Cottam Solar Project

Environmental Statement Appendix 10.1:

Annex D – 10.1.3

Flood Risk Assessment and Drainage Strategy – Cottam 1 West

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Cottam
SOLAR PROJECT

Flood Risk Assessment and Drainage Strategy

Annex D - Cottam 1 West

Presented to: Cottam Solar Energy Farm Limited

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Protecting people and planet

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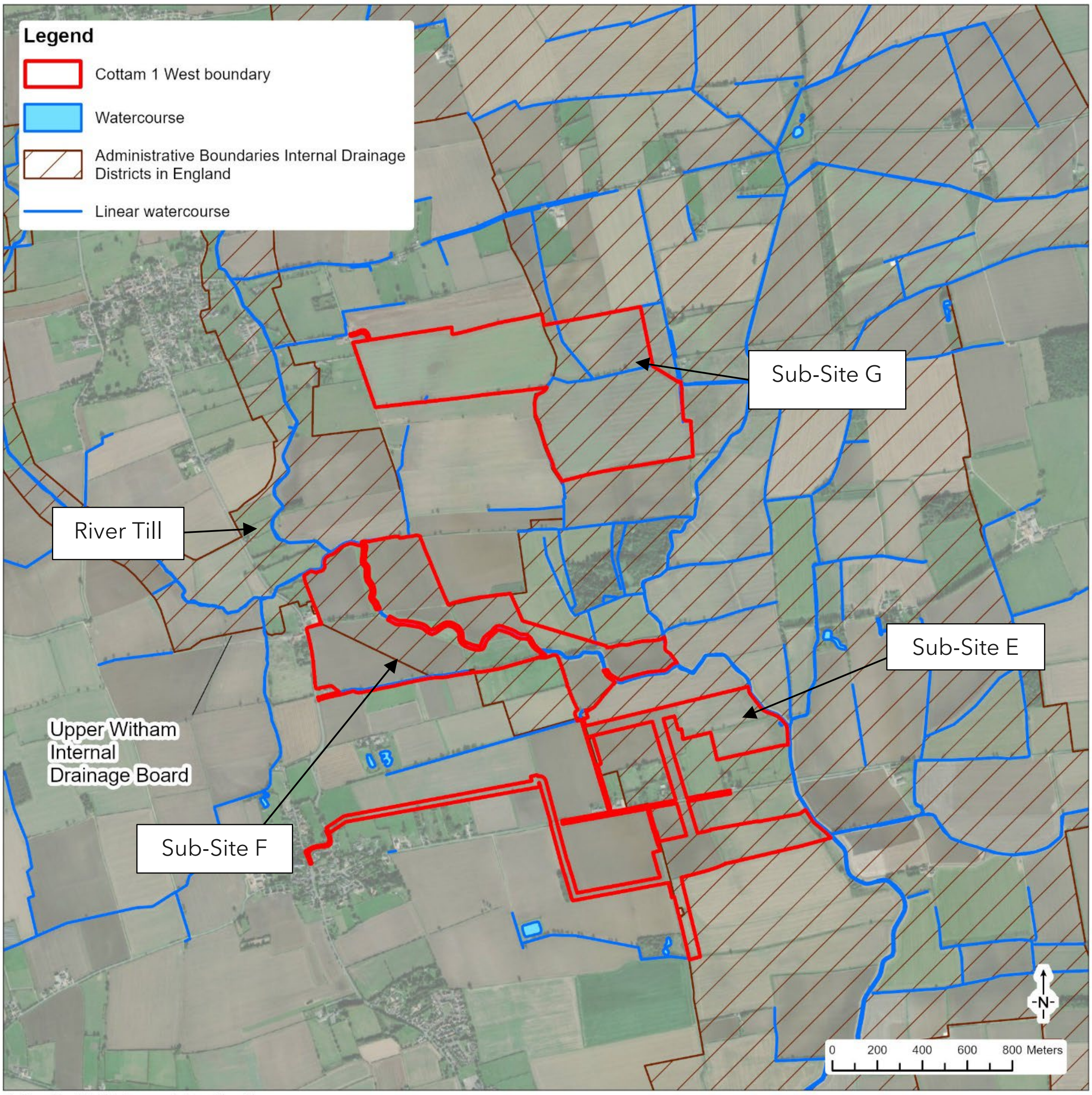
1.0 Site Description

1.1.1 The aim of this section of the report is to outline key environmental information associated with the baseline environment.



Site Location Plan	
Co-ordinates	Centred approximately at National Grid Reference (NGR) 488996, 383201
Site Location	The Cottam 1 West site is located within a rural setting and comprises multiple parcels of agricultural fields, approximately 1.5 km north-east of the village of Stow.

Existing Site Conditions	Online mapping (including Google Maps / Google Streetview imagery accessed May 2022) shows that the Site is greenfield comprising agricultural / arable fields.
Topography	Topographic levels to metres Above Ordnance Datum (m AOD) have been derived from a 1 m resolution Environment Agency (EA) composite 'Light Detecting and Ranging' (LiDAR) Digital Terrain Model (DTM). A review of LiDAR ground elevation data shows that the Site slopes from approximately 24 m AOD in the north-east to approximately 8 m AOD in the west. Given the size of the Site the gradients are shallow and the Site is relatively flat. A LiDAR extract is included in Annex B.
Hydrology	The River Till flows in a generally south-easterly direction through Sub-Sites F and E. The River Till is a Main River and is therefore the responsibility of the EA to maintain. Other watercourses include several land drainage ditches which are located in Sub-Site G and within the wider vicinity of the Site. Flows within the land drains are expected to travel towards the course of the River Till. The Site is partly located within the Upper Witham Internal Drainage Board (IDB).
Water Framework Directive Status	The Site is located within the River Till and Fillingham Beck Catchments. Both Catchments have a Cycle 3 2019 Ecological status of Moderate and a Failing chemical status. A summary of the Water Body Classification for the catchments are included as Annexes C and D.
Geology	Reference to the British Geological Survey (BGS) online mapping (1:50,000 scale) indicates that the east of Sub-Site G is underlain by superficial River Terrace Deposits (Undifferentiated) generally comprising sand and gravel. The central extent of Sub-Site F and north of Sub-Site E is underlain by superficial deposits of Alluvium comprising clay, silt, sand and gravel. No superficial deposits are mapped across the remaining Site areas. The majority of the Site is underlain by bedrock deposits of Scunthorpe Mudstone Formation consisting of interbedded mudstone and limestone with the eastern extent of Sub-Site E underlain by Charmouth Mudstone Formation. The geological mapping is available at a scale of 1:50,000 and as such may not be accurate on a Site-specific basis.
Hydrogeology	According to the EA's Aquifer Designation data, obtained from MAGIC Map's online mapping [accessed May 2022], the River Terrace and Alluvium deposits are classified as a Secondary A Aquifer. Secondary A Aquifers are 'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers'; The Scunthorpe Mudstone Formation is classified as a Secondary B Aquifer. Secondary B Aquifers are 'predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers'. The Charmouth Mudstone Formation is classified as a Secondary Undifferentiated Aquifer. Secondary Undifferentiated Aquifers are assigned in 'cases where it has

	not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type'. The EA's 'Source Protection Zones' data, obtained from MAGIC Map's online mapping indicates that the Site is not located within a Groundwater Source Protection Zone.
Proposed Site Conditions	The proposed development at Cottam 1 West comprises a solar energy substation and battery storage area in the northern extent of Sub-Site G, with associated ground mounted solar photo-voltaic panels, associated power stations and access throughout the remaining Site. Two Illustrative Layout Options are proposed for the Site which depict two arrangements of battery storage. Option A is included as Annex E and Option B is included as Annex F. For the purposes of this report, Option B has been assessed as it depicts the 'conservative' scenario from a flood risk and drainage perspective. Option B is considered to be conservative given it is the larger of the two proposals and therefore proposes the larger area of hardstanding. Therefore any drainage proposals considered at Option B can be considered to be able to be scaled to also be appropriate for Option A.

2.0 Assessment of Flood Risk

2.1 Tidal Flood Risk

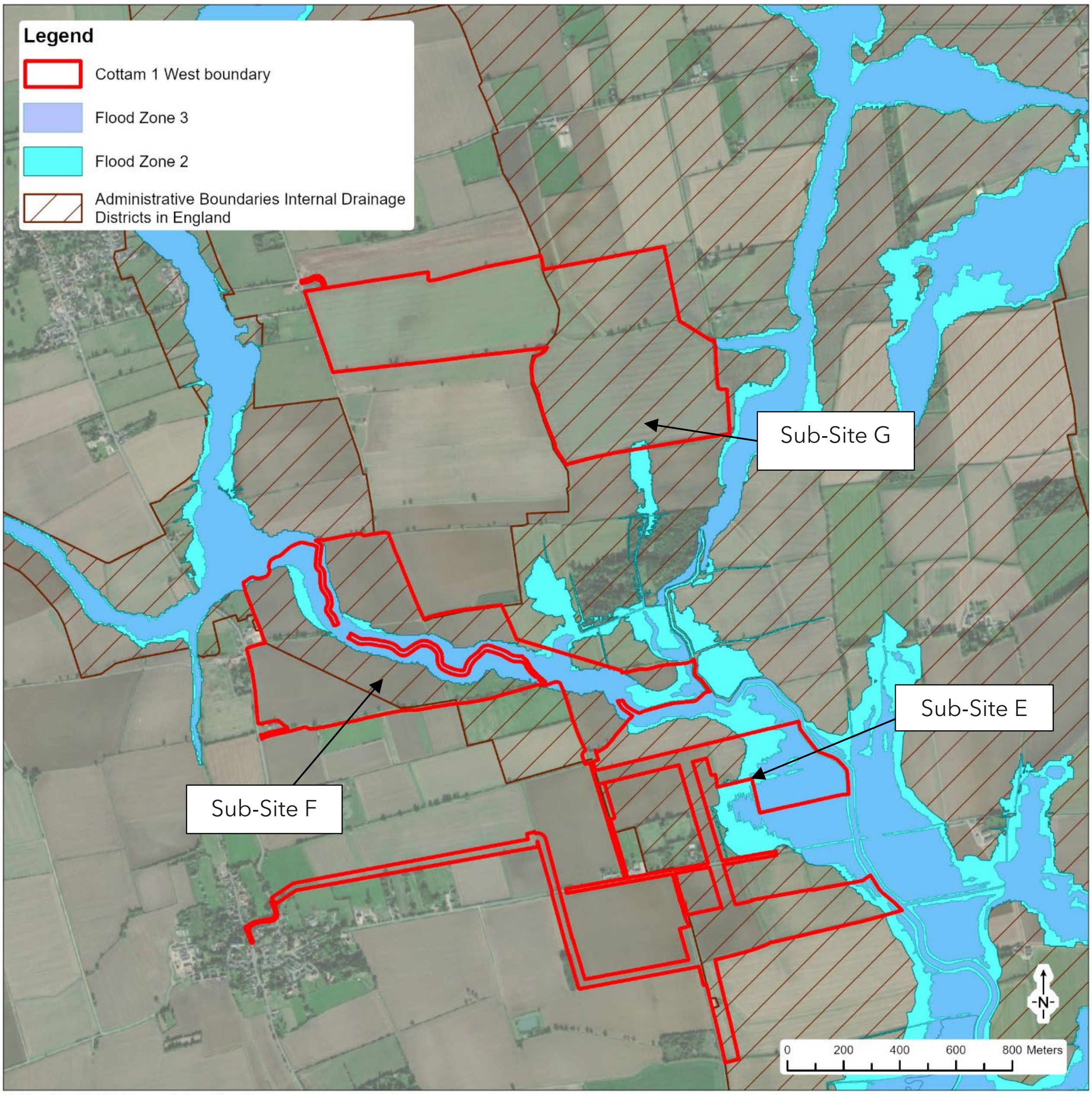
2.1.1 The Site is situated inland at a minimum of 8 m AOD. Therefore, the risk from tidal flooding is considered to be Negligible.

2.2 Fluvial Flood Risk

EA Online Flood Maps

2.2.1 The EA's Flood Map for Planning (Figure 1) indicates that the central extents of Sub-Site F and northern and eastern extents of Sub-Site E are located within Flood Zone 3. Flood Zone 3 is defined as land assessed as having a 1 in 100 or greater (>1% Annual Exceedance Probability) of river flooding.

Figure 1: EA's Flood Map for Planning



2.2.2 Fluvial flooding could occur if the River Till or land drains overtopped their banks during or following an extreme rainfall event

2.2.3 According to the EA's 'Historic Flood Map' the Site has not been impacted by a historic fluvial flood event.

Flood Defences

2.2.4 The EA's Spatial Flood Defences dataset indicates that formal EA Flood Defences are present along the length of the River Till that runs through the Site. The defences are shown as 'embankments' on the dataset which upon inspection of Google Streetview appear to be raised grassy banks. The Standard of Protection (SoP) of the defence is shown as up to the 1 in 10 year event. The upstream crest level of the defence is stated as 10.45 m AOD and the downstream crest level as 8.41 m AOD.

Third Party Reports

2.2.5 Based on a review of relevant third party reports there is no indication that the Site adjacent to the River Till has historically fluvially flooded.

EA Product Data

2.2.6 The EA have made available modelled fluvial depth mapping for the River Till. The flood model is derived from the Upper Witham Lincoln 2015 model.

2.2.7 The Site is considered to be 'Essential Infrastructure' within the Witham Catchment of the Anglian River Basin District and therefore the higher central Climate Change (CC) allowance of 15% for the 2050s epoch should be utilised. It is understood that the agreements on use of the land for PV solar panels is not greater than 40 years and therefore, the 2050s epoch allowance is considered to be appropriate.

2.2.8 The modelled depth information provided by the EA only included a 20% allowance greater than the 15% higher central CC allowance and therefore, depicts a scenario worse than the assessment event.

2.2.9 During the 1% AEP event + 20 % CC (Annex F), the vast majority of the Site is shown to remain flood free. A minor extent of flooding is shown to encroach the south-eastern corner of Sub-Site E however depths are shown to remain below 0.5 m.

2.2.10 During the 0.1% AEP + 20% CC scenario (Annex G), a minor extent of Sub-Site G is encroached by flooding however the depths are shown to remain below 0.3 m. Flooding is shown on both sides of the River Till within the centre of Sub-Site F, with some areas indicated to have flooding reaching depths above 0.9 m. The majority of the north of Sub-Site E is shown to be flooded however the depths are shown to be below 0.7 m across the entire parcel. The eastern extent of Sub-Site E is also shown to be impacted, with maximum flood depths above 0.9 m in the eastern area of the parcel that bounds the River Till.

Summary

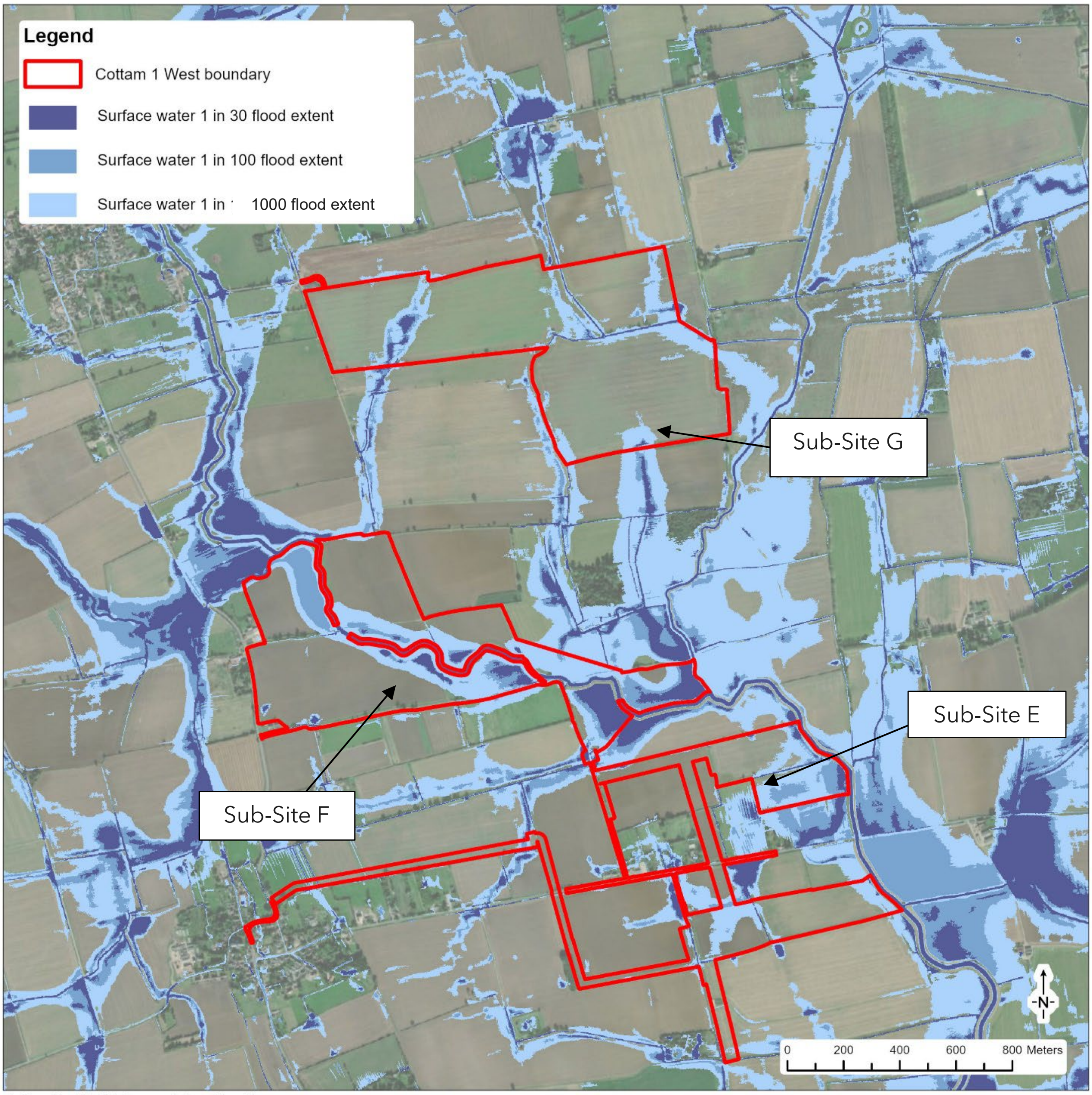
2.2.11 Based on the evidence provided above, the majority of the Site remains flood free during the 1% AEP + 20% CC event with only minor flood depths < 0.5 m in the south-eastern corner of Sub-Site E. The Site includes embedded mitigation measures including the proposed solar panels being raised above surrounding ground levels and associated power infrastructure appropriately raised and waterproofed. Embedded mitigation measures are considered in 3.2 of the covering report and in section 2.7 of this annex.

