CAUDWELL SOLAR FARM, EASTERN ROAD, HOLBEACH,
ST MATTHEWS, SPALDING, PE12 8EW

FLOOD RISK AND DRAINAGE ASSESSMENT

Final Report v1.2
April 2024

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Report Title	**Caudwell Solar Farm, Eastern Road, Holbeach, St Matthews, Spalding, PE12 8EW** Flood Risk and Drainage Assessment Final Report v1.2
Client	Green Energy International
Date of issue	29 April 2024

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1 INTRODUCTION

1.1 Purpose of Report

Weetwood Services Ltd ('Weetwood') has been instructed by Green Energy International to prepare a Flood Risk and Drainage Assessment (FRDA) report to accompany a planning application for the proposed development of land at Hartley Farm, Holbeach, St Matthews, Spalding ("the site") for use as a solar farm.

The assessment has been undertaken in accordance with the requirements of the revised National Planning Policy Framework (NPPF) updated on 20 December 2023 and the Planning Practice Guidance (PPG) updated on 14 February 2024.

The FRDA report (v1.0) was submitted to South Holland District Council in August 2023 in support of the planning application H09-0699-23. The Environment Agency issued a holding objection by way of consultation response letter dated 1 September 2023.

A response was provided to the Environment Agency dated 13 September 2023 (v1.1 of this report) responding to the matters raised. However, the Environment Agency maintained its objection (dated 25 October 2023) and stated that the FRDA fails to acknowledge the impacts of flooding arising from a breach in the defences during a 1 in 1,000 AEP event plus climate change (2115 scenario) and that appropriate mitigation measures will be required to ensure that the development remains operational during this event.

Through further consultation with the Environment Agency[1], it was agreed that a climate change allowance of 40 years was appropriate for the development to reflect its development lifetime.

This version of the report (v1.2) responds to matters raised by the Environment Agency as set out below:

- Assessment of the 0.1% event (2064 scenario) *(refer to Section 4.2.2 and Section 4.2.3 of this revised FRDA)*
- Demonstrate appropriate mitigation measures have been incorporated into the development *(refer to Section 4.7 of this revised FRDA).*

1.2 Structure of the Report

The report is structured as follows:

Section 1 Introduction and report structure
Section 2 Provides background information relating to the development site
Section 3 Presents national and local flood risk and drainage planning policy
Section 4 Assesses the potential risk of flooding to the development site
Section 5 Presents an illustrative surface water drainage scheme
Section 6 Presents a summary of key findings and the recommendations

1.3 Relevant Documents

The assessment has been informed by the following documents:

- South East Lincolnshire Local Plan 2011 - 2036, March 2019
- Sustainable Drainage: Design and Evaluation Guide, Lincolnshire County Council, 2018
- Strategic Flood Risk Assessment, South East Lincolnshire, March 2017
- The Wash Shoreline Management Plan 2 – Gibraltar Point to Old Hunstanton, The Wash SMP2, East Anglia Coastal Group, August 2010

[1] Email correspondence between Emily Fisher (Environment Agency) and Weetwood dated 21 November 2023

2 SITE DETAILS AND PROPOSED DEVELOPMENT

2.1 Site Location

The approximately 111.1 ha greenfield site is located at Hartley Farm, to the south of Eastern Road and north/north-east of Marsh Road, Holbeach, Spalding at Ordnance Survey National Grid Reference TF 408 303, as shown in **Figure 1**. The site comprises agricultural farmland.

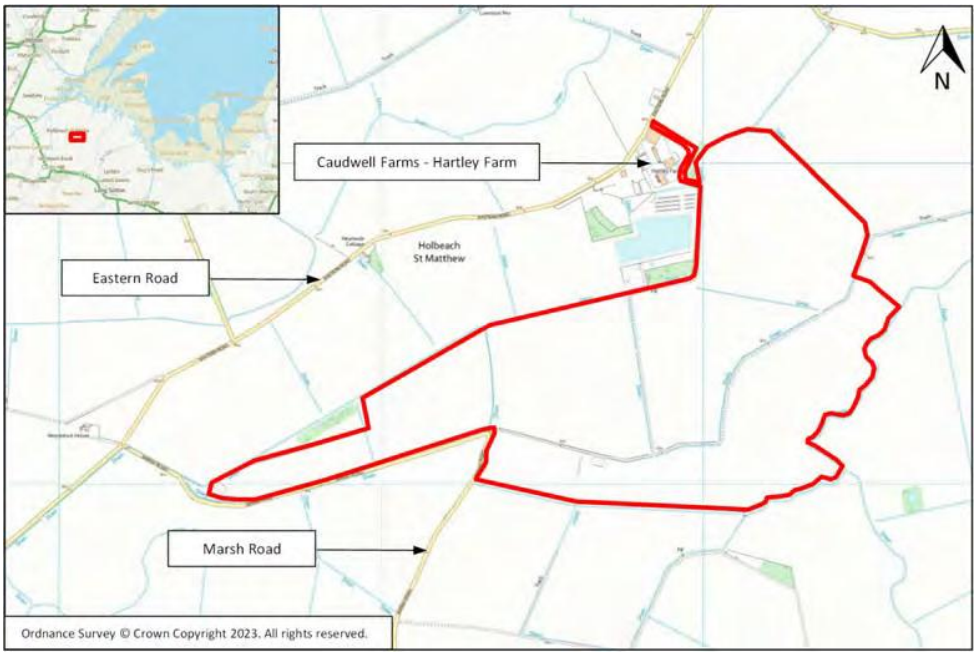

Figure 1: Site Location

2.2 Proposed Development

The proposed development comprises of a solar farm consisting of: 50 Megawatt solar array; security fencing; access tracks; inverter units; substation building; battery storage compound for units; construction compound; and landscaping and biodiversity enhancements across the site.

The height of the photovoltaic (PV) panels are 0.8 m (rear) and 2.2 m (front) respectively.

The proposed site plan is provided in **Appendix A**. Vehicular access will be provided via Eastern Road and Marsh Road.

The proposed development would be for a lifetime period of 40 years, after which the site would be decommissioned and restored back to agricultural use.

The NPPF classifies solar farm development as Essential Infrastructure.

2.3 Surface Waterbodies in the Vicinity of the Site

The Wash is located approximately 2.8 km to the north of the site.

There is a network of drainage ditches, classified as High Priority and Ordinary watercourses, on and within the vicinity of the site, including Sot's Hole, Middle Drain, Fleet Haven Drain and Sot's Hole and Connection. Most of the on-site drains fall under the jurisdiction of South Holland Internal Drainage Board (IDB) as shown in **Figure 2**. The site falls within two drainage catchments within South Holland IDB:

- Lawyers – watercourses within the Lawyers catchment flow towards Lawyers pumping station approximately 3.5 km north of the site where water is pumped to The Wash. The pumping station was commissioned in 2003. The flow of water prior to Lawyers pumping station is controlled at Thimbleby Sluice and Salt Marsh Soke Dyke Sluice approximately 800 m south of Lawyers pumping station.
- Fleet Haven – watercourses within the Fleet Haven catchment are in part pumped from Manor Farm pumping station approximately 1.5 km to the south of the site towards Middle Drain and Fleet Haven Drain. The flow of water in Fleet Haven Drain is controlled by Coffee Tan Sluice approximately 2.1 km north-east of the site. Approximately 1.0 km north-east of the sluice, Fleet Haven pumping station (commissioned in 2020) pumps Fleet Haven Drain towards The Wash.

A number of unnamed drains are located on site which flow into the IDB High Priority and Ordinary watercourses.

A small water impounded structure is located at Hartley Farm adjacent to the west of Sot's Hole and to the north of Sot's Hole and Connection. The water within the water impounded structure is used for irrigation purposes.

