Tillbridge Solar

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PEI Report Volume II Appendix 10-3: Drainage Strategy

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tillbridgesolar.com

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

Prepared for:

Tillbridge Solar Ltd

Prepared by:

AECOM Ltd

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1. Introduction

1.1 Scheme Description and Background

1.1.1 AECOM has been commissioned to prepare a Drainage Strategy (DS) as an Appendix to the Preliminary Environmental Information (PEI) Report in relation to the Development Consent Order (DCO) application for the construction, operation and decommissioning of the Tillbridge Solar scheme (Scheme) located 13km north of the city of Lincoln, near Gainsborough, Lincolnshire, UK.

1.1.2 The Scheme comprises the construction, operation (including maintenance) and decommissioning of ground mounted solar photovoltaic (PV) panel arrays to generate electricity, a Battery Energy Storage System (BESS) and infrastructure to export and import electricity to the national electricity transmission network.

1.1.3 The Scheme will consist of the following infrastructure:

- Solar PV panels (also known as solar modules);
- Solar stations (invertor, transformer and switchgear);
- Battery Energy Storage System (BESS);
- Battery Direct Current (DC)/DC convertors;
- On-site cabling;
- On-site sub-stations;
- Solar farm control centre;
- Equipment storage;
- Fencing, security and lighting;
- Site access and access tracks;
- Surface water drainage; and
- Electricity connection to National Grid via Cable Route Corridor. The Tillbridge circuit will be connected to an existing free bay at Cottam sub-station.

1.1.4 The Scheme Boundary has two sections:

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

1.1.5 The Principal Site is located within the county of Lincolnshire and falls within the administrative area of West Lindsey District Council (WLDC).

1.1.6 The Principal Site covers an area of approximately 1,400 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.

1.1.7 This Preliminary Drainage Strategy solely relates to the preliminary 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.

1.1.8 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.

1.1.9 The Framework Construction Environment Management Plan (CEMP) provides detail on management of surface water runoff during the construction phase, including for the Cable Route Corridor. For further detail refer to **PEI Report Volume II Appendix 3-1**.

1.1.10 The following stakeholders will be consulted during the PEI consultation where applicable:

- Lead Local Flood Authority – Lincolnshire County Council.
- The Environment Agency.
- Scunthorpe & Gainsborough Water Management Board.
- Upper Witham Internal Drainage Board.

1.1.11 The Drainage Strategy will be reviewed prior to the DCO submission, having regard to comments by stakeholders.

1.2 Design Assumptions

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

- 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.
- 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.
- At this early design stage, the BESS areas and 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.

- 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.
- 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.
- All swale features will avoid all archaeological sites and sensitive sites.
- Flood Estimation Handbook (FEH) 2013 rainfall 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 the Preliminary Flood Risk Assessment that is included in **PEI Report Volume II Appendix 10-2**.

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.

Flood Risk Source	Pre-Scheme Flood Risk Level	Post-Scheme Flood Risk Level	Comments
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.
Groundwater	Low	Low	The 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 Boundary 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 is not available at present, therefore the location of watercourses has been assumed based on available LiDAR data for the site. The location of these watercourses will be confirmed once the topographic survey is available.

2.2.2 There is currently no known formal piped 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 located along the field boundaries as identified by LiDAR data.

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 WLDC Strategic Flood Risk Assessment (SFRA) details that groundwater flooding is not considered to be a significant flood risk within West Lindsley, 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 (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 diameter piled legs (<100mm diameter). 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 2.50.7 from the Draft NPS EN-3. 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 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) and substation areas. The swale will collect and treat surface water before discharge. Paragraph 056 of the Planning Practice Guidance for Flood Risk and Coastal Change 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 BESS and substation will be able to discharge via infiltration. Therefore, surface water from the BESS and substation swales 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 Swales around the BESS and substation areas will be lined with an impermeable membrane or similar to prevent any pollution associated with fire water runoff from entering the ground. Penstocks 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.

3.1.6 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. These swales will be installed with an outfall to the watercourses within the Principal Site Boundary.

3.2 Contributing Areas

3.2.1 The new impermeable areas within the Principal Site are related to the BESS and substation areas. The proposed impermeable areas associated with these are 0.176ha per BESS and 0.797ha per substation. BESS areas are spread across the site and can be located individually or in groups of up to five. There are two separate substations in the Principal Site. The BESS and substation areas 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 BESS and substation have been calculated for the Principal Site using 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 Table 2 and 3 below.

Table 2 – Greenfield Discharge Rates for BESS

Return Period (years)	Discharge Rate (l/s) (0.176 ha)
1	0.57
Qbar	0.69
30	1.37
100	1.77

Table 3 – Greenfield Discharge Rates for Substation

Return Period (years)	Discharge Rate (l/s) (0.797 ha)
1	2.58
Qbar	3.11
30	6.23
100	8

3.4 Proposed Attenuation

3.4.1 Attenuation will be required, within the Principal Site, to temporarily store surface water runoff generated from the BESS and substation areas spread across the Principal Site 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 (if located on its own) or surrounding three side of a group of BESS. Substations 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) 2013 rainfall 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 Figure 1 below.

Figure 1 – FEH catchments within Principal Site boundary

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 BESS and substation 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 4 below.

Table 4 – Attenuation Volume Requirements

Feature	Attenuation Volume Required (m3) Catchment A	Attenuation Volume Required (m3) Catchment B
Single BESS	184.5*	190.5*
Substation	NA (No substations in catchment A)	868

* Total attenuation requirements for BESS 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 Preliminary Drainage Strategy.

3.4.6 In areas of the Principal Site where BESS sites are grouped together, the attenuation requirements of the swale around them will be increased proportionately. A breakdown of the storage requirements within each field across the site is in Annex C.

3.4.7 This required storage volume will be provided in the form of swales around 3 sides of the BESS/substation. Swales will be approximately 0.6m deep with 1 in 3 side slopes. The location of swales is shown in the Preliminary Drainage Strategy drawings in Annex D.

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. 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 the substations. In accordance with the SuDS Manual this land use is best defined as ‘commercial/industrial’ roofs. Table 5 below details the pollution hazard indices associated with this land use. Table 6 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 substations are sufficient to treat the runoff from these areas.