2.2.12 It can therefore be concluded that the risk of fluvial flooding is considered **Low.**

2.3 Surface Water Flood Risk

2.3.1 The EA's Long Term Flood Risk Map (Surface Water), shown in Figure 2, indicates that the majority of the Site is at Very Low (< 0.1% annual probability) risk of surface water flooding. Surface Water flooding with a High risk (> 3.3% annual probability) of occurrence is present across the Site, predominantly in the central extent of Sub-Site F and northern extent of Sub-Site E.

Figure 2: EA's Long-Term Flood Risk Map (Flood Risk from Surface Water)



2.3.2 During the High risk scenario (>3.3% annual probability) a minor portion of surface water flooding with depths greater than 0.3 m is present in the north-western corner of Sub-Site E which appears to be associated with surface water ponding against the River Till's embankments.

2.3.3 During the Medium risk scenario (1% - 3.3% annual probability) ponding with depths greater than 0.3 appears in the western extent of Sub-Site F and the north-eastern extent of Sub-Site E.

2.3.4 During the Low risk scenario (<1% annual probability) surface water with depths greater than 0.3 m appears across the central extent of Sub-Site F and the majority of the northern extent of Sub-Site E (associated with the course of the River Till).

2.3.5 There is no indication within relevant third party reports to suggest that the Site has historically experienced surface water flooding.

2.3.6 Based on the above and considering the embedded mitigation as part of the design of the solar panels, the overall risk of surface water flooding is considered to be **Low**.

2.3.7 The battery storage and substation will be bunded to ensure that all infrastructure remains flood free across all surface water flood risk scenarios. The proposed solar panels will be raised above surrounding ground levels and will be appropriately waterproofed thereby reducing the potential to be impacted in the event of surface water flooding.

2.3.8 The impact of the proposed substation/battery storage is covered in Sections 3.0, to ensure that surface water risk is not exacerbated.

2.4 Groundwater Flood Risk

2.4.1 There is no information within relevant third party reports (detailed in Section 1.4 'Sources of Information' of this Flood Risk Assessment and Drainage Strategy) to suggest that the Site has experienced historical groundwater flooding.

2.4.2 No buildings other than the supporting unstaffed infrastructure and no basement levels are identified on plans which may otherwise be at increased risk from groundwater seepage.

2.4.3 It can therefore be concluded that the risk of groundwater flooding is **Low** and no specific mitigation measures are required.

2.5 Artificial Sources Flood Risk

Sewer Flooding

2.5.1 No site-specific incidents of sewer flooding have been identified from relevant third party reports.

2.5.2 On the basis of the Site's rural setting, the presence of sewerage infrastructure is unlikely.

2.5.3 It can therefore be concluded that the risk of sewer flooding is **Low**.

Canal Flooding

2.5.4 There are no canals within the vicinity of the Site. Therefore, the risk from canal flooding is considered to be **Negligible**.

Reservoir Flooding

2.5.5 The EA 'Flood Risk from Reservoirs' map shows that the eastern extent of the Site is within the extents of a reservoir flood event.

2.5.6 The EA 'Flood Risk from Reservoirs' map shows that the Site is not within the extents of a reservoir breach. The EA states within their Preliminary Flood Risk Assessment for England (dated October 2018) that 'reservoir flooding is extremely unlikely to happen'. All large reservoirs must be inspected and supervised by reservoir panel engineers. As the enforcement authority for the Reservoirs Act 1975 in England, the EA ensure that reservoirs are inspected regularly, and essential safety work is carried out. It can therefore be concluded that the risk from reservoir flooding is considered to be **Low.**

2.6 Summary of Flood Risk

2.6.1 It can be concluded that the risk to the Site from all sources of flooding is **Negligible to Low**, and therefore mitigation is not required in this instance, however it would be prudent to include the below mitigation measures.

2.7 Embedded Mitigation

2.7.1 8m easements have been established around all watercourses, including Main Rivers and Ordinary Watercourses and 9 m from IDB assets.

2.7.2 Either fixed or tracker panels will be utilised throughout the Sites.

2.7.3 The minimum height of the lowest part of the fixed solar panel units will be 0.6 m above ground level.

2.7.4 The tracker solar panel units will be mounted on raised frames (usually raised a minimum of 0.4 m) when on maximum rotation angle) and will therefore be raised above surrounding ground levels and fitted with a tracking system. During times of flooding, solar panels may be stowed by the tracking system algorithm onto a horizontal plane, to the minimum post height of 2.3 m above ground level. This ensures that all sensitive and electrical equipment on the solar panel is raised to a minimum of 2.3 m above ground level in the horizontal position.

2.7.5 Fixed panels should be located within areas of the Site which are located in Flood Zone 1 whereas tracker panels can be located in areas that are within Flood Zones 2 and 3 on the basis of the additional flood protection offered by their potential to be stowed horizontally.

2.7.6 Electrical infrastructure associated with the panels can be adequately waterproofed to withstand the effect of flooding. Where possible the sensitive electrical equipment has been located in parts of the Site that are within Flood Zone 1. Where this hasn't been possible, equipment will be raised 0.6 m above the 0.1% AEP flood level or where this is not possible as high as practicable.

Flood Warnings and Evacuation

2.7.7 Flood Warnings / Flood Alerts do partly cover this area. However, access to the Site will be required relatively infrequently, typically by technicians for maintenance and inspection works or Site management. Such works can be scheduled as to avoid the site during times of flood.

2.8 Residual Risks

2.8.1 A residual risk is an exceedance event, such as the 1 in 1000 year (0.1% AEP) flood event that would overtop the River Till and associated land drains and potentially impact the Site. As the probability of a 1 in 1000 year flood event occurring is 0.1% in any given year, the probability is low and, therefore, no further mitigation beyond what is proposed is required.

2.8.2 In the event of the defences failing or an exceedance event occurring, the residual risk to people working within the Site can be managed through the implementation of an appropriate Site management plan, which recognises the residual risks and details what action is to be taken by staff in the event of a flood to put occupants in a place of safety.

2.9 Impact on Off-Site Flood Risk

2.9.1 The battery storage and substation has been sequentially located outside the most extreme 0.1% + 20% CC flood zone extent. The solar panels will be mounted on frames and raised above ground level allowing flood water to flow freely underneath. Therefore, there will be no loss of floodplain volume as a result of the proposed development and no increased in flood risk elsewhere.

2.9.2 Surface water management for proposed ground mounted panels has been considered with Section 5.0 of the Covering Report.

2.9.3 Surface water management for the proposed substation and battery storage area has been considered in Section 3.0 below.

3.0 Substation and Battery Storage Drainage Strategy

3.1 Introduction

3.1.1 This Drainage Strategy has been prepared in accordance with the Option B Illustrative Layout (Annex F) as the battery storage arrangement is larger and therefore depicts the 'conservative' scenario. The surface water drainage and firewater principles described still apply to Option A (Annex E) albeit the attenuation requirement would be on a smaller scale due to the smaller arrangement of battery storage. There would be no changes to the principals of the proposed drainage between Options A and B purely the area and total volume of the underlying subgrade.

3.1.2 For the purpose of this drainage strategy, the infrastructure depicted in the Option B Layout (Annex F) will be assessed within two Drainage Parcels separated by an existing land drain. A plan depicting the Parcel arrangement is included as Figure 3 and Annex I.

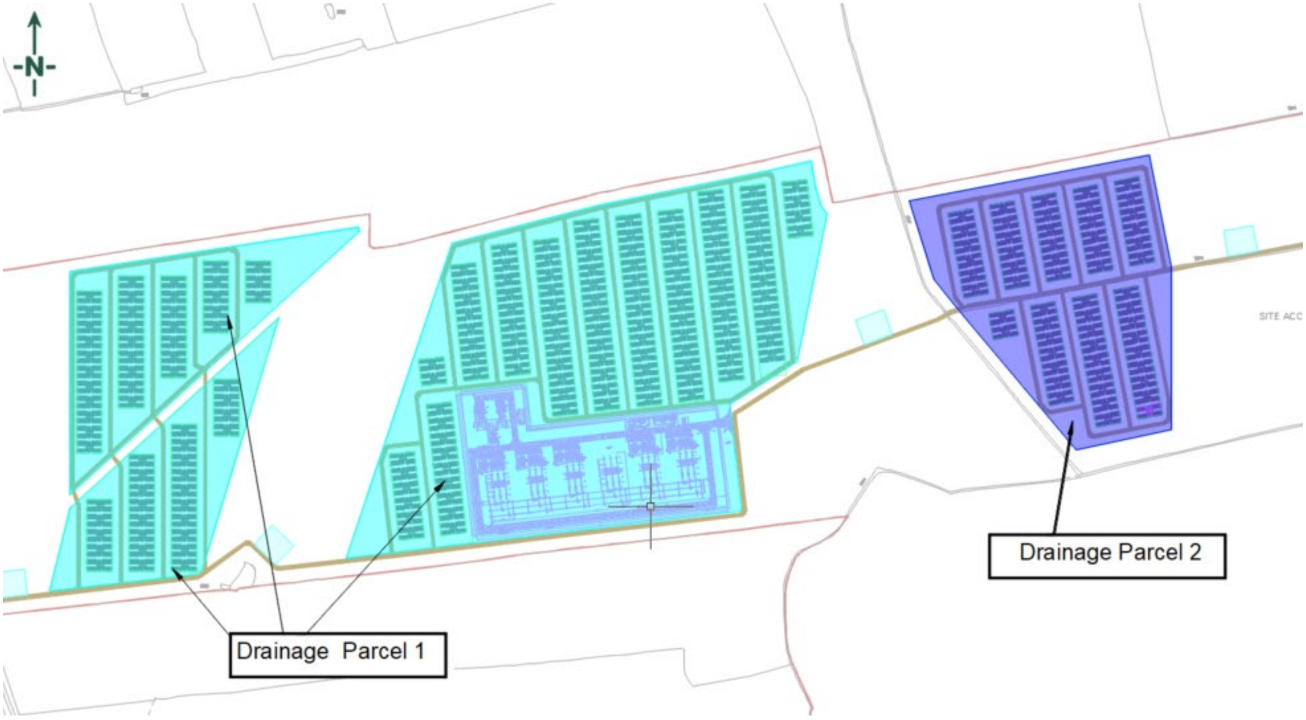


Figure 3: Option B Drainage Parcel Arrangement

3.1.3 Drainage Parcel 1 will introduce 49,212 m^2 of hardstanding in the form of foundation pads for the substation and battery storage.

3.1.4 Drainage Parcel 2 will introduce 8,410 m^2 of hardstanding in the form of foundation pads for battery storage.

3.1.5 The increase in hardstanding area will result in an increase in surface water runoff rates and volumes. In order to ensure the proposed development will not increase flood risk elsewhere, surface water discharge from the Site will be controlled through the implementation of an appropriately designed surface water drainage scheme as detailed below and secured via DCO.

3.2 Existing Runoff Rates

3.2.1 The existing greenfield runoff rates for Parcel 1 and 2 have been estimated using the Revitalised Flood Hydrograph Model (ReFH2) method provided as Table 1 below.

3.2.2 The existing 1 in 2 year event greenfield rate for Drainage Parcel 1 is 22.69 l/s.

3.2.3 The existing 1 in 2 year event greenfield rate for Drainage Parcel 2 is 3.83 l/s

3.2.4 Restricting runoff from both parcels to the existing 1 in 2 year event greenfield rate is proposed for both parcels to ensure a significant betterment during higher intensity storms and to ensure the drainage systems are self-cleansing.

Table 1: Greenfield Runoff Rates

Return Period (Years)	Drainage Parcel 1 Runoff Rate (l/s)	Drainage Parcel 2 Runoff Rate (l/s)
1 in 2	22.69	3.83
1 in 10	41.18	6.94
1 in 30	54.69	9.22
1 in 100	72.13	12.16
1 in 1000	123.27	20.79

3.3 Attenuation Storage

3.3.1 In order to achieve the above discharge rates, attenuation storage will be required.

3.3.2 MicroDrainage Quick Storage Estimates have been undertaken to determine the potential attenuation requirement during both the 1 in 30 plus 20% Climate Change (CC) and the 1 in 100 plus 20% CC events based on the hardstanding values stated in Section 5.1. MicroDrainage Quick Storage Estimates for Drainage Parcels 1 and 2 are included as Annexes J and K and are provided in Table 2 below.

Table 2: Summary of Attenuation Requirements

Return Period	Drainage Parcel 1 Attenuation Storage Requirement (m^3)	Drainage Parcel 2 Attenuation Storage Requirement (m^3)
1 in 30 + 20 % CC	2323 - 2907	391 - 489
1 in 100 + 20 % CC	3140 - 3888	528 - 654

3.3.3 The attenuation volumes are provided for indicative purposes only and should be verified at the detailed design stage.

3.4 Drainage Hierarchy

3.4.1 The recommended surface water drainage hierarchy The recommended surface water drainage hierarchy (Paragraph 5.7.19 of the NPS EN-1 and Paragraph 080 of the NPPG: Flood Risk and Coastal Change) is to utilise soakaway systems or infiltration as the preferred option, followed by discharging to an appropriate watercourse. If this is not feasible, the final option is to discharge to an existing public sewer.

Surface Water Discharge to Soakaway / Porous Surfacing

3.4.2 The first consideration for the disposal of surface water is infiltration (soakaways and permeable surfaces). As described above, no superficial deposits are recorded across the majority of Sub-Site G, where the battery storage and substation will be located. The bedrock geology comprises Mercia Mudstone Formation.

3.4.3 Soilscapes mapping indicates that the northern extent of Sub-Site G is underlain by 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils with impeded drainage'.

3.4.4 The proposed development is for battery storage which has a potential elevated risk of fire, which can mobilise contamination within fire water. Given the potential risk of mobilised contamination during a fire, it is proposed to control the surface water runoff during a fire event, stopping it from leaving the site so that the potentially contaminated runoff can be managed. Soakaways and / or porous surfacing releasing water to the ground, cannot be adequately controlled and is therefore, discounted as an appropriate option for the battery and substation sites. This is considered further in section 3.10 below.

3.4.5 Based on the above, it is unlikely that soakaways will be suitable for the discharge of surface water runoff.

Surface Water Discharge to Watercourse

3.4.6 Where soakaways are not suitable a connection to watercourse is the next consideration.

3.4.7 The nearest watercourse in an unnamed land drain which flows between the west of Drainage Parcel 1 and the east of Drainage Parcel 2.

3.4.8 Based on an assessment of elevation data, the base of the drain is situated approximately 2 m below surrounding ground levels which would support a gravity fed connection from Drainage Parcels 1 and 2.

3.4.9 Runoff from the two parcels will be limited to the rates stated in Section 5.2.

Surface Water Discharge to Sewer

3.4.10 As described above, a connection to an existing land drain is considered feasible and therefore a connection to the public surface water sewer is not required.

3.5 Sustainable Drainage Systems

3.5.1 Attenuation storage should be provided in the form of Sustainable Drainage Systems (SuDS) where practical. The following SuDS options have been considered:

Soakaways

3.5.2 As described above, the use of soakaways is not considered to be feasible due to the underlying geology and potential contamination risk.

Swales, Detention Basins and Ponds

3.5.3 Based on the development plans there is limited space available to accommodate above ground storage features such a ponds and basins within the northern extents of Sub-Site G.

Rainwater Harvesting

3.5.4 The attenuation benefits provided through the use of rainwater harvesting are considered to be limited and would only be realised when the tanks were not full. However, rainwater harvesting via the proposed drainage system will feed the proposed fire water attenuation tanks.

Green Roofs

3.5.5 Based on the nature of the proposed development, the installation of green roofing is not considered feasible.

Porous/Permeable Surfacing

3.5.6 All proposed access roads will be constructed utilising porous / permeable surfacing, with surface water passing to the ground mimicking the existing situation.

3.5.7 The substation and battery storage areas could be constructed within bunded areas lined to prevent infiltration and filled with subgrade to provide attenuation. Storage would be provided within the sub-grade material prior to controlled release to the existing land drain. The amount of storage offered by permeable surfacing is subject to sub-grade depth and Site gradient. The use of permeable surfacing should be considered at the detailed design stage.

3.5.8 An approximate area of 25,419 m^2 is available if bunded areas are retained close to each row of batteries. By incorporating permeable surfacing with a subgrade depth of 0.45 m and a void ratio of 30% across 13,891 m^2 and permeable surfacing with a subgrade depth of 0.3 m and a void ratio of 30% across 11,528 m^2, there is potential to accommodate 2,913 m^3 of attenuation storage under the battery storage area of Drainage Parcel 1.

3.5.9 Based on a subgrade depth of 0.45 m and a void ratio of 30%, there is potential to accommodate 459 m^3 of attenuation within the sub-grade of permeable surfacing in the access road within the substation area.

3.5.10 An approximate area of 8,067 m^2 is available beneath the battery storage in Drainage Parcel 2 to accommodate permeable surfacing. By incorporating permeable surfacing with a subgrade depth of 0.3 m and a void ratio of 30%, 726 m^3 of attenuation storage is available.

Underground Attenuation Tanks

3.5.11 Storage could be provided within underground attenuation tanks or within oversized pipes. Sufficient space for an underground tank is provided in the lower southern extents of development area however as described above, the incorporation of permeable surfacing with storage provided within the subgrade is considered to be the most suitable type of attenuation.

3.6 Preferred Drainage Scheme

3.6.1 A Conceptual Drainage Sketch (Annex L) has been prepared to illustrate the proposed drainage strategy for the Option B Layout, as the conservative scenario. The principles depicted still apply to Option A (Annex E) albeit the attenuation requirement would be on a smaller scale due to the smaller arrangement of battery storage.

3.6.2 It should be noted that detailed drainage design will be required at the detailed design stage.

3.6.3 As soakaways are not considered to be appropriate, surface water runoff will be discharged to the existing land drain which is located to the east of Drainage Parcel 1 and Drainage Parcel 2. Both parcels will discharge through a gravity fed connection to the land drain via new outfalls. Discharge will be limited to the 1 in 2 year greenfield discharge rate of 22.69 l/s for Drainage Parcel 1 and 3.83 l/s for Drainage Parcel 2.

3.6.4 Attenuation will be required to achieve the above discharge rates. The attenuation can be provided by bunding the rows of batteries to an average height of 0.45 m in Drainage Parcel 1 and 0.3m in Drainage Parcel 2. The bunded areas can then be filled with subgrade to provide the required attenuation volume. Check damming of the bunded areas may be required within the subgrade to mitigate the topographical differences across the battery rows.

3.6.5 The total attenuation volumes for Drainage Parcels 1 and 2 are provided in Table 3, MicroDrainage Source Control calculations are included as Annex M and N. Attenuation will be provided in the form of permeable surfacing within the access roads.

Table 3: Total Attenuation Volumes (m^3)

Drainage Parcel 1	Drainage Parcel 2
551.8	3,335.6

3.7 Event Exceedance

3.7.1 Storage will be provided for the 1 in 100 year plus 20 % CC event. Storm events in excess of the 1 in 100 year plus 20 % CC event should be permitted to produce temporary shallow depth flooding.