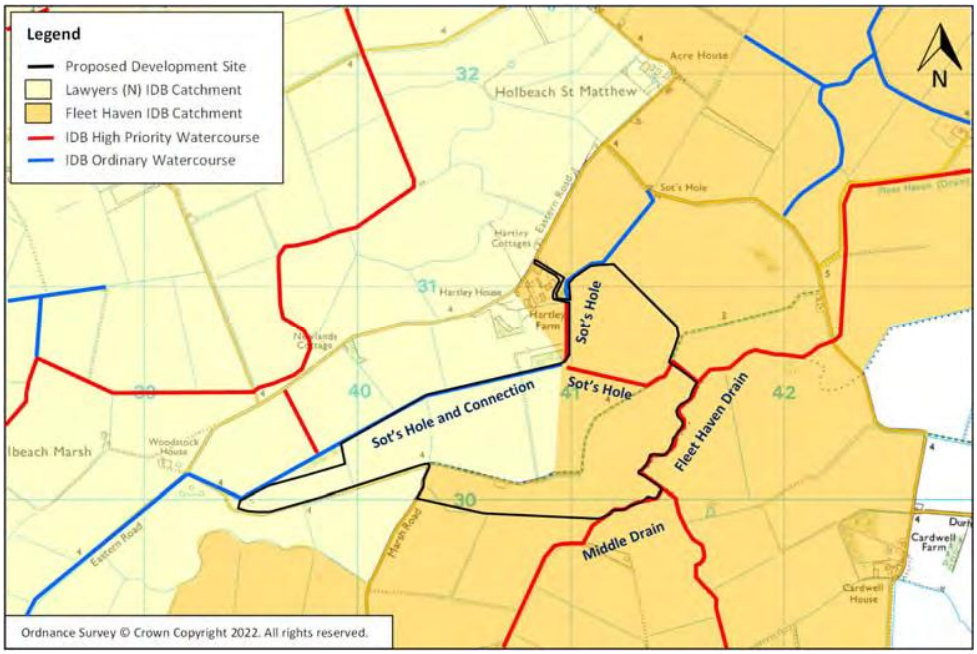

Figure 2: Location and Designation of South Holland IDB Waterbodies

2.4 Ground Conditions

According to the Soilscapes soils dataset produced by the Cranfield Soil and AgriFood Institute[2], soil conditions at the site and within the surrounding area are described as loamy and clayey soils of coastal flats with naturally high groundwater.

British Geological Survey mapping of surface geology[3] indicates the underlying bedrock formation comprises mudstone (Ampthill Clay Formation), overlain by superficial deposits of clay and silt (Tidal Flat Deposits).

According to the MAGIC website[4] the underlying bedrock and superficial deposits are classified as Unproductive aquifers. The site is not shown to be located within a designated groundwater source protection zone.

2 www.landis.org.uk/soilscapes/
3 https://www.bgs.ac.uk/map-viewers/geoindex-onshore/
4 https://magic.defra.gov.uk/MagicMap.aspx

2.5 Topographic Levels

LiDAR data has been used to develop a digital terrain model of the site and surrounding area as illustrated in **Figure 3**. Site levels are shown to be generally flat and in the region of approximately 3.1 to 3.6 m AOD, with levels along watercourses in the region of approximately 1.5 to 2.0 m AOD.

Ground levels on Eastern Road adjacent to the site range between approximately 3.4 to 4.4 m AOD, with levels on Marsh Road ranging between approximately 3.6 to 4.0 m AOD.

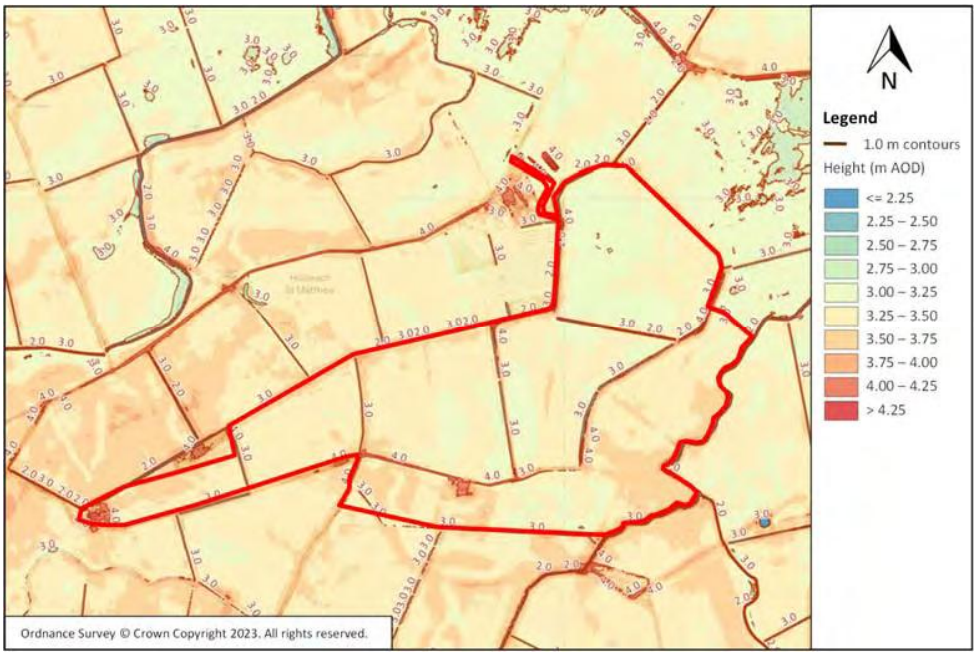

Figure 3: Digital Terrain Model from LiDAR Data

3 PLANNING POLICY AND GUIDANCE

3.1 National Planning Policy and Policy Guidance

The thrust of national planning policy, as articulated in the NPPF is that inappropriate development in areas at risk of flooding should be avoided where possible, as summarised below:

- Inappropriate development in areas at risk of flooding should be avoided and that development should be directed away from areas at highest risk (whether existing or future), but where development is necessary in such areas, the development should be made safe for its lifetime without increasing flood risk elsewhere (NPPF para. 165).
- The policy of seeking to steer development to areas with the lowest risk of flooding, from any source, is implemented through the application of the flood risk Sequential Test. Development should not be allocated or permitted if there are reasonably available sites, appropriate for the proposed development in areas with a lower risk of flooding. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding (NPPF para. 168).
- If it is not possible for development to be located in zones with a lower risk of flooding (taking into account wider sustainable development objectives) the Exception Test may have to be applied. The need for the test will depend on the potential vulnerability of the site and of the development proposed (as set out in Annex 3 of NPPF; also PPG Table 2) (NPPF para. 169). For example, the Exception Test need not be applied for less vulnerable development in any flood zone, or for more vulnerable development in flood zones 1 or 2.
- Where the Exception Test must be applied, application of the test for development proposals at the application stage should be informed by a site-specific flood risk assessment. For the test to be passed it should be demonstrated that: (a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; (b) and the development will be safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, will reduce flood risk overall (NPPF para. 170). Both elements of the test should be satisfied for the development to be permitted (NPPF para. 171).
- A site-specific flood risk assessment should be provided for all development in flood zones 2 and 3 [whilst] in flood zone 1, an assessment should accompany all proposals involving: sites of 1 ha or more; land which has been identified by the Environment Agency as having critical drainage problems; land identified in a strategic flood risk assessment as being at increased flood risk in future; or land that may be subject to other sources of flooding, where its development would introduce a more vulnerable use (NPPF para. 173).
- Development should not increase flood risk elsewhere (NPPF para. 173).
- Development should only be allowed in areas at risk of flooding where the flood risk assessment (and the sequential and exception tests, as applicable), demonstrate that: a) within the site, the most vulnerable development is located in areas of lowest flood risk (unless there are overriding reasons to prefer a different location); b) the development is appropriately flood resistant and resilient such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment; c) the development incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate; d) any residual (flood) risk can be safely managed; and e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan (NPPF para.173).
- Applications for some minor development and changes of use should not be subject to the sequential or exception tests (NPPF para. 174). The exceptions are stated in Footnote 60.
- Major development should incorporate sustainable drainage systems unless there is clear evidence that this would be inappropriate. The systems should: a) take account of advice from the lead local flood authority; b) have appropriate proposed minimum operational standards; c) have maintenance arrangements in place to ensure an acceptable standard of operation for the lifetime of the development; and d) where possible, provide multifunctional benefits (NPPF para. 175).