Table 5 – Pollution Hazard Indices for BESS and substations

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 6 – Mitigation Indices for BESS and substation swales

Type of SuDS Component	Mitigation indices		
	TSS	Metals	Hydrocarbons
BESS/Substation 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. Tables 7 and 8 below lists 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 7 – 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 8 – 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 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 (please see section below on Fire Water Runoff 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 an extreme storm event in advance of this, any exceedance flows that cannot be retained by the proposed attenuation will flow overland, following the existing topography, where ultimately, they will be contained

within the perimeter swales and discharge to the nearest watercourse at a controlled rate.

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 will be presented in the DCO submission.

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, scheduled monuments or listed buildings within the Principal Site Boundary.

3.8.2 Runoff from fire water from the BESS areas will be captured so it cannot discharge off site or to ground, and will be tested/removed off site by tanker if contamination is found to be present.

3.9 Fire Water Runoff

3.9.1 The BESS areas require fire water tanks to supress a fire, should one break out.

3.9.2 Fire water runoff 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 fire water runoff within the swale surrounding the BESS, where it can be held and tested before either being released into the surrounding watercourses or taken off site by a tanker for treatment elsewhere. The swale will then be cleaned of all contaminants.

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.

3.9.6 National Fire Chiefs Council (NFCC) guidance 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 unlikely event of a fire, only one BESS would be on fire at the 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 should 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 on its own, 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 A), which gave a value of 28m^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 Tables 9 and 10 below, which highlight the worst-case storage provided in the design for each BESS configuration.

Table 9 - 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	28		300	328
		184.5		184.5
2 BESS	56		300	356
		369		369
3 BESS	84		300	384
		553.5		553.5
4 BESS	112		300	412
		738		738
5 BESS	140		300	440
		922.5		922.5

Table 10 - 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	28		300	328
		190.5		184.5
2 BESS	56		300	356
		381		381
3 BESS	84		300	384
		571.5		571.5
4 BESS	112		300	412
		762		762
5 BESS	140		300	440
		952.5		952.5

3.9.9 The worst case storage volumes as detailed within Tables 9 and 10 above have then been provided within the swales as part of the drainage design for the site. The swales are shown in the Preliminary Drainage Strategy drawings in Annex D.

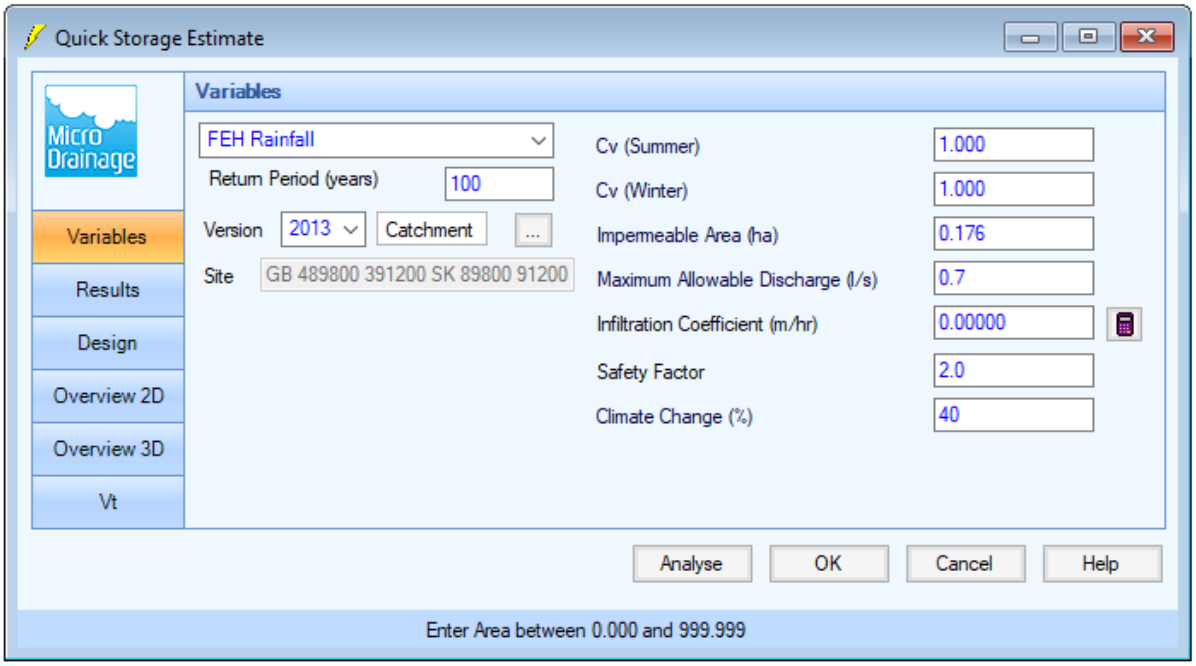
3.9.10 The volume requirements for containment of fire water runoff within the swale and its configuration are subject to agreement with the Fire and Rescue Service.

