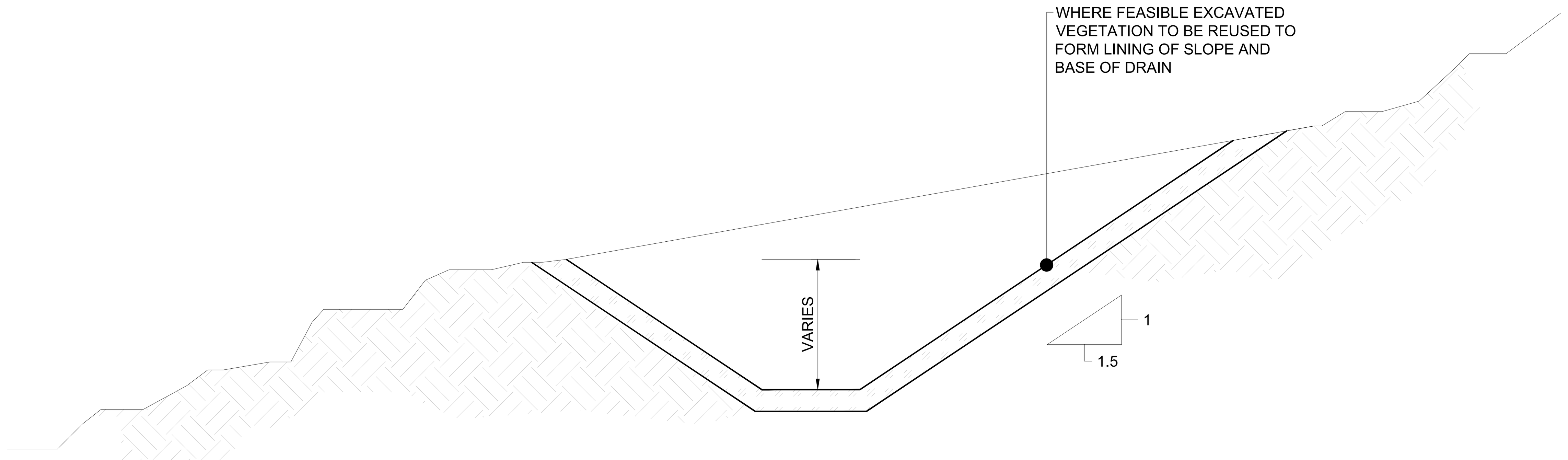
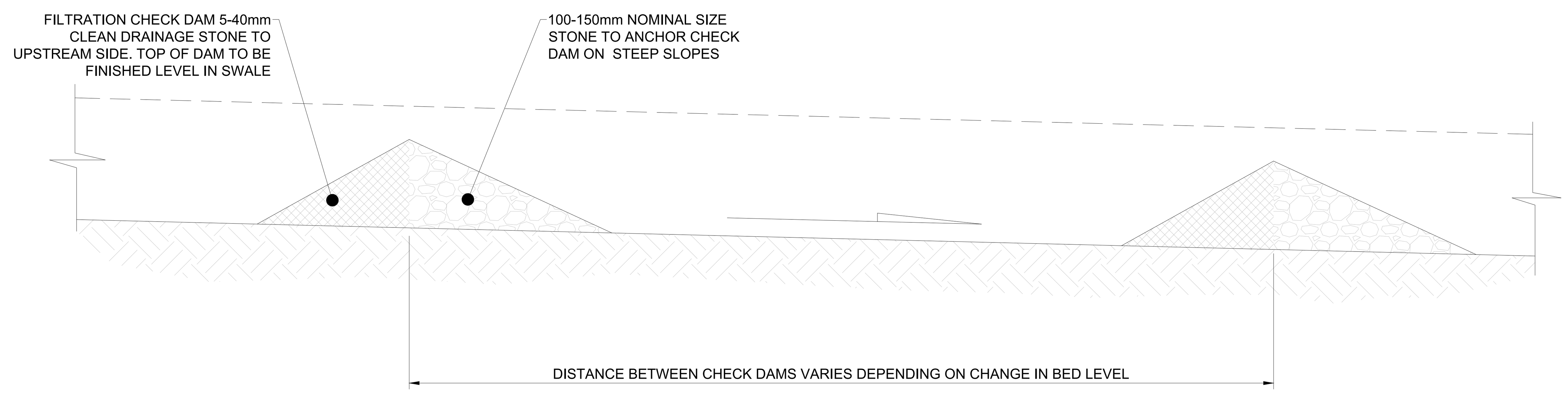


TYPICAL SECTION OF ATTENUATION BASIN
SCALE - 1:20



TYPICAL SWALE DETAIL
SCALE - 1:20



TYPICAL SWALE CHECK DAM DETAIL
SCALE - 1:20

NOTES:

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SHEET 2 OF 3

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
2	BM	JM	JM	2024-12-12	ADDED SWALE AND TRENCH DETAIL
1	BM	AP	VM	2024-06-24	FIRST ISSUE

PURPOSE: PLANNING	COORDINATES: N/A
SCALE: AS SHOWN @ A1	DATUM: N/A
LAYOUT DWG: N/A	T-LAYOUT NO.: N/A

PROJECT TITLE
BISHOPS DAL STORAGE

DRAWING TITLE
TYPICAL DRAINAGE DETAILS

RES DRAWING NUMBER: 05389-RES-DRN-DR-PT-001 REV: 2

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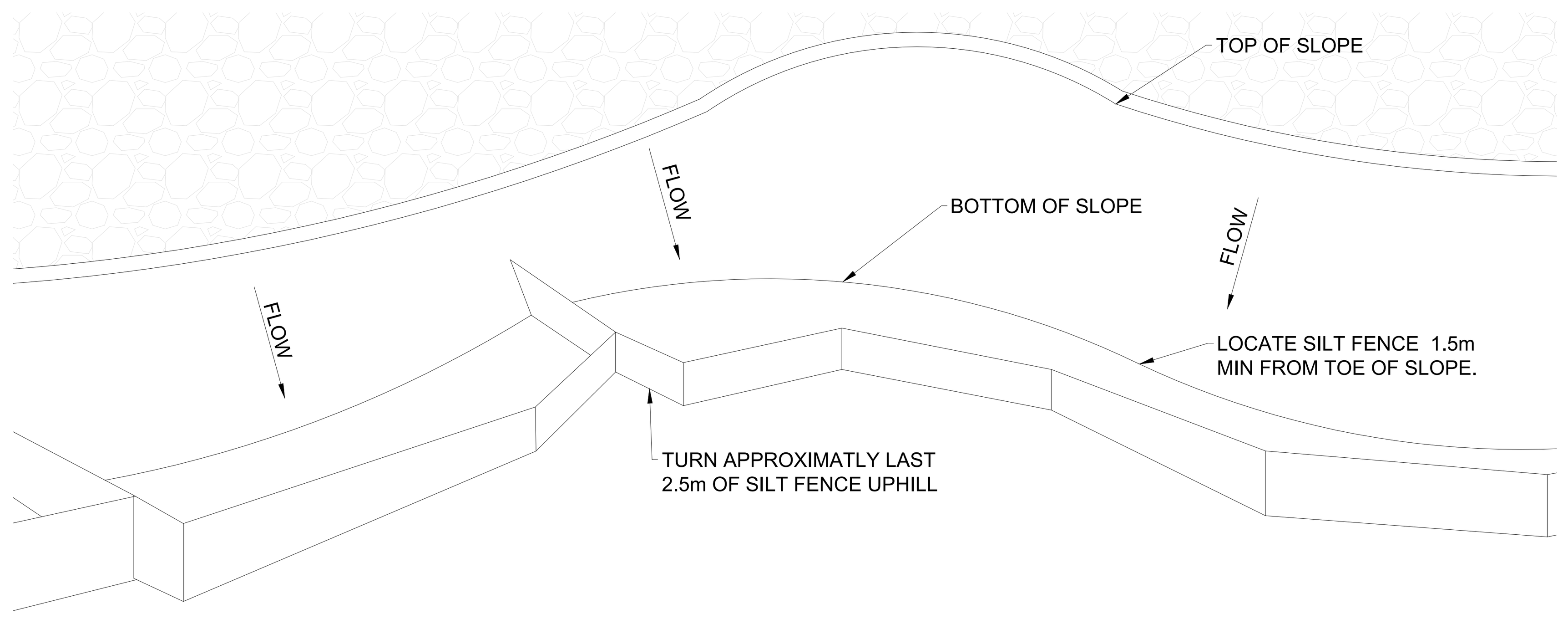
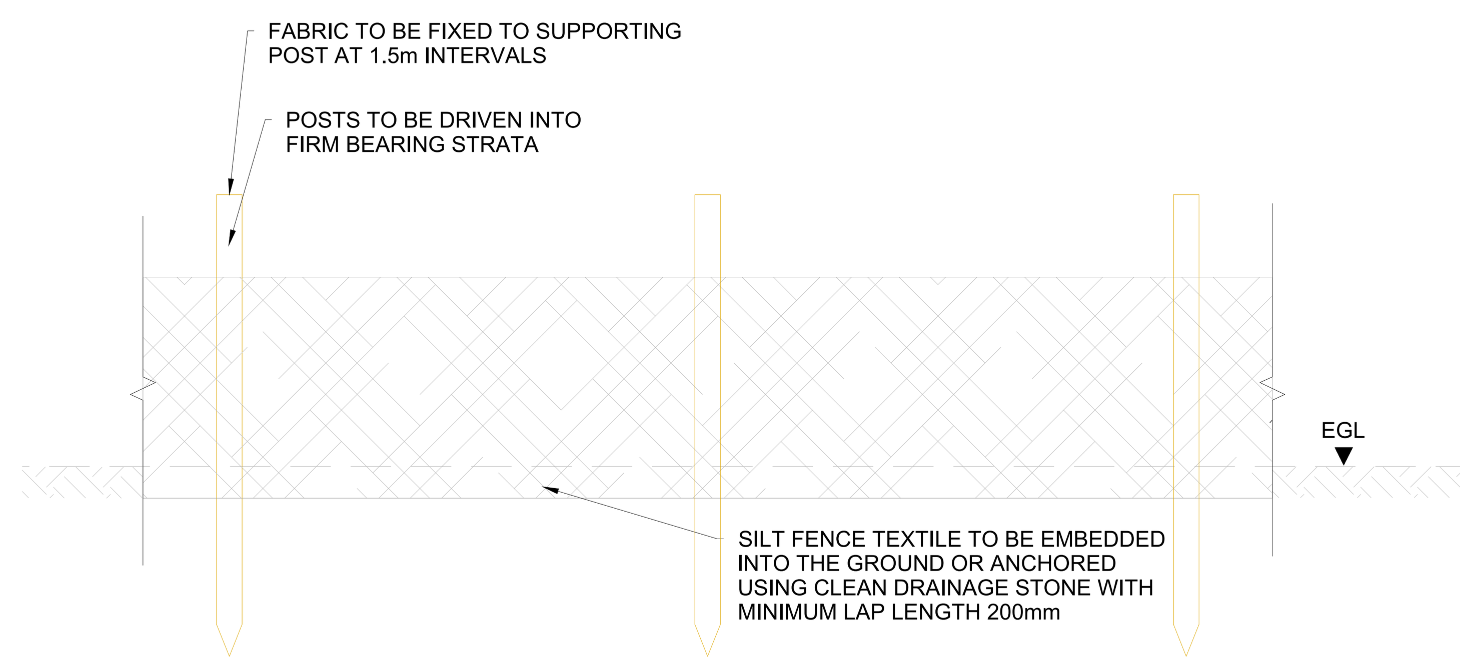
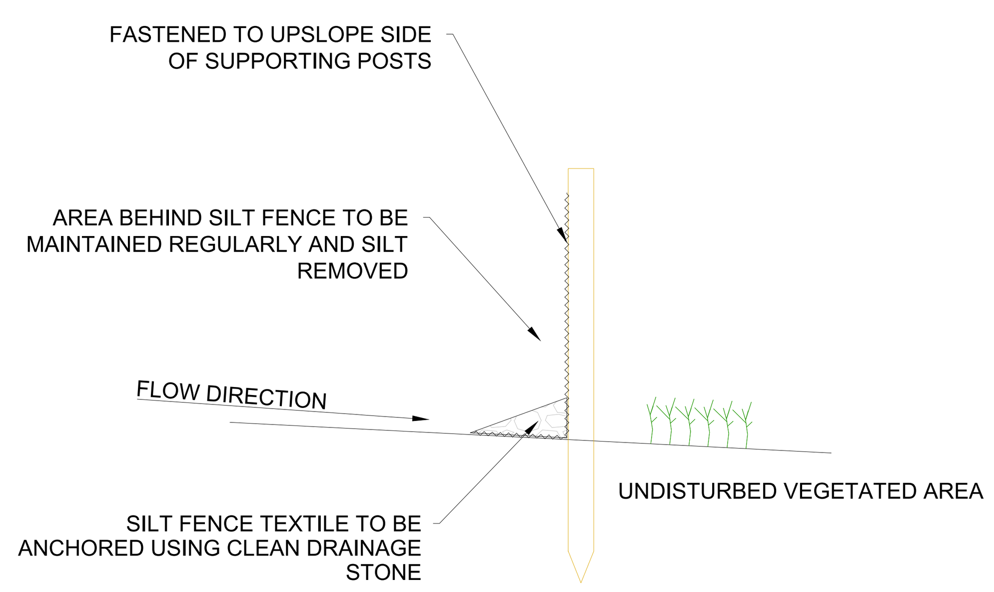