Guidance on application of the sequential and exception test is provided in the PPG - Flood Risk and Coastal Change. For example:

- The approach is designed to ensure that areas at little or no risk of flooding from any source are developed in preference to areas at higher risk. This means avoiding, so far as possible, development in current and future (i.e. taking climate change into account) medium and high flood risk areas considering all sources of flooding including areas at risk of surface water flooding (PPG para. 023).
- Where it is not possible to locate development in low risk areas, the Sequential Test should go on to compare reasonably available sites within medium risk areas and then, only where there are no reasonably available sites in low and medium risk areas, within high risk areas (PPG para. 024).
- Initially, the presence of existing flood risk management infrastructure should be ignored, as the long-term funding, maintenance and renewal of this infrastructure is uncertain. Climate change will also impact upon the level of protection infrastructure will offer throughout the lifetime of development (PPG para. 024).
- The Sequential Test should be applied to 'Major' and 'Non-major development' proposed in areas at risk of flooding, but it will not be required where; the site has been allocated for development and subject to the test at the plan making stage (provided the proposed development is consistent with the use for which the site was allocated and provided there have been no significant changes to the known level of flood risk to the site, now or in the future which would have affected the outcome of the test); the site is in an area at low risk from all sources of flooding, unless the Strategic Flood Risk Assessment, or other information, indicates there may be a risk of flooding in the future; the application is for a development type that is exempt from the test, as specified in footnote 60 of the NPPF (PPG para. 027).
- For individual planning applications subject to the Sequential Test, the area to apply the test will be defined by local circumstances relating to the catchment area for the type of development proposed. For some developments this may be clear, for example, the catchment area for a school. In other cases, it may be identified from other Plan policies. For example, where there are large areas in Flood Zones 2 and 3 (medium to high probability of flooding) and development is needed in those areas to sustain the existing community, sites outside them are unlikely to provide reasonable alternatives. Equally, a pragmatic approach needs to be taken where proposals involve comparatively small extensions to existing premises (relative to their existing size), where it may be impractical to accommodate the additional space in an alternative location. For nationally or regionally important infrastructure the area of search to which the Sequential Test could be applied will be wider than the local planning authority boundary (PPG para. 027).
- 'Reasonably available sites' are those in a suitable location for the type of development with a reasonable prospect that the site is available to be developed at the point in time envisaged for the development. These could include a series of smaller sites and/or part of a larger site if these would be capable of accommodating the proposed development. Such lower-risk sites do not need to be owned by the applicant to be considered 'reasonably available' (PPG para. 028).
- The Exception Test should only be applied as set out in Table 2 [of the PPG ("Flood Risk Vulnerability and Flood Zone Incompatibility")] and only if the Sequential Test has shown that there are no reasonably available, lower risk sites, suitable for the proposed development, to which the development could be steered (PPG para. 032).

3.2 Local Planning Policy

The South East Lincolnshire Local Plan 2011 – 2036 was adopted in March 2019. The Local Plan is a partnership of Boston Borough, South Holland District and Lincolnshire County Councils. The following policies are relevant in respect of flood risk and drainage:

Policy 2: Development Management

The policy states in part, that "*Proposals requiring planning permission for development will be permitted provided that sustainable development considerations are met, specifically in relation to:*

7. *Sustainable drainage and flood risk."*

Policy 3: Design of New Development

The policy states in part, that "*Development proposals will demonstrate how the following issues, where they are relevant to the proposal, will be secured:*

12. *The mitigation of flood risk through flood-resistant and flood-resilient design and sustainable drainage systems.*
14. *The incorporation of existing hedgerows and trees and the provision of appropriate new landscaping to enhance biodiversity, green infrastructure, flood risk mitigation and urban cooling."*

Policy 4: Approach to Flood Risk

"Development proposed within an area at risk of flooding (Flood Zones 2 and 3 of the Environment Agency's flood map or at risk during a breach or overtopping scenario as shown on the flood hazard and depths maps in the Strategic Flood Risk Assessment) will be permitted, where:

1. *It can be demonstrated that there are no other sites available at a lower risk of flooding (i.e. that the sequential test is passed). The sequential test will be based on a Borough or District wide search area of alternative sites within the defined settlement boundaries, unless local circumstances relating to the catchment area for the development justify a reduced search area, i.e. there is a specific need for the development in that location. The sequential test is not required for sites allocated in the Local Plan, minor development or change of use (except for a change of use to a caravan, camping or chalet site, or to a mobile home or park home site).*
2. *It can be demonstrated that essential infrastructure in FZ3a & FZ3b, highly vulnerable development in FZ2 and more vulnerable development in FZ3 provide wider sustainability benefits to the community that outweigh flood risk.*
3. *The application is supported with a site-specific flood risk assessment, covering risk from all sources of flooding including the impacts of climate change and which:*

    a. *demonstrate that the vulnerability of the proposed use is compatible with the flood zone;*
    b. *identify the relevant predicted flood risk (breach/overtopping) level, and mitigation measures that demonstrate how the development will be made safe and that occupants will be protected from flooding from any source;*
    c. *propose appropriate flood resistance and resilience measures (following the guidance outlined in the Strategic Flood Risk Assessment), maximising the use of passive resistance measures (measures that do not require human intervention to be deployed), to ensure the development maintains an appropriate level of safety for its lifetime;*
    d. *include appropriate flood warning and evacuation procedures where necessary (referring to the County's evacuation routes plan), which have been undertaken in consultation with the authority's emergency planning staff;*
    e. *incorporates the use of Sustainable Drainage Systems (SuDS) (unless it is demonstrated that this is not technically feasible) and confirms how these will be maintained/managed for the lifetime of development (surface water connections to the public sewerage network will only be permitted in exceptional circumstances where it is demonstrated that there are no feasible alternatives);*
    f. *demonstrates that the proposal will not increase risk elsewhere and that opportunities through layout, form of development and green infrastructure have been considered as a way of providing flood betterment and reducing flood risk overall;*
    g. *demonstrates that adequate foul water treatment and disposal already exists or can be provided in time to serve the development;*
    h. *ensures suitable access is safeguarded for the maintenance of water resources, drainage and flood risk management infrastructure.*

Development in all flood zones, and development over 1 hectare in size in Flood Zone 1, will need to demonstrate that surface water from the development can be managed and will not increase the risk of flooding to third parties.

Change of use of existing buildings will be supported providing they do not pose an increase in risk to people. Change of use that would result in self- contained ground floor residential accommodation in areas of hazard rating 'danger for some', 'danger for most' and 'danger for all' will not be supported. In these areas

unrestricted access to a habitable room above the flood level and an emergency evacuation plan will be required.

Caravans, mobile homes and park homes intended for permanent residential use will not be permitted in areas at risk of flooding. Caravan, chalet, log cabin, camping and touring sites at risk of fluvial flooding where there is a ' danger not for most' and ' danger for all' will not be permitted. Occupancy of caravan, chalet, log cabin, camping and touring sites at risk of tidal flooding will not be permitted to open between 1st November in any one year and the 14th March in the succeeding year.

No development will be permitted within a 50 m buffer from the toe of the raised Witham Haven Banks (flood defences), as shown on the indicative Plan contained in Appendix 10, to allow access for construction and maintenance.

Flood risk management infrastructure shall be provided at the strategic level, where development opportunities allow, to reduce the hazard and probability of flooding."

