AECOM

Tillbridge Solar Project
EN010142

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Environmental Statement
Appendix 10-4: Outline Drainage Strategy
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tillbridgesolar.com

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@: info@tillbridgesolar.com T: 0800 046 9643

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1. Introduction

1.1 Scheme Description and Background

1.1.1 The Tillbridge Solar Project (the Scheme) will comprise the construction, operation (including maintenance), and decommissioning of ground-mounted solar photovoltaic (PV) arrays. The Scheme will also include associated development to support the solar PV arrays.

1.1.2 The Scheme is made up of the Principal Site, the Cable Route Corridor and works to the existing National Grid Cottam Substation. The Principal Site comprises the solar PV arrays, electrical substations, grid balancing infrastructure, cabling and areas for landscaping and ecological enhancement.

1.1.3 The associated development element of the Scheme includes but is not limited to access provision; a Battery Energy Storage System (BESS), to support the operation of the ground mounted solar PV arrays; the development of on-site substations; underground cabling between the different areas of solar PV arrays; and areas of landscaping and biodiversity enhancement.

1.1.4 The Scheme also includes a 400kV underground Cable Route Corridor of approximately 18.5km in length connecting the Principal Site to the National Electricity Transmission System (NETS) at the existing National Grid Cottam Substation. The Scheme will export and import electricity to the NETS.

1.1.5 A full description of the Scheme is included in **Chapter 3: Scheme Description** of the Environmental Statement (ES) **[EN010142/APP/6.1]**. An overview of the Scheme and its environmental impacts is provided in the Environmental Statement **Non-Technical Summary [EN010142/APP/6.4]**.

1.1.6 AECOM has been commissioned to prepare an **Outline Drainage Strategy** as an Appendix to **Chapter 10: Water Environment** of the ES **[EN010142/APP/6.1]** in relation to the Development Consent Order (DCO) application for the construction, operation and decommissioning of the Scheme, located 13km north of the city of Lincoln, near Gainsborough, Lincolnshire, UK.

1.1.7 The Scheme will consist of the following infrastructure:

a. Solar PV infrastructure consisting of solar PV panels and mounting structures (also known as solar modules);

b. Solar Stations (invertor, transformer and switchgear);

c. Battery Energy Storage System (BESS);

d. Battery Direct Current (DC)/DC convertors;

e. On-site cabling;

f. On-site sub-stations;

g. Solar farm control building;

h. Equipment storage;

i. Fencing, security and lighting;

j. Site access and access tracks;

k. Surface water drainage; and

l. Electricity connection to National Grid via Cable Route Corridor. The Tillbridge circuit will be connected to an existing free bay at Cottam sub-station.

1.1.8 The Order limits of the Scheme have two sections:

a. 'The Principal Site', which is the location where ground mounted solar photovoltaic (PV) panels, electrical sub-stations and energy storage facilities will be installed; and

b. 'The Cable Route Corridor', which will comprise the underground electrical infrastructure required to connect the Principal Site to national transmission system.

1.1.9 The Principal Site is located within the county of Lincolnshire and falls within the administrative area of West Lindsey District Council.

1.1.10 The Principal Site covers an area of approximately 1,350 hectares. The Principal Site consists mostly of greenfield agricultural land, with some rural dwellings as well as agricultural buildings dispersed across the area. The topography of the Principal Site is relatively flat with many small watercourses and drainage ditches running across it.

1.1.11 This **Outline Drainage Strategy** solely relates to the outline drainage design of the Principal Site, with regards to handling surface water generated by new impermeable areas within the Principal Site. It will only consider the drainage of the Principal Site during operation.

1.1.12 No drainage design is proposed for the Cable Route Corridor during operation, as this is deemed to not contribute any additional runoff as the cables will be buried below ground, and the above ground routes will be restored to greenfield conditions.

1.1.13 The **Framework Construction Environment Management Plan (CEMP) [EN010142/APP/7.8]** provides detail on management of surface water runoff during the construction phase, including for the Cable Route Corridor. During decommissioning, measures for the management of surface water runoff are set out within the **Framework Decommissioning Environmental Management Plan (DEMP) [EN010142/APP/7.10]**.

1.1.14 The following stakeholders have been consulted in producing this strategy:

a. Lead Local Flood Authority – Lincolnshire County Council.

b. The Environment Agency.

c. Scunthorpe & Gainsborough Water Management Board.

d. Upper Witham Internal Drainage Board (IDB),

e. Trent Valley IDB (now part of the newly formed Water Management Consortium (WMC)).

1.1.15 A meeting was held with the stakeholders listed above on the 4 September 2023 to discuss the proposed drainage strategy. During the meeting stakeholders confirmed they agreed in principle with the drainage strategy presented. The minutes from the meeting are included in **Appendix 10-5** of this ES **[EN010142/APP/6.2]**.

1.2 Design Assumptions

1.2.1 The following design assumptions have been used to produce this strategy:

a. The solar PV panels will be raised from the ground, allowing rainfall/runoff to infiltrate into the ground beneath the panels. Therefore, the solar PV panels will not lead to a substantive increase in impermeable area within the Principal Site. The drainage regime of the solar PV panel areas is therefore assumed to remain consistent with its pre-developed state.

b. New access roads will be permeable. Therefore, the Principal Site's access roads will not lead to an increase in impermeable area. The drainage regime of the access roads is therefore assumed to remain consistent with its pre-developed state.

c. At this early design stage, the new impermeable areas on site, namely the BESS and Solar Station areas, solar farm control centre, equipment storage and on-site substations spread throughout the Principal Site are considered 100% impermeable as a worst-case scenario. It has also been assumed 100% of the runoff from these areas will contribute to the drainage system, and therefore a Volumetric Runoff Coefficient (Cv) of 1 has been used.

d. The drainage system for new impermeable areas has been designed to accommodate the 1 in 100-year storm, plus a 40% allowance for an increase in peak rainfall intensity due to climate change.

e. The discharge of surface water for new impermeable areas via infiltration is unlikely to be viable due to ground conditions. This will be confirmed with on-site Ground Investigation works during detailed design following DCO consent. These works will consist of infiltration testing and groundwater monitoring to confirm the viability of an infiltration drainage scheme.

f. All swale features will avoid all archaeological sites and sensitive sites.

g. Flood Estimation Handbook (FEH) data has been used for this assessment.

2. Supporting Information

2.1 Flood Risk

2.1.1 The potential flood risk to the Scheme is summarised in **Table 1** below. For further detail on the Scheme's potential flood risk, refer to **Appendix 10-3: Flood Risk Assessment** of this ES **[EN010142/APP/6.2]**.

Table 1: Flood risk summary for Principal Site only

Flood Risk Source	Pre-Scheme Flood Risk Level	Post-Scheme Flood Risk Level	Comments
Fluvial	Low (majority of Principal Site)	Low (majority of Principal Site)	Discharge from impermeable areas detailed in the Drainage Strategy are to be restricted to Greenfield rates, mitigating increases to peak river flow rates. Solar PV Panel infrastructure within Flood Zones 2/3 are not envisaged to alter the existing flood extents' topography and are proposed to be installed to enable sufficient freeboard during the worst case flooding scenarios. No material change to flood risk level.
Tidal	Low (Principal Site)	Low (Principal Site)	No change to flood risk level.
Pluvial (surface water)	Low	Low	Increased surface water runoff is proposed to be managed to mimic the pre-Scheme conditions for up to and including the 1 in 100 + 40% climate change event. No material change to flood risk level.
Ground water	Low	Low	This **Outline Drainage Strategy** does not propose to utilise infiltration techniques to discharge increased surface water runoff from impermeable areas. No material change to flood risk level.
Sewers	Low	Low	No change to flood risk level.
Artificial sources	Low (majority of Principal Site)	Low (majority of Principal Site)	No change to flood risk level.