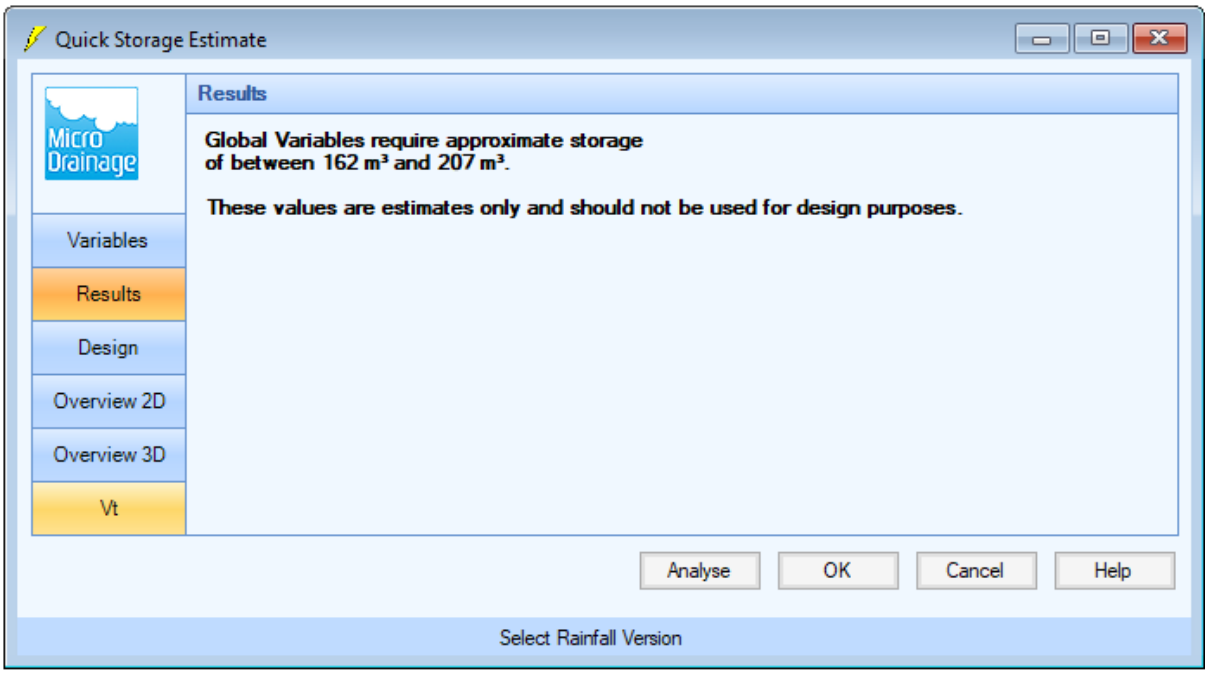
3.10 Adoption and Maintenance

3.10.1 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.

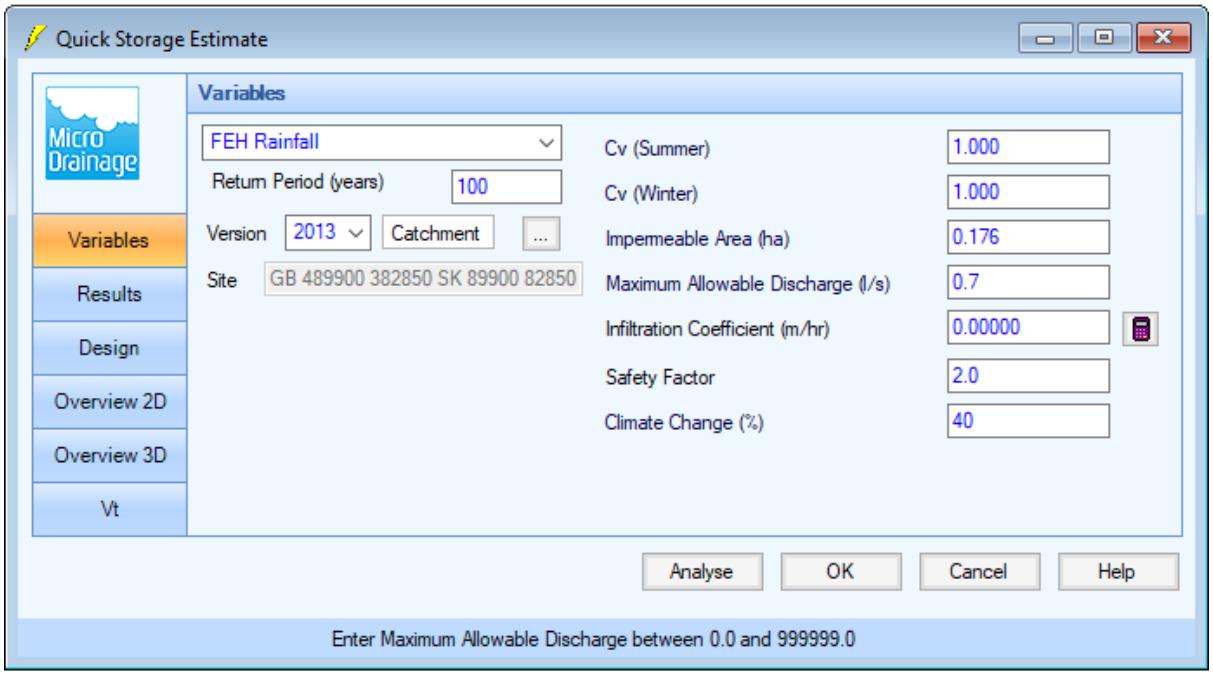
Annex A – Microdrainage Quick Storage Estimates for Swales

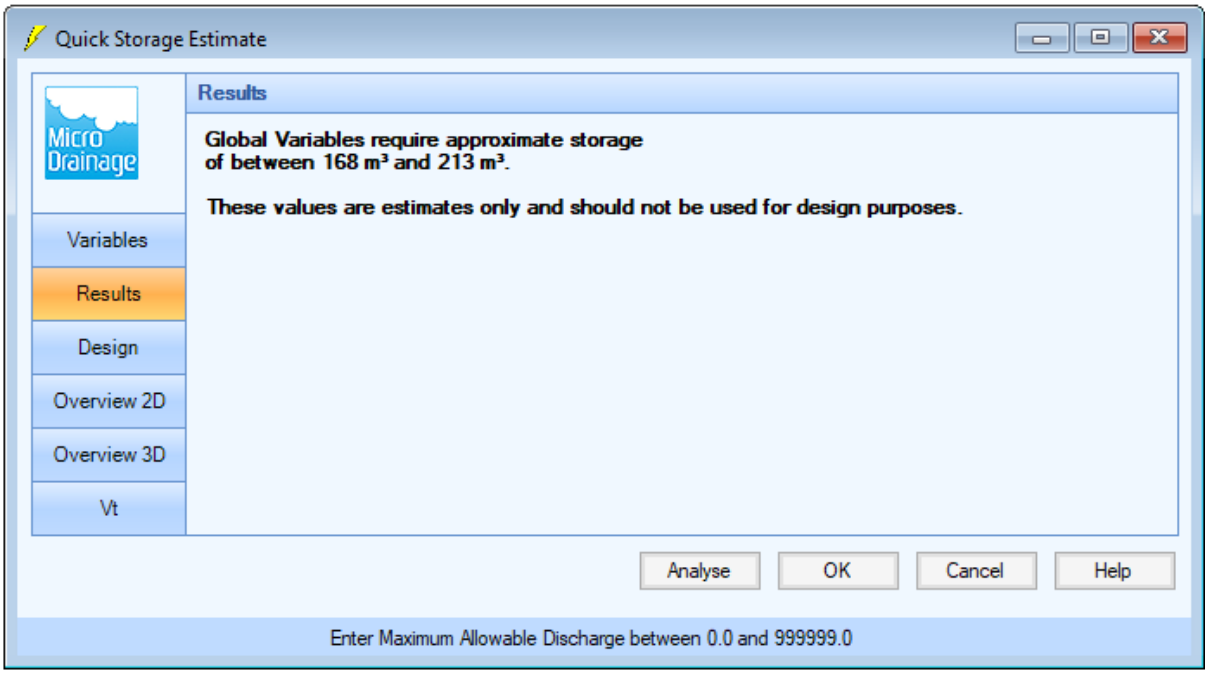
MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event catchment A single BESS swales