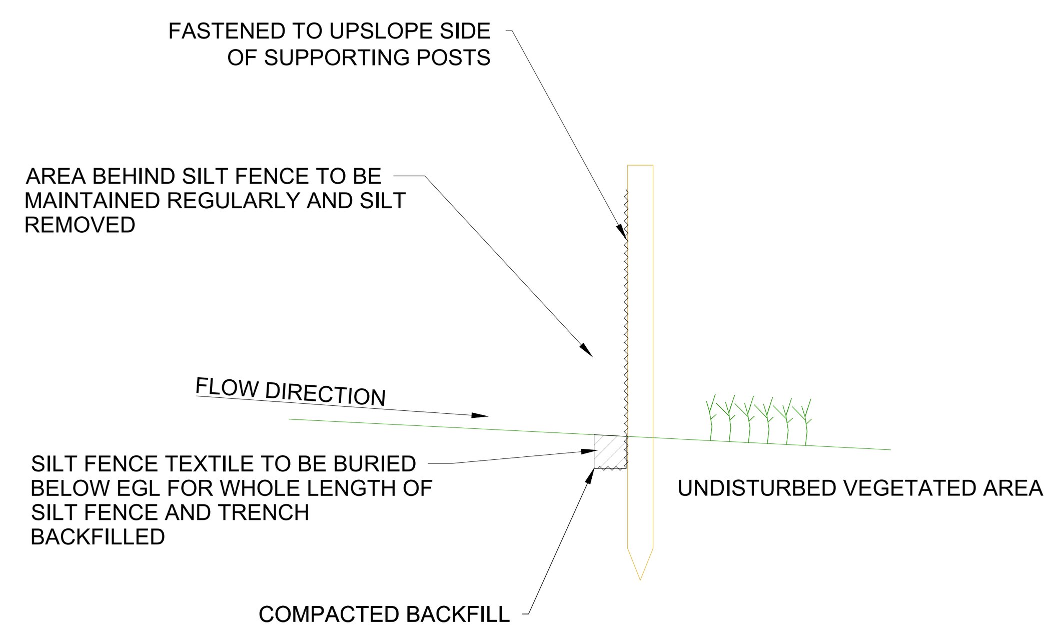
TYPICAL SILT FENCE BOTTOM OF SLOPE
SCALE - NTS



SILT FENCE TEXTILE DETAIL
SCALE 1:20



ANCHORED TYPE OPTION
SCALE 1:20



BURIED TYPE OPTION
SCALE 1:20

NOTES:

1. DO NOT SCALE, ANY DISCREPANCIES SHALL BE HIGHLIGHTED TO THE DESIGNER FOR CONFIRMATION.
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SHEET 3 OF 3

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
2	BM	JM	JM	2024-12-12	ADDED SWALE AND TRENCH DETAIL
1	BM	AP	VM	2024-06-24	FIRST ISSUE

PURPOSE: PLANNING
COORDINATES: N/A
SCALE: AS SHOWN @ A1
DATUM: N/A
LAYOUT DWG: N/A
T-LAYOUT NO.: N/A

PROJECT TITLE: BISHOPS DAL STORAGE

DRAWING TITLE: TYPICAL DRAINAGE DETAILS

RES DRAWING NUMBER: 05389-RES-DRN-DR-PT-001
REV: 2

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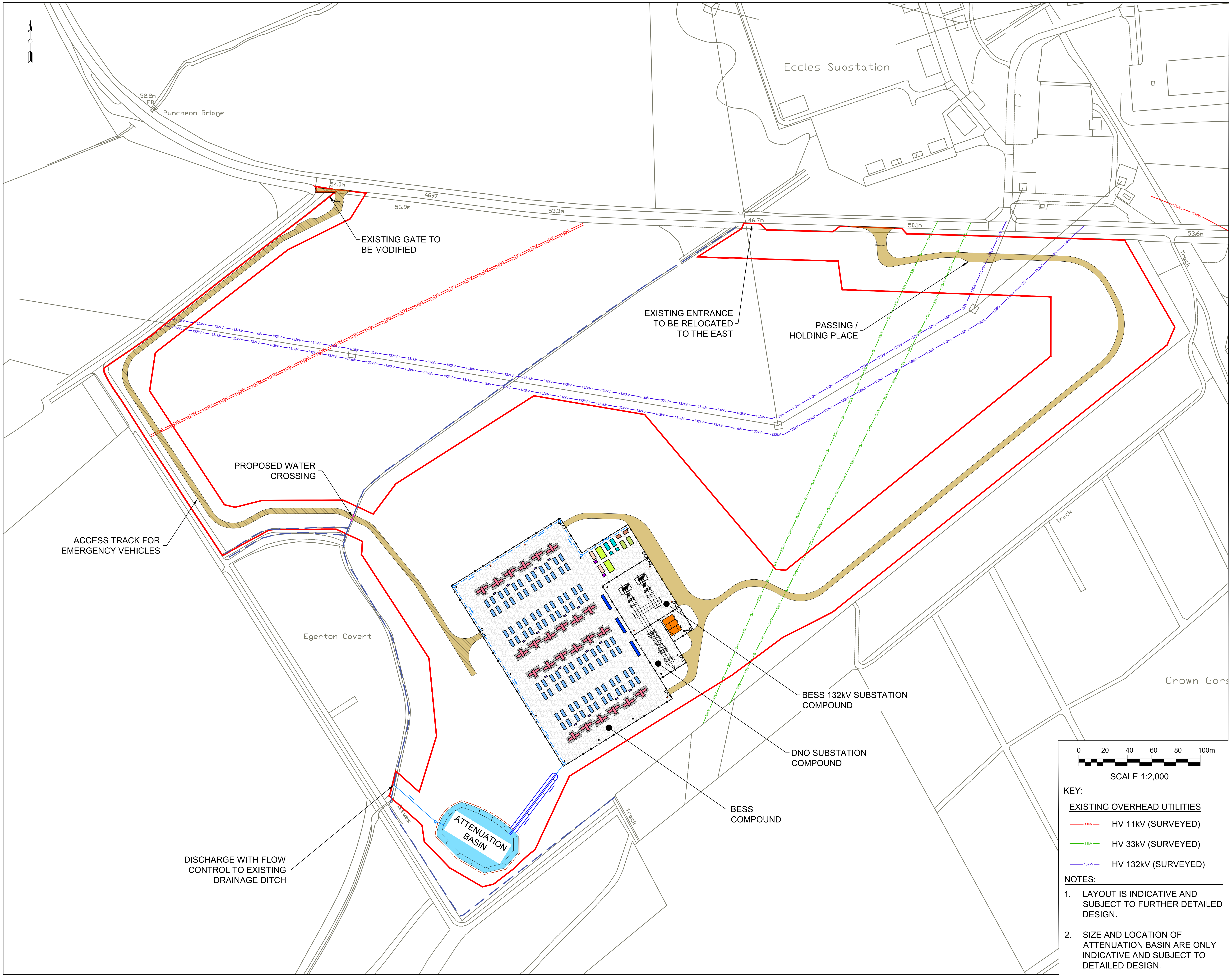

KEY:

- DEVELOPMENT BOUNDARY (OUTSIDE OF LINE DENOTES BOUNDARY)
- PALISADE, WELDMESH OR ACOUSTIC FENCE
- BATTERY STORAGE ENCLOSURE (BSE)
- 2 No. POWER CONVERSION SYSTEMS (PCS) WITH TWIN MV SKID AND APRON SLAB
- BESS SUBSTATION BUILDING
- DNO SUBSTATION BUILDING
- AUXILIARY TRANSFORMER
- LV SWITCHGEAR ROOM
- AGGREGATION PANEL WITH LV PILLAR
- PRE-INSERTION RESISTOR
- CAPACITOR BANK
- HARMONIC FILTER AND RESISTOR
- SPARES CONTAINER
- LIGHTING / CCTV COLUMN
- GRAVEL OR ASPHALT FINISH TO SUIT DETAILED EARTHING DESIGN
- ACCESS TRACK
- EMERGENCY ACCESS TRACK
- STOCK PROOF FENCE
- SURFACE WATER FILTER DRAIN
- SURFACE WATER PIPE
- SURFACE WATER CATCH PIT/ INSPECTION CHAMBER
- FLOW CONTROL MANHOLE
- SWALE
- EXISTING DRAINAGE INFRASTRUCTURE
- WATER CHANNEL CROSSING CULVERT
- GATE

CONTINUED...