2.2 Existing Surface Water Drainage

2.2.1 The area within the Principal Site Order limits is largely greenfield. It consists of mainly agricultural fields (arable) with smaller areas of individual trees, hedgerows, tree belts (linear), small woodlands, watercourses, and ditches. A topographic survey across the site has confirmed the location of watercourses and ditches across the Principal Site. At detailed design stage further topographic and drainage surveys may be required to determine if there are any additional watercourses or ditches across the Principal Site not picked up in the topographic survey.

2.2.2 There is currently no known formal piped surface water drainage system within the Principal Site. It is assumed that for low intensity rainfall events, rainfall would infiltrate to ground where it lands. For rainfall events where rainfall intensity exceeds the local rate of infiltration, it is assumed that any runoff generated would naturally drain to the watercourses and ditches within the Principal Site.

2.2.3 No details on any field drainage systems have been provided at this stage. If any existing field drainage systems are present on the Principal Site, they must not be compromised as a result of the Scheme.

2.3 Geology and Hydrogeology

2.3.1 The bedrock and superficial geology for the area has been identified from mapping produced by the British Geological Survey.

2.3.2 The mapping indicates the majority of the Bedrock geology within the Principal Site is Marlstone Rock Formation and Scunthorpe Mudstone Formation with smaller areas of Charmouth Mudstone Formation, Penarth Group, and Mercia Mudstone Group bedrock formations.

2.3.3 The mapping indicates the Principal Site lies within various superficial deposit types, the majority of which is Till, Mid Pleistocene with smaller areas of Alluvium and Glaciofluvial Deposits, Mid Pleistocene.

2.3.4 The Soilscape map viewer, describes the soils beneath the Principal Site as *'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils'* with *'Impeded drainage'* properties.

2.3.5 The West Lindsey District Council Strategic Flood Risk Assessment (SFRA) details that groundwater flooding is not considered to be a significant flood risk within West Lindsey, therefore the chances of high ground water are likely to be low within the Principal Site.

2.3.6 The Principal Site is not located within a Source Protection Zone.

3. Proposed Surface Water Drainage Strategy

3.1 Overview

3.1.1 As the Principal Site is largely a greenfield site, it is considered that rainfall will currently permeate into the ground where it falls, and that any runoff generated within arable fields collects in local low spots where it naturally infiltrates to ground or enters a watercourse. The proposed Surface Water Drainage Strategy aims to mimic the natural drainage conditions of the Principal Site as far as possible.

3.1.2 The proposed solar PV panels will be held above ground level, typically on narrow piles with a total combined cross sectional area of less than $0.01m^2$ per panel. This prevents sealing the ground with an impermeable surface beneath the solar panels, allowing rainfall/runoff to infiltrate to ground throughout the Principal Site. As a result, it is considered that the Principal Site's impermeable area within solar PV panel areas will remain substantively consistent to its pre-development state. Despite not contributing towards the impermeable areas, in order to limit the potential for channelisation from rainfall dripping of the end of the panels, the areas between, under and surrounding the solar PV panels will be planted with native grassland and wildflower mix. This planting will intercept and absorb rainfall running off the panels, preventing it from concentrating and potentially forming channels in the ground.

3.1.3 New access roads will be permeable, in accordance with paragraph 2.10.85 from the NPS EN-3 (Ref. **1**). Therefore, the Principal Site's access roads will not lead to an increase in impermeable area. The drainage regime of the access roads is therefore assumed to remain consistent with its pre-developed state.

3.1.4 The BESS and Solar Station areas, Solar Farm Control Centre, equipment storage and on-site substations spread across the Principal Site are assumed to be 100% impermeable. In order to drain surface water from these proposed impermeable areas, it is proposed to construct a swale around the BESS (or groups of BESS), solar farm control centre, equipment storage and on-site substation areas, in accordance with paragraph 2.10.85 from the NPS EN-3 (Ref. **1**). The swale will collect and treat surface water before discharge. Paragraph 056 of the Planning Practice Guidance for Flood Risk and Coastal Change (Ref. **2**) states that the surface water should be discharged in the following hierarchy – into the ground (infiltration); to a surface water body; to a surface water sewer, highway drain, or another drainage system; to a combined sewer. Due to the current understanding of the ground conditions within the Principal Site, it is unlikely that runoff from the impermeable areas will be able to discharge via infiltration. Therefore, surface water is proposed to be discharged to local watercourses. The discharge to these watercourses will be maintained at existing greenfield runoff rates by restricting rates using a flow control. The flow control will use a restriction on the outlet of the swale which will hold water back within the swale and release it at a controlled rate.

3.1.5 In accordance with Paragraph 056 of the Planning Practice Guidance for Flood Risk and Coastal Change, rainwater harvesting should also be considered as part of the drainage strategy. During detailed design stage following DCO consent the use of rainwater harvesting for non-potable water supplies for operational buildings will be investigated.

3.1.6 Swales will be lined with an impermeable membrane or similar to prevent any pollution associated with fire water runoff from entering the ground. Penstock valves will also be used in the event of a fire to prevent any pollution associated with fire water runoff from entering the local watercourses without prior testing.

3.1.7 Solar panels may be located above swales. In order to maintain the height of the panels when located above a swale the panel legs will be extended to the base of the swale.

3.1.8 In the event of an extreme event, which is an event greater than the design event, the drainage system will likely become inundated and overtop. In this scenario exceedance flows will be generated from the drainage system and will flow overland. To intercept these exceedance flows it is proposed to install perimeter swales within low laying areas on the edge of certain fields with an outfall to the nearest watercourse.

3.1.9 Outfalls from swales and perimeters swales have been made to the nearest watercourse identified in the topographic survey. During detailed design stage further drainage survey work should be undertaken to determine if there are any additional watercourses or ditches suitable for connection that were not identified within the topographic survey, with the intent of shortening drainage runs from swale to watercourse where possible.

3.1.10 Where possible, surface water will drain from the Scheme's swale based drainage system to local receiving watercourses via a new open green ditch. If a pipe system is required, the piped section will be shortened and the last 10m section of the outfall route will be open green ditch wherever possible, unless this affects maintenance of the watercourse by the IDB.

3.2 Contributing Areas

3.2.1 The new impermeable areas within the Principal Site are related to the BESS and Solar Stations areas, Solar Farm Control Centre, equipment storage and on-site substations. The proposed impermeable areas associated with these are 0.176ha per BESS and Solar Station area and 1.272ha per substation. The solar farm control centre and equipment storage are linked together to give a total area of 0.150ha. BESS and Solar Station areas are spread across the site and can be located individually or in groups of up to six. There are two separate on-site substations in the Principal Site. The Solar Farm Control Centre and equipment storage are linked together in one place at the centre of the Principal Site. All these features are considered 100% impermeable, with 100% of the runoff contributing to the drainage system, therefore a Volumetric Runoff Coefficient (Cv) of 1 has been used in this design.

3.3 Greenfield Runoff Rates

3.3.1 The equivalent greenfield runoff rates for the impermeable areas have been calculated for the Principal Site using the FEH method within HR Wallingford's UKSuDS Greenfield Runoff Rate Estimation tool, based on the proposed contributing impermeable area. Refer to **Annex A** for the calculated rates. These rates are also shown in **Tables 2**, **3** and **4** below.

Table 2: Greenfield Discharge Rates for BESS and solar station areas in Catchment A and B

Return Period (years)	Discharge Rate (l/s) (0.176 ha)
1	0.46 (Catchment A) 0.44 (Catchment B)
Qbar	0.55 (Catchment A) 0.53 (Catchment B)
30	1.11(Catchment A) 1.06 (Catchment B)
100	1.42(Catchment A) 1.36 (Catchment B)

Table 3: Greenfield Discharge Rates for Substation (Catchment B only)

Return Period (years)	Discharge Rate (l/s) (1.272 ha)
1	3.17
Qbar	3.81
30	7.63
100	9.80

Table 4: Greenfield Discharge Rates for solar farm control centre and equipment storage (Catchment A only)

Return Period (years)	Discharge Rate (l/s) (0.150 ha)
1	0.37
Qbar	0.45
30	0.9
100	1.16

3.4 Proposed Attenuation

3.4.1 Attenuation will be required, within the Principal Site, to temporarily store surface water runoff generated from the impermeable areas before it is discharged to the surrounding watercourses at the restricted greenfield rate. Attenuation will be provided in the form of swales surrounding three sides of the BESS and solar station (if located on its own) or surrounding three side of a group of BESS and Solar Stations. On-site substations and the combined Solar Farm Control Centre and equipment storage will also have a swale surrounding three sides.