3.8 Surface Water Treatment

3.8.1 In accordance with the CIRIA C753 publication 'The SuDS Manual' (2015), Low Traffic Roads have a 'very low' pollution hazard level. Table 4 below shows the pollution hazard indices for each land use.

Table 4: Pollution Hazard Indices

Land Use	Pollution Hazard Level	Total Suspended Solids (TSS)	Metals	Hydrocarbons
Low Traffic Roads	Low	0.5	0.4	0.4

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.2

3.8.2 Where practical, runoff will be directed to permeable surfacing. Table 5 below demonstrates that permeable pavement provides sufficient treatment.

Table 5: SuDS Mitigation Indices

	Mitigation Indices		
Type of SuDS	**Total Suspended Solids (TSS)**	**Metals**	**Hydrocarbons**
Permeable Surfacing	0.7	0.6	0.7

Table extract taken from the CIRIA C753 publication 'The SuDS Manual' – Table 26.3

3.9 Development Consent Order (DCO)

3.9.1 The proposed drainage scheme will be secured by DCO. Wording such as that presented below should be applied in order to ensure the proposed development is appropriately consented.

3.9.2 No phase of the solar farm works and grid connection works may commence until written details of the surface water drainage scheme and (if any) foul water drainage system (which must be substantially in accordance with the outline drainage strategy prepared by Delta-Simons) have been submitted to and approved by the relevant planning authority for that phase or, where the phase falls within the administrative areas of both Braintree District Council and Chelmsford City Council, both relevant planning authorities such approval to be in consultation with Essex County Council as the lead local flood authority.

3.9.3 Any approved scheme must be implemented as approved and maintained throughout the construction and operation of the solar farm works and grid connection works.

3.10 Maintenance

3.10.1 Maintenance of communal drainage features such as permeable surfacing will be the responsibility of the Site owner.

3.10.2 A maintenance schedule for permeable surfacing is included in Annex O.

3.11 Firewater Risks

3.11.1 Lincolnshire Fire and Rescue within their response to the PEIR have stated that the Scheme must minimise fire risk through mitigations incorporated as part of the design. Within their response they state the following:

Ensure that sufficient water is available for manual fire-fighting. An external fire hydrant should be located in close proximity of the BESS containers. – The water supply should be able to provide a minimum of 1,900 l/min for at least 120 minutes (2 hours). Further hydrants should be strategically located across the development. These should be tested and serviced at regular intervals by the operator. If the site is remote from a pressure feed water supply, then an Emergency Water Supply (EWS) meeting the above standard should be incorporated into the design of the site e.g. an open water source and/or tank(s). If above ground EWS tanks are installed, these should include facilities for the FRS to discharge (140/100mm RT outlet) and refill the tank.

3.11.2 To ensure the proposed battery storage area provides adequate water in case of a fire. Water storage has been provided adjacent to the battery units. Four fire water storage units are proposed each holding 228 m^3 (1,900 l/min for at least 120 minutes (2 hours)).

3.11.3 Potential environmental risks are associated with the escape of firewater from the battery storage area.

3.11.4 The principal route for firewater loss from the Site is via the proposed surface water drainage system into the existing land drainage network. In order to isolate the Site's drainage, two automatically actuated valves should be installed at the two outfalls to the land drain. In the event of a fire, the valve will be designed to activate to close off the battery storage area's drainage system triggered by the fire alarm systems. Flows will then back up in the system. The system will be designed to accommodate the 1 in 100 plus 20% climate change storm event, therefore a sufficient amount of storage is provided to contain a reasonable worst case 1 in 10 year storm event plus the provided firewater requested by the Lincolnshire Fire and Rescue Service. Each block of permeable surfacing will be bunded to contain any above ground firewater.

3.11.5 After a fire event, the wastewater will be tested to ascertain the level of contamination. A decision will then be made as to the appropriate methodology to dispose of the attenuated water. This may involve on-site treatment and release or tankering.

3.12 Other Considerations

3.12.1 Maintenance access to all land drains should be retained. Maintenance access can be ensured by providing an 9 m buffer either side of the watercourse.

4.0 Conclusions and Recommendations

4.1 Conclusions

4.1.1 The proposed development comprises a solar energy substation and battery storage area in the northern extent of Parcel 1, with associated ground mounted solar photo-voltaic panels, associated power stations and access throughout the remaining Site.

Flood Risk

4.1.2 Based on the evidence provided above, the majority of the Site remains flood free during the 1% AEP + 20% CC event with only minor flood depths < 0.5 m in the south-eastern corner of Parcel 3. The proposed battery storage area and substations are located within areas of the Site that are shown to be outside of the 0.1% AEP + 20% CC flood extent with the proposed solar panels will be raised above surrounding ground levels with associated power infrastructure appropriately waterproofed.

4.1.3 The risk of flooding from all sources has been assessed and the flood risk to the Site is considered to be **Negligible to Low** and therefore does not require Site-specific mitigation measures.

4.1.4 The solar panels will be mounted on raised frames and therefore raised above surrounding ground level allowing flood water to flow freely underneath. Therefore, there will be no loss of floodplain volume as a result of the proposed development.

Ground Mounted PV Panels Drainage Commentary

4.1.5 Surface water management for proposed ground mounted panels has been considered with Section 5.0 of the Covering Report

4.1.6 The proposed development is free draining through perimeter gaps around all panels, allowing for infiltration as existing within the grassland/vegetation surrounding and beneath the panels. There will be minimal increase in impermeable area meaning the proposals will not increase surface water flood risk elsewhere.

4.1.7 Any surface water exceeding the infiltration capacity of the surrounding strata will naturally drain to the surrounding Land Drains in line with the existing scenario.

4.1.8 The heavily managed agricultural land will be replaced with grassland. This will help to reduce run off rates by increasing the roughness of the ground, help to increase infiltration by reducing compaction, and improve water quality by reducing erosion and mobilisation of pollutants. As a result, runoff rates may be reduced following development when compared to the existing greenfield scenario.

Battery Storage and Substation Drainage Strategy

4.1.9 The Drainage Strategy has been prepared in accordance with the Option B Illustrative Layout (Annex F) as the battery storage arrangement is larger and therefore depicts the 'conservative' scenario. The surface water drainage and firewater principles described still apply to Option A (Annex E) albeit the attenuation requirement would be on a smaller scale due to the smaller arrangement of battery storage.

4.1.10 The proposed development will introduce impermeable drainage area in the form of battery storage, substation infrastructure and access. This will result in an increase in surface water runoff. In order to ensure the increase in surface water runoff will not increase flood risk elsewhere, flow control will be used, and attenuation provided on Site to accommodate storm events up to and including the 1 in 100 year plus 20 % climate change event. Two separate drainage parcels are proposed for the Option B Layout.

4.1.11 All methods of surface water discharge have been assessed. Soakaways are not considered to be a feasible option, therefore discharge of surface water to an existing land drain at a rate of 22.69 l/s for Drainage Parcel 1 and 3.83 l/s for Drainage Parcel 2 appears to be most practical option.

4.1.12 Attenuation storage will be required on Site in order to restrict surface water discharge. Attenuation can be provided within the sub-grade of permeable surfacing (see Annex L).

4.2 Recommendations

4.2.1 The recommendations below have been taken into account in the design of the Illustrative Site Layout:

Flood Risk

- 8m easements have been established around all watercourses, including Main Rivers and Ordinary Watercourses and 9 m from IDB assets;
- All service cabling should be designed and installed to be flood resilient / water compatible. This should be achieved in accordance with appropriate design standards and best practise guidance;

Drainage Strategy

- Verify the attenuation volumes included in this report when undertaking detailed drainage design.

Annex A – Limitations

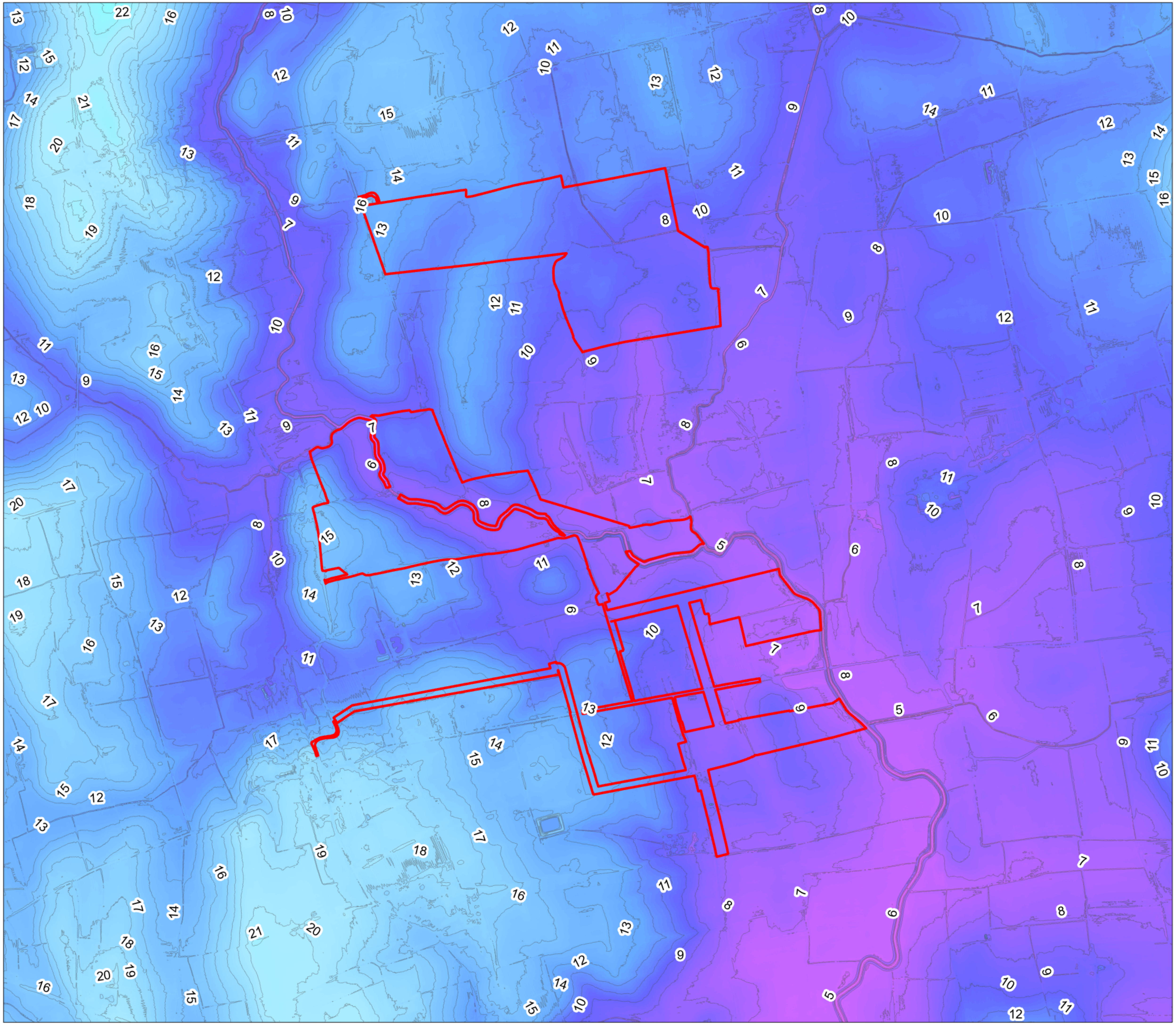
Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Annex B – LiDAR Plan



Legend

Cottam 1 West boundary

Contours

LiDAR

70.96

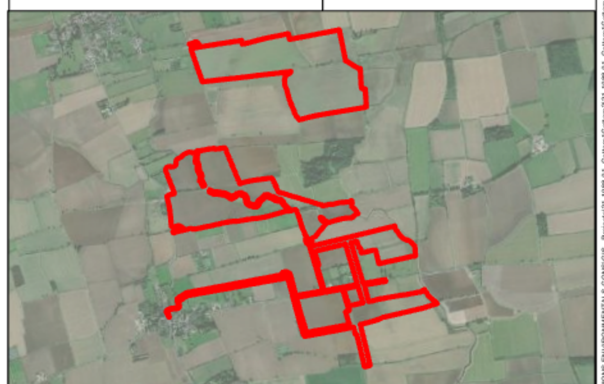
3.13

0 150 300 450 600 Meters

N

Figure	LIDAR & Contours
Job	Cottam 1 West
Client	Island Green Power

Appendix	B	Revision	A	Date	03/11/2022
Drawn	KH	Checked	EB	Scale	1:15,000 @ A3
Job No.	21-1088.03			Central GR	489385E 383032N



DO NOT SCALE.
NOT FOR CONSTRUCTION.

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Annex C – River Till Water Body Classification Summary

Classification Item	Cycle 2 2019 Classification	Cycle 3 2019 Classification	Cycle 3 Objectives		
Ecological	N/A	Moderate	Moderate	2015	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Biological quality elements	N/A	Poor	Moderate	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Fish	N/A	Poor	Moderate	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Invertebrates	N/A	Good	Good	2015	
Macrophytes and Phytobenthos Combined	N/A		Not assessed	2015	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Physico-chemical quality elements	N/A	Moderate	Moderate	2015	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Acid Neutralising Capacity	N/A	High	Good	2015	
Ammonia (Phys-Chem)	N/A	High	Good	2015	
Dissolved oxygen	N/A	Poor	Good	2015	
Phosphate	N/A	Poor	Moderate	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens; Disproportionately expensive: Unfavourable balance of costs and benefits
Temperature	N/A	High	Good	2015	
pH	N/A	High	Good	2015	
Hydromorphological Supporting Elements	N/A	Supports good	Supports good	2015	
Hydrological Regime	N/A	Supports good	Supports good	2015	

Supporting elements (Surface Water)	N/A	Good	Good	2015	
Mitigation Measures Assessment	N/A	Good	Good	2015	
Specific pollutants	N/A	High	High	2015	
Copper	N/A	High	High	2015	
Mecoprop	N/A	High	High	2015	
Chemical	N/A	Fail	Good	2063	Natural conditions: Chemical status recovery time; Technically infeasible: No known technical solution is available
Priority hazardous substances	N/A	Fail	Good	2063	Natural conditions: Chemical status recovery time; Technically infeasible: No known technical solution is available
Benzo(a)pyrene	N/A	Good	Good	2015	
Dioxins and dioxin-like compounds	N/A	Good	Good	2015	
Heptachlor and cis-Heptachlor epoxide	N/A	Good	Good	2015	
Hexabromocyclododecane (HBCDD)	N/A	Good	Good	2015	
Hexachlorobenzene	N/A	Good	Good	2015	
Hexachlorobutadiene	N/A	Good	Good	2015	
Mercury and Its Compounds	N/A	Fail	Good	2040	Natural conditions: Chemical status recovery time
Perfluorooctane sulphonate (PFOS)	N/A	Fail	Good	2039	Technically infeasible: No known technical solution is available
Polybrominated diphenyl ethers (PBDE)	N/A	Fail	Good	2063	Natural conditions: Chemical status recovery time
Priority substances	N/A	Good	Good	2015	
Cypermethrin (Priority)	N/A	Good	Good	2015	
Fluoranthene	N/A	Good	Good	2015	

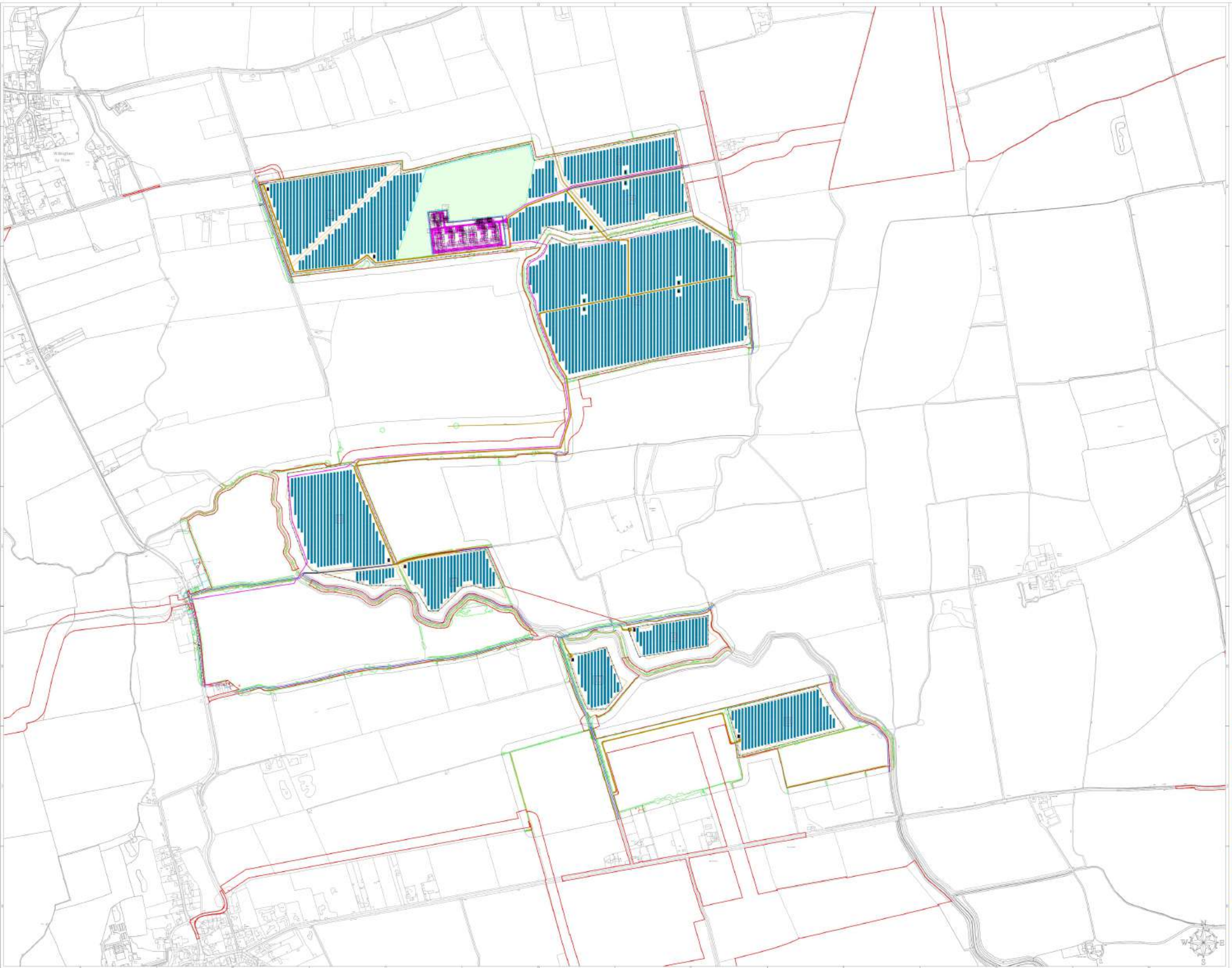
Other Pollutants	N/A	Does not require assessment	Does not require assessment	2015	