KEY:

EXISTING OVERHEAD UTILITIES

- HV 11kV (SURVEYED)
- HV 33kV (SURVEYED)
- HV 132kV (SURVEYED)

NOTES:

1. LAYOUT IS INDICATIVE AND SUBJECT TO FURTHER DETAILED DESIGN.
2. SIZE AND LOCATION OF ATTENUATION BASIN ARE ONLY INDICATIVE AND SUBJECT TO DETAILED DESIGN.

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
6	BM	AP	JH	2024-11-26	UPDATED DEVELOPMENT BOUNDARY AND ACCESS TRACK
5	BM	AP	JH	2024-10-29	UPDATED ACCESS TRACK, DEVELOPMENT BOUNDARY AND LAYOUT
4	BM	AP	CH	2024-08-30	UPDATED DRAINAGE AND EMERGENCY ACCESS ROUTE
3	BM	VM	JH	2024-06-24	UPDATED BOUNDARY, UPDATED ACCESS TRACK AND CHANGED SHEET SIZE

PURPOSE: PLANNING	COORDINATES: OSGB 1936
SCALE: 1:2,000 @ A2	DATUM: N/A
LAYOUT DRAWING: N/A	T-LAYOUT NO: N/A

PROJECT TITLE
BISHOPS DAL STORAGE

DRAWING TITLE
INFRASTRUCTURE LAYOUT

RES DRAWING NUMBER: 05389-RES-LAY-DR-PT-001 REV: 6

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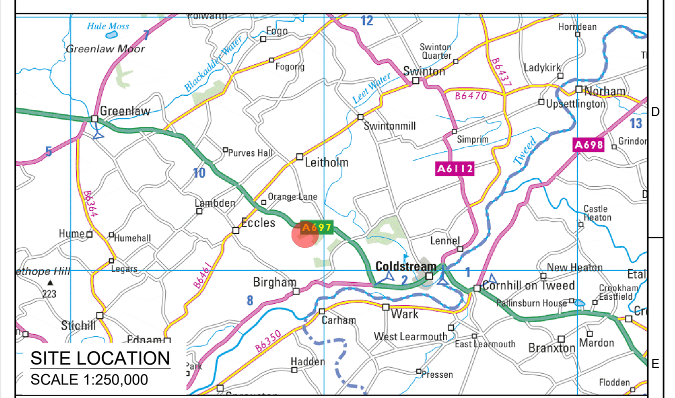
KEY:

DEVELOPMENT BOUNDARY
(OUTSIDE OF LINE DENOTES BOUNDARY)

KEY PLAN



SITE LOCATION
SCALE 1:250,000

0 20 40 60 80 100m
SCALE 1:2,000

ISSUE	DRAWN	CHKD	APPD	DATE	REVISION NOTES
1	BM	AP	JH	2024-11-25	FIRST ISSUE

PURPOSE: PLANNING	COORDINATES: OSGB 1936
SCALE: 1:2,000 @ A1	DATUM: N/A
LAYOUT DWG: N/A	T-LAYOUT NO.: N/A

PROJECT TITLE
BISHOPS DAL STORAGE

DRAWING TITLE
BLOCK PLAN

RES DRAWING NUMBER: 05389-RES-MAP-DR-XX-002
REV: 1

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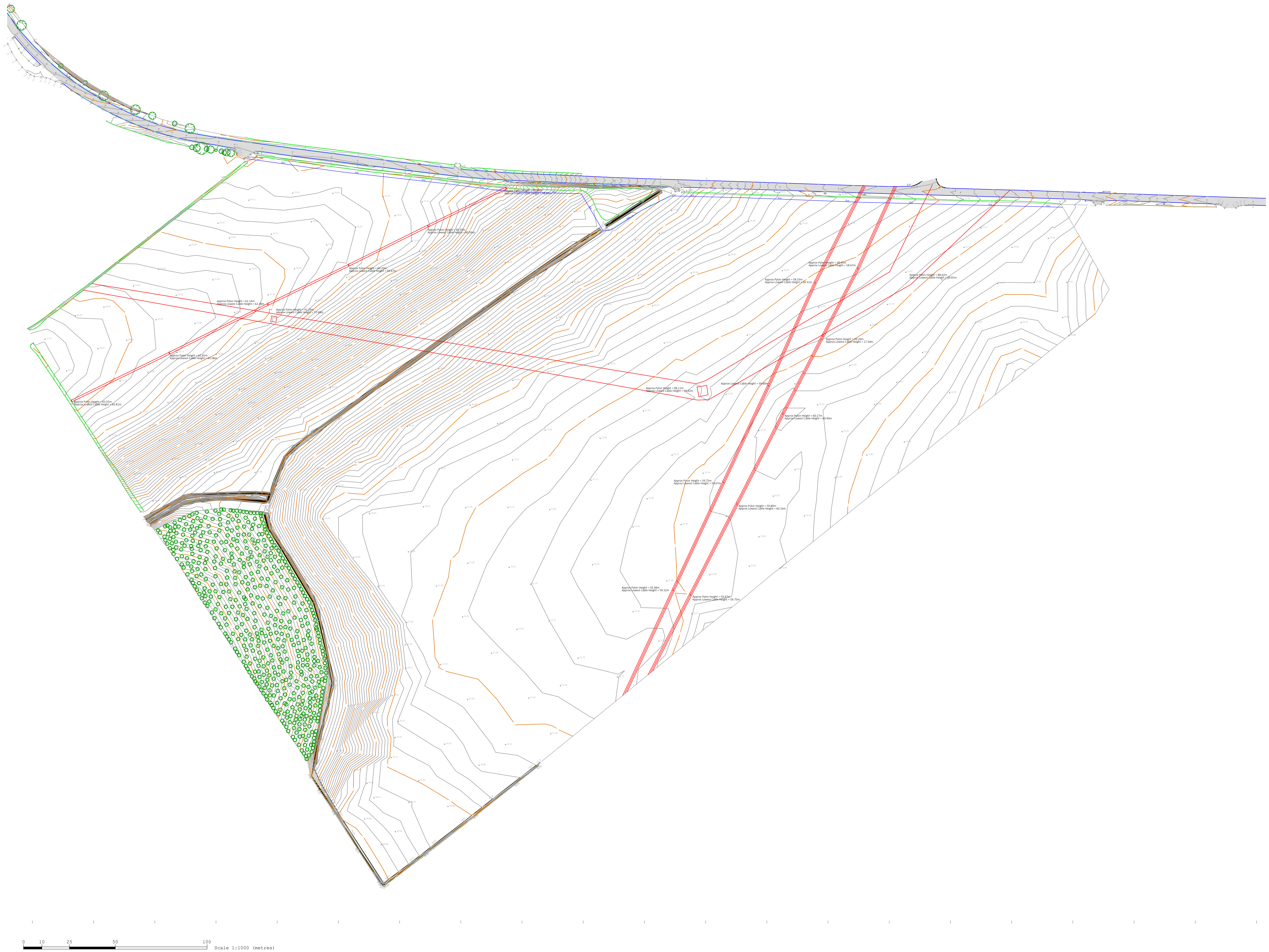
Appendix B Topographical Survey

317328 Bishops Dal, Coldstresm.pdf – Topographical Survey



Rev.	Description	Drawn	Date
2	Additional Survey area	GM	22.10.24
1	North Verge Surveyed/Added	GM	12.2.24

Mabbett
Planning | Design | Environment | Engineering | Safety

Willow House
Stoneyfield Business Park
Inverness IV2 7PA
Tel: 01463 237229
www.mabbett.eu

CHARTERED PRACTICE

Client
Renewable Energy Systems Ltd

Project
Bishops Dal BESS
Coldstream

Drawing
Topographic Survey

Status
ISSUE

Scale 1:1000 Sheet A1

Drawn SP Check GM Date 22/10/24

Drawing No: 317328 SU001 Rev 2

Appendix C   Infiltration and Percolation Test Results

6635 Siteworks.pdf – Site Work (Infiltration and Percolation Test Results)

greencat Geotechnical

BISHOPS DAL

ANNEX A:
SITE WORK

Contract No: **6635-1381**

Approved for Issue by:

GG Henderson
Head of Geotechnics
gavinh@greencatrenewables.co.uk

Client:
RES UK Ltd
Beaufort Court
Egg Farm Lane
Kings Langley
Herts
WD4 8LR

Print Date: 25th October 2024

ANNEX A
TABLE OF CONTENTS

PROJECT TITLE: BISHOPS DAL	Contract No: 6635-1381	Date 25/10/24 DWN CHK APP CH	CLIENT: RES UK Ltd	
DRAWING TITLE: CONTENTS FOR ANNEX A	Fig. No.	Revisions DWN CHK APP		
SCALE:				

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greencat Geotechnical

Boring

The standard method of boring in soil for ground investigation is known as the cable percussion method. It uses various tools worked on a wire cable, typically a shell in non-cohesive soils, and a clay cutter in cohesive soils. Very dense soils, boulders or other hard obstructions are disturbed or broken up by chiselling and the fragments removed with the shell. To prevent the borehole falling in, the borehole is normally lined with driven steel casings of such sizes that the bottom of the borehole is not less than 150mm diameter.

Where there are constraints upon access, alternative methods of soft ground boring are available. However, each has limitations that need to be taken into account when assessing their suitability and the ground conditions inferred from their results.

Rotary Drilling

Rotary drilling is employed to extend ground investigation beyond the practical limit of cable tool boring in hard formations, commonly rock. Core drilling is used to obtain continuous intact samples of the formation and is generally undertaken with double tube swivel type core barrels fitted with tungsten or diamond bits as appropriate to formation type and hardness. Open-hole rotary drilling using, tricone rock roller bits or tungsten insert drag bits, or down-the-hole hammers, is carried out where core is not required, strata identification being made from cuttings only. Open-hole rotary drilling methods may also be employed for fast penetration of soils where sampling is not required, prior to coring at depth. Air or water is the flushing medium normally used with rotary drilling methods. The borehole is normally lined with inserted or drilled-in casing through the soils, and into the bedrock, where ground conditions require.

Samples and In-situ Tests

Tube samples of cohesive soils are generally taken with a 100mm internal diameter open drive sampler known as a U100, with an area ratio of 30%. The sampler is driven into the soil at the bottom of the borehole by a sliding hammer. After a sample is taken, the drive head and cutting shoe are unscrewed from the sample tube and any wet or disturbed soil removed from either end. The sample tube is then sealed with wax and fitted with plastic end caps.