Policy 31: Climate Change and Renewable and Low Carbon Energy

The policy states in part, that:

"A. Climate Change

All development proposals will be required to demonstrate that the consequences of current climate change has been addressed, minimised and mitigated by:

2. *The adoption of the sequential approach and Exception Test to flood-risk and the incorporation of flood-mitigation measures in design and construction to reduce the effects of flooding, including SuDS schemes for all 'Major' applications."*

3.3 Drainage Technical Guidance

Non-statutory technical standards for sustainable drainage published by DEFRA in March 2015 set out how surface water runoff generated during the present day 1 in 30 and 1 in 100 annual exceedance probability (AEP) rainfall events and for events exceeding the present day 1 in 100 AEP event should be managed, how peak runoff rates should be restricted and how runoff volumes should be controlled.

South Holland IDB has advised by way on an email dated 3 February 2023 (refer **Appendix B** for full response) that the Board would need to view the proposed site layout and intensity of impermeable surfaces. As a minimum, for low intensity development under drainage of fields which runoff to soakaway may be required, although this may not be adequate for more intense development.

3.4 Water Framework Directive

The Water Framework Directive (WFD) provides a legal framework for the protection, improvement and sustainable use of inland surface waters, groundwater, transitional waters, and coastal waters across England, and seeks to:

- Prevent deterioration in the status of aquatic ecosystems, protect them and improve the ecological condition of waters
- Achieve at least 'good' status for all waterbodies by 2015
- Promote the sustainable use of water as a natural resource
- Conserve habitats and species that depend directly on water
- Progressively reduce or phase out the release of individual pollutants or groups of pollutants that present a significant threat to the aquatic environment
- Progressively reduce the pollution of groundwater and prevent or limit the entry of pollutants; and
- Contribute to mitigating the effects of floods and droughts.

The WFD applies to any proposed development which has the potential to impact on a waterbody. Where this is the case, the Environment Agency may require evidence demonstrating that the proposed development does not compromise the aims of the WFD.

3.5 Land Drainage Consent

Land drainage consent may be required from the lead local flood authority or drainage board for work to an ordinary watercourse. Undertaking activities controlled by local byelaws also requires the relevant consent.

4 REVIEW OF FLOOD RISK

4.1 Historical Records of Flooding

The Environment Agency Historic Flood Map[5], South Holland IDB and the 2017 Strategic Flood Risk Assessment indicate that there are no records of flooding at or within the immediate vicinity of the site.

4.2 Flood Risk from the Sea (Tidal / Coastal)

The Environment Agency Flood Map for Planning (Rivers and Sea)[6] (**Figure 4**) indicates the site to be located in flood zone 3. Table 1 of the PPG defines flood zones as follows[7]:

- Flood zone 1: Low Probability. Land having a less than 1 in 1,000 annual probability of river or sea flooding
- Flood zone 2: Medium Probability. Land having between a 1 in 100 and 1 in 1,000 annual probability of river flooding or between a 1 in 200 and 1 in 1,000 annual probability of sea flooding
- Flood zone 3a: High Probability. Land having a 1 in 100 or greater annual probability of river flooding or a 1 in 200 or greater annual probability of sea flooding
- Flood zone 3b: Functional Floodplain. Land where water from rivers or the sea has to flow or be stored in times of flood. Land having a 1 in 30 or greater annual probability of flooding, with any existing flood risk management infrastructure operating effectively or land that is designed to flood (such as a flood attenuation scheme), even if it would only flood in more extreme events (such as a 1 in 1,000 annual probability of flooding).

The zones do not take account of the possible impacts of climate change and consequent changes in the future probability of flooding.

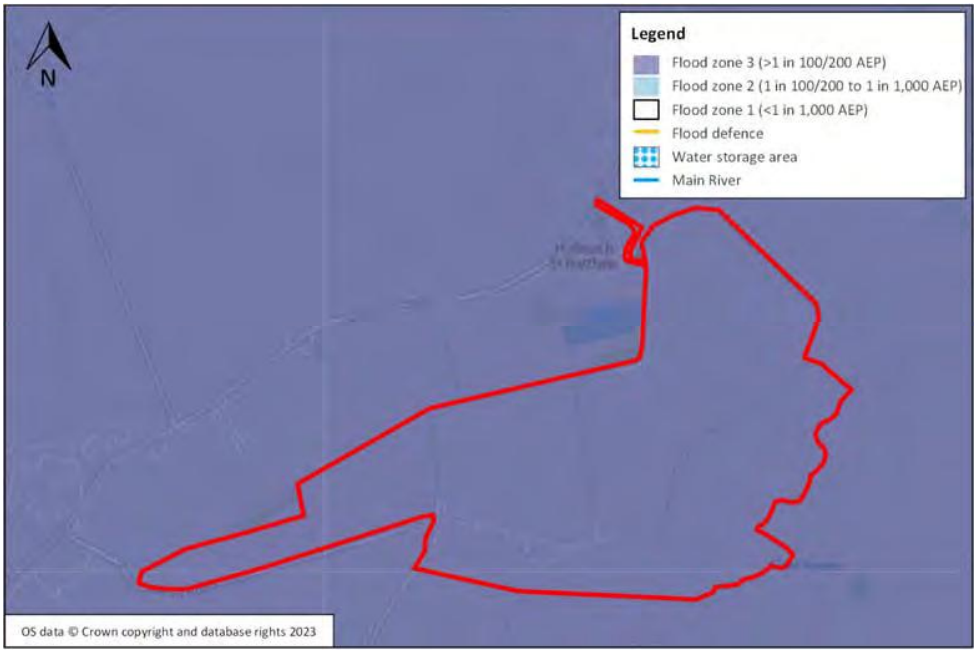

Figure 4: Flood Map for Planning
Source: gov.uk website; Accessed: April 2024

[5] https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map
[6] https://flood-map-for-planning.service.gov.uk/
[7] https://www.gov.uk/guidance/flood-risk-and-coastal-change#flood-zone-and-flood-risk-tables

4.2.1 Flood Defences

The site is located approximately 2.8 km from The Wash and is defended from the sea by earth embankments along the shoreline supplemented by salt marsh to maintain foreshore levels. The embankments are owned and maintained by the Environment Agency. According to Environment Agency records, the defences within the vicinity of the site are in fair condition, have a crest level of between 6.9 – 8.0 m AOD, and provide a 1 in 150 annual exceedance probability (AEP) standard of protection.

Government policy regarding sea defences is set out in shoreline management plans published in December 2010. The site is located in the Gibraltar Point to Old Hunstanton (The Wash) shoreline management plan and is covered by Policy Development Zone (PDZ) 1 (Gibraltar Point to Wolferton Creek).

The policy for PDZ1 requires continuation of the current levels of flood defence management, with established settlements continuing to be protected to the existing standard (i.e. 1 in 150 AEP).

4.2.2 Risk of Flooding due to Defence Overtopping

The Environment Agency has provided extreme tide levels for Immingham to the West Lighthouse (**Appendix C**) for an assessment base date of 2017. There are three locations within the vicinity of the site: Hobhole, Fosdyke Bridge and West Lighthouse. Of these locations, Hobhole provides the worst case scenario as follows:

- 1 in 200 (2017) AEP event 6.04 m AOD
- 1 in 1,000 (2017) AEP event 6.31 m AOD

The NPPF requires an allowance for climate change to be made. Using the allowance set out in Government guidance[8] and a development lifetime of 40 years (PPG para. 006), this allowance has been calculated as 0.35 m (70th Percentile; 70P) and 0.45 m (95th Percentile; 95P). The peak still tidal level for the 1 in 200 AEP event plus climate change (2064) is therefore estimated to be 6.39 m AOD (70P) and 6.49 m AOD (95P) and for the 1 in 1,000 AEP event plus climate change (2064) is estimated to be 6.66 m AOD (70P) and 6.76 m AOD (95P).