Annex D – Fillingham Water Body Classification Summary

Classification Item	Cycle 3 2019 Classification	Cycle 3 Objectives		
	Status	Status	Year	Reasons
Ecological	Moderate	Good	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens; Good status prevented by A/HMWB designated use: Action to get biological element to good would have significant adverse impact on use
Biological quality elements	Moderate	Moderate	2015	Disproportionately expensive: Disproportionate burdens; Good status prevented by A/HMWB designated use: Action to get biological element to good would have significant adverse impact on use
Invertebrates	Moderate	Moderate	2015	Good status prevented by A/HMWB designated use: Action to get biological element to good would have significant adverse impact on use
Macrophytes and Phytobenthos Combined		Not assessed	2015	Disproportionately expensive: Disproportionate burdens
Physico-chemical quality elements	Moderate	Good	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens
Ammonia (Phys-Chem)	High	Good	2015	
Dissolved oxygen	High	Good	2015	
Phosphate	Poor	Good	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens
Temperature	High	Good	2015	
pH	High	Good	2015	
Hydromorphological Supporting Elements	Supports good	Supports good	2015	
Hydrological Regime	Supports good	Supports good	2015	
Supporting elements (Surface Water)	Good	Good	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens
Mitigation Measures Assessment	Good	Good	2027 - Low confidence	Disproportionately expensive: Disproportionate burdens
Specific pollutants		Not assessed	2015	
Chemical	Good	Good	2063	Natural conditions: Chemical status recovery time

Priority hazardous substances	Does not require assessment	Good	2063	Natural conditions: Chemical status recovery time
Benzo(a)pyrene		Good	2015	
Dioxins and dioxin-like compounds		Good	2015	
Heptachlor and cis-Heptachlor epoxide		Good	2015	
Hexabromocyclododecane (HBCDD)		Good	2015	
Hexachlorobenzene		Good	2015	
Hexachlorobutadiene		Good	2015	
Mercury and Its Compounds		Good	2040	Natural conditions: Chemical status recovery time
Perfluorooctane sulphonate (PFOS)		Good	2015	
Polybrominated diphenyl ethers (PBDE)		Good	2063	Natural conditions: Chemical status recovery time
Priority substances	Does not require assessment	Good	2015	
Cypermethrin (Priority)		Good	2015	
Fluoranthene		Good	2015	
Other Pollutants	Does not require assessment	Does not require assessment	2015	

Annex E – Option A Illustrative Layout



General Legend

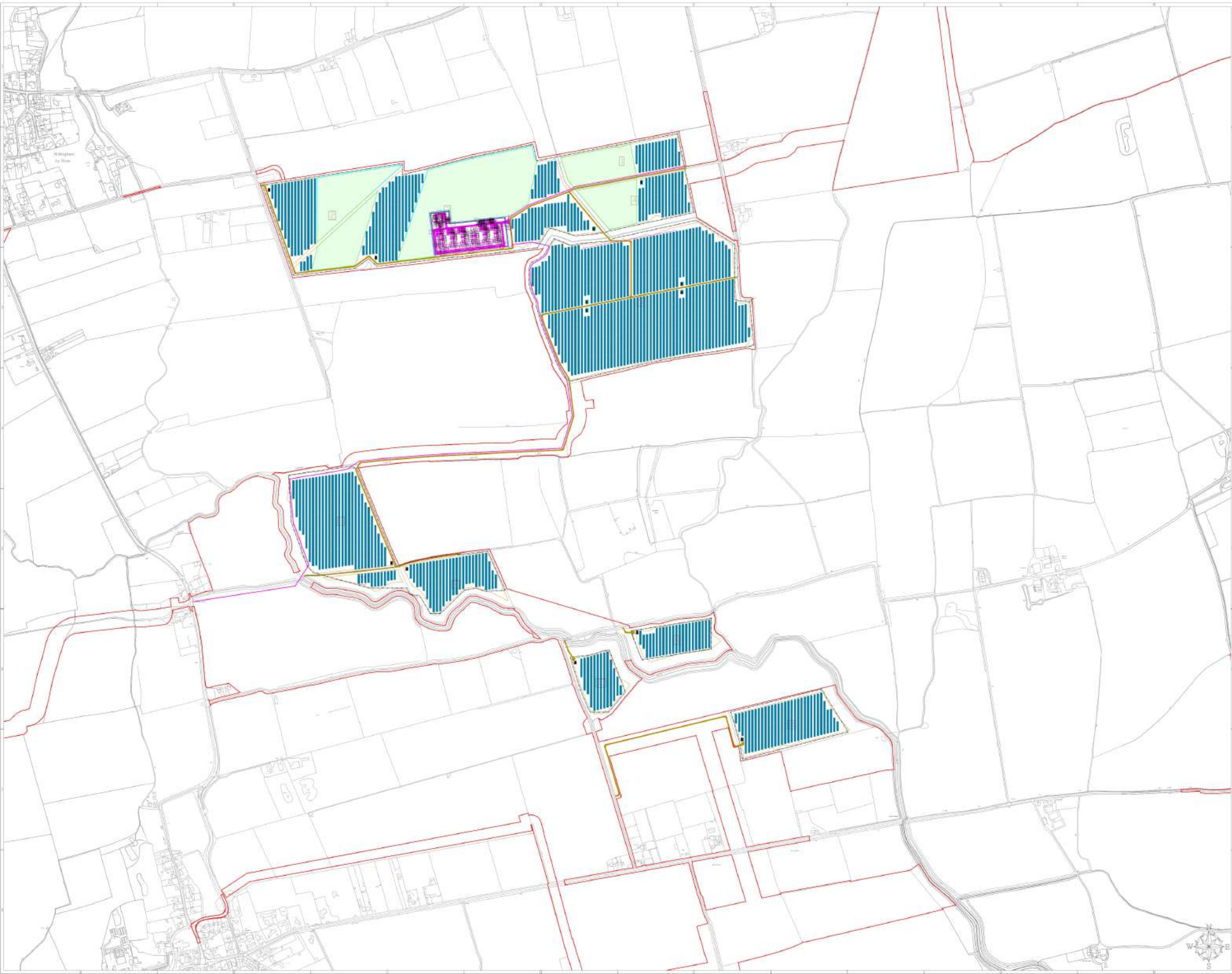
—	Project Boundaries
—	Fence
—	Development Area
—	Mounting Structures
—	Power Stations
—	Electrical Substation
—	High Voltage Electricity Cable
—	Energy Storage Area
—	Maintenance Tracks
—	Gates
—	Acoustic Barrier
—	CCTV

Project	Cottam 1 West A Solar Project
Project Location	Land near Coates, Lincoln Lincolnshire, LN1 2XR, England
Ownership	Cottam Solar Project Limited
Document Title	Layout
Sheet format	A1 "841 x 594"
Scale	1:5000

Document amendments			Comments
v.1	10/03/2022	A.A	Preliminary Layout
v.2	15/04/2022	A.A	Updated Layout
v.3	27/05/2022	WR	Key amendment
v.4	16/08/2022	A.A	Final Layout
v.5	14/10/2022	A.A	Updated Application Boundary

Company: Island Green Power UK Limited
Unit 20.2, Coda Studios
189 Munster Road, London SW6 6AW

Annex F – Option B Illustrative Layout



General Legend

(red line)	Project Boundaries
(grey line)	Fence
(orange line)	Development Area
(blue hatched)	Mounting Structures
(black box)	Power Stations
(pink hatched)	Electrical Substation
(magenta line)	High Voltage Electrode Cable
(green box)	Energy Storage Area
(brown bar)	Maintenance Tracks
(green line)	Gates
(cyan line)	Acoustic Barrier
(cyan dot)	CCTV

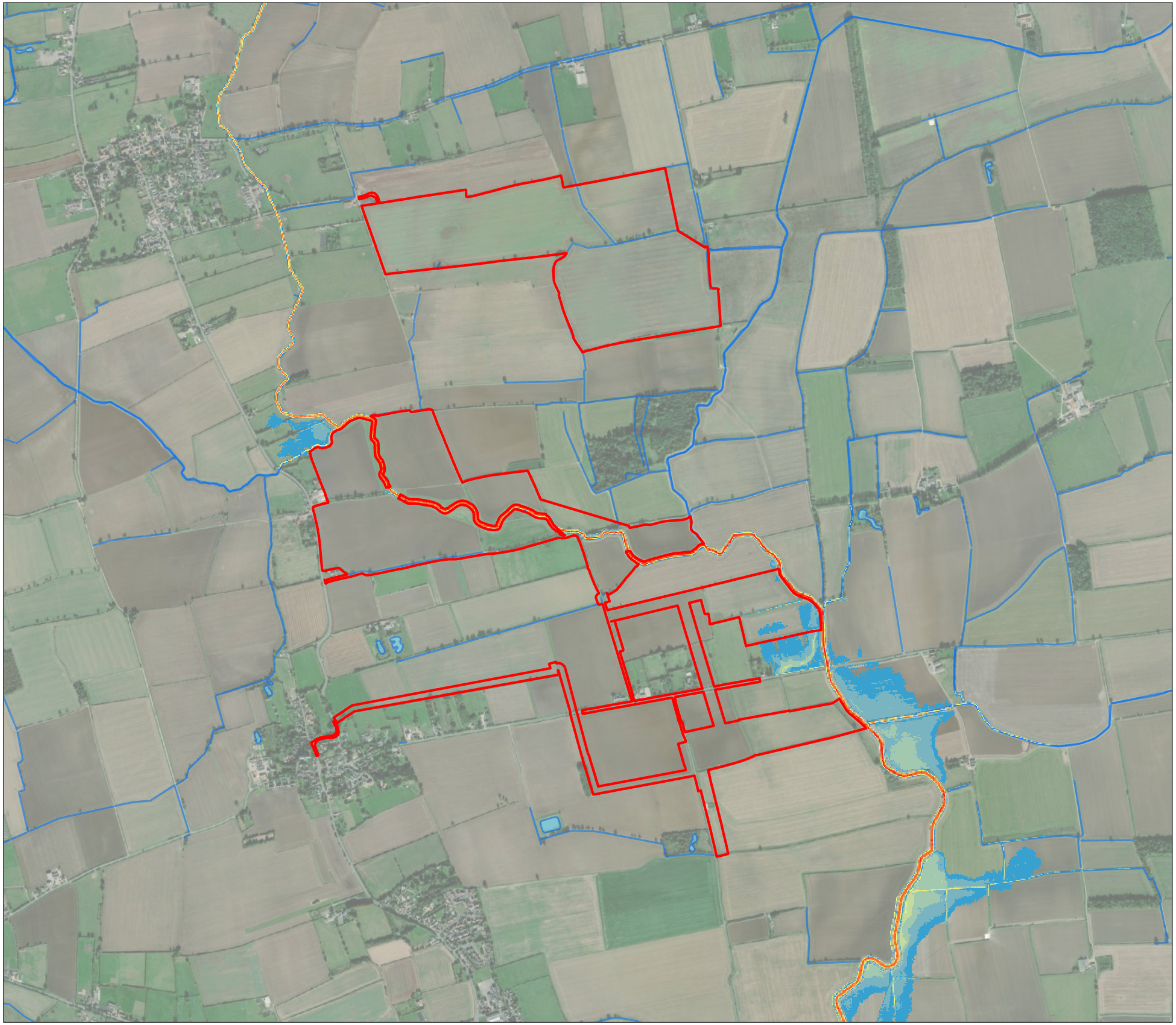
Project	Cottam 1 West A Solar Project
Project Location	Land near Cottam, Lincoln Lincolnshire, LN1 2DW, England
Ownership	Cottam Solar Project Limited
Document Title	Layout
Sheet format	A1 "841 x 594"
Scale	1:5000

Document amendments			Comments
v.1	[illegible]	A.A	Preliminary Layout
v.2	[illegible]	A.A	Updated Layout
v.3	[illegible]	W.B	Re-amendment
v.4	[illegible]	A.A	Final Layout
v.5	[illegible]	A.A	Updated Application Boundary

Company: Island Green Power UK Limited
Unit 20.2, Coda Studios
189 Munster Road, London SW6 6AW

0 50 100 200

Annex G - 1% AEP + 20% CC Flood Depth Map



Legend

Cottam 1 West boundary

Watercourse

Linear watercourse

1 in 100 year event + CC depth (m)

- 0.01 m - 0.23 m
- 0.24 m - 0.49 m
- 0.5 m - 0.8 m
- 0.81 m - 1.1 m
- 1.11 m - 1.4 m
- 1.41 m - 1.7 m
- 1.71 m - 2.1 m
- 2.11 m - 2.57 m
- 2.58 m - 3.18 m
- 3.19 m - 4.83 m

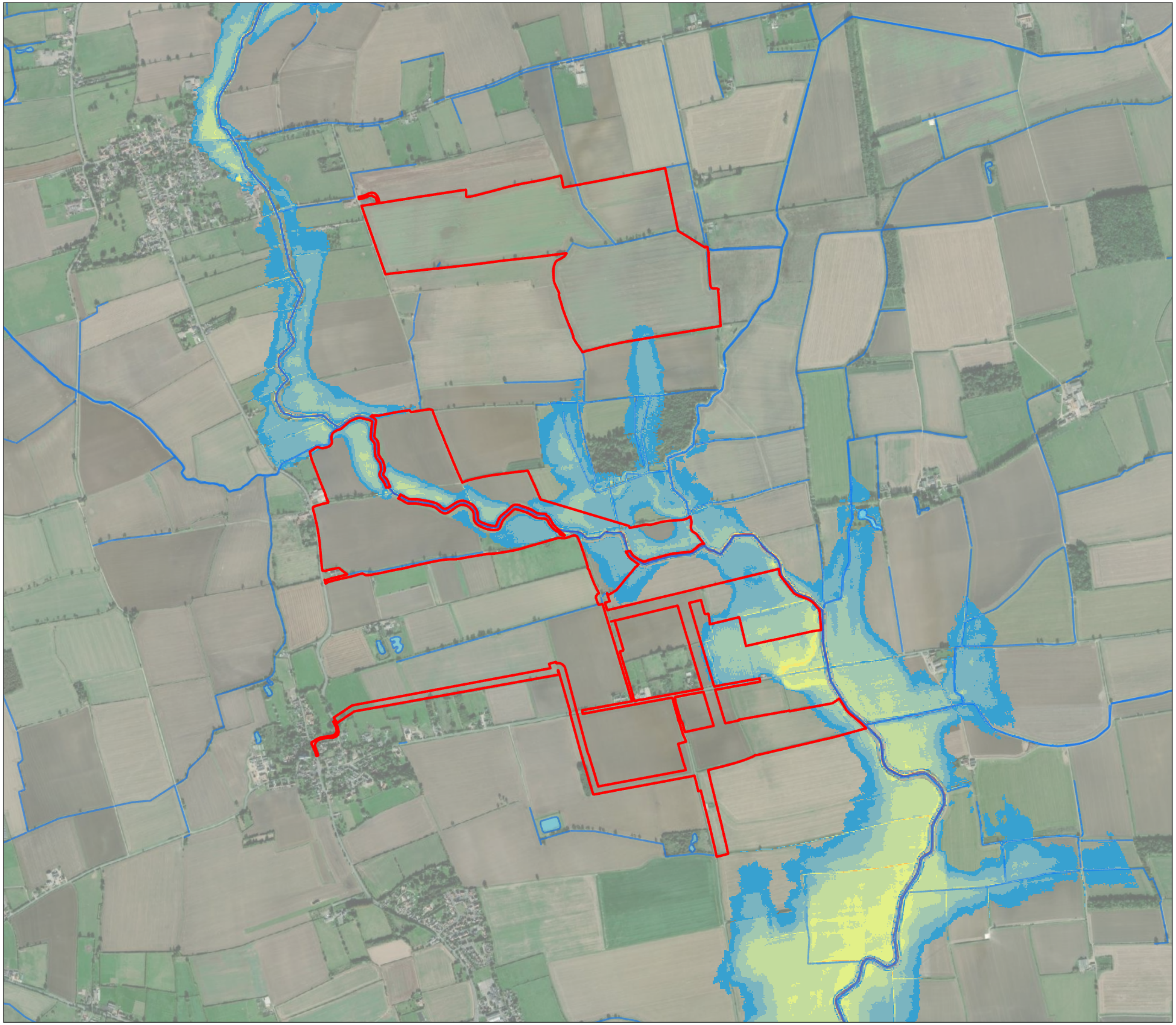
0 150 300 450 600 Meters

N

Figure	1% AEP + CC Flood Map				
Job	Cottam 1 West				
Client	Island Green Power				
Appendix	G	Revision	A	Date	03/11/2022
Drawn	KH	Checked	EB	Scale	1:15,000 @ A3
Job No.	21-1088.03			Central GR	489385E 383032N

DO NOT SCALE.
NOT FOR CONSTRUCTION.

Annex H – 0.1% AEP + 20% CC Flood Depth Map



Legend

- Cottam 1 West boundary
- Watercourse
- Linear watercourse

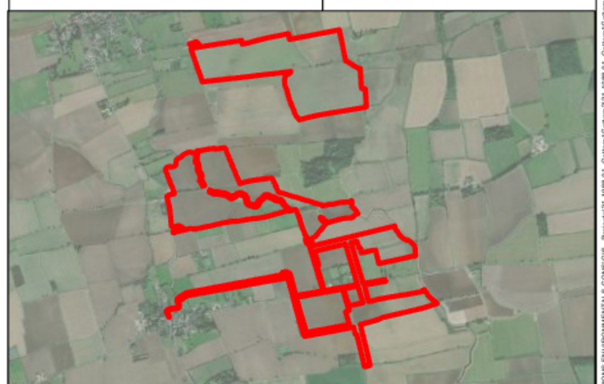
1 in 1000 year event + CC depth (m)

- 0.01 m - 0.27 m
- 0.28 m - 0.57 m
- 0.58 m - 0.88 m
- 0.89 m - 1.2 m
- 1.21 m - 1.55 m
- 1.56 m - 1.9 m
- 1.91 m - 2.26 m
- 2.27 m - 2.69 m
- 2.7 m - 3.3 m
- 3.31 m - 5.2 m

0 150 300 450 600 Meters

N

Figure	0.1% AEP + CC Flood Map				
Job	Cottam 1 West				
Client	Island Green Power				
Appendix	H	Revision	A	Date	03/11/2022
Drawn	KH	Checked	EB	Scale	1:15,000 @ A3
Job No.	21-1088.03			Central GR	489385E 383032N



DO NOT SCALE.
NOT FOR CONSTRUCTION.