3.4.2 In order to calculate the size of the attenuation for the Principal Site, the rainfall data to be used needs to be defined. Flood Estimation Handbook (FEH) data has been used and, due to the size of the Principal Site, two FEH catchments have been used. Catchment A is broadly associated with the River Eau and catchment B is broadly associated with the River Till. These are labelled as catchment A and catchment B as shown in **Plate 1** below.

Plate 1 – FEH catchments within Principal Site boundary

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3.4.3 Based on DEFRA online climate change allowance tool, both the Lower Trent and Erewash Management Catchment and the Witham Management Catchment (which are both contained within the Principal Site) require a 40% uplift for rainfall intensity associated with the 1 in 100-year event based on using the upper end allowance.

3.4.4 The attenuation features for the impermeable areas have been sized to accommodate the 1 in 100-year event plus a 40% allowance for climate change. The discharge from the swale has been restricted to the greenfield QBAR rate. The required storage volume was determined using the MicroDrainage ‘Quick Storage Estimate’ tool. The ‘Quick Storage Estimate’ tool provides an upper and lower estimate for the storage volume required, as shown in Annex B. The median value of the upper and lower estimates will be used to size the attenuation. The volume requirements are detailed in the **Table 5** below.

Table 5: Attenuation Volume Requirements

Feature	Attenuation Volume Required (m^3) Catchment A	Attenuation Volume Required (m^3) Catchment B
Single BESS and solar station	191*	205*
On-site substation	NA (No on-site substations in catchment A)	1465
Combined solar farm control centre and equipment store	164	(Not in Catchment B)

** Total attenuation requirements for BESS and solar station areas discussed further in fire water runoff section*

3.4.5 In addition to the attenuation requirements for regular surface water runoff during normal operation, the swale will also be required to store fire water runoff in the event of a fire. The impact on attenuation requirements as a result of fire water runoff storage are discussed further in the Fire Water Runoff section of this **Outline Drainage Strategy**.

3.4.6 In areas of the Principal Site where BESS and solar station sites are grouped together, the attenuation requirements of the swale around them will be increased proportionately.

3.4.7 This required storage volume will be provided in the form of swales around 3 sides of the impermeable area. Swales will be approximately 0.6m deep with 1 in 3 side slopes.

3.5 Water Quality

3.5.1 To assess the risk to receiving watercourses, an assessment has been undertaken of the proposed surface water drainage system in accordance with the Simple Index Approach as detailed within CIRIA C753 - The SuDS Manual (Ref. 3). This method determines the pollution hazard level of the land use proposed and then assesses the level of treatment the proposed drainage system will provide to ensure it provides sufficient water quality mitigation. In order to pass the Simple Index Approach the following condition must be met for each of the three pollutants (Total Suspended Solids, Metals and Hydrocarbons) considered in this approach –

Total SuDS Mitigation Index ≥ Pollution Hazard Index

3.5.2 The impermeable areas within the Principal Site consist of the BESS and Solar Stations, the on-site substations and the combined Solar Farm Control Centre and equipment store. In accordance with the SuDS Manual this land use is best defined as ‘commercial/industrial’ roofs. **Table 6** below details the pollution hazard indices associated with this land use. **Table 7** below lists the mitigation indices associated with the swale. These values demonstrate the Simple Index Approach (SIA) condition is met for each of the pollutants as the mitigation indices are higher than the hazard indices. Therefore, the proposed swales surrounding the BESS and Solar Stations, on -site substations and the combined solar farm control centre and equipment store are sufficient to treat the runoff from these areas.

Table 6: Pollution Hazard Indices for impermeable areas

Land use	Pollution Hazard Indices			
	Pollution Hazard Level	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Other roof (typically commercial/industrial roofs)	Low	0.3	0.2	0.05

Table 7: Mitigation Indices for impermeable area swales

Type of SuDS Component	Mitigation indices		
	TSS	**Metals**	**Hydrocarbons**
Swales	0.5	0.6	0.6

3.5.3 The access roads will not contribute any additional impermeable area to the Principal Site, but they will be trafficked and therefore they have the potential to pollute the watercourses within the Principal Site. The perimeter swales will be used to capture any pollutants from the access roads before discharging to the watercourses. **Table 8** and **Table 9** below list the pollutant hazard indices and mitigation indices used as part of the Simple Index Approach (SIA) and demonstrates the proposed perimeter swales are sufficient to treat the runoff from the access roads.

Table 8: Pollution Hazard Indices for access road

Land use	Pollution Hazard Indices			
	Pollution Hazard Level	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Low Traffic roads and non-residential car parking with infrequent change (i.e. <300 traffic movements/day)	Low	0.5	0.4	0.4

Table 9: Mitigation Indices for access road swales

Type of SuDS Component	Mitigation indices		
	TSS	Metals	Hydrocarbons
Perimeter Swales	0.5	0.6	0.6

3.5.4 Firefighting water, and its potential contaminants, is not included in this section as any fire water applied to BESS and Solar Station areas would be contained within the swale and removed from the Principal Site via controlled methods (e.g. tanker) if found to be polluted following testing (refer to **Section 3.9** for further details).

3.6 Exceedance Flows

3.6.1 The proposed surface water drainage network has been designed to accommodate runoff from all storms up to and including the 100 year +40% return period. For storm events in advance of this, exceedance flows that cannot be retained by the proposed attenuation will flow overland, following the existing topography and natural flow paths. To intercept these exceedance flows it is proposed to install perimeter swales within low laying areas on the edge of certain fields with an outfall to the nearest watercourse.

3.7 Amenity and Ecological Value of SuDS Features

3.7.1 SuDS features will not be on publicly accessible land. Consequently, the potential amenity benefit provided by the proposed drainage is not considered relevant to the design. The design of the drainage, however, will be discrete so that is does not hinder the aesthetic value of the Principal Site.

3.7.2 Incorporating swales within the Principal Site provides an opportunity to add ecological value to the Principal Site. Opportunities for biodiversity enhancements such as this will be explored further as the Principal Site design is refined and progressed through detailed design.

3.8 Impact of Sites of Special Scientific Interest (SSSI) Sites

3.8.1 There are no SSSIs, Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Local Wildlife Sites (LWSs), scheduled monuments or listed buildings within the Principal Site Order limits.

3.9 Fire Water Runoff

3.9.1 The BESS areas require fire water tanks to supress a fire, should one break out. The BESS containers will contain an internal fire suppression system, with a sump to contain any water used in the event of an internal fire. This water will not be directed to the surrounding swales.

3.9.2 Fire water runoff from any external events may contain particles from a fire. In the unlikely event of fire water being discharged, the runoff will be contained and tested/treated before being allowed to discharge to the local watercourses.

3.9.3 It is proposed to contain the external fire water runoff within the swale surrounding the BESS, where it can be held and tested before either being released into the surrounding watercourses (if found to have no contaminants present, or contaminants that are within acceptable legal limits) or taken off site by a tanker for treatment elsewhere. The swale will then be cleaned of all contaminants. Testing of emissions is discussed in more detail in Appendix 17-5 of **Chapter 17: Other Environmental Topics** of the Environmental Statement (ES) **[EN010142/APP/6.1],** and the **Framework Battery Safety Management Plan [EN010142/APP/7.13]** discusses fire management in more detail.