A range of more specialised equipment, e.g. piston samplers or thin-walled tubes, may be used where the soil is suitable to obtain higher quality samples in conditions where conventional open drive sampling is unsatisfactory.

Disturbed samples are taken from the boring tools at regular intervals. The samples are sealed in airtight containers. Bulk samples are larger disturbed samples from the boring tools, or from trial pits.

The Standard Penetration Test (SPT) carried out in accordance with BS EN ISO 22476-3+A1 (2011), determines the resistance of soil to the penetration of a split barrel sampler. A 50mm diameter split barrel sampler is driven 450mm into the soil using a 63.5kg hammer with a 760mm drop, and the penetration resistance recorded. This "N" value is expressed as the number of blows required to achieve 300mm penetration (the "test drive") below an initial penetration of 150mm (the "seating drive") through any disturbed soil at the bottom of the borehole.

In coarse soils, the Cone Penetration Test (CPT) is conducted in the same manner as the SPT but using a 50mm diameter 60 degree apex solid cone point to replace the split barrel sampler.

Groundwater

Borehole water levels are recorded, together with the depths at which seepages or inflows of groundwater are detected and the observations noted on the borehole records. These observations may not give an accurate indication of groundwater conditions, for the following reasons:

(a) The borehole is rarely left standing at the relevant depth for sufficient time for the water level to reach equilibrium.
(b) A permeable stratum may have been sealed off by the borehole casing.
(c) It may have been necessary to add water to the borehole to facilitate progress.
(d) There may be seasonal, tidal or other effects at the site.

A more accurate assessment of groundwater behaviour may be obtained from standpipes or standpipe piezometers.

PI Statement

Certified that the above mentioned samples/parts/materials have been tested/examined in accordance with the terms of the contract/order applicable and unless otherwise stated conform fully to the standards/specifications quoted. This does not however, guarantee the balance of production from which the tested samples/parts/materials have been taken to be of equal quality.

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SOIL SAMPLES

U (X)	General purpose tube sample; X No of blows to drive sampler
UP	Piston sample
	NOTE: Tube samples are 100mm diameter, 0.45m drive (86mm diameter, 1.0m drive with Competitor rig) unless otherwise specified in the remarks.
	Suffix 'a' indicates sample not recovered. Suffix 'b' indicates partial recovery.
J/T	Jar/Tub sample
B/LB	Bag/Large Bag sample
V	Volatile Vial
E	Environmental Sample Set (J, T & V)

CORE RECOVERY AND ROCK QUALITY

TCR	Total Core Recovery: The total core recovered expressed as a percentage of the core run length
SCR	Solid Core Recovery: The core recovered as solid cylinders expressed as a percentage of the core run length
RQD	Rock Quality Designation: The core recovered as solid cylinders of length 100mm or more expressed as a percentage of core run length.
RO-S/RO-R	Rotary Open Hole Drilling through Soil / Rotary Open Hole Drilling through Rock
If	Fracture Index: The number of discontinuities expressed as fractures per metre
Flush	"Depth" indicates depth down to which recorded "Returns" relate

GROUND-WATER

W	Ground-water sample
▼	Ground-water encountered
▽	Depth to which ground-water rose
▽	Ground-water cut off by the casing

IN SITU AND FIELD TESTS

SPT=X a/b (pen) or CPT=X a/b (pen)	Standard penetration test (split barrel sampler(SPT)or cone (CPT)); X is the penetration (N) value; 'a' is blow/75mm for seating drive; 'b' is blows/75mm for test drive; (pen) is test drive penetration if less than 300mm.		
CBR	California bearing ratio test		
MCV	Moisture condition value test	FV	Field vane test
K	Permeability test	HV	Hand vane test
HP	Hand penetrometer test	ID	Density test
PLT	Constant deformation Plate Load Testing carried out in accordance with DIN18134:2012 using referred loading sequence		

LEGENDS

Material legends are in accordance with BS 5930:1999

before a description indicates that it is based on the Driller's record.

INSTALLATIONS (BACKFILL)

Concrete	Bentonite
Spoil	Bentonite/cement grout
Sand	Solid pipe
Gravel	Slotted pipe
Porous element	Wooden plug

ROTARY DRILLING SIZES

Designation	Nominal Diameter (mm)	
	Borehole	Core
N	76	54
H	100	76
P	121	92
S	146	113
412	108	75

DIMENSIONS

All dimensions in metres unless otherwise stated.

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24 DWN CHK APP CH	CLIENT: RES UK Ltd
DRAWING TITLE: **KEY TO BOREHOLE AND TRIAL PIT RECORDS**	Fig. No.	Revisions DWN CHK APP	
SCALE:			

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Exploration Point	Co-ordinates		Ground Level	Method	Figure No	Installation	Remarks
	Easting (m)	Northing (m)	(mOD)				
TPINF1	379030.0	641160.0	-	TP	A1	-	
TPINF2	379060.0	641155.0	-	TP	A2	-	
TPINF3	379055.0	641130.0	-	TP	A3	-	
HPPER1	379205.0	641330.0	-	HP	A4	-	
HPPER2	379203.0	641315.0	-	HP	A5	-	

HP Hand Excavated Trial Pit
TP Trial Pit/Trench

PROJECT TITLE:
BISHOPS DAL

Contract No: 6635-1381

Date 25/10/24

DWN	CHK	APP
GGH	GGH	GGH

Final

CLIENT: RES UK Ltd

DRAWING TITLE:
SCHEDULE OF SITE WORKS

Fig. No. A0
Sheet 1 of 1

Revisions

DWN	CHK	APP

SCALE:

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Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
22/10 2024						0.35	Brown slightly gravelly TOPSOIL.				
22/10	1.00	B				1.10	Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content and pockets of sandy clay. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.		1.10		1.10
							END OF TRIAL PIT				

Remarks:
The walls of the pit stood vertical.

Ground-water			
Struck	Rose To	Time(mins)	Stopped

Location: E 379030.0 N 641160.0

Level: -

Method:
Trial Pit to 1.10m

Equipment:
JCB 3CX

Dimensions:
1.1 x 1.4

Trial Pit No:

TPINF1

PROJECT TITLE:
BISHOPS DAL

Contract No: 6635-1381

Date 25/10/24 | DWN CH | CHK GGH | APP GGH

FINAL

CLIENT:
RES UK Ltd

DRAWING TITLE:
TRIAL PIT RECORD

Fig. No. A1
Sheet 1 of 1

Revisions: DWN | CHK | APP

SCALE: 1:50

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01506 416553

Progress	Sample Depth	Type	Samples and Tests Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
22/10 2024						0.35	Brown slightly gravelly TOPSOIL.				
							Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.				
22/10	1.00	B				1.15	END OF TRIAL PIT		DRY		1.15

Remarks:
The walls of the pit stood vertical.

Ground-water			
Struck	Rose To	Time(mins)	Stopped

Location: E 379060.0 N 641155.0

Level: -

Method:
Trial Pit to 1.15m

Equipment:
JCB 3CX

Dimensions:
1 x 1.3

Trial Pit No:

TPINF2

PROJECT TITLE:
BISHOPS DAL

Contract No: 6635-1381

Date 25/10/24

DWN	CHK	APP
CH	GGH	GGH

FINAL

CLIENT:
RES UK Ltd

DRAWING TITLE:
TRIAL PIT RECORD

Fig. No. A2
Sheet 1 of 1

Revisions

DWN	CHK	APP

SCALE: 1:50

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Progress	Sample Depth	Samples and Tests Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
22/10 2024						0.35	Brown slightly gravelly TOPSOIL.				
22/10	1.00	B				1.20	Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content and some fragments of field drain. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.		1.20		1.20
							END OF TRIAL PIT				

Remarks:
The walls of the pit stood vertical.

Ground-water			
Struck	Rose To	Time(mins)	Stopped

Location: E 379055.0 N 641130.0

Level: -

Method:
Trial Pit to 1.20m

Equipment:
JCB 3CX

Dimensions:
1.1 x 1.4

Trial Pit No:

TPINF3

PROJECT TITLE:
BISHOPS DAL

DRAWING TITLE:
TRIAL PIT RECORD

SCALE: 1:50

Contract No: 6635-1381

Fig. No. A3
Sheet 1 of 1

Date	25/10/24	
DWN	CHK	APP
CH	GGH	GGH

Revisions

DWN	CHK	APP

FINAL

CLIENT:
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Style: GCR_TRIALPIT File: \\BATHGATE\GEOTECH\GINT\PROJECTS\6635.GPJ Printed: 25/10/2024 15:08:50 Green Cat Renewables Ltd, Bethany Hall, Biggar ML12 6DA trading as Green Cat Geotechnical E-mail: info@greencatrenewables.co.uk Tel: 01899-309100

Progress	Sample Depth	Samples and Tests Type	Samples and Tests Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
22/10 2024						0.30	Brown gravelly TOPSOIL.				
						0.45	Stiff light reddish brown slightly sandy slightly gravelly CLAY with pockets of sandy clay. Gravel is angular to rounded fine to coarse.				0.45
							END OF TRIAL PIT				

Remarks:
The walls of the pit stood vertical.

Ground-water			
Struck	Rose To	Time(mins)	Stopped

Location: E 379205.0 N 641330.0

Level: -

Method:
Trial Pit to 0.45m

Equipment:
Hand Excavated

Dimensions:
0.3 x 0.3

Trial Pit No:

HPPER1

PROJECT TITLE:
BISHOPS DAL

Contract No: 6635-1381

DRAWING TITLE:
TRIAL PIT RECORD

Fig. No. A4
Sheet 1 of 1

SCALE: 1:50

Date	25/10/24	
DWN	CHK	APP
CH	GGH	GGH

Revisions

DWN	CHK	APP

FINAL

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Progress	Sample Depth	Type	Result		Level (mOD)	Depth	Description of Strata	Legend	Water Depth	Backfill Symbol	Backfill Depth
22/10 2024						0.35	Brown gravelly TOPSOIL.				0.40
						0.40	Stiff light reddish brown slightly sandy slightly gravelly CLAY with pockets of sandy clay. Gravel is angular to rounded fine to coarse.				
							END OF TRIAL PIT				

Remarks:
The walls of the pit stood vertical.