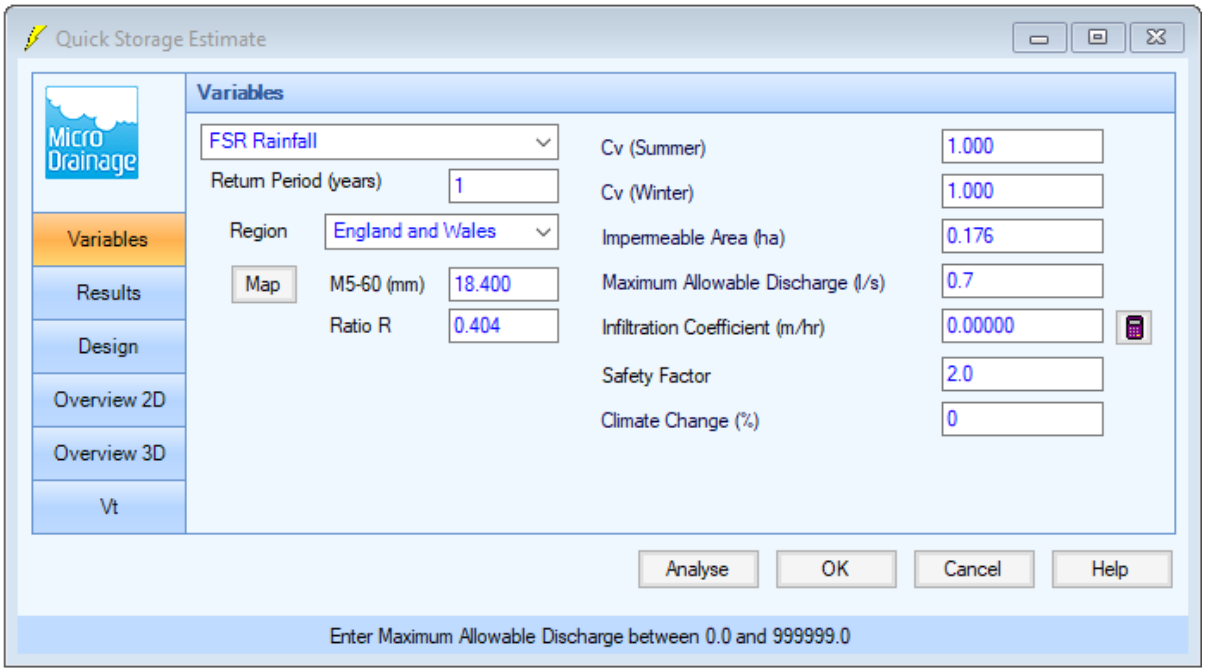


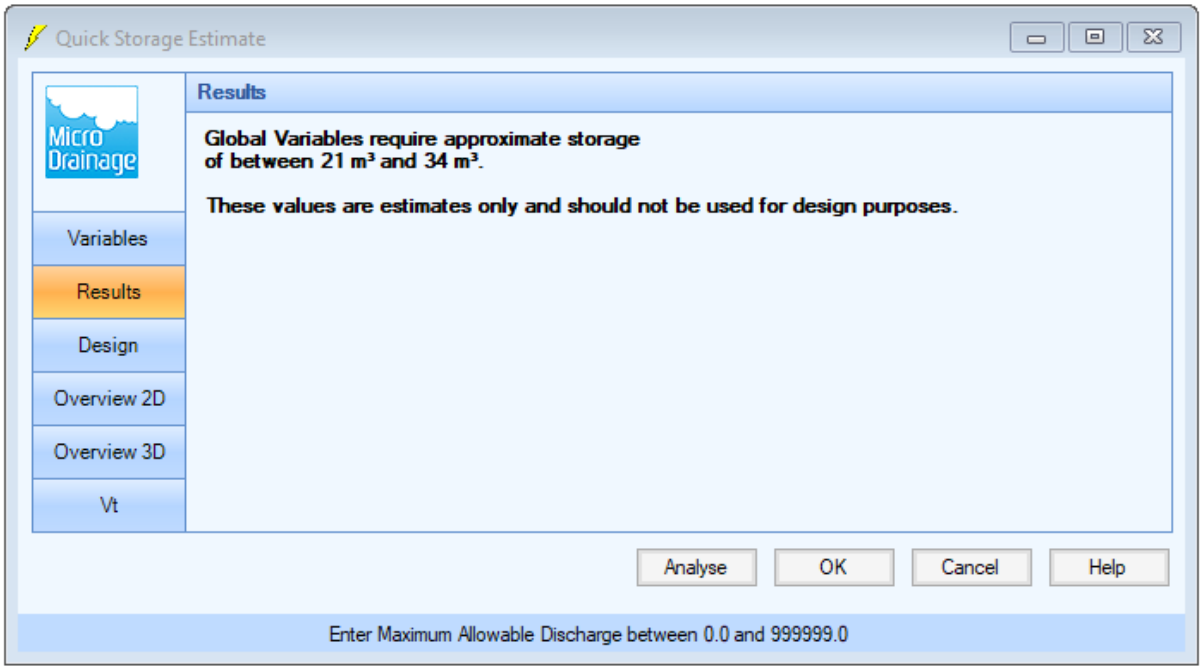
MicroDrainage Quick Storage Estimator Analysis for 1 in 100 year + 40% CC event catchment B single BESS swales