3.9.4 The swale will be underlain with an impermeable liner to prevent any contaminants entering the ground.

3.9.5 The swale will be controlled by a penstock valve that can be closed before a fire is put out. The penstock valves will be located in proximity to the access road so they can be easily reached in the event of a fire. They will also be located to the west of the BESS/ on-site substation wherever possible to reduce the potential of their operation being affected by the prevailing wind conditions directing a potential fire towards the penstock.

3.9.6 National Fire Chiefs Council (NFCC) guidance (Ref. **4**) has been used to determine the volume storage of fire water runoff. The NFCC guidance states firefighting supplies *'should be capable of delivering no less than 1,900 litres per minute for at least 2 hours'*. On top of this supply requirement, a 30% additional capacity has been applied for storage in the swale. This equates to approximately 300m^3. It should be noted that the 300m^3 storage is required for each group of BESS (i.e. 300m^3 will be required if there is one BESS on its own or five BESS grouped together). This is based on the likely scenario that, in the event of a fire, only one BESS would be on fire at any given time.

3.9.7 By using the swale for fire water storage as well as surface water storage, there is the potential that, in the event of a fire, the swale may already contain surface water and reduce the capacity for fire water storage. Therefore, the swale will be sized to serve both purposes. It is considered overly conservative to provide the required fire water storage on top of the 1 in 100 year + 40% storage already provided, as it is extremely unlikely a fire will occur at the same time as the 1 in 100 year event. Therefore, taking a pragmatic approach, an allowance has been made that a 1 in 1 year event could occur at the same time as a fire. Therefore, the swale will need to contain the 1 in 1 year event plus the fire water storage runoff or the 1 in 100 year + 40% event, whichever is greater (thereby providing for the worst case scenario).

3.9.8 In order to determine the attenuation volume required, a quick storage estimate calculation was made for a single BESS based on the 1 in 1 year event (see **Annex B**), which gave a value of 31m^3. A comparison was then made between the 1 in 1 year plus fire water storage and the 1 in 100 year +

40% event for each BESS configuration in catchment A and B. See **Table 10** and **Table 11** below, which highlight (in green highlight) the worst-case storage provided in the design for each BESS size configuration, for each catchment.

Table 10: Attenuation storage for Catchment A

	Attenuation storage (m3)			
Number of BESS	1 in 1 year	1 in 100 year + 40%	Fire water storage	Total
1 BESS	31		300	331
		191		191
2 BESS	62		300	362
		382		382
3 BESS	93		300	393
		573		573
4 BESS	124		300	424
		764		764
5 BESS	155		300	455
		955		955
6 BESS	186		300	486
		1146		1146

Table 11: Attenuation storage for Catchment B

	Attenuation storage (m3)			
Number of BESS	1 in 1 year	1 in 100 year + 40%	Fire water storage	Total
1 BESS	31		300	331
		205		205
2 BESS	62		300	362
		410		410
3 BESS	93		300	393
		615		615
4 BESS	124		300	424
		820		820
5 BESS	155		300	455
		1025		1025
6 BESS	186		300	486
		1230		1230

3.9.9 The worst case storage volumes as detailed within **Table 10** and **Table 11** above have then been provided within the swales as part of the drainage design for the Principal Site. A breakdown of the storage volumes provided by the swales within each field across the Principal Site is detailed in **Annex C** confirming that these storage volume requirements have been met. The location of swales is shown in the **Outline Drainage Strategy** drawings in **Annex D**.

3.9.10 The volume requirements for containment of fire water runoff within the swale and its configuration are subject to agreement with the Fire and Rescue Service.

4. Proposed Foul Water Drainage Strategy

4.1.1 Once the Principal Site is operational, foul water drainage will only be required for the proposed equipment storage and control building. This building will only be used by a small number of staff, therefore the anticipated foul flows from the building will be low. It is understood both Severn Trent Water and Anglian Water have public sewers within the Principal Site, however following a review of asset records for both companies there are no public sewers within at least 200m of the building. Due to the low flows and no public sewers being present in the vicinity of the building, the foul water flows will be dealt with via a cesspit.

5. Adoption and Maintenance

5.1.1 The proposed Drainage Strategy will be maintained by the Applicant, or another private operator to be confirmed and secured through the DCO. All proposed drainage features should be maintained according to standard practice.

6. References

Ref. 1 Department for Energy Security and Net Zero (November 2023). National Policy Statement for Renewable Energy Infrastructure (EN-3).

Ref. 2 Department of Communities and Local Government (2014, updated August 2022) National Planning Practice Guidance: Flood Risk and Coastal Change.

Ref. 3 CIRIA (2015) Report C753 The SuDS Manual 2nd Edition.

Ref. 4 National Fire Chiefs Council (2022) Grid Scale Battery Energy Storage System planning – Guidance for FRS. Available at: [redacted] Accessed 25 September 2023]

Annex A – Greenfield Runoff Rate

Greenfield runoff rates for single BESS in Catchment A

Site characteristics

Total site area (ha):	0.176

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.350
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	595	601
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		0.55
1 in 1 year (l/s):		0.46
1 in 30 years (l/s):		1.11
1 in 100 year (l/s):		1.42
1 in 200 years (l/s):		1.68

Greenfield runoff rates for single BESS in Catchment B

Site characteristics

Total site area (ha):	0.176

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.350
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	595	592
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		0.53
1 in 1 year (l/s):		0.44
1 in 30 years (l/s):		1.06
1 in 100 year (l/s):		1.36
1 in 200 years (l/s):		1.6

Greenfield runoff rates for Substation (Catchment B only)

Site characteristics

Total site area (ha):	1.272

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.350
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	595	592
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		3.81
1 in 1 year (l/s):		3.17
1 in 30 years (l/s):		7.63
1 in 100 year (l/s):		9.8
1 in 200 years (l/s):		11.59

Greenfield runoff rates for combined solar farm control centre and equipment store (Catchment A only)

Site characteristics

Total site area (ha):	0.15

Methodology

Q_{MED} estimation method:	Calculate from BFI and SAAR
BFI and SPR method:	Specify BFI manually
HOST class:	N/A
BFI / BFIHOST:	0.350
Q_{MED} (l/s):	
Q_{BAR} / Q_{MED} factor:	1.12

Hydrological characteristics

	Default	Edited
SAAR (mm):	595	592
Hydrological region:	4	4
Growth curve factor 1 year:	0.83	0.83
Growth curve factor 30 years:	2	2
Growth curve factor 100 years:	2.57	2.57
Growth curve factor 200 years:	3.04	3.04

Notes

(1) Is Q_{BAR} < 2.0 l/s/ha?

When Q_{BAR} is < 2.0 l/s/ha then limiting discharge rates are set at 2.0 l/s/ha.

(2) Are flow rates < 5.0 l/s?

Where flow rates are less than 5.0 l/s consent for discharge is usually set at 5.0 l/s if blockage from vegetation and other materials is possible. Lower consent flow rates may be set where the blockage risk is addressed by using appropriate drainage elements.

(3) Is SPR/SPRHOST ≤ 0.3?