Ground-water			
Struck	Rose To	Time(mins)	Stopped

Location: E 379203.0 N 641315.0

Level: -

Method:
Trial Pit to 0.40m

Equipment:
Hand Excavated

Dimensions:
0.3 x 0.3

Trial Pit No:

HPPER2

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24; DWN CH; CHK GGH; APP GGH	FINAL
DRAWING TITLE: **TRIAL PIT RECORD**	Fig. No. A5 Sheet 1 of 1	Revisions; DWN; CHK; APP	
SCALE: 1:50			

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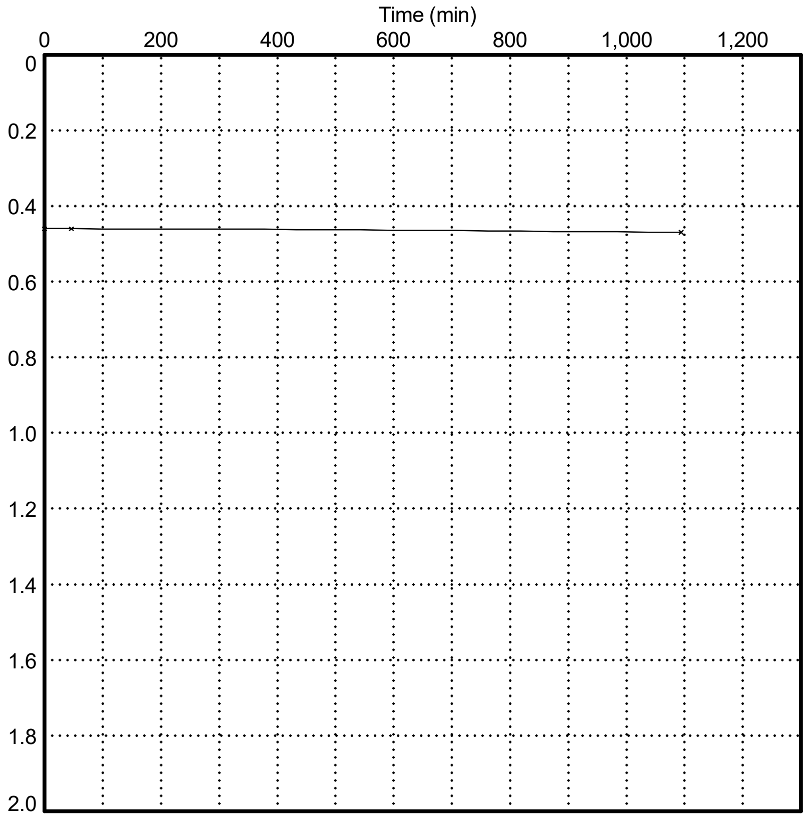
Test Pit Dimensions

Depth to Base (m bGL)	**1.20**
Length (m)	**1.40**
Width (m)	**1.10**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**0.46**
75% Effective Depth (m)	**0.65**
25% Effective Depth (m)	**1.02**
Effective Storage Volume (m^3)	**0.57**
Surface Area (m^2)	**3.39**

Soil Infiltration Rate (m/s) **Indeterminate**



Time (minutes)	Depth to Water (m below GL)
0	0.46
46	0.46
1094	0.47

Description of Strata

0m to 0.35m : Brown slightly gravelly TOPSOIL.
0.35m to 1.1m : Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content and pockets of sandy clay. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.

Trial Pit No: **TPINF1**

Test No: **1**

PROJECT TITLE: **BISHOPS DAL**

DRAWING TITLE: **RESULTS OF INFILTRATION TEST**

SCALE:

Contract No: 6635-1381

Fig. No. **A6**

Date	25/10/24	
DWN	CHK	APP
CH	GGH	GGH

Revisions

DWN	CHK	APP

Final

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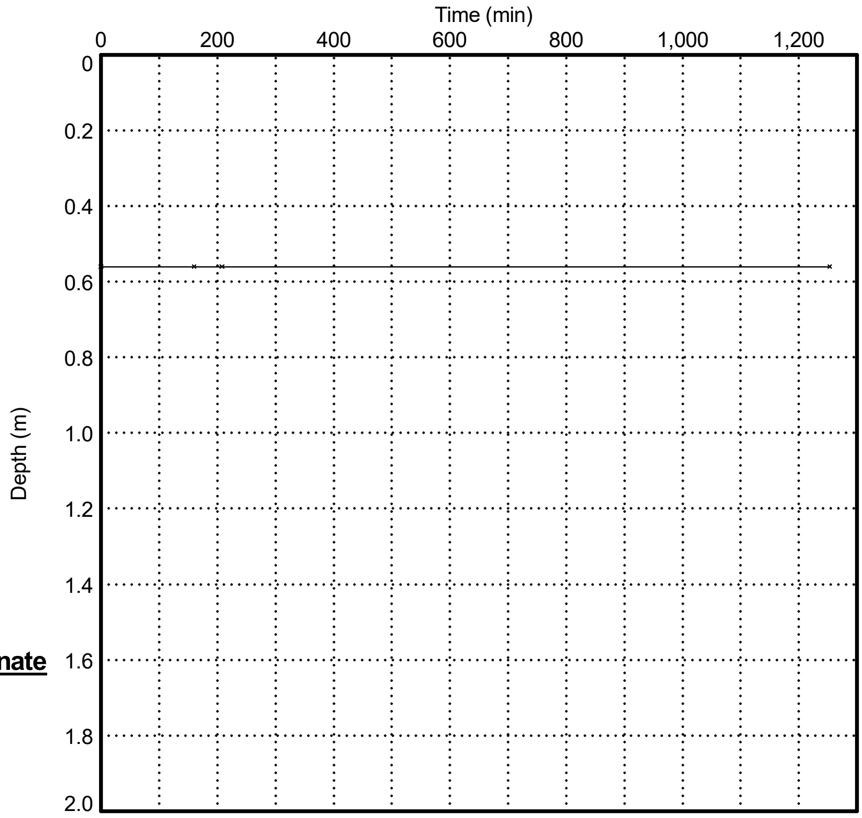
Test Pit Dimensions

Depth to Base (m bGL)	**1.15**
Length (m)	**1.30**
Width (m)	**1.00**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**0.56**
75% Effective Depth (m)	**0.71**
25% Effective Depth (m)	**1.00**
Effective Storage Volume (m^3)	**0.38**
Surface Area (m^2)	**2.66**

Soil Infiltration Rate (m/s) **Indeterminate**



Time (minutes)	Depth to Water (m below GL)
0	0.56
160	0.56
208	0.56
1253	0.56

Description of Strata

0m to 0.35m : Brown slightly gravelly TOPSOIL.
0.35m to 1.15m : Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.

Trial Pit No: **TPINF2**

Test No: **1**

PROJECT TITLE:	Contract No:	Date	25/10/24		Final	CLIENT:
BISHOPS DAL	6635-1381	DWN	CHK	APP		RES UK Ltd
		CH	GGH	GGH		
DRAWING TITLE:	Fig. No.	Revisions				
RESULTS OF INFILTRATION TEST	**A7**	DWN	CHK	APP		
SCALE:						

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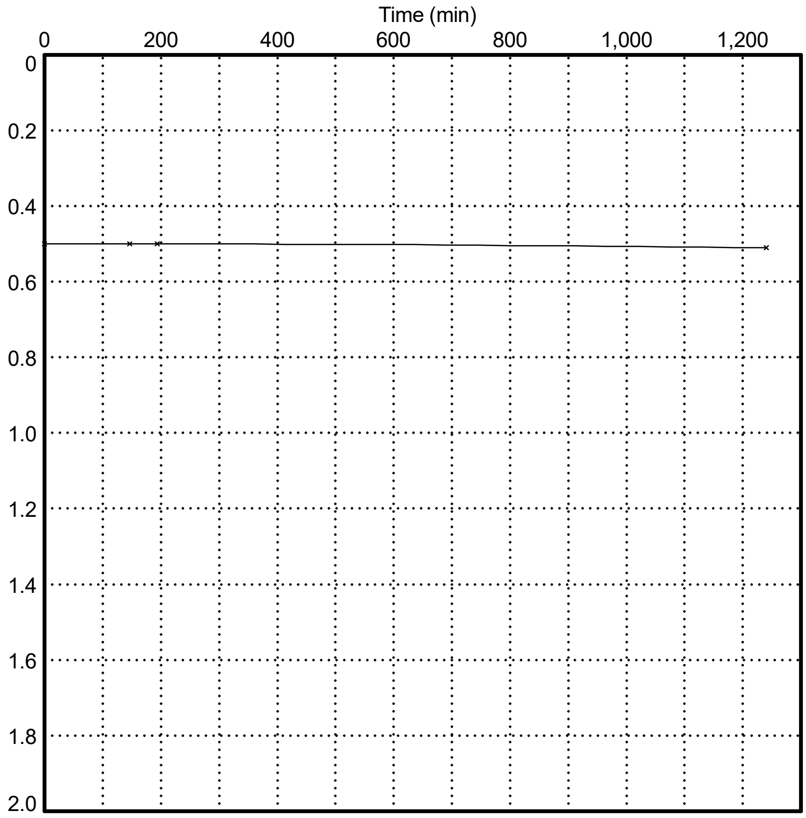
Test Pit Dimensions

Depth to Base (m bGL)	**1.20**
Length (m)	**1.40**
Width (m)	**1.10**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**0.50**
75% Effective Depth (m)	**0.68**
25% Effective Depth (m)	**1.03**
Effective Storage Volume (m^3)	**0.54**
Surface Area (m^2)	**3.29**

Soil Infiltration Rate (m/s) **Indeterminate**



Time (minutes)	Depth to Water (m below GL)
0	0.50
146	0.50
194	0.50
1240	0.51

Description of Strata

0m to 0.35m : Brown slightly gravelly TOPSOIL.
0.35m to 1.2m : Stiff light reddish brown slightly sandy slightly gravelly CLAY with a low cobble content and some fragments of field drain. Gravel is angular to rounded fine to coarse. Cobbles are angular to subrounded.