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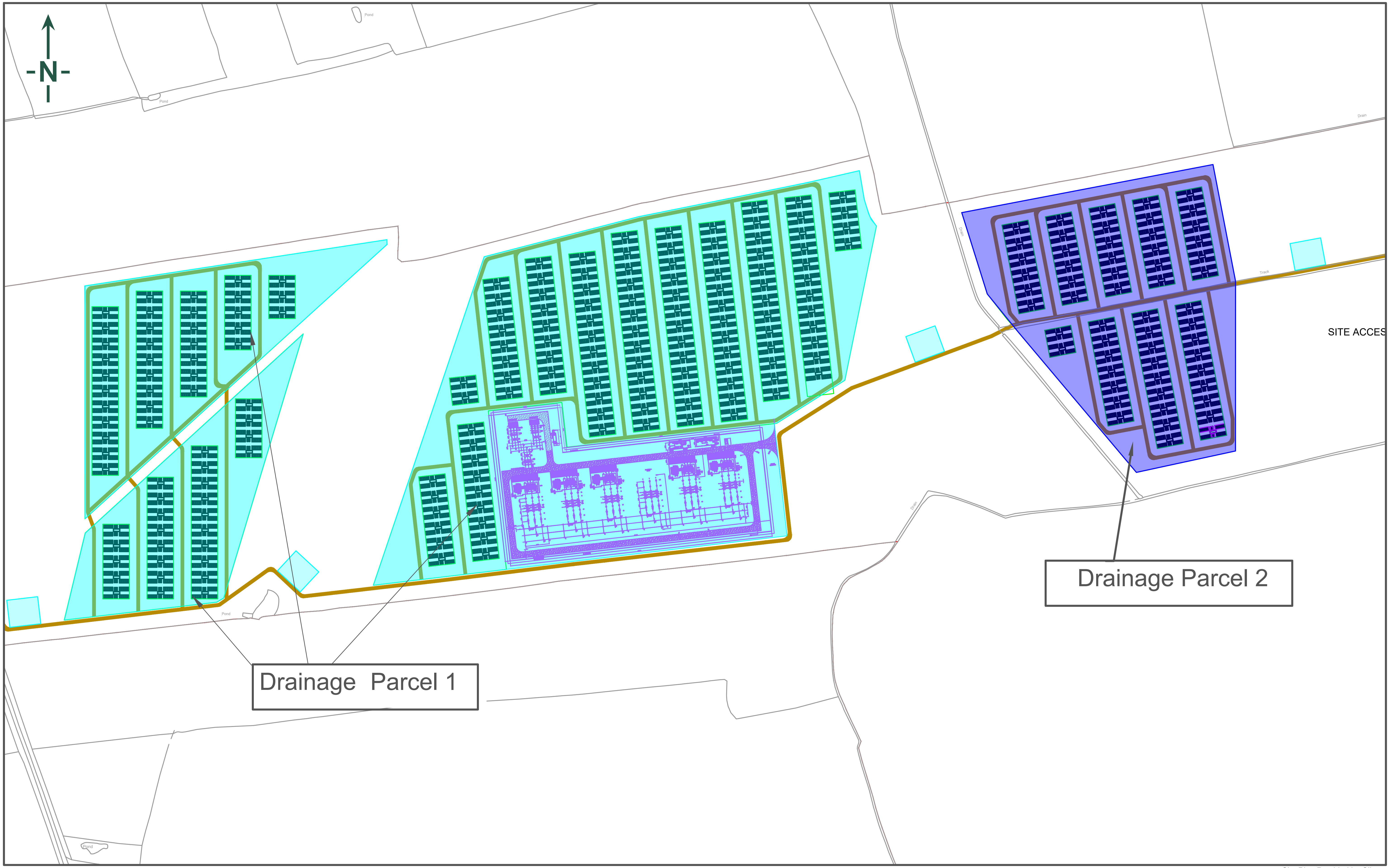
Annex I – Substation and Battery Storage Drainage Parcel Plan



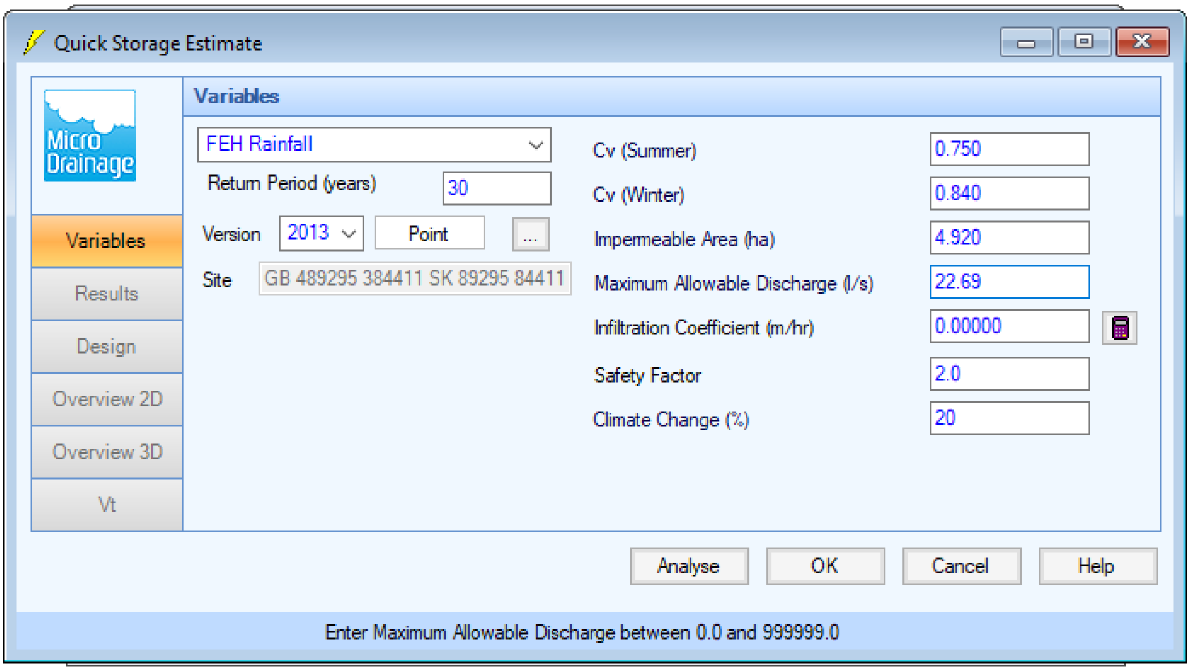
Site Plan Provided by Client

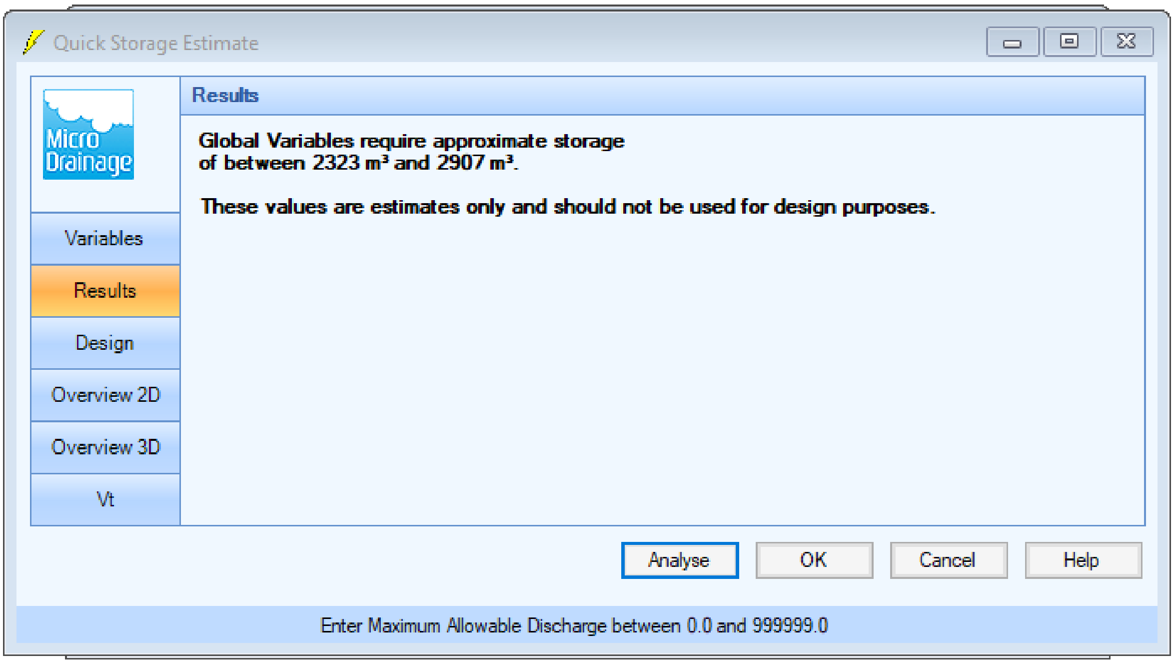
DeltaSimons

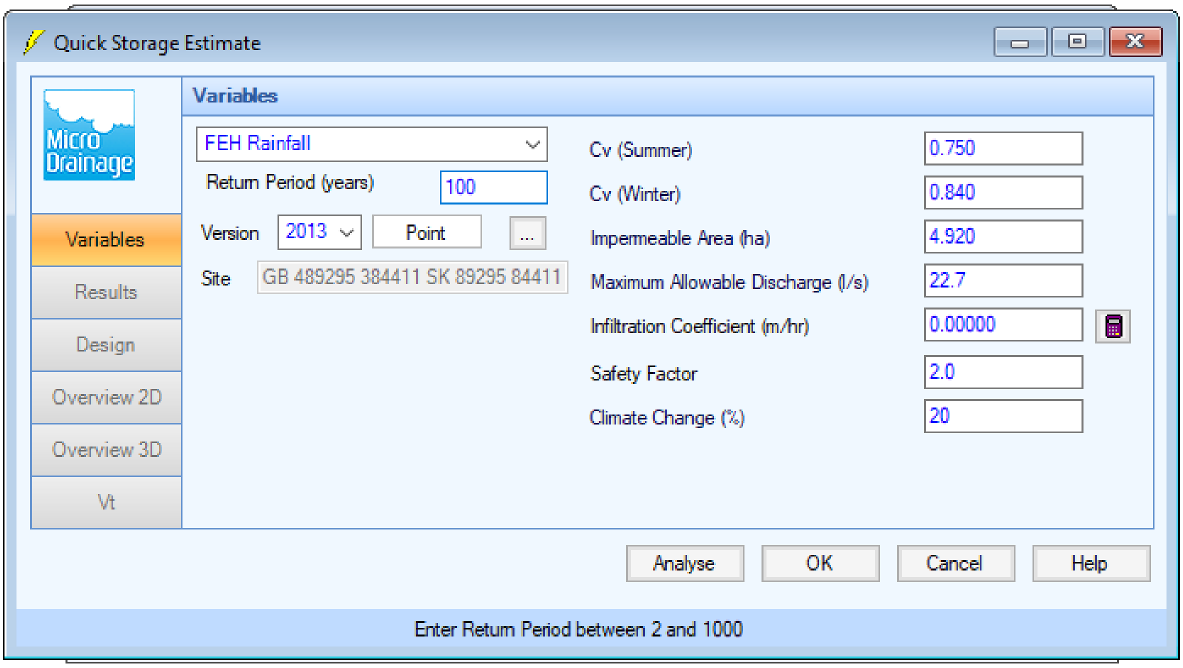
TITLE:
Option B Layout Drainage Parcel Catchment Areas
Cottam 1 West

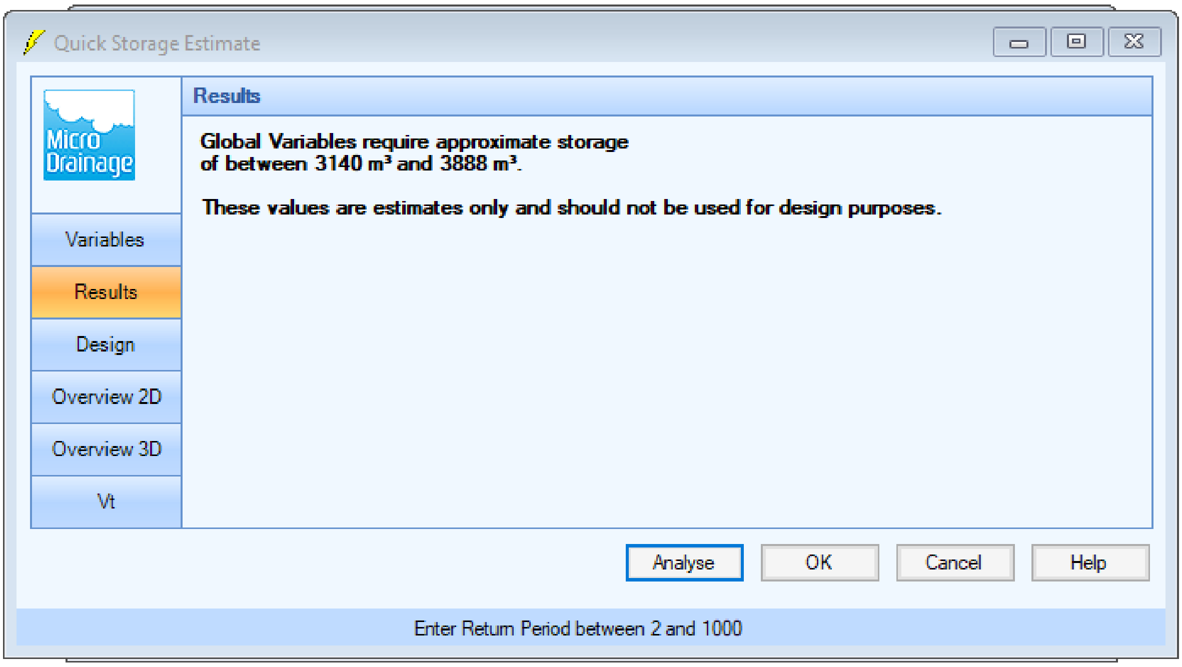
DRAWN BY: EB	SCALE: Not to Scale	PROEJCT NO: 21-1088.01
CHECKED BY: JR	REVISION: 1	APPENDIX: I
DATE: 26/10/22		

Annex J – Parcel A MicroDrainage Quick Storage Estimate

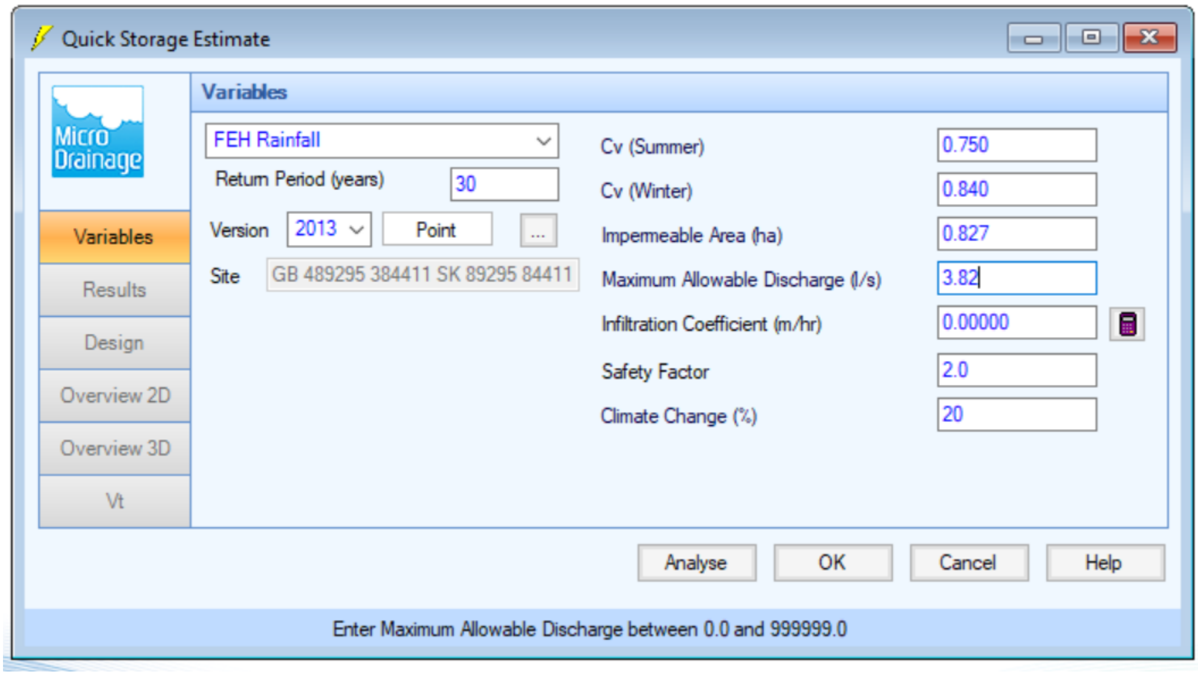

Quick Storage Estimate
Variables
FEH Rainfall
Return Period (years)
30
Version
2013
Point
...
Site
GB 489295 384411 SK 89295 84411
Cv (Summer)
0.750
Cv (Winter)
0.840
Impermeable Area (ha)
4.920
Maximum Allowable Discharge (l/s)
22.69
Infiltration Coefficient (m/hr)
0.00000
Safety Factor
2.0
Climate Change (%)
20
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

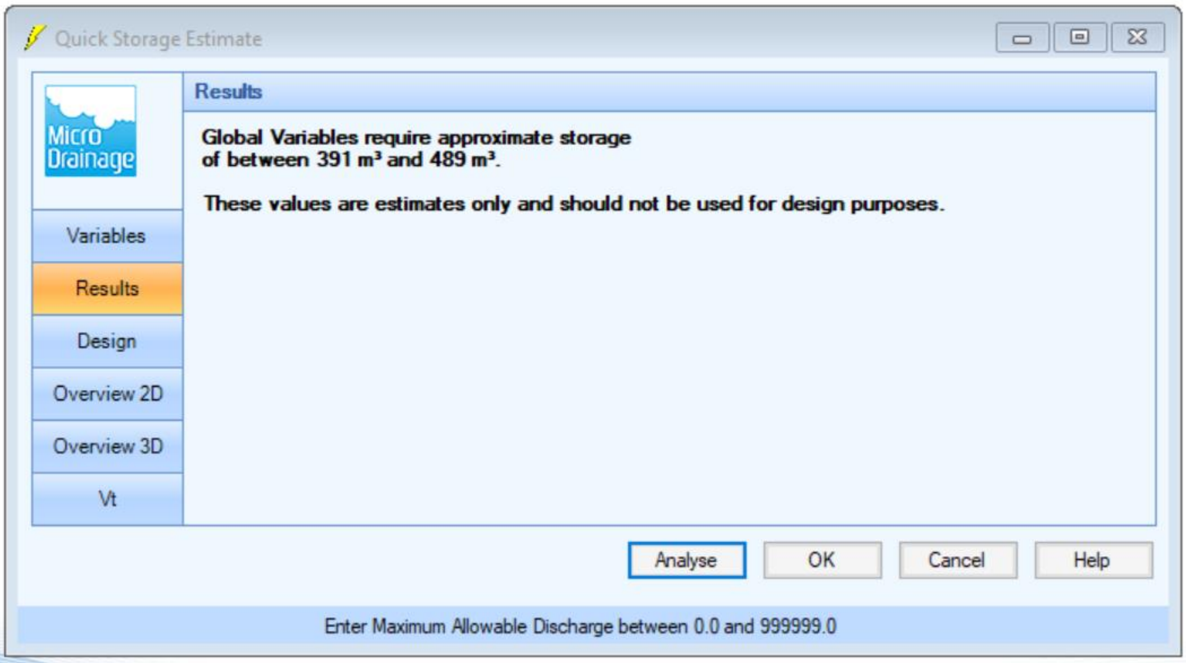

Quick Storage Estimate
Results
Global Variables require approximate storage
of between 2323 m³ and 2907 m³.
These values are estimates only and should not be used for design purposes.
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0