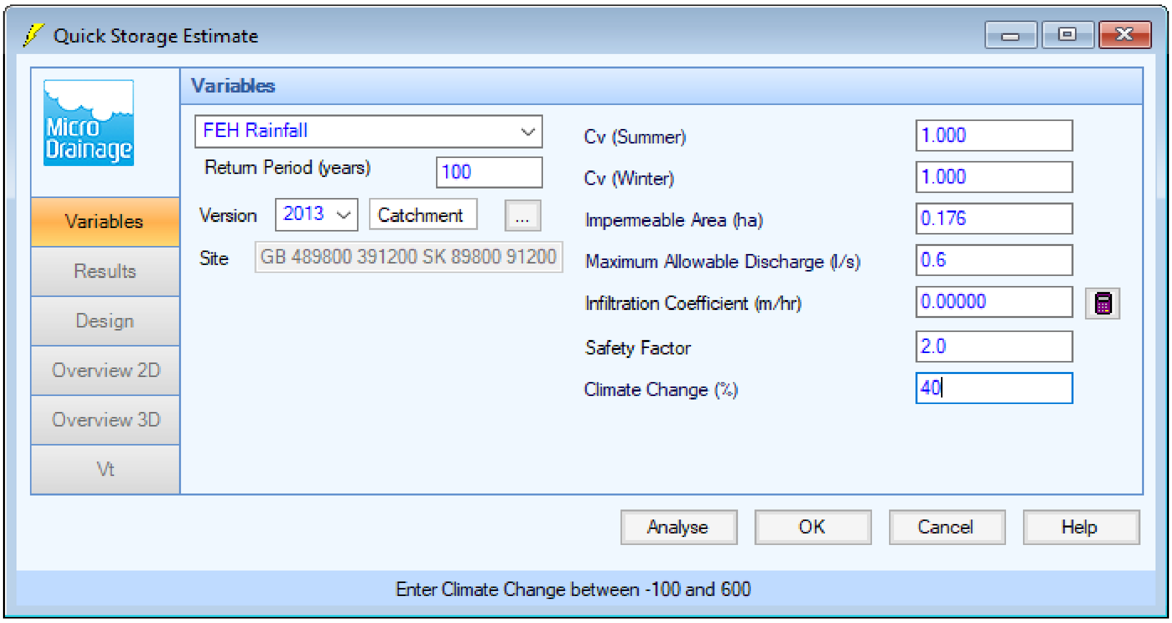
Where groundwater levels are low enough the use of soakaways to avoid discharge offsite would normally be preferred for disposal of surface water runoff.

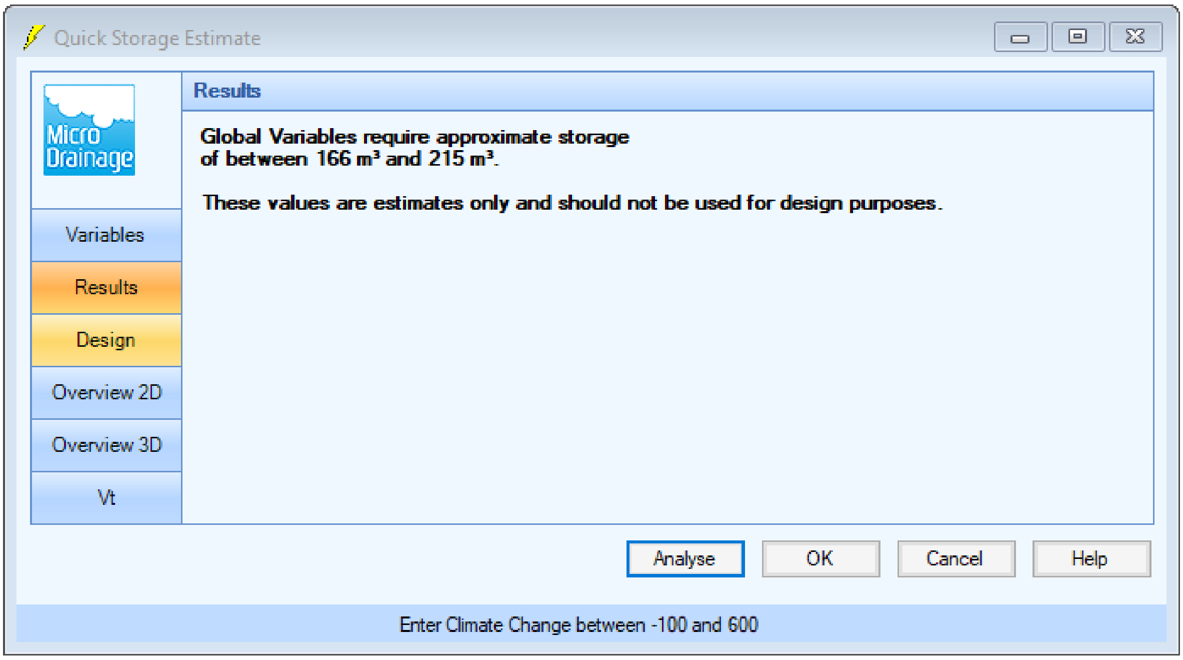
Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):		0.45
1 in 1 year (l/s):		0.37
1 in 30 years (l/s):		0.9
1 in 100 year (l/s):		1.16
1 in 200 years (l/s):		1.37

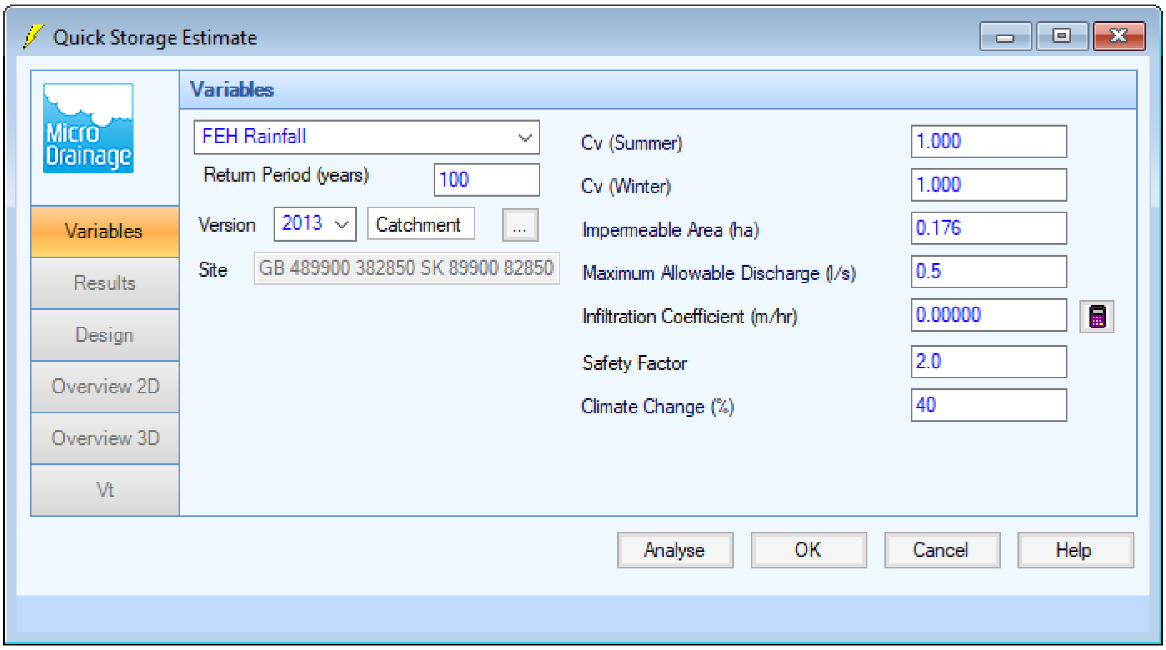
Annex B – Microdrainage Quick Storage Estimates for Swales