The Government climate change guidance states that for flood risk assessments, both the 70P and 95P allowances should be assessed, with the 70P typically used to inform design levels and the 95P to inform mitigation measures, access and egress routes and emergency evacuation plans.

These levels are significantly lower than the crest levels of the sea defences. As such, no overtopping of the defences would be expected in still water conditions during these events.

Still water levels do not account for wave action or other variables and detailed modelling has been undertaken by the Environment Agency to provide a more accurate representation of flood risk due to overtopping of the sea defences taking into account these additional factors.

The modelling shows that the site does not flood during the present day (2006) 1 in 200 and 1 in 1,000 AEP events, the 1 in 200 AEP event plus climate change (to 2115) and the 1 in 1,000 AEP event plus climate change (2115).

[8] Flood Risk Assessments: Climate Change Allowances - https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

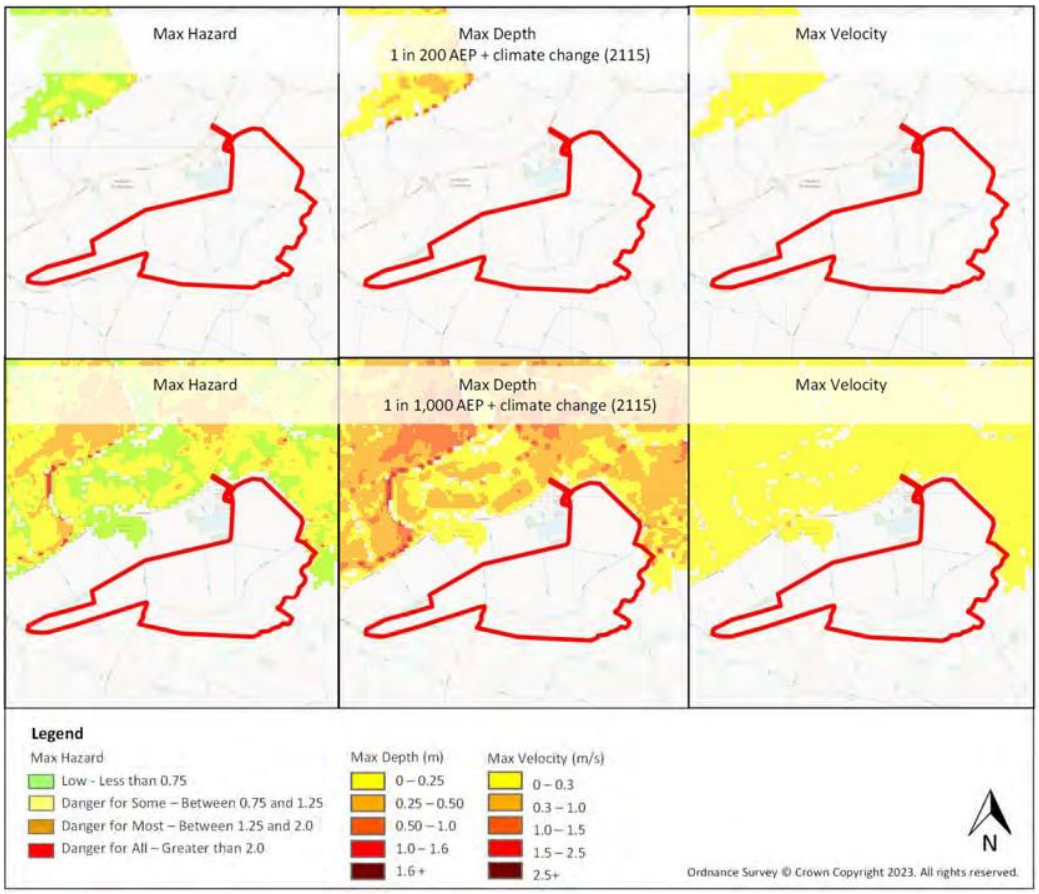

Figure 5: Flood Risk due to Tidal Defence Overtopping
Source: Lincolnshire and Northamptonshire Tidal Overtopping Hazard Mapping, Environment Agency, 2006

4.2.3 Risk of Flooding due to a Breach in the Defences

A breach in sea defences has also been modelled by the Environment Agency. The approach used is to simulate the effect of multiple breaches along the east coast and to prepare a composite (worst case) map of flood depth, velocity and hazard. One of the modelled breach locations is located adjacent to the site (**Appendix C**).

The maximum flood depth, velocity and hazard at the site are presented in **Figure 6**. The outputs indicate that flood depths vary across the site, and that the site, Eastern Road and Marsh Road would flood during the present day (2006) 1 in 200 and 1 in 1,000 AEP breach events to a maximum depth and velocity of 0.5 – 1.0 m and 0.3 m/s respectively, up to 1.0 – 1.6 m and generally 0.3 m/s respectively during the 1 in 200 AEP event plus climate change (to 2115) and up to 1.0 – 1.6 m and 1.0 m/s respectively during the 1 in 1,000 AEP event plus climate change (to 2115).

When taking the lifetime of the development into account, the maximum flood depth during the 1 in 1,000 AEP event plus climate change (2064) may be estimated to be up to 1.10 m (70P) and 1.20 m (95P); this is the modelled flood depth at the site during a present day 1 in 1,000 AEP breach event plus the calculated allowance for climate change of 0.35 m and 0.45 m respectively.

However, due to the variation in flood depths at the site, flood levels have been estimated as to provide a more informed assessment. The assessment, based on ground levels and flood depths, indicates that flood levels across the site may generally be in the region of 3.73 – 3.84 m AOD. When applying the calculated climate change allowance of 0.35 m and 0.45 m, a maximum flood level of 4.19 and 4.29 m AOD may be expected at the site respectively.

Based on the information presented, it is concluded that the site is at a High risk of flooding from the sea (tidal/coastal) due to a breach in flood defences. However, the likelihood of the defences failing, especially during the lifetime of the development, is assessed to be low.