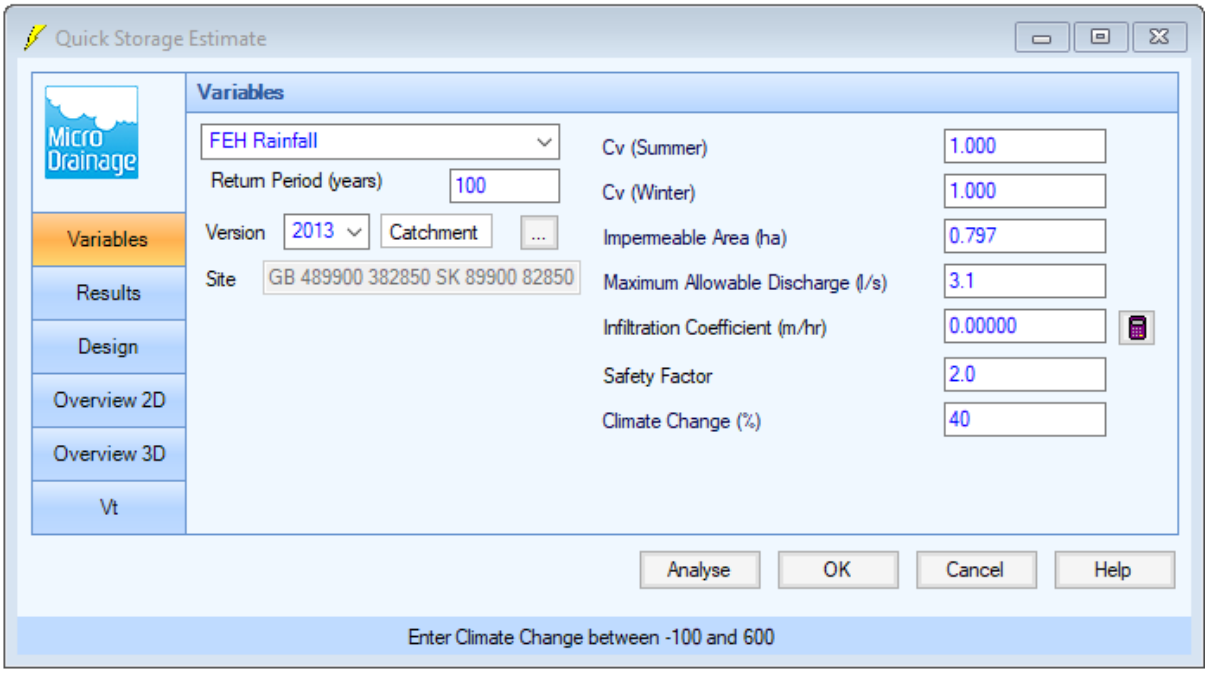


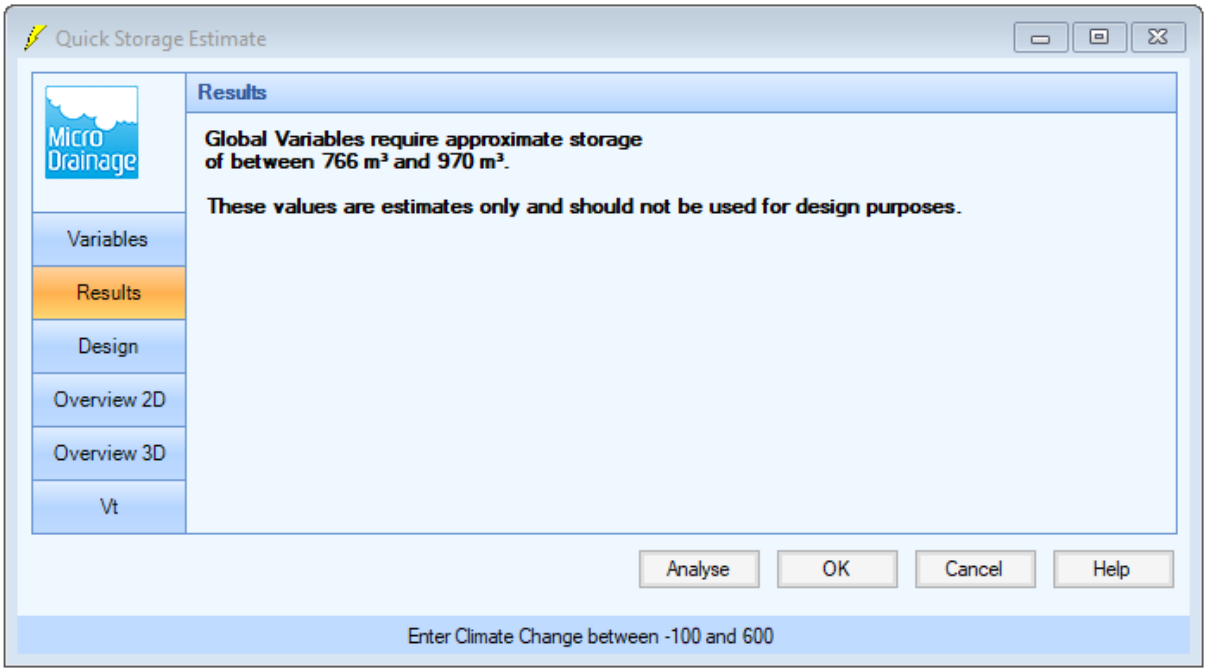
MicroDrainage Quick Storage Estimator Analysis for 1 year event single BESS swales





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





Annex B – Greenfield Runoff Rates

Greenfield runoff rates for single BESS in Catchment A

Site characteristics

Total site area (ha):	0.176

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	584	584
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

Greenfield runoff rates

	Default	Edited
Q_{BAR} (l/s):	0.69	0.69
1 in 1 year (l/s):	0.57	0.57
1 in 30 years (l/s):	1.37	1.37
1 in 100 year (l/s):	1.77	1.77
1 in 200 years (l/s):	2.09	2.09

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 for single BESS in Catchment B

Site characteristics

Total site area (ha):	0.176

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	592	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):	0.7	0.7
1 in 1 year (l/s):	0.58	0.58
1 in 30 years (l/s):	1.4	1.4
1 in 100 year (l/s):	1.79	1.79
1 in 200 years (l/s):	2.12	2.12

Greenfield runoff rates for Substation (Catchment B only)

Site characteristics

Total site area (ha):	0.797

Methodology

Q_{BAR} estimation method:	Calculate from SPR and SAAR
SPR estimation method:	Calculate from SOIL type

Soil characteristics

	Default	Edited
SOIL type:	4	4
HOST class:	N/A	N/A
SPR/SPRHOST:	0.47	0.47

Hydrological characteristics

	Default	Edited
SAAR (mm):	584	584
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):	3.11	3.11
1 in 1 year (l/s):	2.58	2.58
1 in 30 years (l/s):	6.23	6.23
1 in 100 year (l/s):	8	8
1 in 200 years (l/s):	9.46	9.46