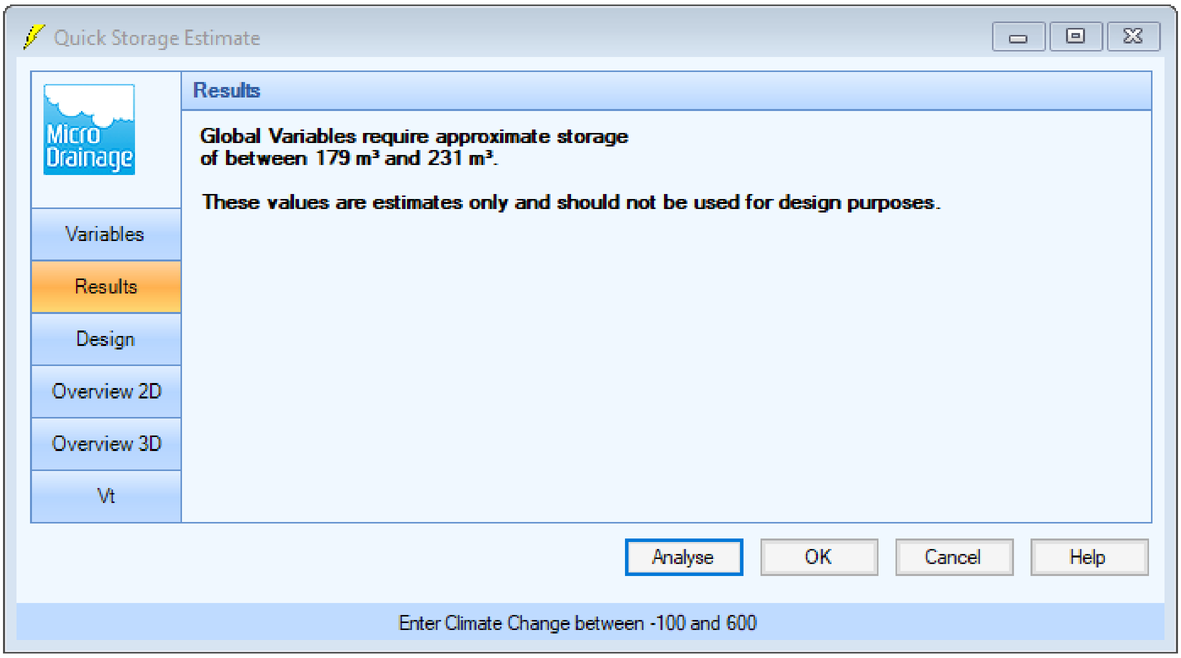
MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event catchment A single BESS swales



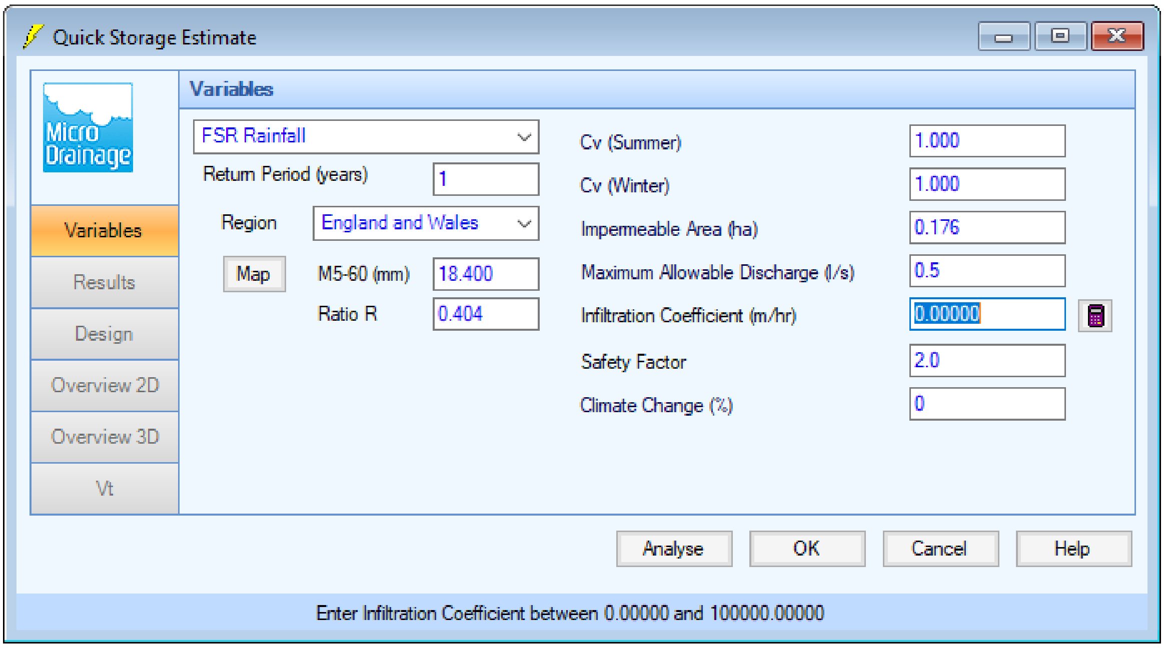


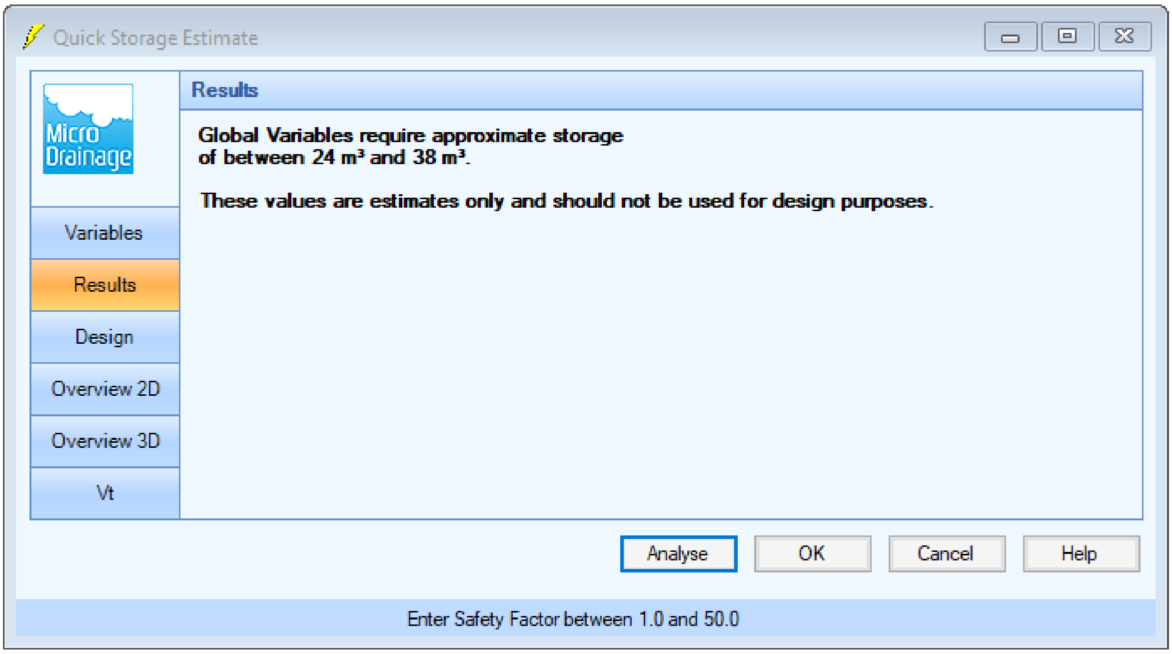
MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event catchment B single BESS swales