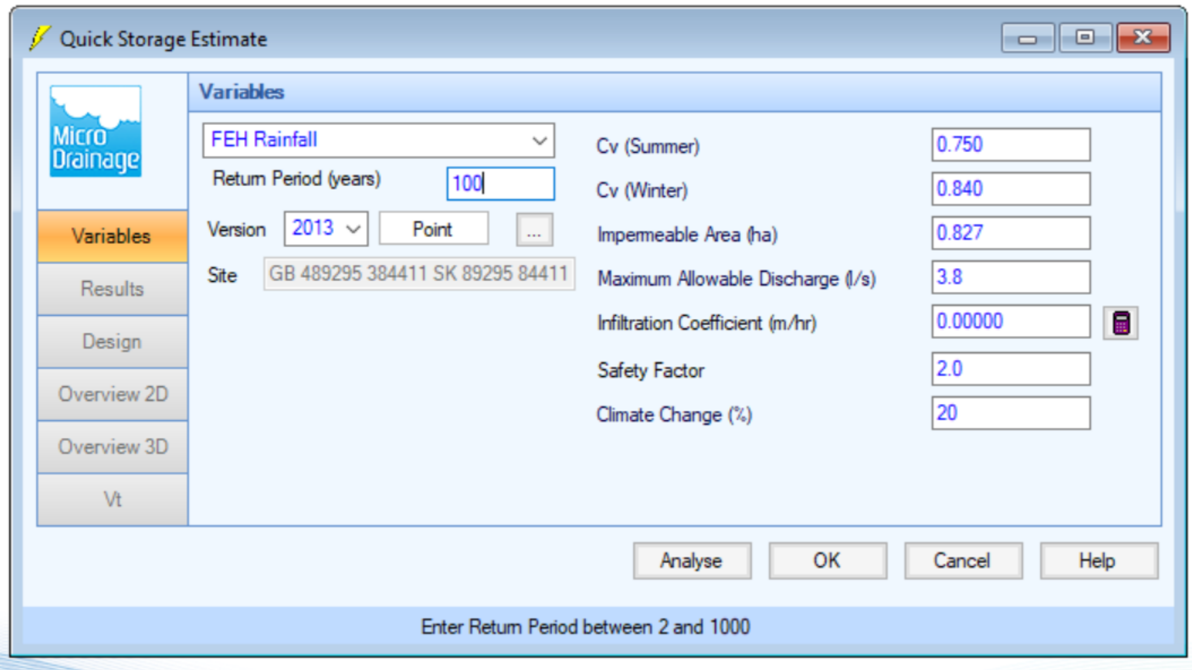

Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FEH Rainfall
Return Period (years)
100
Version
2013
Point
...
Site
GB 489295 384411 SK 89295 84411
Cv (Summer)
0.750
Cv (Winter)
0.840
Impermeable Area (ha)
4.920
Maximum Allowable Discharge (l/s)
22.7
Infiltration Coefficient (m/hr)
0.00000
Safety Factor
2.0
Climate Change (%)
20
Analyse
OK
Cancel
Help
Enter Return Period between 2 and 1000

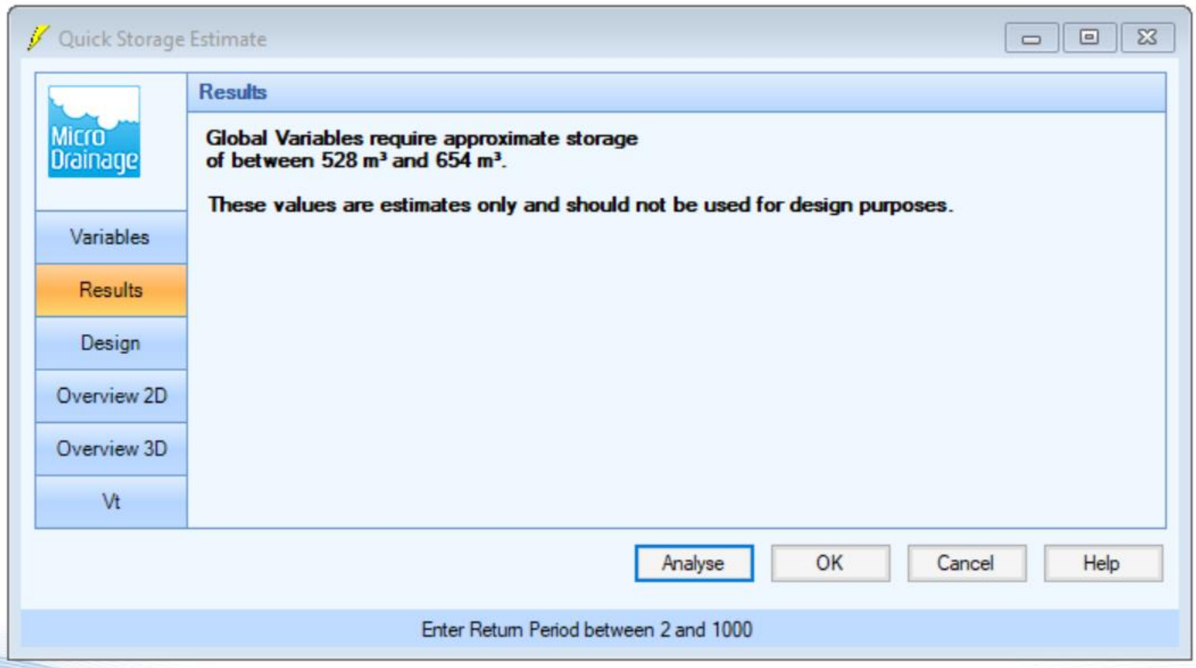

Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage
of between 3140 m³ and 3888 m³.
These values are estimates only and should not be used for design purposes.
Analyse
OK
Cancel
Help
Enter Return Period between 2 and 1000

Annex K – Parcel B MicroDrainage Quick Storage Estimate

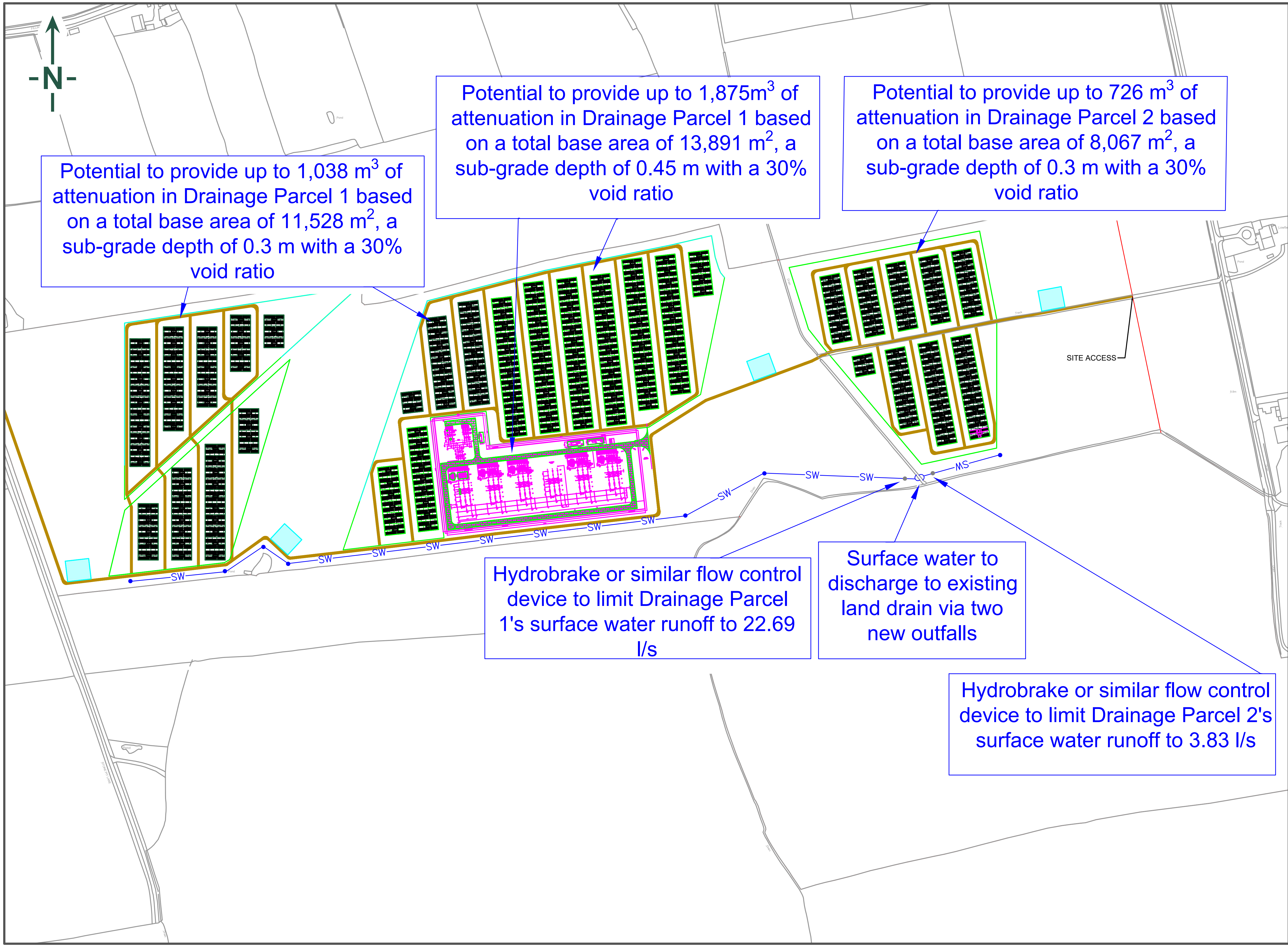

Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Variables
FEH Rainfall
Return Period (years) 30
Version 2013 Point ...
Site GB 489295 384411 SK 89295 84411
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 0.827
Maximum Allowable Discharge (l/s) 3.82
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Analyse OK Cancel Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0


Quick Storage Estimate
Micro Drainage
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Results
Global Variables require approximate storage
of between 391 m³ and 489 m³.
These values are estimates only and should not be used for design purposes.
Analyse OK Cancel Help
Enter Maximum Allowable Discharge between 0.0 and 999999.0


Quick Storage Estimate
Micro Drainage
Variables
FEH Rainfall
Return Period (years) 100
Version 2013 Point ...
Site GB 489295 384411 SK 89295 84411
Cv (Summer) 0.750
Cv (Winter) 0.840
Impermeable Area (ha) 0.827
Maximum Allowable Discharge (l/s) 3.8
Infiltration Coefficient (m/hr) 0.00000
Safety Factor 2.0
Climate Change (%) 20
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Return Period between 2 and 1000


Quick Storage Estimate
Micro Drainage
Results
Global Variables require approximate storage
of between 528 m³ and 654 m³.
These values are estimates only and should not be used for design purposes.
Variables
Results
Design
Overview 2D
Overview 3D
Vt
Analyse
OK
Cancel
Help
Enter Return Period between 2 and 1000

Annex L – Conceptual Drainage Sketch



LEGEND

- Proposed permeable surfacing with a subgrade depth of 0.3 m
- Proposed permeable surfacing with a subgrade depth of 0.45 m
- Indicative Route of Proposed Surface Water Sewer
- Indicative Location of Proposed Surface Water Manhole
- Indicative Location Proposed Flow Control Device (Hydrobrake or similar)

NOTES

1. All dimensions in metres and all levels in metres above ordnance datum unless shown otherwise
2. This drawing provides a concept only and is not intended for detailed design. Detailed drainage design will be required at the detailed design staege
3. Concept drawing based on 'Cottam 1 - Coates West B Layout Revised RLB 13-10-22'
4. Surface water runoff to discharge to existing land drain at a restricted rate of 22.69 l/s for Drainage Parcel 1 and 3.83 l/s for Drainage Parcel 2 during all events up to and including the 1 in 100 year plus 20% climate change
5. Discharge location subject to agreement with LLFA and Upper Witham IDB

Site Plan Provided by Client

DeltaSimons

TITLE:
Concept Drainage Sketch
Cottam 1 West Option B Battery Storage and Substation

DRAWN BY: EB	SCALE: Not to Scale	PROEJCT NO: 21-1088.01	
CHECKED BY: JR	REVISION: 1	APPENDIX: L	
DATE: 27/10/22			

Annex M - Parcel A MicroDrainage Source Control

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.445	0.445	22.7	1489.9	O K
30 min Summer	99.580	0.580	22.7	1943.6	O K
60 min Summer	99.719	0.719	22.7	2409.2	Flood Risk
120 min Summer	99.790	0.790	22.7	2647.1	Flood Risk
180 min Summer	99.826	0.826	22.7	2766.0	Flood Risk
240 min Summer	99.847	0.847	22.7	2837.6	Flood Risk
360 min Summer	99.870	0.870	22.7	2913.1	Flood Risk
480 min Summer	99.878	0.878	22.7	2941.4	Flood Risk
600 min Summer	99.879	0.879	22.7	2943.7	Flood Risk
720 min Summer	99.874	0.874	22.7	2929.4	Flood Risk
960 min Summer	99.857	0.857	22.7	2870.6	Flood Risk
1440 min Summer	99.816	0.816	22.7	2733.4	Flood Risk
2160 min Summer	99.764	0.764	22.7	2557.9	Flood Risk
2880 min Summer	99.711	0.711	22.7	2381.4	Flood Risk
4320 min Summer	99.612	0.612	22.7	2050.8	O K
5760 min Summer	99.528	0.528	22.7	1767.5	O K
7200 min Summer	99.455	0.455	22.7	1524.4	O K
8640 min Summer	99.394	0.394	22.7	1319.5	O K
10080 min Summer	99.344	0.344	22.7	1151.2	O K
15 min Winter	99.499	0.499	22.7	1671.1	O K
30 min Winter	99.651	0.651	22.7	2180.9	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	163.920	0.0	1286.9	27
30 min Summer	107.223	0.0	1647.1	41
60 min Summer	66.906	0.0	2332.4	70
120 min Summer	37.364	0.0	2596.8	130
180 min Summer	26.469	0.0	2750.2	190
240 min Summer	20.705	0.0	2858.8	248
360 min Summer	14.642	0.0	3010.8	366
480 min Summer	11.453	0.0	3115.0	486
600 min Summer	9.470	0.0	3189.3	604
720 min Summer	8.109	0.0	3241.2	722
960 min Summer	6.353	0.0	3288.6	958
1440 min Summer	4.501	0.0	3171.2	1170
2160 min Summer	3.201	0.0	4161.8	1556
2880 min Summer	2.521	0.0	4359.2	1960
4320 min Summer	1.806	0.0	4646.4	2728
5760 min Summer	1.429	0.0	5028.5	3512
7200 min Summer	1.194	0.0	5243.6	4248
8640 min Summer	1.032	0.0	5424.6	4936
10080 min Summer	0.913	0.0	5568.5	5648
15 min Winter	163.920	0.0	1436.6	26
30 min Winter	107.223	0.0	1787.7	41

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	99.807	0.807	22.7	2704.7	Flood Risk
120 min Winter	99.887	0.887	22.7	2973.1	Flood Risk
180 min Winter	99.928	0.928	22.7	3109.9	Flood Risk
240 min Winter	99.953	0.953	22.7	3193.6	Flood Risk
360 min Winter	99.981	0.981	22.7	3285.6	Flood Risk
480 min Winter	99.993	0.993	22.7	3325.1	Flood Risk
600 min Winter	99.996	0.996	22.7	3335.6	Flood Risk
720 min Winter	99.993	0.993	22.7	3327.9	Flood Risk
960 min Winter	99.979	0.979	22.7	3280.4	Flood Risk
1440 min Winter	99.929	0.929	22.7	3112.0	Flood Risk
2160 min Winter	99.862	0.862	22.7	2888.5	Flood Risk
2880 min Winter	99.796	0.796	22.7	2666.2	Flood Risk
4320 min Winter	99.649	0.649	22.7	2173.7	O K
5760 min Winter	99.518	0.518	22.7	1736.9	O K
7200 min Winter	99.411	0.411	22.7	1375.9	O K
8640 min Winter	99.327	0.327	22.7	1094.4	O K
10080 min Winter	99.265	0.265	22.4	888.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	66.906	0.0	2605.8	70
120 min Winter	37.364	0.0	2893.4	128
180 min Winter	26.469	0.0	3057.0	186
240 min Winter	20.705	0.0	3169.8	244
360 min Winter	14.642	0.0	3319.7	360
480 min Winter	11.453	0.0	3410.5	476
600 min Winter	9.470	0.0	3460.5	590
720 min Winter	8.109	0.0	3476.6	704
960 min Winter	6.353	0.0	3426.4	926
1440 min Winter	4.501	0.0	3244.8	1328
2160 min Winter	3.201	0.0	4659.7	1652
2880 min Winter	2.521	0.0	4874.8	2112
4320 min Winter	1.806	0.0	5187.9	2984
5760 min Winter	1.429	0.0	5635.7	3752
7200 min Winter	1.194	0.0	5878.3	4464
8640 min Winter	1.032	0.0	6083.6	5104
10080 min Winter	0.913	0.0	6250.9	5744

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 489295 384411 SK 89295 84411
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 4.920

Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)	Time From:	(mins) To:	Area (ha)
0	4	1.640	4	8	1.640	8	12	1.640

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	3350.0	1.000	3350.0

Hydro-Brake® Optimum Outflow Control

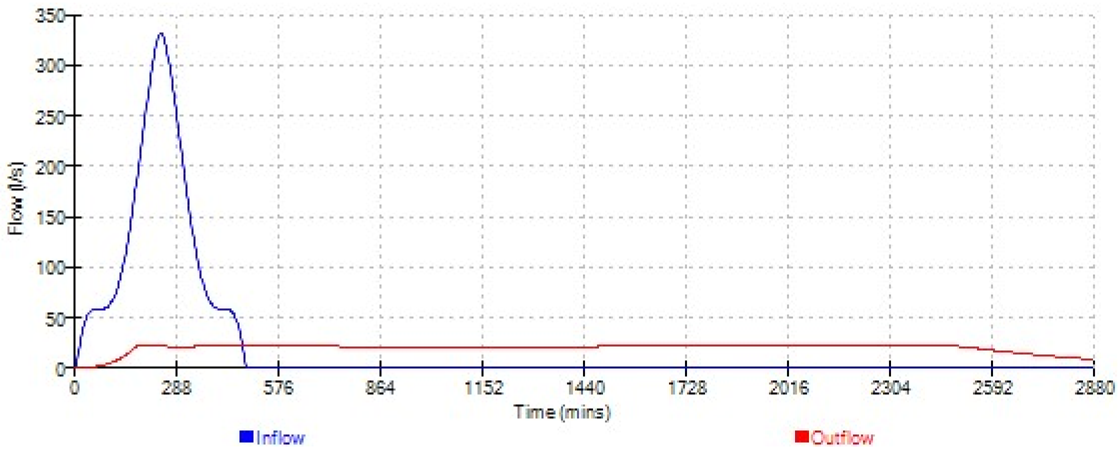
Unit Reference	MD-SHE-0210-2270-1000-2270
Design Head (m)	1.000
Design Flow (l/s)	22.7
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	210
Invert Level (m)	99.000
Minimum Outlet Pipe Diameter (mm)	225
Suggested Manhole Diameter (mm)	1500