Annex C – Field Storage Requirements

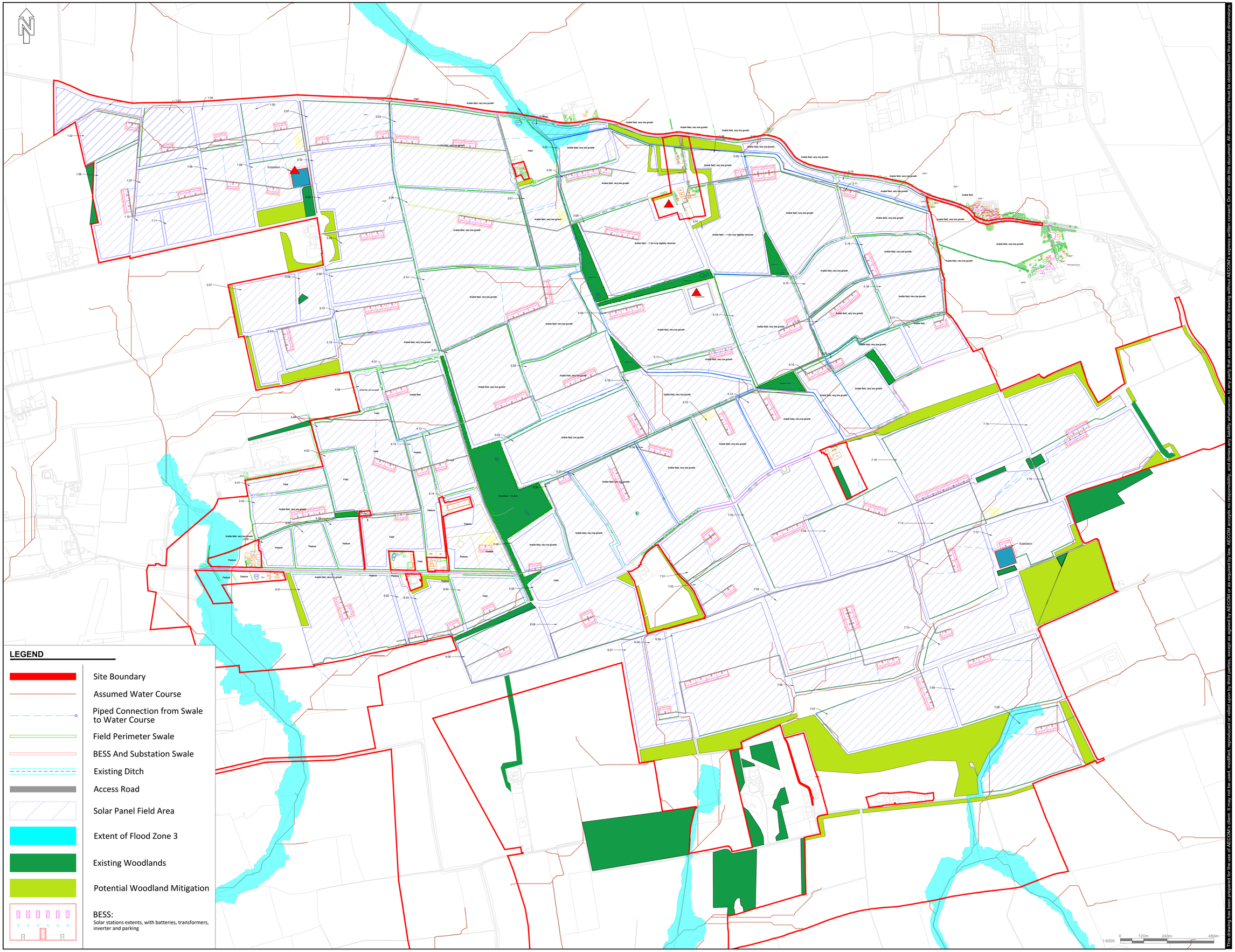
For location of fields associated with the field numbers in the table below please see the drawings within Annex D.

Field Number (As per masterplan)	Area (M^2)	Area(ha)	Batteries	Substation	Existing Catchment	Swale Volume (M^3)
1.02	57481.958	5.748	1		B	328.815
1.03	74158.083	7.416	1		B	328.815
1.04	46679.588	4.668	1		B	328.815
1.05	81451.081	8.145	1		B	328.815
1.06	98181.373	9.818	2		B	385.805
1.07	74646.967	7.465	2		B	385.805
1.08	95188.730	9.519	1		B	328.815
1.09	63615.533	6.362	1	1	B	1212.760
2.01	98174.120	9.817	2		A	375.091
2.03	228537.174	22.854	4		A	750.182
2.05	69152.592	6.915	2		A	375.091
2.06	235216.901	23.522	3		A	560.294
2.11	55464.378	5.546	2		B	385.805
2.12	73231.138	7.323	3		B	575.407
2.14	302284.520	30.228	3		B	575.407
3.04	131852.230	13.185	4		A	750.182
3.05	190835.032	19.084	3		A	560.294
3.06	33736.936	3.374	1		A	328.815
3.09	172923.669	17.292	4		A	750.182
3.11	69950.493	6.995	1		A	328.815
4.02	69478.090	6.948	3		B	575.407
4.04	150136.437	15.014	2		B	385.805
4.07	104406.662	10.441	2		B	385.805
4.11	61265.299	6.127	1		B	328.815
4.14	75335.181	7.534	1		B	328.815
5.01	183367.473	18.337	3		B	575.407
5.02	125192.121	12.519	3		B	575.407
5.03	183382.011	18.338	2		B	385.805
5.04	51568.469	5.157	1		B	328.815
5.06	102357.157	10.236	1		B	328.815
5.07	162500.674	16.250	3		B	575.407
5.09	166701.151	16.670	3		A	560.294