Trial Pit No: **TPINF3**

Test No: **1**

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24; DWN CH, CHK GGH, APP GGH	Final	CLIENT: RES UK Ltd
DRAWING TITLE: **RESULTS OF INFILTRATION TEST**	Fig. No. **A8**	Revisions: DWN, CHK, APP		
SCALE:				

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Test Pit Dimensions

Depth to Base (m bGL)	**0.45**
Length (m)	**0.30**
Width (m)	**0.30**
Depth to Ground-Water (m bGL)	**Dry**

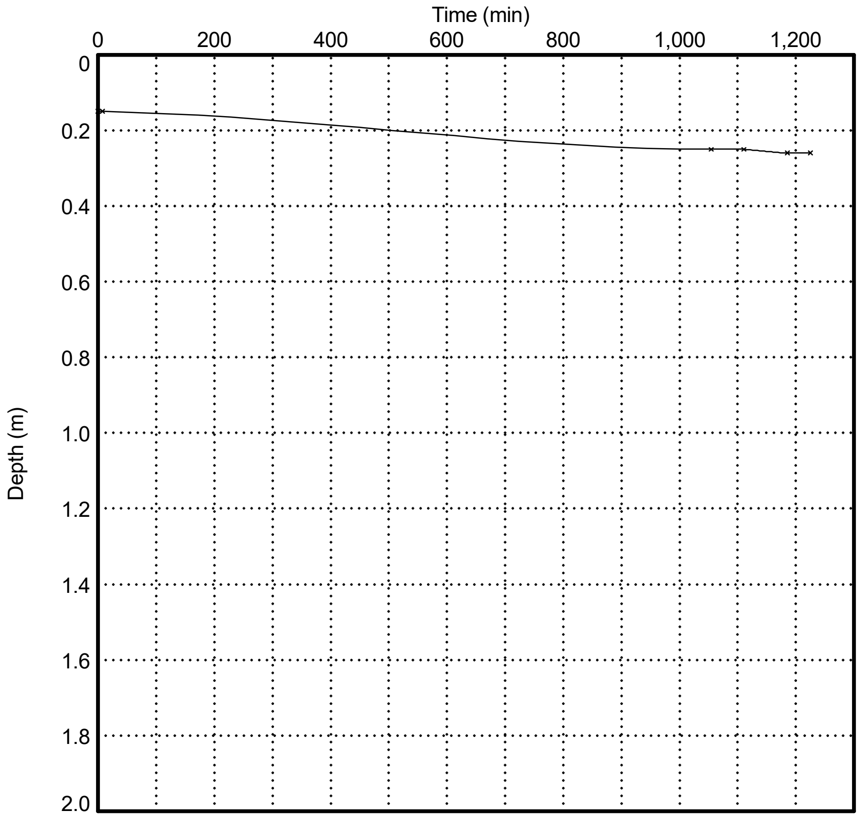
Test Results

Maximum Effective Depth (m bGL)	**0.15**
75% Effective Depth (m)	**0.23**
25% Effective Depth (m)	**0.38**
Effective Storage Volume (m^3)	**0.01**
Surface Area (m^2)	**0.27**
Time to 75% (min)	**793**
Extrapolated time to 25% (min)	**2048**
t_{p75-25}	**1255**

Soil Infiltration Rate (m/s) **6.64E-7**

Percolation Value (s/mm) **502**

Based on linear extrapolation



Time (minutes)	Depth to Water (m below GL)
0	0.15
8	0.15
1054	0.25
1110	0.25
1185	0.26
1225	0.26

Description of Strata

0m to 0.3m : Brown gravelly TOPSOIL.
0.3m to 0.45m : Stiff light reddish brown slightly sandy slightly gravelly CLAY with pockets of sandy clay. Gravel is angular to rounded fine to coarse.

Trial Pit No: **HPPER1**

Test No: **1**

PROJECT TITLE:	Contract No:	Date	25/10/24		Final	CLIENT:
BISHOPS DAL	6635-1381	DWN	CHK	APP		RES UK Ltd
		CH	GGH	GGH		
DRAWING TITLE:	Fig. No.	Revisions				
RESULTS OF INFILTRATION TEST	**A9**	DWN	CHK	APP		
SCALE:						

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<u>**Test Pit Dimensions**</u>

Depth to Base (m bGL)	**0.40**
Length (m)	**0.30**
Width (m)	**0.30**
Depth to Ground-Water (m bGL)	**Dry**

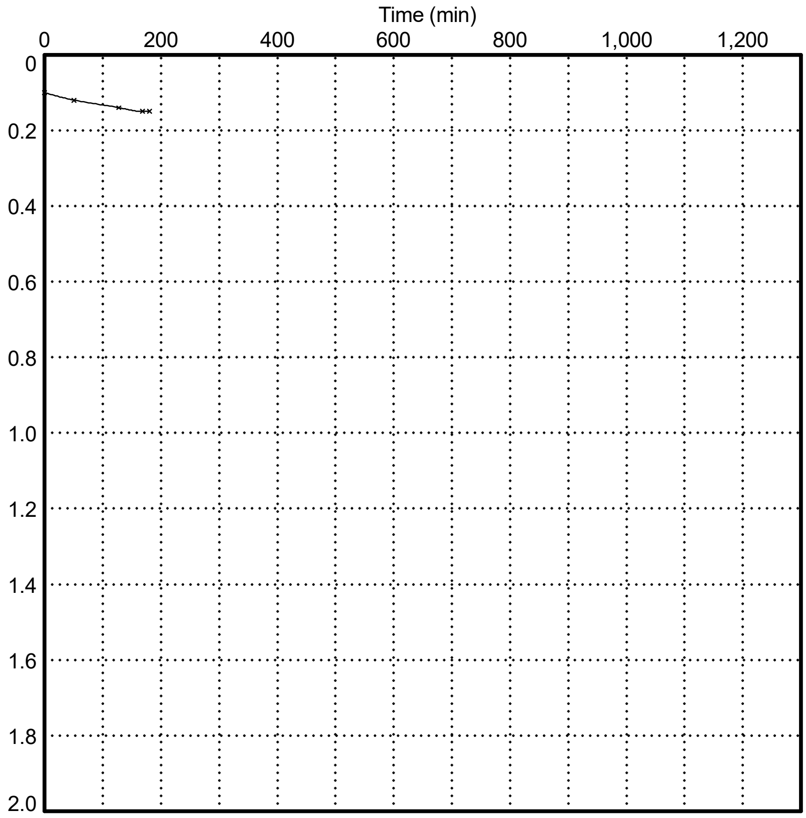
<u>**Test Results**</u>

Maximum Effective Depth (m bGL)	**0.10**
75% Effective Depth (m)	**0.18**
25% Effective Depth (m)	**0.33**
Effective Storage Volume (m^3)	**0.01**
Surface Area (m^2)	**0.27**
Extrapolated time to 75% (min)	**268**
Extrapolated time to 25% (min)	**868**
t_{p75-25}	**600**

Soil Infiltration Rate (m/s) <u>**1.39E-6**</u>

Percolation Value (s/mm) <u>**240**</u>

Based on linear extrapolation



Time (minutes)	Depth to Water (m below GL)
0	0.10
51	0.12
128	0.14
168	0.15
180	0.15

Description of Strata

0m to 0.35m : Brown gravelly TOPSOIL.
0.35m to 0.4m : Stiff light reddish brown slightly sandy slightly gravelly CLAY with pockets of sandy clay. Gravel is angular to rounded fine to coarse.

Trial Pit No: **HPPER2**

Test No: **1**

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24; DWN CH; CHK GGH; APP GGH	Final
DRAWING TITLE: **RESULTS OF INFILTRATION TEST**	Fig. No. **A10**	Revisions; DWN; CHK; APP	
SCALE:			

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Trial Pit No: TPINF1

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24; DWN CH; CHK GGH; APP GGH	Final
DRAWING TITLE: **TRIAL PIT PHOTOGRAPHS**	Fig. No. A11	Revisions; DWN; CHK; APP	
SCALE:			

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Trial Pit No: TPINF2

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24 (DWN: CH, CHK: GGH, APP: GGH)	Final	CLIENT: RES UK Ltd	Ritchie House, Starlaw Business Park, Livingston, West Lothian, EH54 8SF, info@greencatrenewables.co.uk, 01506 416553
DRAWING TITLE: **TRIAL PIT PHOTOGRAPHS**	Fig. No. A12	Revisions (DWN, CHK, APP)			
SCALE:					

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Trial Pit No:

TPINF3

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 25/10/24; DWN CH; CHK GGH; APP GGH	Final
DRAWING TITLE: **TRIAL PIT PHOTOGRAPHS**	Fig. No. A13	Revisions; DWN; CHK; APP	
SCALE:			

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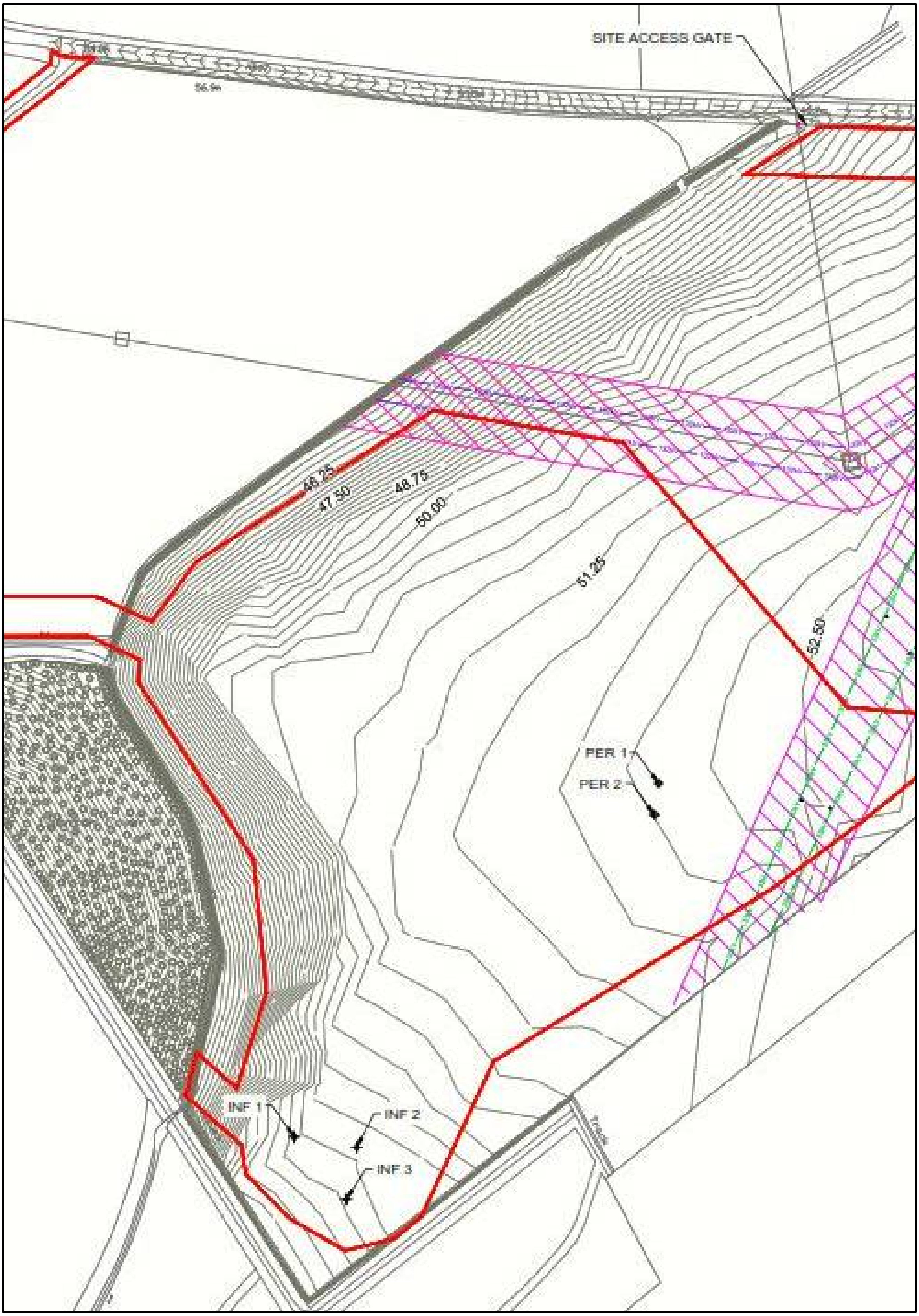