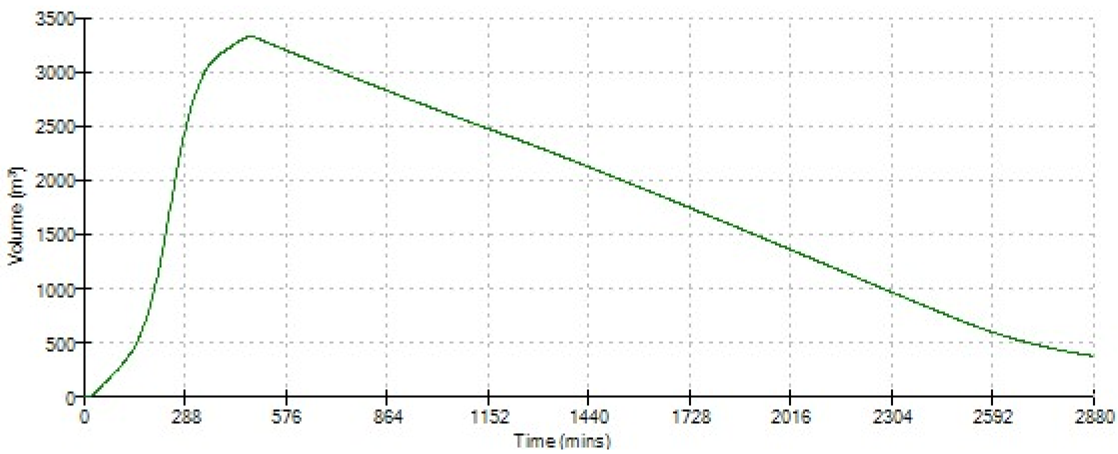
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	22.7
Flush-Flo™	0.351	22.7
Kick-Flo®	0.729	19.5
Mean Flow over Head Range	-	19.0

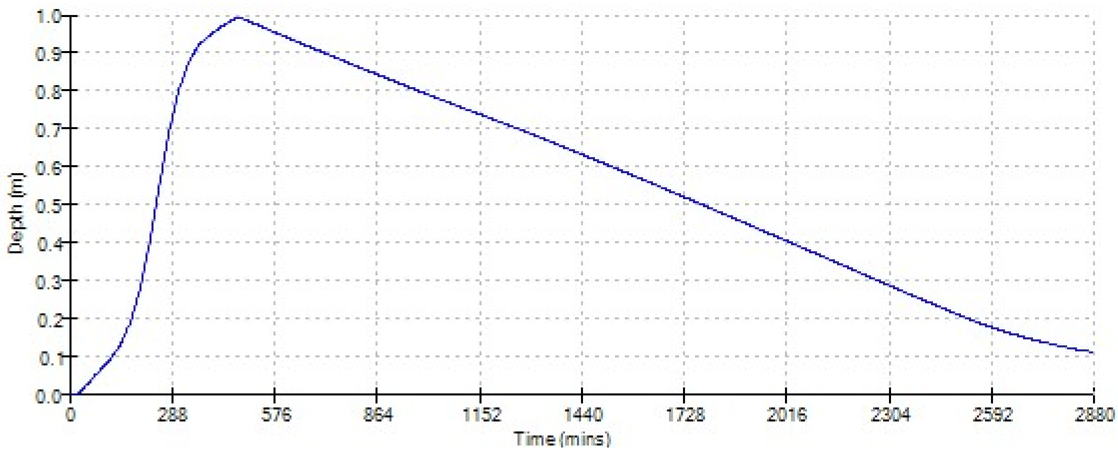
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	7.2	1.200	24.8	3.000	38.4	7.000	57.9
0.200	20.3	1.400	26.7	3.500	41.4	7.500	59.9
0.300	22.6	1.600	28.4	4.000	44.2	8.000	61.8
0.400	22.6	1.800	30.1	4.500	46.8	8.500	63.7
0.500	22.2	2.000	31.6	5.000	49.2	9.000	65.5
0.600	21.6	2.200	33.1	5.500	51.5	9.500	67.2
0.800	20.4	2.400	34.5	6.000	53.7		
1.000	22.7	2.600	35.9	6.500	55.9		

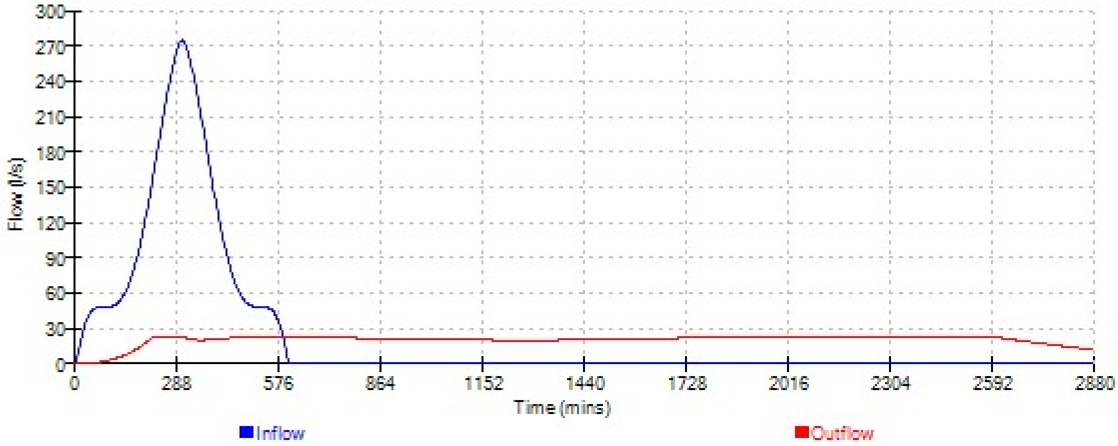
Event: 480 min Winter

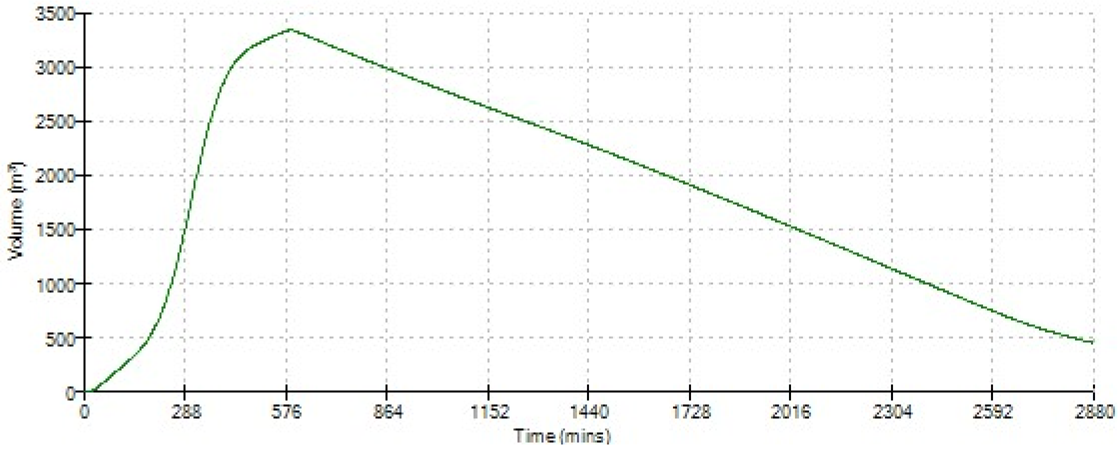


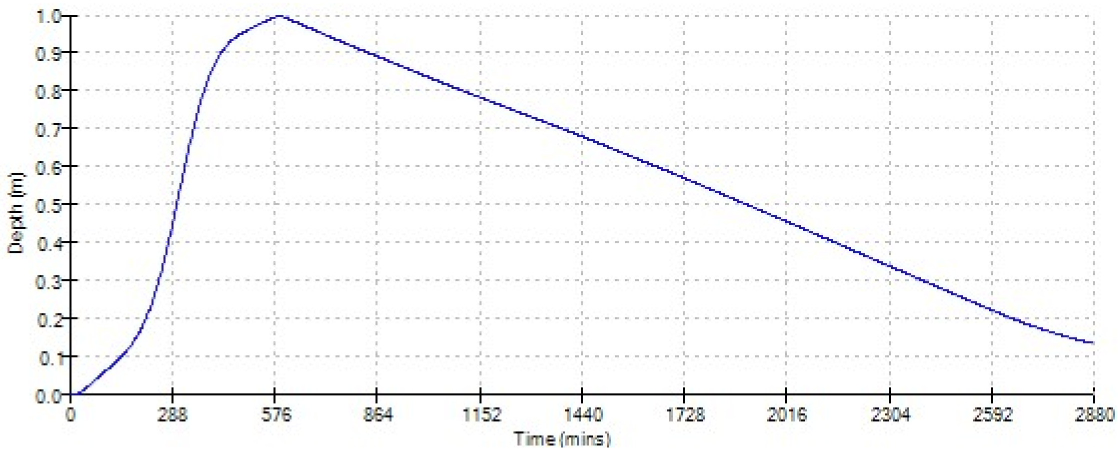




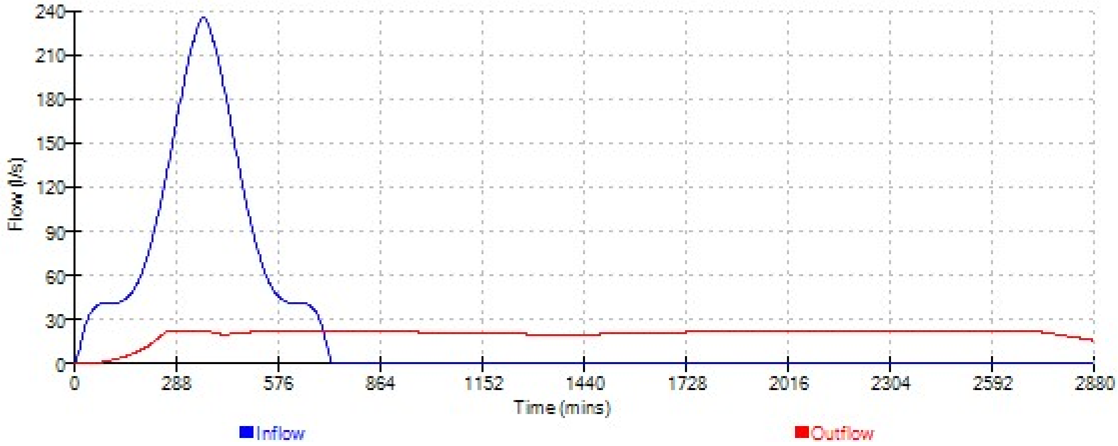
Event: 600 min Winter

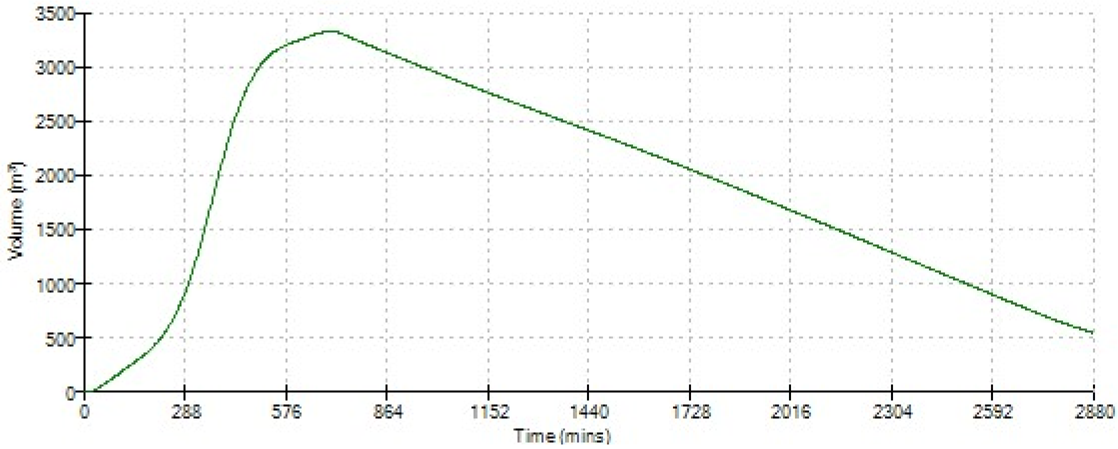


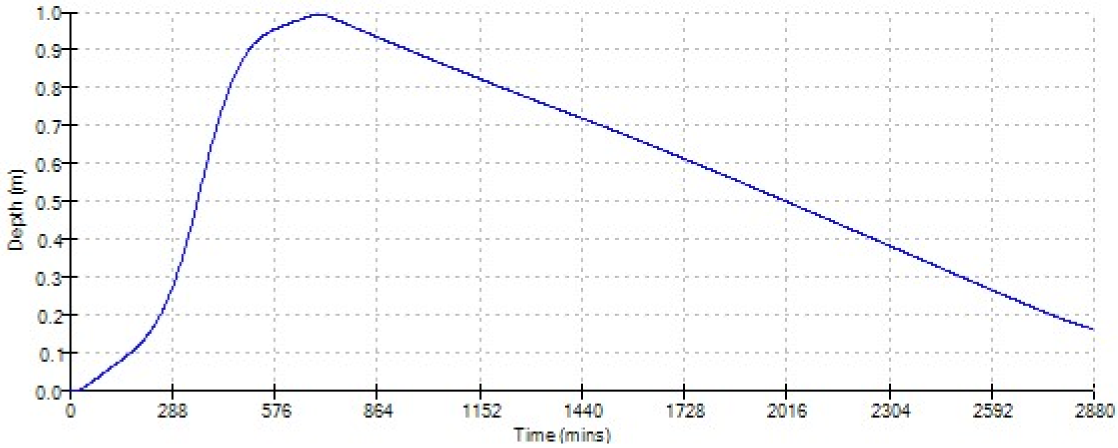




Event: 720 min Winter







Annex N - Parcel B MicroDrainage Source Control

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
15 min Summer	99.451	0.451	3.8	250.1	O K
30 min Summer	99.588	0.588	3.8	326.3	O K
60 min Summer	99.728	0.728	3.8	404.2	Flood Risk
120 min Summer	99.798	0.798	3.8	442.8	Flood Risk
180 min Summer	99.832	0.832	3.8	461.6	Flood Risk
240 min Summer	99.851	0.851	3.8	472.4	Flood Risk
360 min Summer	99.870	0.870	3.8	483.0	Flood Risk
480 min Summer	99.875	0.875	3.8	485.7	Flood Risk
600 min Summer	99.873	0.873	3.8	484.2	Flood Risk
720 min Summer	99.865	0.865	3.8	480.1	Flood Risk
960 min Summer	99.842	0.842	3.8	467.2	Flood Risk
1440 min Summer	99.791	0.791	3.8	438.8	Flood Risk
2160 min Summer	99.729	0.729	3.8	404.3	Flood Risk
2880 min Summer	99.674	0.674	3.8	374.0	O K
4320 min Summer	99.564	0.564	3.8	312.8	O K
5760 min Summer	99.473	0.473	3.8	262.4	O K
7200 min Summer	99.397	0.397	3.8	220.3	O K
8640 min Summer	99.334	0.334	3.8	185.1	O K
10080 min Summer	99.282	0.282	3.8	156.6	O K
15 min Winter	99.505	0.505	3.8	280.6	O K
30 min Winter	99.660	0.660	3.8	366.4	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
15 min Summer	163.920	0.0	238.5	27
30 min Summer	107.223	0.0	298.2	41
60 min Summer	66.906	0.0	407.2	70
120 min Summer	37.364	0.0	453.7	130
180 min Summer	26.469	0.0	481.0	190
240 min Summer	20.705	0.0	500.4	248
360 min Summer	14.642	0.0	527.9	366
480 min Summer	11.453	0.0	546.6	486
600 min Summer	9.470	0.0	559.4	604
720 min Summer	8.109	0.0	567.0	722
960 min Summer	6.353	0.0	567.0	960
1440 min Summer	4.501	0.0	541.7	1180
2160 min Summer	3.201	0.0	710.4	1560
2880 min Summer	2.521	0.0	745.1	1968
4320 min Summer	1.806	0.0	798.7	2736
5760 min Summer	1.429	0.0	849.6	3512
7200 min Summer	1.194	0.0	886.8	4248
8640 min Summer	1.032	0.0	919.0	4936
10080 min Summer	0.913	0.0	946.7	5648
15 min Winter	163.920	0.0	264.7	26
30 min Winter	107.223	0.0	306.8	41

Summary of Results for 100 year Return Period (+20%)

Storm Event	Max Level (m)	Max Depth (m)	Max Control (l/s)	Max Volume (m³)	Status
60 min Winter	99.817	0.817	3.8	453.7	Flood Risk
120 min Winter	99.897	0.897	3.8	497.8	Flood Risk
180 min Winter	99.937	0.937	3.8	519.8	Flood Risk
240 min Winter	99.960	0.960	3.8	532.9	Flood Risk
360 min Winter	99.985	0.985	3.8	546.6	Flood Risk
480 min Winter	99.994	0.994	3.8	551.6	Flood Risk
600 min Winter	99.994	0.994	3.8	551.8	Flood Risk
720 min Winter	99.989	0.989	3.8	549.0	Flood Risk
960 min Winter	99.970	0.970	3.8	538.3	Flood Risk
1440 min Winter	99.911	0.911	3.8	505.4	Flood Risk
2160 min Winter	99.833	0.833	3.8	462.4	Flood Risk
2880 min Winter	99.761	0.761	3.8	422.4	Flood Risk
4320 min Winter	99.609	0.609	3.8	338.0	O K
5760 min Winter	99.464	0.464	3.8	257.3	O K
7200 min Winter	99.352	0.352	3.8	195.1	O K
8640 min Winter	99.266	0.266	3.8	147.8	O K
10080 min Winter	99.205	0.205	3.7	113.8	O K