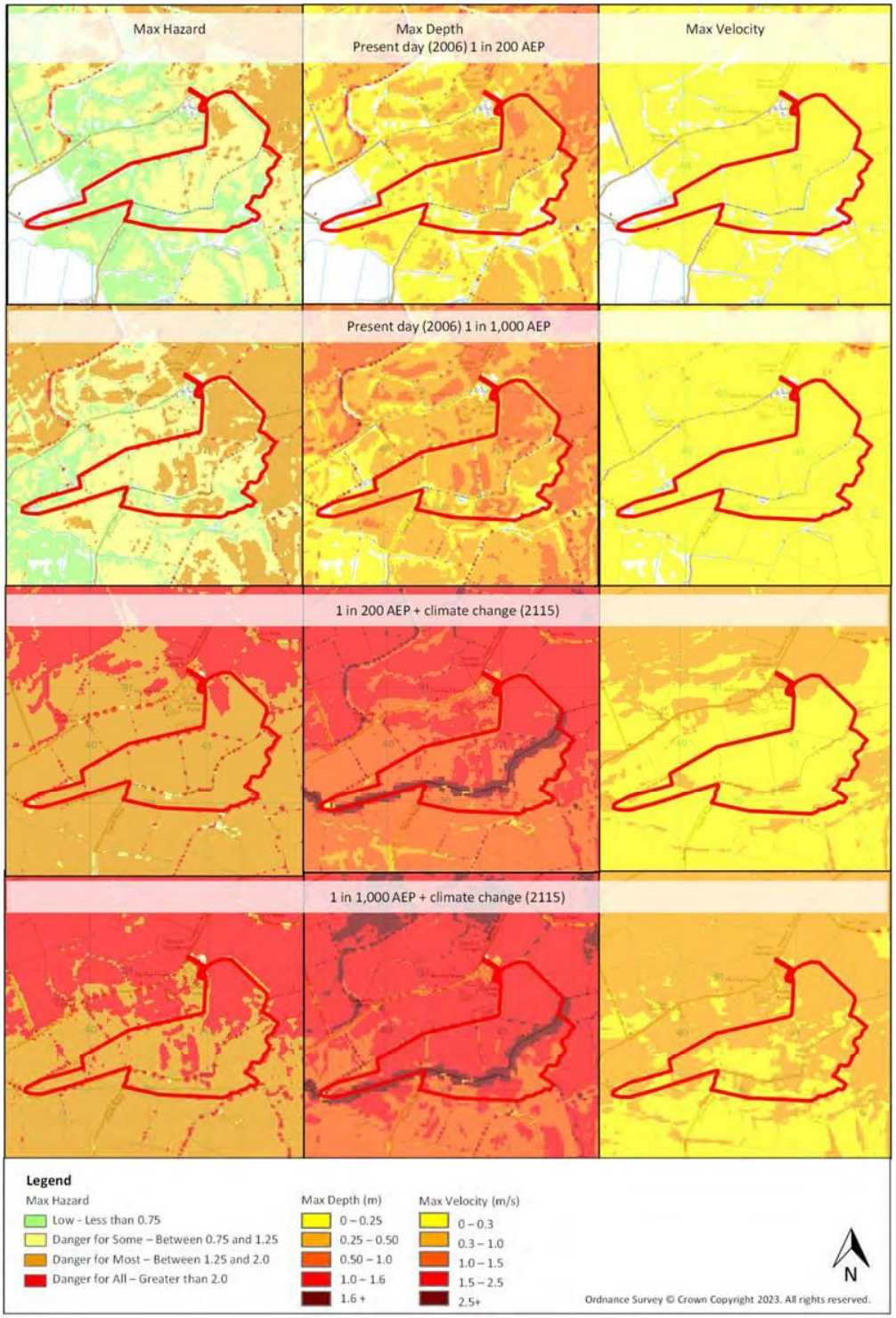

Figure 6: Tidal Hazard Mapping - Breach
Source: Lincolnshire and Northamptonshire Tidal Breaching Hazard Mapping, Environment Agency, 2006

4.3 Flood Risk from Rivers (Fluvial)

As outlined in **Section 2.3**, a number of IDB drainage ditches are located on site. South Holland IDB has provided the peak modelled water levels for these watercourses during the 1 in 100 AEP event plus 20% climate change.

The current Environment Agency guidance on climate change allowances (May 2022) advises that for essential infrastructure in flood zone 3, the Higher Central allowance should be used to assess flood risk for the lifetime of the development. The Higher Central allowance for the Welland management catchment is +10% (2050s) and +28% (2080s). Based on the lifetime of the development, a +18% (2064) allowance should be utilised. As such, the +20% provides a slightly conservative estimate.

The peak modelled water levels during the 1 in 100 AEP event plus 20% climate change are as follows:

- Sot's Hole: 2.92 m AOD
- Middle Drain: 2.91 m AOD
- Fleet Haven Drain: 2.87 m AOD
- Sot's Hole and Connection: 2.84 m AOD

A comparison of the peak modelled water levels and site levels indicates that peak flows would remain in channel during the 1 in 100 AEP event plus 20% climate change.

There is a risk of the pumping stations referenced in Section 2.3 failing, potentially rendering the site at a residual risk of flooding. However, South Holland IDB has advised by way of an email dated 24 February 2023 (refer **Appendix B** for full response) that the pumping stations are constantly monitored through the Board's telemetry system, with pumps being serviced every 8-10 years and major refurbishments occurring approximately every 30 years.

Based on the above, the site is assessed to be at a Low risk of flooding from rivers (fluvial).

4.4 Flood Risk from Small Watercourses and Surface Water (Pluvial)

As detailed in **Section 2.3**, a number of drainage ditches are located on and within the vicinity of the site that flow into IDB watercourses. No modelled information is available for these watercourses. The Flood Risk from Surface Water map (**Figure 7**) has therefore been utilised to assess the risk of flooding from these sources.

This mapping indicates that the site is predominantly at a Very Low risk of flooding from small watercourses and surface water.

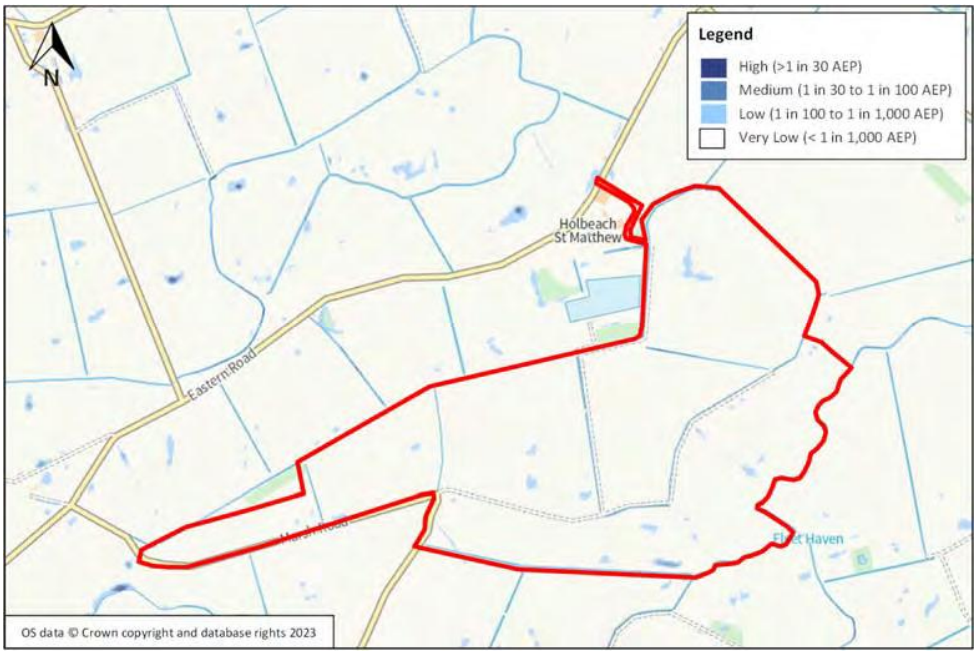

Figure 7: Flood Risk from Surface Water
Source: gov.uk website; Accessed: April 2024

4.5 Flood Risk from Reservoirs, Canals and Other Water Impounding Structures

There are no canals located within the immediate vicinity of the site. The Flood Risk from Reservoirs map (not shown) indicates that the site is not at risk of flooding from such sources.

As discussed in **Section 2.3**, a small water impounded structure is located at Hartley Farm adjacent to the west of Sot's Hole and to the north of Sot's Hole and Connection. The small water impounded structure is embanked in its entirety, with water used for irrigation purposes. Given the presence of the watercourses between the small water impounded structure and the site, any flood waters due to a breach in the embankment would be expected to flow into the watercourses.

It is concluded that the site is not at risk of flooding from reservoirs and canals and at a Low risk of flooding from other water impounding structures.

4.6 Flood Risk from Groundwater

The JBA Groundwater Flood Risk Indicator map (not shown) indicates that the site is at a Negligible risk during a 1 in 100 AEP groundwater flood event.