PROJECT TITLE: **BISHOPS DAL**	Contract No: 6635-1381	Date 28/10/24 DWN CHK APP GGH	CLIENT: RES UK Ltd
DRAWING TITLE: **SITE PLAN**	Fig. No. **A14**	Revisions DWN CHK APP	
SCALE:			

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Appendix D Calculations

05389-9024176 - Bishops Dal Culvert Catchment

05389-8464291 - Calculation - UK Peak Runoff Rates Culvert at Bishops Dal

05389-9024089 - Bishops Dal Culvert Design - (C786) (750mm)

05389-8464291 - Calculation - UK Peak Runoff Rates Bishops Dal

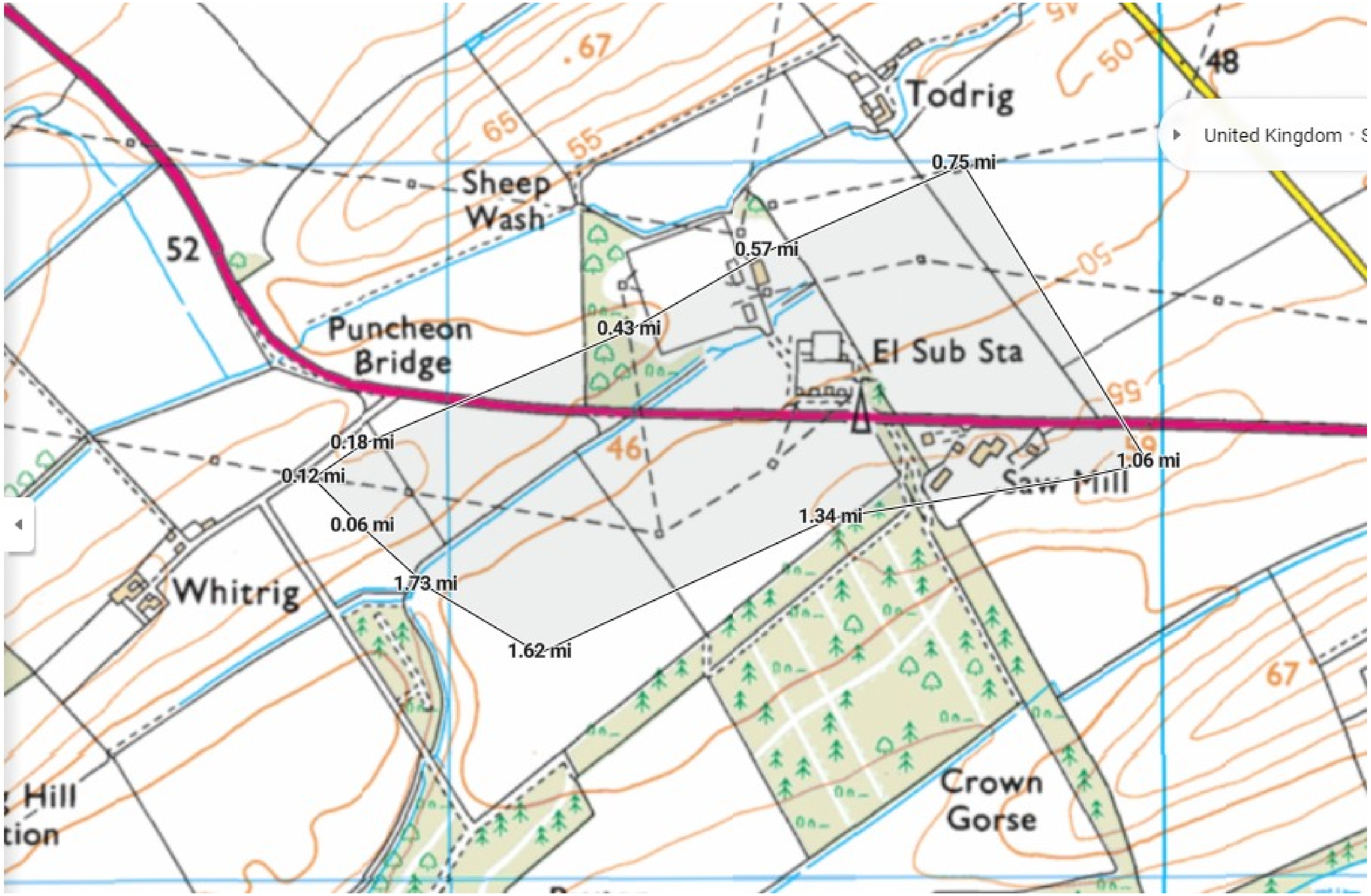
05389-8465248 - Calculation - UK Storage Volumes

Measure Distance & Area

Click or tap on the map to create a new point. Tap and drag an existing point to move it. Right-click (or tap and hold) on a point to remove it.

Distance: 1.74 mi (2.80 km)
Area: 0.14 sq mi (0.38 sq km)

Reset Edit



Calculation - UK Peak Runoff Rates - Culvert at Bishops Dal

PROJECT: Bishops Dal
PROJECT NO: 5389
REFERENCE NO: 05389-8464291

Issue	Date	Author	Checker	Nature and Location of Change
1	05/12/2024	J McAlpine	A. Poulakis	First issue

Note: revision history should include design stage, revision of load and other relevant information.

Peak Runoff Rates

This calculation will determine the peak runoff rate for a given catchment, in a certain geographic location for a select return period.

To determine peak runoff flows for a particular catchment, the modified rational method can be used to model the impervious areas and the IH124 can be used to calculate the pervious areas in accordance with CIRIA Guide C753.

1. INPUT PARAMETERS AND ASSUMPTIONS
1.1 First category of inputs - Hydrological Characteristics

	YES		Does this calculation include pervious area?
	NO		Does this calculation include impervious / semi-impervious area?
SAAR	636	mm	*Standard Average Annual Rainfall from FSR Map (see "Data" Tab)*
RP	200		*Return Period (1 in #)*
Gc	2.99		*Growth Curve Factor*
SPR	37	%	*Standard Percentage Runoff from Wallingford maps or FSR Soil maps (see "Data" Tab)*
Fc	1.35		*Climate Change Factor (refer to the hyperlink for what to choose)*

1.2 Second category of inputs - Catchment Area Characteristics

Ap	38.00	ha	*Pervious area*

2. CALCULATIONS

2.2 Second calculation section - runoff from pervious areas (IH 124 Method)

Qbar	97.58	l/s	*Mean annual greenfield peak flow - Qbar = 0.00108 x AREA $^{0.89}$ x SAAR $^{1.17}$ x SPR $^{2.17}$*
Q200	291.77	l/s	*Greenfield peak flow For a 1 in 200 year event*

Project: Bishops Dal BESS
HIVE Ref: 05389-9024089
Author: Joseph McAlpine
Checker: A Poulakis

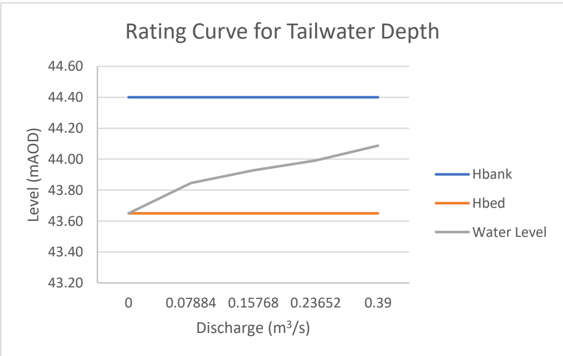
<u>Culvert Design based on C786</u>

Peak design discharge (1 in 200 year event)	Q	0.29	m^3/s	hydrological assessment
Climate change allowance uplift	cc	0.35		from local guidance
Peak design discharge (1 in 200 year event with cc)	Qcc	0.39	m^3/s	
Elevation of bed at culvert inlet	Z_{bi}	43.75	mAOD	from Topo
Elevation of bed at culvert outlet	Z_{bo}	43.65	mAOD	from Topo
Length of culvert	L	12	m	
Average channel invert width	W	0.5	m	From Topo
Average channel top of bank width	Tw	2.7	m	From Topo
Average channel depth to bank	d	0.75	m	From Topo
Mannings coefficient of channel	n	0.045		Table A7 from C786
Bedslope across culvert	1 in S	120.00		
Channel side slopes	1 in Z	1.47		

Tailwater elevation and water level

Depth of water in downstream channel (initial estimation)		0.437	m	iteration required
Depth of water in downstream channel	y_{dc}	0.437	m	
Wetted perimeter of downstream channel	P_{dc}	2.05	m	
Cross sectional area of flow in downstream channel	A_{dc}	0.50	m^2	From equation in Box 11.3 and Table A7.3
Hydraulic radius in downstream channel (A_{dc}/P_{dc})	R_{dc}	0.24	m	
Velocity in downstream channel (Q/A_{dc})	V_{dc}	0.79	m/s	
Water level of the tailwater ($Z_{bo}+y_{dc}$)	WL_t	44.09	mAOD	
Tailwater Elevation ($Z_{bo}+y_{dc}+V_{dc}^2/2g$)	H_t	44.12	mAOD	

Tailwater rating curve



Q	y (it. req)	y	Hbed	Hbank	WL
0	0.010	0.000	43.65	44.40	43.65
0.08	0.194	0.195	43.65	44.40	43.85
0.16	0.279	0.278	43.65	44.40	43.93
0.24	0.341	0.342	43.65	44.40	43.99
0.39	0.437	0.437	43.65	44.40	44.09

Fraude number and critical depth calculation

Top width	w	1.78	m	
Hydraulic mean depth	D_n	0.28	m	Equation from Table A7.3
Froude number $(V_{dc}/(gD_n)^2)$	Fr	0.48		Equation from Box 11.9
Solving for critical depth in channel		0.3		iteration required
Critical depth in channel (where Fr = 1)	$y_{dc,c}$	0.30	m	rearranged from equation in Box 11.14
Critical velocity in channel $(Q/A_{dc,c})$	$V_{dc,c}$	1.41	m/s	

Initial design

As stated in C786 Box 11.8, the initial culvert size and shape can be estimated from the tailwater depth and flow area of the downstream channel.

For free flow design, the internal height of the culvert D is at least tailwater depth plus freeboard allowance for uncertainty (y_{dc}+F) and the trial area At is tailwater area plus freeboard area obtained by extending the free surface vertically above bank level (A_{dc} + F.W) (Figure 6.17). For surcharged flow design, freeboard is omitted and the internal height is determined from site constraints while the trial area is simply A_{dc}.