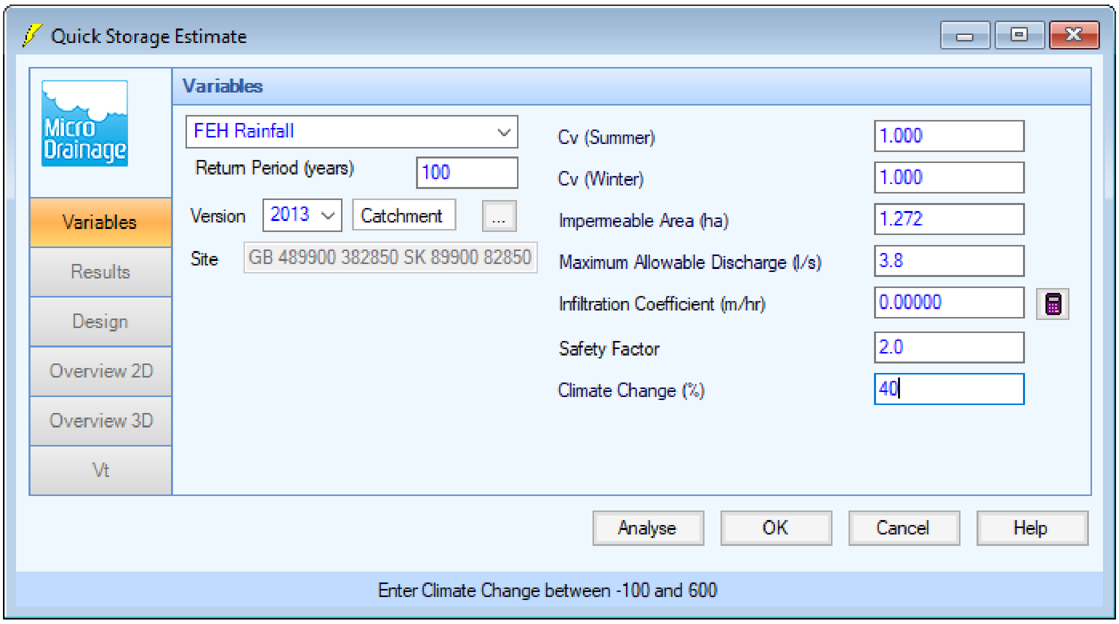


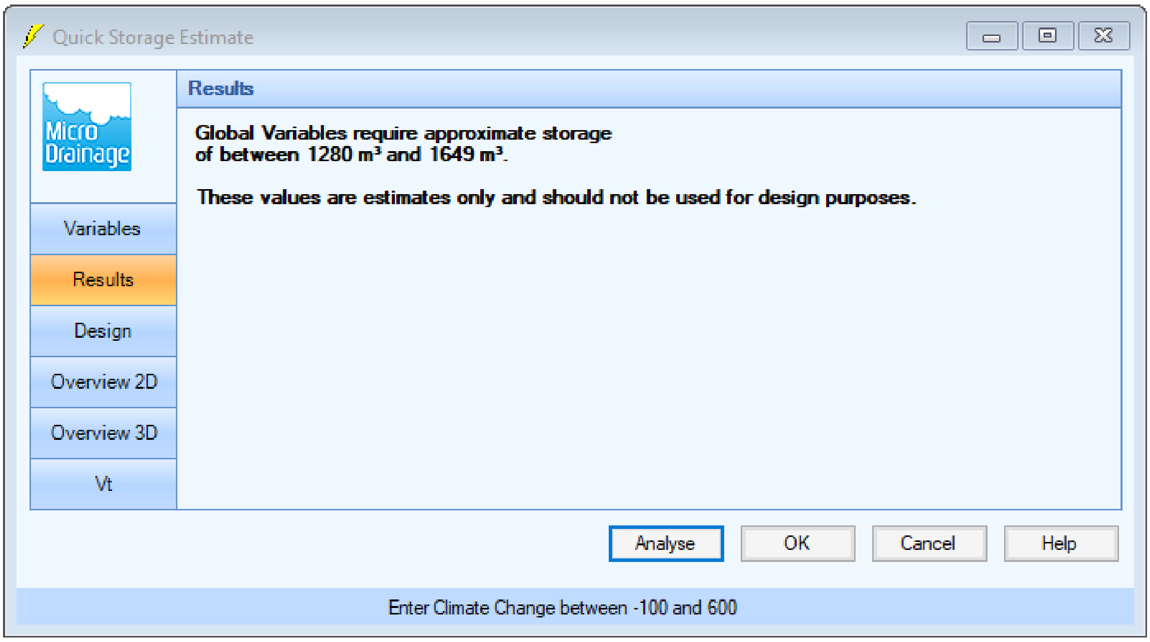
MicroDrainage Quick Storage Estimator Analysis for 1 year event single BESS swales



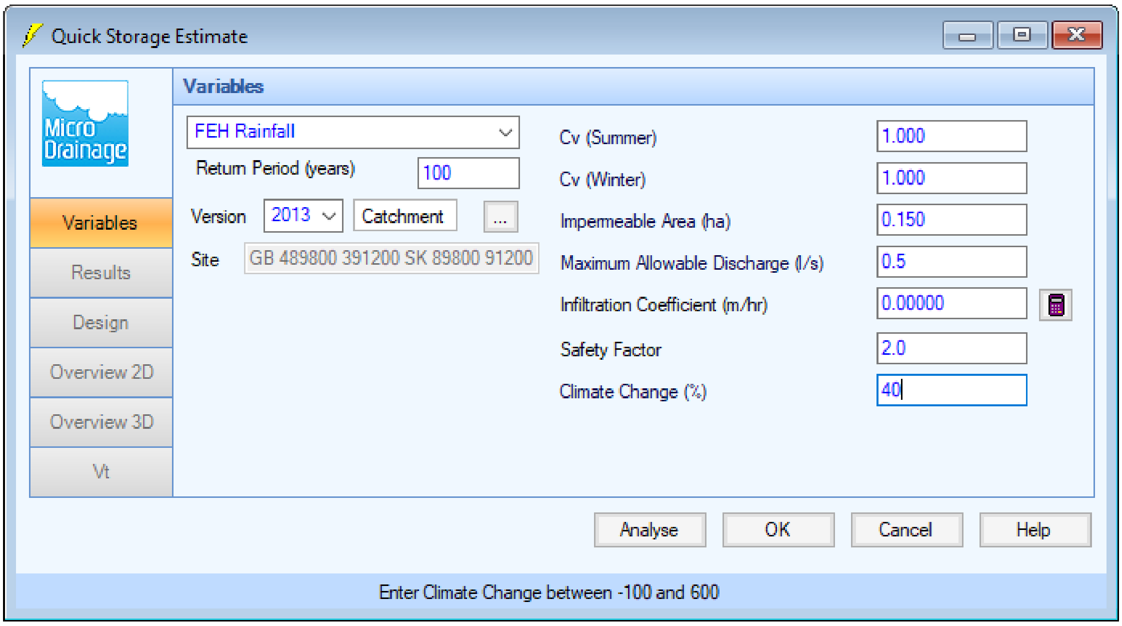


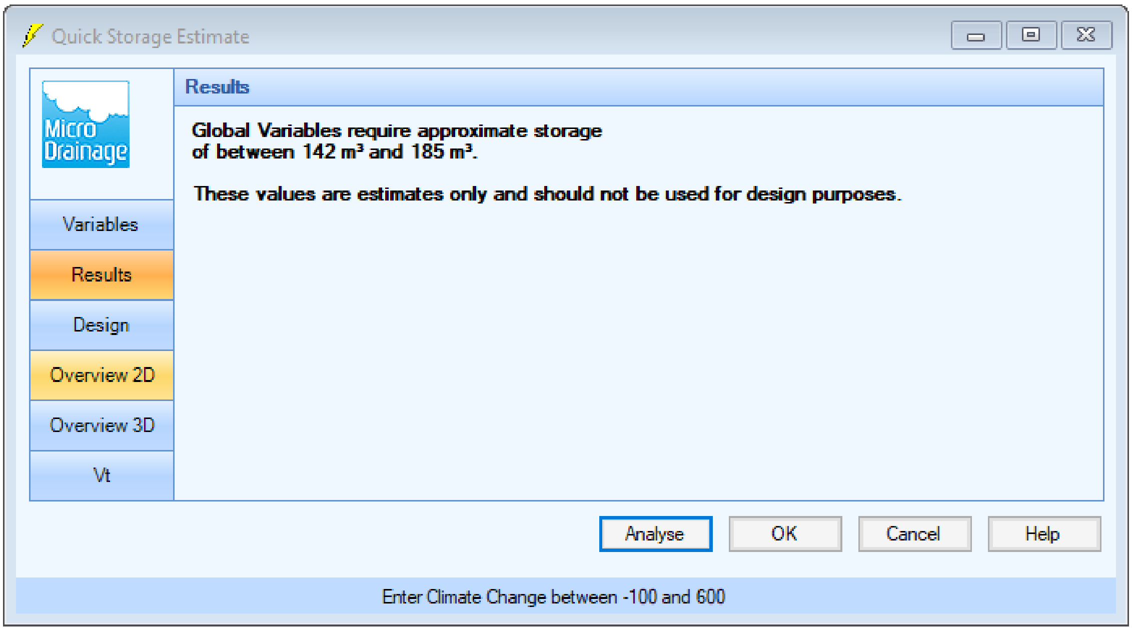
MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event Substation swales (catchment B only)





MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event combined solar farm control centre and equipment store swales (catchment A only)



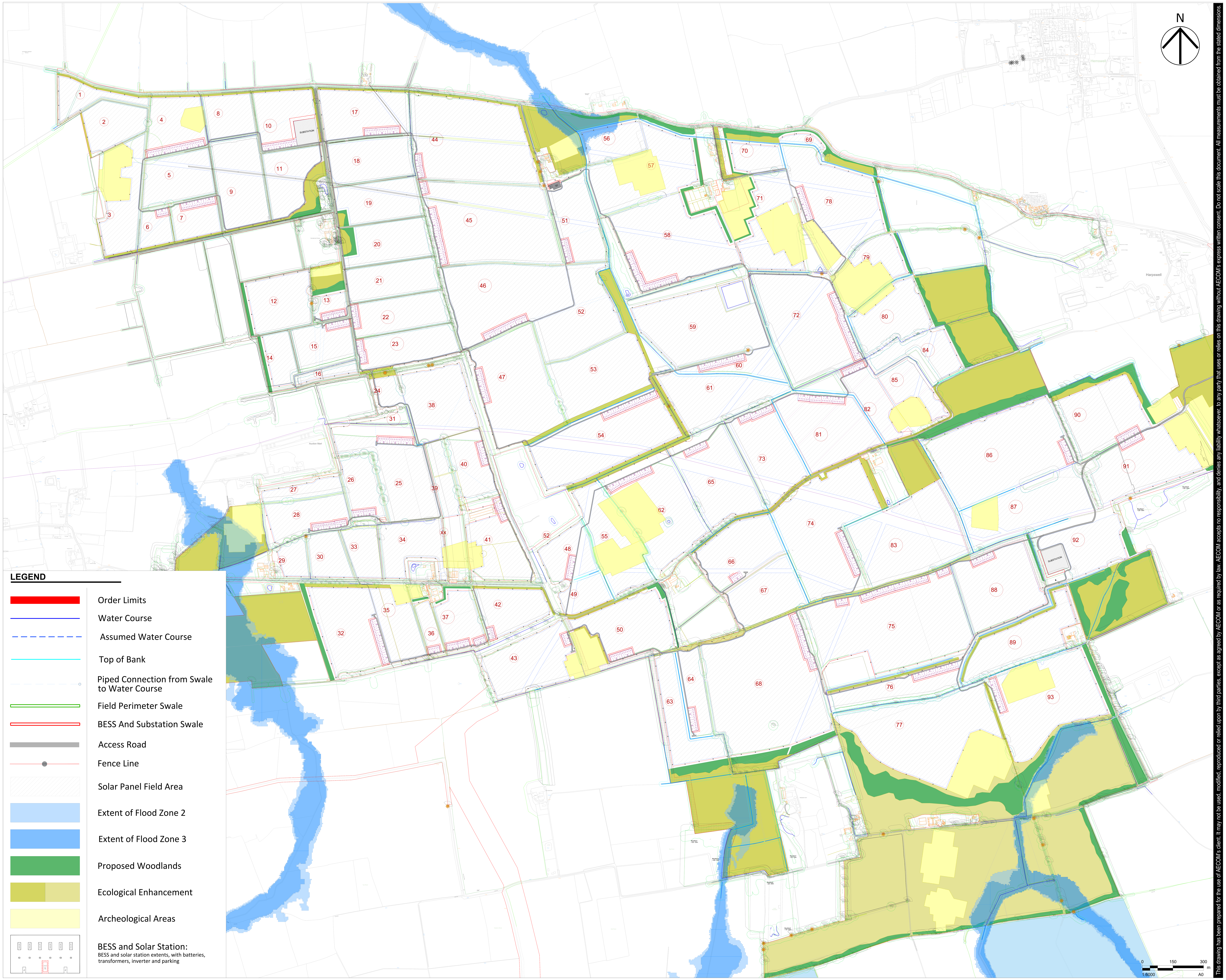


Annex C – Field Storage Requirements

For location of fields associated with the field numbers in the table below please see the drawings within Annex D.

Field Number (As per masterplan)	BESS	Substation	Control Room/ Equipment Store	Existing Catchment	Swale Volume (M^3)
4	5			B	1044
6	1			B	337
7	3			B	618
10	3	1		B	2086
13	2			B	421
15	2			B	421
17	3			A	583
22	2			B	421
23	2			B	421
25	3			B	618
26	2			B	421
28	3			B	618
32	4			B	832
36	1			B	337
37	3			B	618
40	2			B	421
41	2			B	421
42	1			B	337
43	1			B	337
44	2			A	421
45	6			A	1156
46	4			B	832
47	3			B	618
48	2			B	421
50	2			B	421
51	2		1	A	552
54	5			B	1044
58	6			A	1156
60	4			A	771
62	4			B	832
64	2			B	421
65	2			B	421
66	1			B	337
68	5			B	1044
72	6			A	1156
73	3			B	618
74	4			B	832
75	8			B	1924
76	4			B	832
78	3			A	583
81	4			B	832
82	2			B	421
86	2			B	421
88	2			B	421
90	2			B	421
91	2			B	421
92		1		B	1469
93	3			B	618

Annex D – Drainage Strategy Drawings



AECOM

Project

TILLBRIDGE SOLAR PROJECT

Client

TILLBRIDGE SOLAR LIMITED

Consultant

Aecom
Marlborough Court
10 Bricket Road
St Albans
Herts, AL1 3JX
United Kingdom

T +44 (0)1727 535000
www.aecom.com

Notes

1. DO NOT SCALE FROM THIS DRAWING
2. ALL LEVELS SHOWN ARE IN METERS ABOVE ORDNANCE DATUM (AOD) UNLESS STATED OTHERWISE
3. SITE LEVELS AND WATERCOURSE LOCATIONS BASED ON TOPOGRAPHIC SURVEYS 'GRETA-II_UAV-TOPO_LINEWORK_OSGB36_ODN_REV1_2022-12-12' AND 'TILBRIDGE-GRETA-II_UAV-TOPO_LINEWORK_OSGB36_ODN_REV1_2023-08-09' BY ABOVE SURVEYING LTD.'
4. ASSUMED WATERCOURSE LOCATIONS TAKEN FROM OS BASE MAP DATASET. SITE BACKGROUND TAKEN FROM OS BASE MAP DATASET AND SHOULD NOT BE USED FOR DETAILED DESIGN PURPOSES
5. SITE LAYOUT BASED ON FIGURE 3-1: INDICATIVE PRINCIPAL SITE LAYOUT PLAN OF THE ENVIRONMENTAL STATEMENT [EN010142/APP/6.3]
6. THE INFORMATION ON THIS PLAN IS GIVEN WITHOUT OBLIGATION OR WARRANTY. NO LIABILITY OF ANY KIND WHATSOEVER IS ACCEPTED BY AECOM FOR ANY ERRORS OR OMISSIONS. DRAINAGE STRATEGY DESIGN INDICATIVE AND SUBJECT TO CHANGE.

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P04	21.03.24	Design Updates
P03	23.02.24	Design Updates
P02	12.01.24	Boundary and Design Updates
P01	27.01.23	First Issue

Purpose Of Issue

DCO SUBMISSION

Project Number

60682158

Sheet Title

TILLBRIDGE SOLAR PROJECT DRAINAGE STRATEGY OVERVIEW

Reference Number

EN010142/APP/6.2

Legislation Reference

APFP 2009 Regulation 5(2)(a)

Sheet Number

60682158-ACM-ZZ-XX-DR-CE-000000

Scale: As shown @ A0 **Rev:** P04

ISO A0 841mm x 1189mm
Approved: AT
Checked: IH
Designer: MT
Project Management Initials:
Last saved by: MARK.TRICKER(2024-03-25) Last Plotted: 2024-03-25
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