4.7 Flood Risk Mitigation

The assessment indicates that the site is not at risk of flooding from overtopping of sea defences during all modelled scenarios including during the 1 in 1,000 AEP event plus climate change (2115) and is at a negligible to low risk of flooding from all other sources. However, there is a residual risk of flooding in the unlikely event of a breach in sea defences. As such, the residual risk of flooding to the site due to a breach in sea defences will be mitigated through the implementation of the following measures:

- The minimum height of the solar panels is 0.8 m. It should be noted that panels are entirely watertight and would be unaffected by floodwater should it occur in a breach event
- Sensitive equipment contained within the inverter/transformer stations to be set a minimum height of 4.29 m AOD. This is the estimated flood level (95P) during the 1 in 1,000 AEP breach event plus climate change (2064)

- Construction of a flood barrier around the DNO substation, battery storage compound and substation buildings within the south-western corner of the site up to a minimum height of 4.29 m AOD. Gated access should remain closed when not required for access
- Existing drainage ditches should be retained
- No substations, inverter/transformer stations or storage containers proposed within 9 m of the top of bank of existing drainage ditches (refer to **Appendix D**)
- It is recommended that the area under the panel drip line is seeded with a suitable grass mix to prevent rilling and an increase in surface water runoff rates
- Any new access crossings on existing drainage ditches should be designed to maintain existing conveyance capacity

4.8 Flood Risk Sequential Test

The section of the NPPF (July 2021) on "planning and flood risk" states that the Sequential Test is intended to be applied to all sources of flood risk, not just river/sea flooding. NPPF para. 162 states:

> *"The aim of the Sequential Test is to steer new development to areas with **the lowest risk of flooding from any source**. Development should not be…permitted if there are reasonably available sites appropriate for the proposed development in areas with **a lower risk of flooding**. The strategic flood risk assessment will provide the basis for applying this test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding." (our emphasis added)*

The approach presented within this report is to assess the risk of flooding from all identified sources to determine whether the Sequential Test needs to be applied - i.e. the site has been assessed to establish whether it is an area with a low risk of flooding from any source.

A summary of the risk assessment from all potential sources of flooding using a low to very high risk classification (as defined in **Appendix E**) is presented in **Table 1**.

Table 1: Site Summary of Flood Risk from All Sources

Source of Risk	Risk Classification					Sources of Information
	None/Negligible	Low	Medium	High	Very High	
Sea (tidal / coastal) (direct risk)		✔ *				a, b, c
Rivers (fluvial)		✔				a, b
Small watercourses		✔				a, b, d, g
Surface water (pluvial)		✔ **				b, d
Reservoirs	✔					b, d, g
Canals	✔					b, g
Other water impounding structures		✔				b, g
Groundwater		✔				b, f

* Whilst the Environment Agency Flood Map for Planning indicates the site to be located in flood zone 3, Environment Agency hazard mapping indicates that the site is only at risk of flooding from the sea due to a breach in flood defences. However, the likelihood of the defences failing is assessed to be low.

** The flood risk to the site from surface water is defined as 'Very Low' on the Flood Risk from Surface Water map (**Figure 7**). Within the sequential assessment a Low risk classification has been attributed to the site in accordance with **Appendix E**, which is defined as land having a < 1 in 1,000 annual probability of surface water flooding.

Notes - Sources of information: (a) Environment Agency Flood Map for Planning (Rivers and Sea); (b) Strategic Flood Risk Assessment (March 2017); (c) Environment Agency flood risk information – Lincolnshire and Northamptonshire Tidal Overtopping and Breach Hazard Mapping (d) Environment Agency Flood Risk from Surface Water; (e) Environment Agency Flood Risk from Reservoirs; (f) JBA Groundwater Flood Risk Indicator Map; (g) Ordnance Survey mapping.

On the basis of the assessment, it is concluded that the proposals satisfy the requirements of the flood risk Sequential Test and that no sequential assessment of potential alternative sites is required.

4.9 Exception Test

Table 2 of the PPG requires the Exception Test to be applied for 'Essential Infrastructure' within flood zone 3.

The assessment presented in this report demonstrates that the proposed development passes element (b) of the test, i.e. the development will be safe for its lifetime taking account of the vulnerability of its users and will not increase flood risk elsewhere.

Element (a) of the test has been addressed by Green Energy International and is separately reported.

5 SURFACE WATER MANAGEMENT

5.1 Surface Water Drainage at the Existing Site

As described in **Section 2.1**, the site currently comprises agricultural farmland. It is possible that field drains are present, but no other formal drainage infrastructure is believed to be present. Overland flow is expected to be limited due to the flat nature of the site and surface water runoff would be expected to slowly infiltrate where conditions allow.

The greenfield surface water runoff rates for the site, calculated using the ICP SUDS method within MicroDrainage are presented in **Table 2**. Details of the input parameters and the output results are provided in **Appendix F**.

Table 2: Greenfield Runoff Rate

AEP of Rainfall Event	Greenfield Runoff Rate (l/s/ha)	Greenfield Runoff Rate for 112.1 ha Site (l/s)
1 in 1	1.3	145.7
QBAR	1.5	168.2
1 in 30	3.7	414.8
1 in 100	5.4	605.3

5.2 Surface Water Drainage at the Developed Site

Panelled Areas of the Solar Farm

According to published research into the impact of solar-farm panels on runoff rates and volumes[9], solar panels do not have a significant impact on the hydrologic response of a site when the ground comprises of well managed vegetation such as good grass cover. In such instances, the research cites that well managed vegetation beneath the solar panels would limit the potential increase in runoff volume to less than 0.35%.

Given that the site is virtually flat, and that the proposed development is to include managed grassland beneath the solar panels, the impact on runoff rates and volumes from the panelled part of the development is assessed to be negligible. As such, no specific drainage for the panelled part of the site is proposed.

As part of the proposals, existing access tracks will be utilised and will therefore continue to drain as per the current arrangement. The location of the existing tracks are illustrated on the preliminary surface water drainage layout (refer **Appendix G**).

The inverter/transformer stations have relatively small impermeable areas. It is recommended that an infiltration trench is implemented alongside one edge of each inverter/transformer station to promote infiltration into the ground, or if located adjacent to an existing track a connection into the sub-base material.

Access Tracks and Other Areas of Hardstanding

In accordance with PPG para. 056, surface water runoff should be disposed of according to 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.

As detailed in **Section 2.4**, the site is underlain by soils with impeded drainage comprising of silt and clay. Although infiltration testing has not been undertaken at this stage, the desktop study, together with the density of the network of agricultural drainage ditches, provides strong evidence that the disposal of surface water via infiltration is unlikely to be feasible. It is therefore proposed to direct runoff from the developed site to the on-site drainage ditches.

For the purposes of this assessment, the site has been subdivided into eight drainage areas based on the site layout and the location of surface waterbodies, as illustrated on **Figure 8**.

[9] 'Hydrologic Response of Solar Farms', Cook LM and McCuen RH, American Society of Civil Engineers, 2013

The contributing areas within each drainage area associated with the new access tracks, inverter stations, sub-station, battery storage compound for units and construction compound, has been calculated based on the proposed site layout plan (**Appendix A**) and is presented in **Table 3**.