Field Number (As per masterplan)	Area (M^2)	Area(ha)	Batteries	Substation	Existing Catchment	Swale Volume (M^3)
5.11	33497.733	3.350	2		A	375.091
5.12	100526.670	10.053	2		B	385.805
5.13	117322.500	11.732	2		B	385.805
5.14	180655.592	18.066	3		A	560.294
5.16	67670.424	6.767	2		A	375.091
5.17	85763.392	8.576	3		A	560.294
5.19	120553.829	12.055	2		A	375.091
5.20	50984.187	5.098	1		A	328.815
5.21	50127.469	5.013	1		A	328.815
6.01	195541.747	19.554	3		B	575.407
6.02	24899.884	2.490	1		B	328.815
6.03	51173.236	5.117	1		B	328.815
6.04	65611.724	6.561	1		B	328.815
6.05	114089.158	11.409	1		B	328.815
6.06	131318.158	13.132	2		B	385.805
6.09	285790.452	28.579	4		B	772.693
7.01	94934.732	9.493	2		B	385.805
7.02	79553.256	7.955	1		B	328.815
7.03	195290.174	19.529	3		B	575.407
7.04	176777.714	17.678	2		B	385.805
7.05	293328.215	29.333	4		B	772.693
7.06	68727.793	6.873	2		B	385.805
7.07	175671.027	17.567	3		B	575.407
7.08	137840.761	13.784	2		B	385.805
7.09	175563.439	17.556	2		B	385.805
7.10	94256.501	9.426	1		B	328.815
7.11	136469.397	13.647	2		B	385.805
7.12	88400.62	8.840	1	1	B	1212.760
7.15	114835.814	11.484	2		B	385.805
7.16	142515.670	14.252	2		B	385.805

Annex D – Drainage Strategy Drawings

Project Management Initials: Designer: MT Checked: IH Approved: ST



LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

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Tillbridge Solar

CLIENT

Tillbridge Solar Ltd

CONSULTANT

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

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

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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
OVERVIEW

SHEET NUMBER

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

Project Management Initials: Designer: MT Checked: IH Approved: ST

1.01
1.02
1.03
1.04
1.06
1.07
1.08
1.09
1.10
1.11

LEGEND

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1:1000 0 20m 40m 80m

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CONSULTANT
AECOM
Marlborough Court
10 Bricket Road
St Albans
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United Kingdom

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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 1 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000001

Project Management Initials: Designer: MT Checked: IH Approved: ST

Harpswell Lane (A631) to Gainsborough

Field

1.05

2.01

2.02

2.03

2.04

2.05

2.06

Temporary Construction Compound

Substation

Overhead line on poles ~9m tall

Overhead line on poles ~9m tall

Overhead line on poles ~9m tall

Arable f

9

LEGEND

- Site Boundary
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1:1000 0 20m 40m 80m

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CONSULTANT

AECOM
Marlborough Court
10 Bricket Road
St Albans
Herts, AL1 3JX
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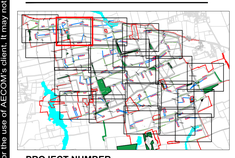

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SHEET TITLE

TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 2 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000002

Project Management Initials: Designer: MT Checked: IH Approved: ST

Arable field, very low growth

3.02

Field

Pond

Arable field, very low growth

3.03

Field

Arable field, very low growth

Building 7m

Building 3m

Building

3.04

Arable field, very low growth

3.01

Temporary Construction Compound

Arable field, very low growth

3.05

Arable field, very low growth

Arable field, very low growth

Arab

1:1000 0 20m 40m 80m

LEGEND

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AECOM
Marlborough Court
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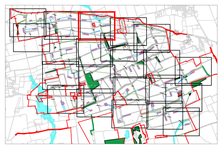

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SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 3 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000003

Project Management Initials: Designer: MT Checked: IH Approved: ST

Arable field, very low growth

3.06

3.08

Harpswell Lane (A631)

Arable field, very low growth

3.09

Arable field, very

Arable field, very low growth

very low growth

Arable field, very low growth

3.07

Arable field - ~1.5m crop digitally removed

Arable field - ~1.5m crop digitally removed

Arable field - ~1.5m crop digitally removed

Woodland ~18m

Pond

Woodland ~14m

LEGEND

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1:1000 0 20m 40m 80m

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AECOM
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DRAINAGE STRATEGY
SHEET 4 OF 22

SHEET NUMBER
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Project Management Initials: Designer: MT Checked: IH Approved: ST

3.10

3.11

5.15

5.16

5.17

5.18

5.21

Arable field, very low growth

Arable field, very low growth

Arable field, very low growth

Arable field, very low growth

Arable field, very low growth

Arable field, very low growth

Arable field, very low growth

Arable field

Arable field, v

Arab

moved

Woodland ~18m

Pond

Harpswell Lane (A631)

Overhead line on poles 9m tall

Overhead line on poles ~9m tall

Overhead line on poles 11m tall

Overhead line on poles 11m tall

Overhead line on poles 9m tall

Building - 5m

Building - 4m

Building 4m

HT 4m

HT 6m

HT 7m

HT 8m

HT 10m

HT 11m

HT 12m

HT 13m

LEGEND

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1:1000 0 20m 40m 80m

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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 5 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000005

Project Management Initials: Designer: MT Checked: IH Approved: ST

1.06

1.07

1.08

1.09

Sub

1.10

1.11

2.07

LEGEND

- Site Boundary
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AECOM
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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 6 OF 22

SHEET NUMBER
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Project Management Initials: Designer: MT Checked: IH Approved: ST

LEGEND

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2.05
2.08
2.09
2.14
2.12
2.11
2.10
2.13
Arable field, very low growth
5.
4.07
4.06
Arable field, very low growth

1:1000 0 20m 40m 80m

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Tillbridge Solar

CLIENT
Tillbridge Solar Ltd

CONSULTANT
AECOM
Marlborough Court
10 Bricket Road
St Albans
Herts, AL1 3JX
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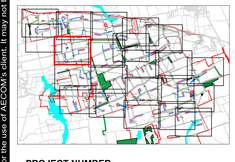

PROJECT NUMBER
60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 7 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000007

Project Management Initials: Designer: MT Checked: IH Approved: ST

Arable field, very low growth

Woodland ~15m

Pond

5.09

Arable field, very low growth

v growth

5.01

5.02

Arable field, very low growth

Arable field, very low growth

5.10

Woo

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

AECOM

PROJECT

Tillbridge Solar

CLIENT

Tillbridge Solar Ltd

CONSULTANT

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

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

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KEY PLAN

PROJECT NUMBER

60682158

SHEET TITLE

TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 8 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000008

Project Management Initials: | Designer: MT | Checked: IH | Approved: ST

3.07

Arable field - ~1.5m crop digitally removed

Arable field - ~1.5m crop digitally removed

Woodland ~15m

Pond

Woodland ~14m

Pond

Man-made reservoir

5.09

5.14

Arable field, very low growth

Arable

5.11

Arable field, very low growth

Woodland ~15m

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
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- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