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Discharge Volume (m³)	Time-Peak (mins)
60 min Winter	66.906	0.0	455.0	70
120 min Winter	37.364	0.0	505.9	128
180 min Winter	26.469	0.0	534.9	186
240 min Winter	20.705	0.0	554.7	244
360 min Winter	14.642	0.0	579.4	360
480 min Winter	11.453	0.0	590.0	476
600 min Winter	9.470	0.0	590.5	590
720 min Winter	8.109	0.0	586.9	704
960 min Winter	6.353	0.0	576.3	926
1440 min Winter	4.501	0.0	550.5	1332
2160 min Winter	3.201	0.0	795.5	1664
2880 min Winter	2.521	0.0	834.0	2132
4320 min Winter	1.806	0.0	892.5	3028
5760 min Winter	1.429	0.0	951.8	3752
7200 min Winter	1.194	0.0	993.5	4472
8640 min Winter	1.032	0.0	1029.7	5112
10080 min Winter	0.913	0.0	1061.3	5752

Rainfall Details

Rainfall Model	FEH
Return Period (years)	100
FEH Rainfall Version	2013
Site Location	GB 489295 384411 SK 89295 84411
Data Type	Point
Summer Storms	Yes
Winter Storms	Yes
Cv (Summer)	0.750
Cv (Winter)	0.840
Shortest Storm (mins)	15
Longest Storm (mins)	10080
Climate Change %	+20

Time Area Diagram

Total Area (ha) 0.827

Time From:	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**	**Time From:**	**(mins) To:**	**Area (ha)**
0	4	0.276	4	8	0.276	8	12	0.276

Model Details

Storage is Online Cover Level (m) 100.000

Tank or Pond Structure

Invert Level (m) 99.000

Depth (m)	Area (m²)	Depth (m)	Area (m²)
0.000	555.0	1.000	555.0

Hydro-Brake® Optimum Outflow Control

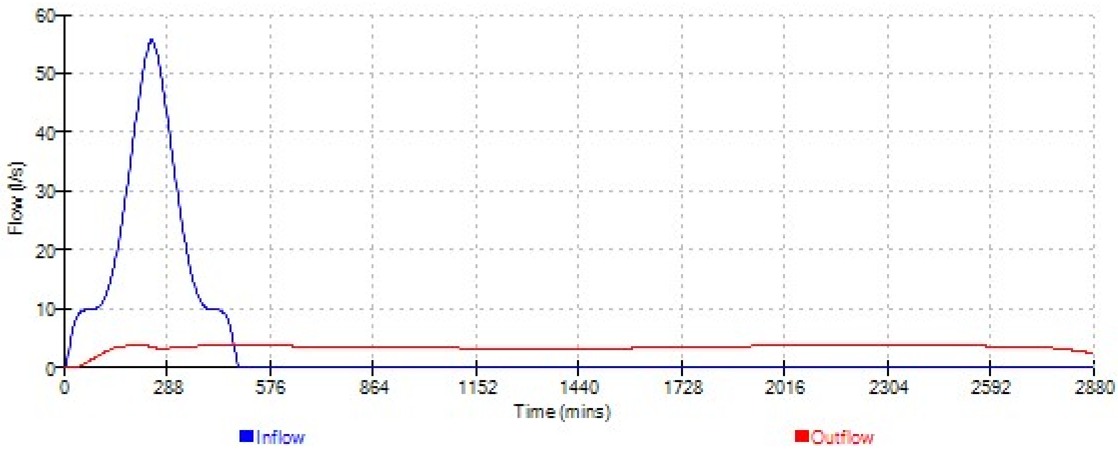
Unit Reference	MD-SHE-0092-3800-1000-3800
Design Head (m)	1.000
Design Flow (l/s)	3.8
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	92
Invert Level (m)	99.000
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

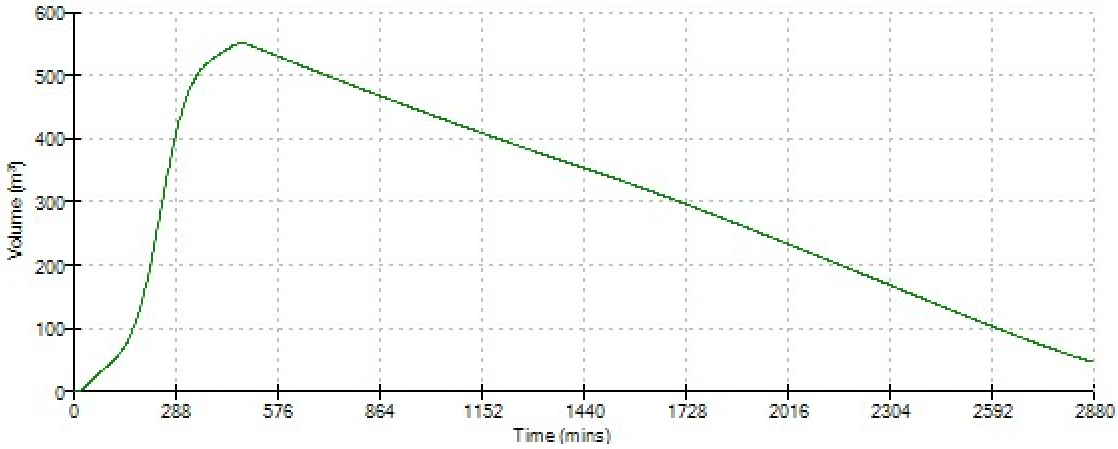
Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.000	3.8
Flush-Flo™	0.298	3.8
Kick-Flo®	0.632	3.1
Mean Flow over Head Range	-	3.3

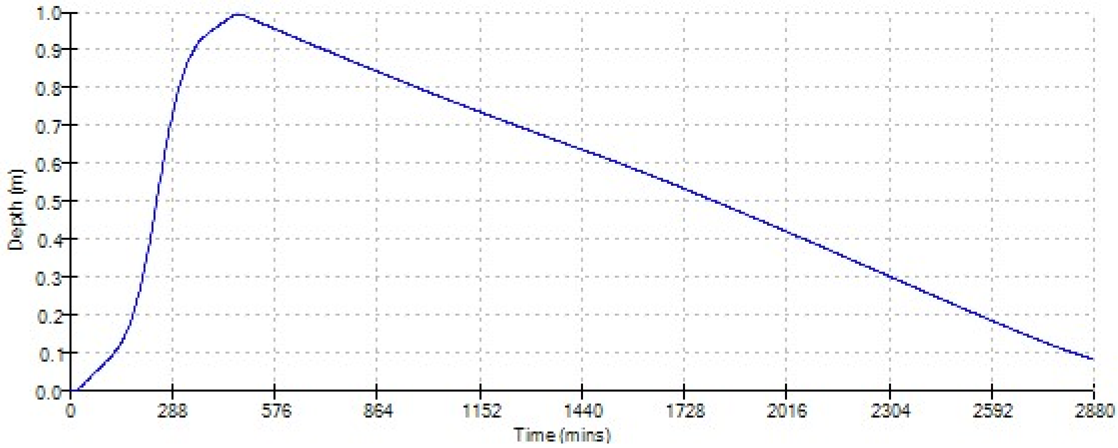
The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	2.9	1.200	4.1	3.000	6.3	7.000	9.5
0.200	3.7	1.400	4.4	3.500	6.8	7.500	9.8
0.300	3.8	1.600	4.7	4.000	7.3	8.000	10.1
0.400	3.7	1.800	5.0	4.500	7.7	8.500	10.4
0.500	3.6	2.000	5.2	5.000	8.1	9.000	10.7
0.600	3.3	2.200	5.5	5.500	8.4	9.500	10.9
0.800	3.4	2.400	5.7	6.000	8.8		
1.000	3.8	2.600	5.9	6.500	9.1		

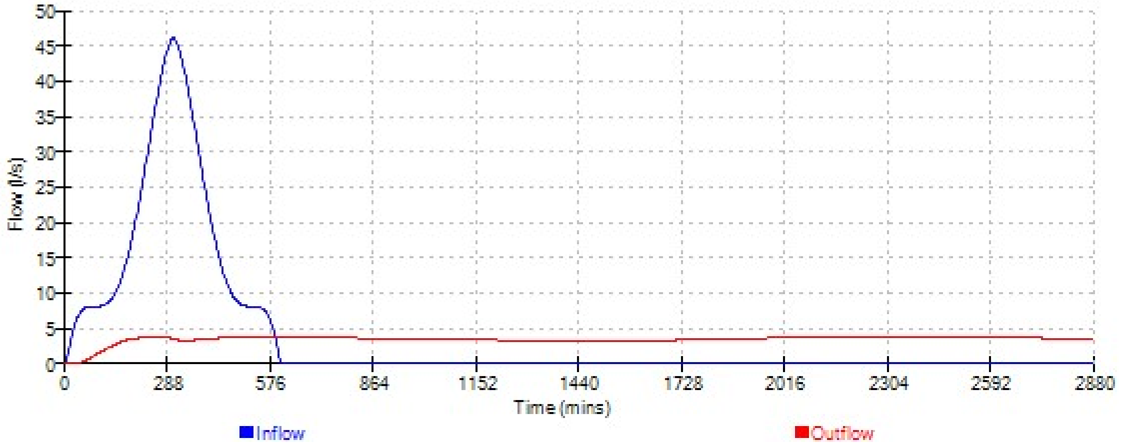
Event: 480 min Winter

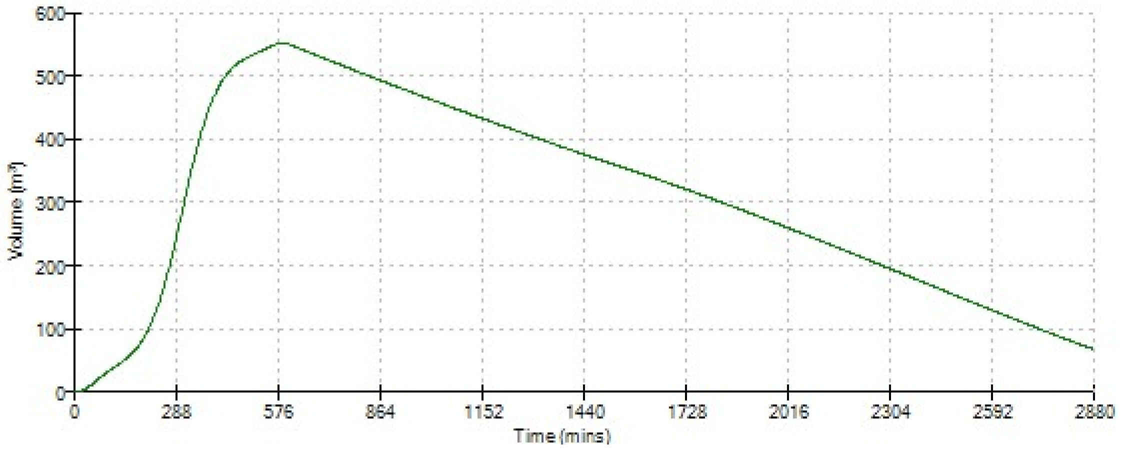


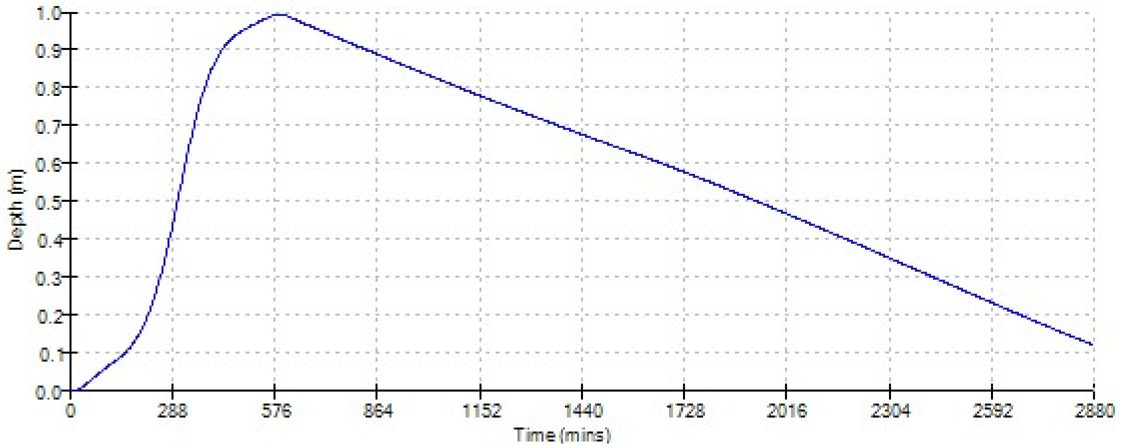




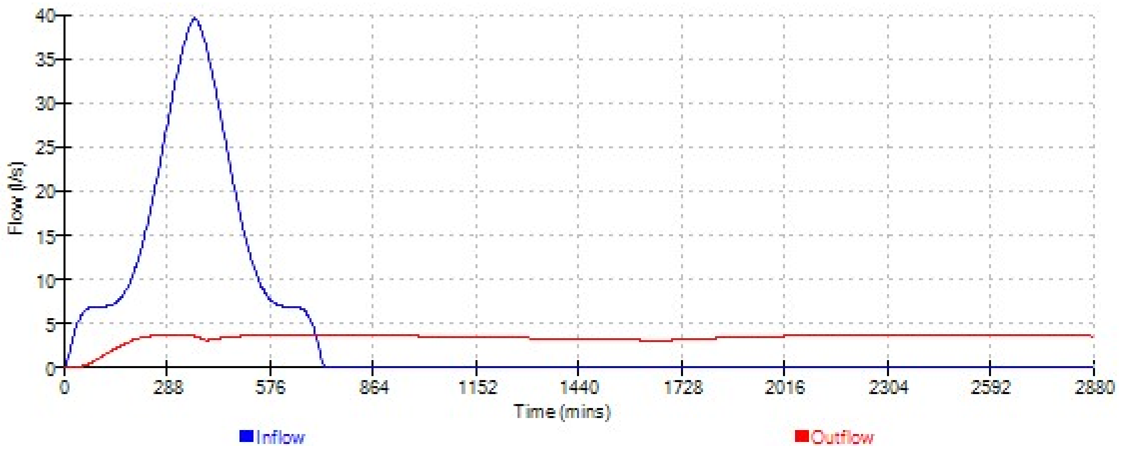
Event: 600 min Winter

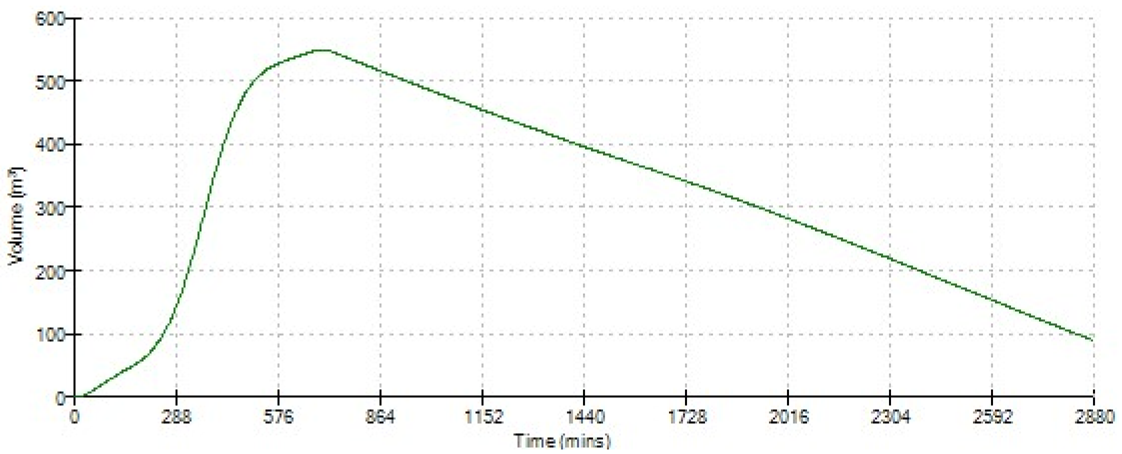


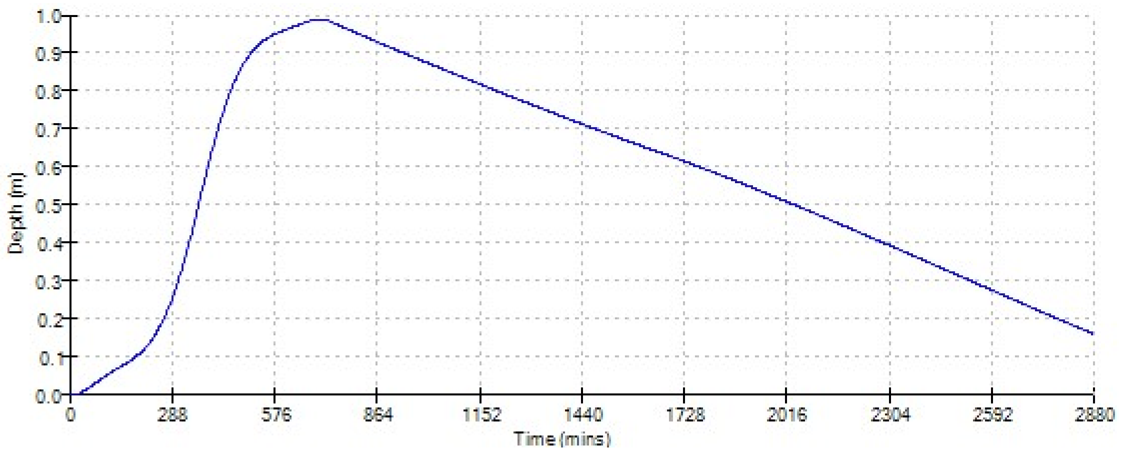




Event: 720 min Winter







Annex O – Permeable Surfacing Maintenance Schedule

Permeable Paving Maintenance Schedule

Maintenance Schedule	Required Action	Typical Frequency
Regular maintenance	Brushing and vacuuming (standard cosmetic sweep over whole surface)	Once a year, after autumn leaf fall, or reduced frequency as required, based on Site-specific observations of clogging or manufacturer's recommendations – pay particular attention to areas where water runs onto pervious surface from adjacent impermeable areas as this area is most likely to collect the most sediment
Occasional maintenance	Stabilise and move contributing and adjacent areas	As required
	Removal of weeds or management using glyphosate applied directly into the weeds by an applicator rather than spraying	As required – once per year on less frequently used pavements
Remedial actions	Remediate any landscaping which, through vegetation maintenance or soil slip, has been raised to within 50mm of the level or the paving	As required
	Rehabilitation of surface and upper substructure by remedial sweeping	Every 10 to 15 years or as required (if infiltration performance is reduced due to significant clogging)
Monitoring	Inspect for evidence of poor operation and / or weed growth – if required, take remedial action	Three-monthly, 48hr after large storms in first six months
	Inspect silt accumulation rates and establish appropriate brushing frequencies	Annually
	Monitor inspection chambers	Annually

Ref. Table 20.15, CIRIA C753 'The SuDS Manual'