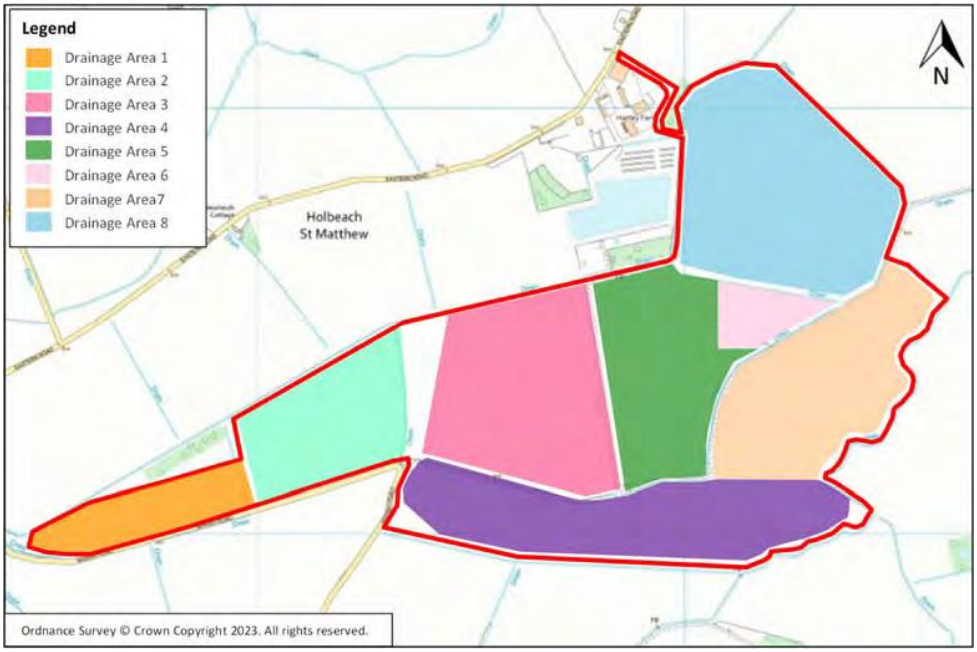

Figure 8: Indicative Drainage Areas

5.2.1 Peak Flow Control

South Holland IDB requires surface water runoff to be restricted to 1.4 l/s/ha. This runoff rate will be achieved so far as is practicable; however, it is recognised that a flow control with a diameter of less than 50 mm may pose a risk of blockage to the drainage system. The proposed peak discharge for each drainage area is presented in **Table 3**.

5.2.2 Volume Control

As outlined within the CIRIA SuDS Manual 2015 extra runoff volumes in extreme events may be managed by releasing all runoff (above the 1 in 1 AEP event) from the site at a maximum rate of 2 l/s/ha or QBAR, whichever is the higher value.

It is therefore proposed to restrict peak discharge rates to 1.4 l/s/ha recognising a flow control with a minimum diameter of 50 mm would apply in up to the 1 in 100 AEP event, including an allowance for climate change.

5.2.3 Attenuation Storage

Attenuation storage will be provided to store surface water runoff generated across contributing areas.

The attenuation storage facilities have been modelled using the Source Control module of MicroDrainage (**Appendix H**). The required storage volume has been sized to store the 1 in 100 AEP rainfall event including a 40% increase in rainfall intensity to allow for climate change in accordance with Environment Agency guidance[10].

The proposed attenuation volumes are provided in **Table 3** below.

[10] Flood Risk Assessments: climate change allowances (https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances)

Table 3: Summary of Proposed Surface Water Drainage Scheme
(1 in 100 AEP Event plus 40% Climate Change)

Drainage Area	Outfall	Impermeable Area (ha)	Peak Discharge (l/s)		Attenuation Volume (m³)
1	S1A	0.682	1.0		494.8
	S1B	0.226	0.3	1.0*	128.5
2	S2	0.361	0.5		228.8
3	S3	0.410	0.6		268.4
4	S4	0.463	0.7		311.5
5	S5	0.131	0.2		65.0
6	S6	0.221	0.3		125.0
7	S7	0.118	0.2		56.9
8	S8	0.459	0.6		308.3

*Based on a flow control (e.g. Hydro-Brake) diameter of 50 mm

The storage volume could be accommodated within a Type 3 sub-base material within the compound area and access tracks at a depth of 0.3 m.

A preliminary surface water drainage layout is provided in **Appendix G**.

5.2.4 Pollution Control

Table 26.2 of the CIRIA SuDS Manual (2015) identifies general access roads as having a low pollution hazard level and indicates that the pollution hazard indices associated with general access roads for total suspended solids, hydrocarbons and metals are 0.50, 0.40 and 0.40 respectively.

It is recommended that the access tracks are constructed with a Type 3 material to allow surface water runoff to be stored and treated within the pavement structure.

Table 26.3 of the CIRIA SuDS Manual indicates that the SuDS mitigation indices for permeable paving for total suspended solids, hydrocarbons and metals are 0.70, 0.60 and 0.70 respectively.

The CIRIA SuDS manual identifies commercial roofs (inverter/transformer stations, sub-stations and storage containers) as having a low pollution hazard level, as such minimal treatment measures would be required to treat the quality of the water.

5.2.5 Adoption and Maintenance of SuDS

The surface water drainage system will be maintained by the site operator or their appointed management company. An indicative maintenance schedule is presented in **Table 4**.

Table 4: Maintenance Requirements

Schedule	Required action	Frequency
Type 3 Permeable Access Tracks		
Occasional maintenance	Stabilise and mow contributing and adjacent areas	As required
	Removal of weeds or management using glyphosphate 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 of the paving	As required
	Remedial work to any depressions and rutting considered detrimental to the structural performance or a hazard to users	
	Rehabilitation of surface and substructure	Every 10 to 15 years or as required
Monitoring	Initial inspection	Monthly for three months after installation

Schedule	Required action	Frequency
	Inspect for evidence of poor operation and/or weed growth- if required, take remedial action	Three-monthly, 48h after large storms in first six months
	Inspect silt accumulation rates and establish appropriate removal frequencies	Annually
Flow Control Unit		
Routine maintenance	Remove litter and debris and inspect for sediment accumulation	Six Monthly
	Remove sediment from sump	As necessary – Indicated by system inspections
Remedial actions	Replace malfunctioning parts or structures	As required
Monitoring	Inspect for evidence of poor operation	Six Monthly
	Inspect flow control unit and establish appropriate replacement frequencies	Six Monthly
	Inspect sediment accumulation rates and establish appropriate removal frequencies	Monthly during first year of operation, then every six months

6 SUMMARY AND RECOMMENDATIONS

This report has been prepared on behalf of Green Energy International and relates to the proposed development of land at Hartley Farm, Holbeach, St Matthews, Spalding for use as a solar farm.

The Environment Agency Flood Map for Planning indicates the site to be located in flood zone 3.

An assessment of flood risk from all identified potential sources of flooding has been undertaken using best available information to determine: a) whether a Sequential Test needs to be applied; and b) whether any specific measures would be required to mitigate flood risk.

A summary of the risk assessment is presented below.

Source	Risk Level				
	None/Negligible	Low	Medium	High	Very High
Sea (tidal / coastal) (direct risk)		✔			
Rivers (fluvial)		✔			
Small watercourses		✔			
Surface water (pluvial)		✔			
Reservoirs	✔				
Canals	✔				
Other water impounding structures		✔			
Groundwater		✔			

On the basis of the assessment, it is concluded that the proposals satisfy the requirements of the Sequential Test and that no sequential assessment of potential alternative sites is required.

The Exception Test should be applied for 'Essential Infrastructure' within flood zone 3. Element (a) of the test has been addressed by Green Energy International. The assessment presented in this report demonstrates that the proposed development may be completed in accordance with the requirements of planning policy, thus satisfying the requirement of element (b) of the test, subject to the following:

Notwithstanding this, the assessment demonstrates that the proposed development may be completed in accordance with the requirements of planning policy subject to the following:

- The minimum height of the solar panels is 0.8 m.
- Sensitive equipment contained within the inverter/transformer stations to be set a minimum height of 4.29 m AOD.
- Construction of a flood barrier around the DNO substation, battery storage compound and substation buildings within the south-western corner of the site up to a minimum height of 4.29 m AOD. Gated access to remain closed when not required for access.
- Existing drainage ditches to be retained.
- No substations, inverter/transformer stations or storage containers proposed within 9 m of the top of bank of existing drainage ditches.
- Panelled part of the site to comprise managed grassland.
- Ground under the solar panel drip line to be seeded with a suitable grass mix to prevent rilling.
- Any new access crossings on existing drainage ditches should be designed to maintain existing conveyance capacity.
- The proposed maintenance access track to be constructed from a Type 3 permeable pavement aggregate to promote water quality treatment.
- Surface water runoff from the access tracks and other areas of hardstanding to be restricted to flow rates to suit a flow control diameter of 50 mm as to avoid the risk of blockages, with storage provided within the Type 3 material.

In conclusion, this report demonstrates that the proposed development may be completed in accordance with the requirements of planning policy.