Freeboard assuming 20% freeboard / silt allowance ($0.2y_{dc}$)	F	0.087	m
Trial tailwater area (A_{dc} + F.W)	A_t	0.66	m^2
Minimum culvert diameter (y_{dc} + F)	D_{min}	0.52	m

Detailed design

Diameter	D	0.75	m	
Shape		Circular		
Freeboard allowance	F	0.19	m	as per ciria guidance Fig 11.6 (D/4 for Pipe diameters 0.45m - 1.05m and D/6 for Pipe diameters 1.2m - 1.8m)
Silt allowance	s	0.19	m	as per ciria guidance Fig 11.6 (D/4 for Pipe diameters 0.45m - 1.05m and D/6 for Pipe diameters 1.2m - 1.8m)
Effective depth / diameter of barrel (D - s)	D'	0.56	m	
Culvert cross sectional area excl freeboard and siltation	A_b	0.27	m^2	Fig 11.6

Discharge Intensity

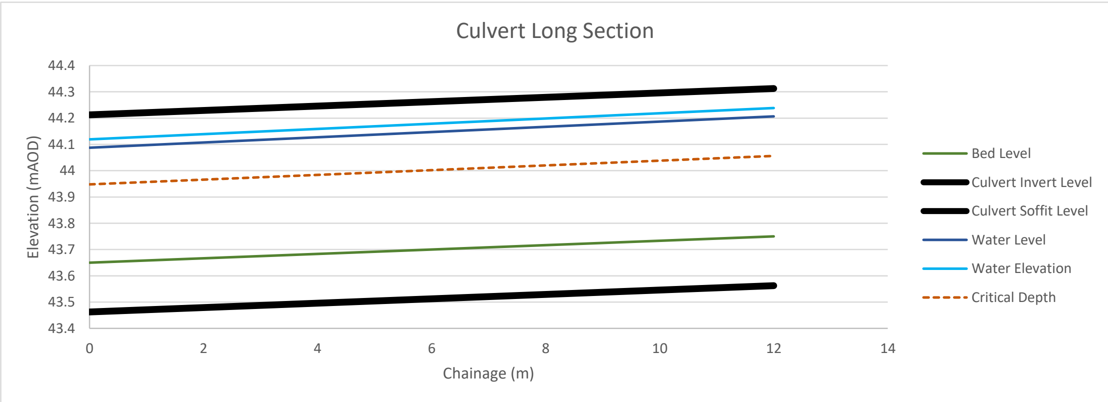
Discharge intensity ($1.811Q/A_bD^{0.5}$)	q_i	3.53		Equation in Box 11.12
Discharge intensity classification is:		Transition		free flow qi < 3.5, submerged flow qi > 4)

Headwater elevation and water level

Culvert type number		3		Table A7.5
Unsubmerged Constant	k	0.0045		Table A7.5
Unsubmerged analysis constant	M	2.00		Table A7.5
Critical depth + silt (initial estimation)		0.496		iteration required
Critical depth + silt	y_c+s	0.494	m	Rearranged equation in Box 11.14
Critical depth	y_c	0.31	m	
Specific energy at critical depth ($1.5y_c$)	Esc	0.46	m	Equation in Box 11.13
Specific energy of headwater ($Esc+D'kq_i^M-0.5D'S$)	Esh	0.49	m	Equation in Box 11.13
Headwater elevation with no screen (Z_i+E_{sh})	H_{hic}	44.24	mAOD	Equation in Box 11.12
Velocity in upstream channel ($V_{uc} = V_{dc}$)	V_{uc}	0.79	m/s	
Water level at inlet (H_{hic} - $V_{uc}/2g$)	Wl_{hic}	44.20659	mAOD	Equation in Box 11.12

Culvert dimesions based on calculations

Upstream Pipe Invert	43.56	mAOD
Upstream Pipe base (w/silt) Elevation	43.75	mAOD
Upsteam Soffit elevation	44.31	mAOD
Downstream Pipe Invert Elevation	43.46	mAOD
Downstream Pipe Base (w/ Silt) Elevation	43.65	mAOD
Downstream Soffit Elevation	44.21	mAOD



Calculation - UK Peak Runoff Rates_Bishops Dal

PROJECT: Bishops Dal
PROJECT NO: 5389
REFERENCE NO: 05389-8464291

Issue	Date	Author	Checker	Nature and Location of Change
1	05/12/2024	A. Poulakis	J McAlpine	First issue

Note: revision history should include design stage, revision of load and other relevant information.

Peak Runoff Rates

This calculation will determine the peak runoff rate for a given catchment, in a certain geographic location for a select return period.

To determine peak runoff flows for a particular catchment, the modified rational method can be used to model the impervious areas and the IH124 can be used to calculate the pervious areas in accordance with CIRIA Guide C753.

1. INPUT PARAMETERS AND ASSUMPTIONS
1.1 First category of inputs - Hydrological Characteristics

	YES		Does this calculation include pervious area?
	NO		Does this calculation include impervious / semi-impervious area?
SAAR	636	mm	*Standard Average Annual Rainfall from FSR Map (see "Data" Tab)*
RP	2.3		*Return Period (1 in #)*
SPR	37	%	*Standard Percentage Runoff from Wallingford maps or FSR Soil maps (see "Data" Tab)*
Fc	1.35		*Climate Change Factor (refer to the hyperlink for what to choose)*

1.2 Second category of inputs - Catchment Area Characteristics

Ap	2.35	ha	*Pervious area*

2. CALCULATIONS

2.2 Second calculation section - runoff from pervious areas (IH 124 Method)

Qbar	6.03	l/s	*Mean annual greenfield peak flow - Qbar = 0.00108 x AREA* $^{0.89}$ *x SAAR* $^{1.17}$ *x SPR* $^{2.17}$

Calculation - UK Storage Volumes

PROJECT:	Bishops Dal
PROJECT NO:	5389
REFERENCE NO:	05389-8465248

Issue	Date	Author	Checker	Nature and Location of Change
1	05/12/2024	A Poulakis	J. McAlpine	First issue

Note: revision history should include design stage, revision of load and other relevant information.

Attenuation Storage

1. INPUT PARAMETERS AND ASSUMPTIONS
1.1 First category of inputs - Hydrological Characteristics

m5-60	17.00	mm	*Five Year - 60 Minute Rainfall Depth*
r	0.30		*Ratio M5-60/M5-2day*
Location	S/NI		*E/W (England and Wales) or S/NI (Scotland and Northern Ireland)*
Fc	1.35		*Climate Change Factor*

1.2 Second category of inputs - Catchment Area Characteristics

Ap	0.00	ha	*Permeable Area*
Cp	0		*Permeable area runoff coefficient (see "Data" Tab)*
Ai	2.35	ha	*Impermeable Area (C= 1 assumed) (ha)*
Qa	0.00603	m^3/s	*Allowable Discharge*

2. CALCULATIONS
2.1 First calculation section - effective catchment area calculation

Ae	2.35	ha	*Effective area*

2.2 Second calculation section - calculation to dermine the m5 rainfall for various durations

m5-D calculation

D (min)	Z1	m5 - D (mm)
15.00	0.59	10.03
30.00	0.77	13.09
60.00	1.00	17.00
120.00	1.25	21.25
240.00	1.57	26.69
360.00	1.78	30.26
600.00	2.12	36.04
1440.00	2.84	48.28
2160.00	3.25	55.25
2880.00	3.50	59.50

2.3 Third calculation section - attenuation volume calculations for various durations and return periods

1 year return period calculation

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	0.68	9	216	5	211
30.00	0.69	12	285	11	274
60.00	0.69	16	374	22	353
120.00	0.70	20	474	43	430
240.00	0.71	26	604	87	517
360.00	0.72	29	692	130	561
600.00	0.73	36	837	217	620
1440.00	0.75	49	1146	521	625
2160.00	0.75	56	1322	781	540
2880.00	0.76	61	1430	1042	388

5 year return period calculation

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	1.03	14	328	5	322
30.00	1.02	18	425	11	414
60.00	1.02	23	550	22	528
120.00	1.02	29	688	43	644
240.00	1.02	37	864	87	777
360.00	1.02	42	979	130	849
600.00	1.02	50	1166	217	949
1440.00	1.02	66	1562	521	1041
2160.00	1.05	78	1835	781	1054

2880.00	1.07	86	2025	1042	983

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	1.19	16	379	5	373
30.00	1.20	21	497	11	486
60.00	1.20	27	645	22	623
120.00	1.19	34	801	43	757
240.00	1.18	43	999	87	912
360.00	1.18	48	1133	130	1002
600.00	1.17	57	1342	217	1125
1440.00	1.16	76	1779	521	1258
2160.00	1.17	87	2050	781	1269
2880.00	1.18	95	2227	1042	1185

10 year return period calculation

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	1.49	20	474	5	469
30.00	1.49	26	620	11	609
60.00	1.49	34	801	22	779
120.00	1.47	42	991	43	948
240.00	1.45	52	1231	87	1145
360.00	1.44	59	1385	130	1255
600.00	1.43	69	1630	217	1412
1440.00	1.38	90	2114	521	1593
2160.00	1.37	102	2404	781	1622
2880.00	1.37	110	2587	1042	1545

30 year return period calculation

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	1.97	27	627	5	621
30.00	1.98	35	821	11	810
60.00	1.96	45	1057	22	1035
120.00	1.92	55	1294	43	1251
240.00	1.88	68	1589	87	1502
360.00	1.85	75	1774	130	1644
600.00	1.80	88	2060	217	1843
1440.00	1.73	113	2648	521	2127
2160.00	1.70	127	2981	781	2200
2880.00	1.69	135	3182	1042	2140

100 year return period calculation

D (min)	Z2	MT-10 (mm)	Inflow Vol m^3	Outflow vol (m^3)	Att Volume
15.00	2.25	30	716	5	711
30.00	2.26	40	937	11	926
60.00	2.24	51	1206	22	1184
120.00	2.19	63	1473	43	1430
240.00	2.12	76	1798	87	1711
360.00	2.09	85	2004	130	1873
600.00	2.02	98	2314	217	2097
1440.00	1.93	126	2957	521	2436
2160.00	1.89	141	3318	781	2536
2880.00	1.87	150	3531	1042	2489

200 year return period calculation

3. RESULTS

Att 1	625	m^3	*Attenuation volume required in a 1 in 1 year event*
Att 5	1054	m^3	*Attenuation volume required in a 1 in 5 year event*
Att 10	1269	m^3	*Attenuation volume required in a 1 in 10 year event*
Att 30	1622	m^3	*Attenuation volume required in a 1 in 30 year event*
Att 100	2200	m^3	*Attenuation volume required in a 1 in 100 year event*
Att 200	2536	m^3	*Attenuation volume required in a 1 in 200 year event*