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60682158

SHEET TITLE

TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 9 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000009

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

Project Management Initials: Designer: MT Checked: IH Approved: ST

5.14

5.17

Arable field, very low growth

Arable field, very low growth

11

Arable field, very low growth

Woodland ~15m

5.19

Woodland ~13m

5.13

Arable field, very low growth

5.12

Temporary Construction Compound

Arable field, very low growth

5.08

Arable field, very low growth

Common Lane

1:1000 0 20m 40m 80m

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Tillbridge Solar

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AECOM
Marlborough Court
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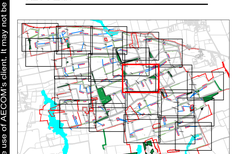

PROJECT NUMBER
60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 10 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000010

Project Management Initials: Designer: MT Checked: IH Approved: ST

Arable field, very low growth

5.21

Arable field

Arable field, very low growth

5.20

Arable field, very low growth

Arable field, very low growth

ow growth

Common Lane

Common Lane

Overhead line on poles 9m tall

Overhead line on poles 9m tall

Building 10m

Building 4m

Building 7m

Building 7m

Building 6m

7.14

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

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60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 11 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000011

Project Management Initials: Designer: MT Checked: IH Approved: ST

7.15

7.16

Temporary

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS:
  Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

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Tillbridge Solar Ltd

CONSULTANT
AECOM
Marlborough Court
10 Bricket Road
St Albans
Herts, AL1 3JX
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60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 12 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000012

Project Management Initials: Designer: MT Checked: IH Approved: ST

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

4.06
Arable field, very low growth
Arable field
Field
4.04
4.13
4.12
4.03
Field
Pasture
Field
Overhead line on poles ~9m tall
4.01
Field
4.14
4.02
Arable field, very low growth
Pasture
4.11
4.10
4.09
1:1000 0 20m 40m 80m

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

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SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 13 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000013

Project Management Initials: Designer: MT Checked: IH Approved: ST

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

5.03

Arable field, low growth

5.08

Pond

Pasture

5.07

Arable field, very low growth

5.06

Woodland ~15-25m

Pond

Pasture

Temporary Construction Compound

5.04

Arable field, very low growth

Pasture

1:1000 0 20m 40m 80m

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PROJECT

Tillbridge Solar

CLIENT

Tillbridge Solar Ltd

CONSULTANT

AECOM
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10 Bricket Road
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Herts, AL1 3JX
United Kingdom

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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 14 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000014

Project Management Initials: Designer: MT Checked: IH Approved: ST

Arable field, very low growth

7.03

7.04

7.02

7.05

Common Lane

HT 6m

HT 9m

HT 13m

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
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- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

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PROJECT

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TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 15 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000015

Project Management Initials: Designer: MT Checked: IH Approved: ST

Building 6m

Building 7m

7.14

7.13

7.12

7.11

Temporary Construction Compound

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
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- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation
- BESS: Solar stations extents, with batteries, transformers, inverter and parking

1:1000 0 20m 40m 80m

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Tillbridge Solar

CLIENT

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SHEET TITLE

TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 16 OF 22

SHEET NUMBER

60682158-ACM-ZZ-XX-DR-CE-000016

Project Management Initials: Designer: MT Checked: IH Approved: ST

Temporary Construction Compound

7.12

Substation

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
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- Access Road
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1:1000 0 20m 40m 80m

AECOM

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SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 17 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000017

Project Management Initials: Designer: MT Checked: IH Approved: ST

4.10

4.09

Pasture

Pasture

Pasture

Field

Pond

Field

Pasture

Field

Pasture

Pasture

Pasture

Arable field, very low growth

Pasture

Pasture

6.01

6.02

6.03

6.04

6.05

1:1000 0 20m 40m 80m

LEGEND

- Site Boundary
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SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 18 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000018

Project Management Initials:
Designer: MT
Checked: IH
Approved: ST

Temporary Construction Compound

5.04

Pasture

Pasture

Field

Pasture

Arable field, very low growth

Arable field, very lo

Pasture

6.04

Field

5.05

Field

6.06

6.05

6.07

1:1000 0 20m 40m 80m

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
- BESS And Substation Swale
- Existing Ditch
- Access Road
- Solar Panel Field Area
- Extent of Flood Zone 3
- Existing Woodlands
- Potential Woodland Mitigation

BESS:
Solar stations extents, with batteries, transformers, inverter and parking

AECOM

PROJECT
Tillbridge Solar

CLIENT
Tillbridge Solar Ltd

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

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

NOTES
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SUITABILITY
S0 WORK IN PROGRESS

ISSUE/REVISION

I/R	DATE	DESCRIPTION
P01	27.01.23	FIRST ISSUE

KEY PLAN

PROJECT NUMBER
60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 19 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000019

Project Management Initials:
Designer: MT
Checked: IH
Approved: ST

6.08

6.09

7.06

7.07

LEGEND

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KEY PLAN

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60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 20 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000020

Project Management Initials: Designer: MT Checked: IH Approved: ST

7.10

7.09

7.08

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
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1:1000 0 20m 40m 80m

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Tillbridge Solar

CLIENT
Tillbridge Solar Ltd

CONSULTANT
AECOM
Marlborough Court
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St Albans
Herts, AL1 3JX
United Kingdom

T +44 (0)1727 535000
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KEY PLAN

PROJECT NUMBER
60682158

SHEET TITLE
TILLBRIDGE SOLAR FARM
DRAINAGE STRATEGY
SHEET 21 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000021

Project Management Initials: Designer: MT Checked: IH Approved: ST

7.09

7.08

LEGEND

- Site Boundary
- Assumed Water Course
- Piped Connection from Swale to Water Course
- Field Perimeter Swale
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1:1000 0 20m 40m 80m

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Tillbridge Solar

CLIENT
Tillbridge Solar Ltd

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

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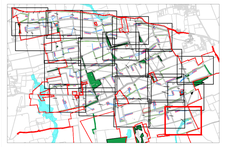

PROJECT NUMBER
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SHEET TITLE
TILLBRIDGE SOLAR FARM
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SHEET 22 OF 22

SHEET NUMBER
60682158-ACM-ZZ-XX-DR-CE-000022