HELIOS RENEWABLE ENERGY PROJECT

Preliminary Environmental Information Report

Volume 3: Technical Appendices

Appendix 9.1: Flood Risk Assessment

HELIOS RENEWABLE ENERGY PROJECT

APPENDIX 9.1: FLOOD RISK ASSESSMENT

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AUGUST 2023

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DOCUMENT CONTROL

Job No	E216	
File Reference	G:\workfiles\E216 CAMBELSFORTH\REPORTS\E216-DOC01-FRA-DRAFT 6.docx	
	Name	Date
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Issue	Approved By	Date	Comments
DRAFT 3	S A Millard MICE IEng	09 June 2023	*For client comment*
DRAFT 4	B Fox BSc (Hons) MCIWEM C.WEM CEnv	23 June 2023	*For client comment*
DRAFT 5	B Fox BSc (Hons) MCIWEM C.WEM CEnv	12 July 2023	*For client comment*
DRAFT 6	B Fox BSc (Hons) MCIWEM C.WEM CEnv	24 August 2023	*For client comment*

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EXECUTIVE SUMMARY

I. The Proposed Development is a solar farm with a modelled operational lifespan of up to 40 years on land located to the south-west of Camblesforth and to the north of the village of Hirst Courtney in North Yorkshire (the 'Site'). The Site is approximately 475.68 hectares in area, and the current use comprises agricultural land situated between the villages of Burn and Camblesforth. The Site is bound by railway lines on the north western and south eastern edges with Selby Road to the north east and Hirst Road to the south west. The Underground Cable Corridor for the Proposed Development extends to the east of Drax Power Station.

II. The majority of the Site falls within Flood Zone 3a meaning it has a high risk of flooding. This is due to the River Ouse to the north and the River Aire to the south, which converge to the east of the Site. The risk of flooding from surface water is very low and so the main source of risk is fluvial.

III. The sequential test is a risk-based approach used to locate development to the lowest risk areas available. The Sequential Test is considered satisfied on the basis that a solar farm is compatible at this location, subject to satisfying the requirements of the Exception Test. A solar farm is classed as essential infrastructure and so The Exception Test is passed owing to the fact that the benefits provided by the solar farm outweigh the flood risks and the measures proposed in this flood risk assessment would make the Proposed Development safe for its users without increasing flood risk elsewhere.

IV. Environment Agency maintained flood defences are present in the vicinity of the Site on both the River Ouse and River Aire. The flood defences provide a level of protection which could be overwhelmed in the 'design flood' and actions are required to ensure the standard of protection can be maintained to mitigate the effect of climate change. A site-specific flood model for the Site is being commissioned to determine the design flood and provide a credible maximum scenario sensitivity test; this will inform the Environmental Statement ('ES') to be submitted in support of the application for development consent for the Proposed Development. At this stage, the scope of the site-specific flood model has yet to be agreed with the Environment Agency and is subject to ongoing consultation.

V. The Proposed Development extends into areas of elevated flood risk from the combined fluvial and tidal flood. The Proposed Development will be designed to appropriately safe in the combined fluvial and tidal design flood without increasing flood risk elsewhere. The following design flood mitigation measures are proposed:

- The construction contractor and operating staff will register to receive flood alerts / warnings from the Environment Agency and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar photovoltaic ('PV') arrays within the areas of elevated flood risk will be rotated to the horizontal stow position which will be a minimum of a 0.3m above the combined fluvial and tidal design flood level;
- Panel supports and security fencing in flood risk areas will be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas is increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary equipment, battery energy storage system ('BESS') facility and 132kv Substation in areas of elevated flood risk will be protected by a suitably designed earth flood

defence bunds. The height of the proposed earth flood defence bunds will be raised at least +0.6m above the combined fluvial and tidal design flood level to protect the equipment from inundation;

- Level for level floodplain compensation will be provided on the Site to mitigate the effect of the earth flood defence bunds;
- Onsite watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the on-Site ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

These flood mitigation measures would ensure that the Proposed Development would remain operational and safe in times of the design flood and can be secured by a suitably worded DCO requirement requiring the submission of details to be submitted to and approved by the Local Planning Authority.

VI. With respect to surface water runoff, the solar PV panels are raised above the existing ground allowing a permanent grass sward to be maintained underneath the panels. Rainfall falling onto the solar PV panels would runoff directly to the ground beneath the panels and infiltrate into the ground at the same rate as it does in the Site's existing greenfield state. Access tracks would be semi permeable in nature. The extent of impermeable cover as a result of the Solar Farm amounts to only 0.1 % of the Solar Farm Zone (the area of the Site where solar PV panels and associated infrastructure is proposed). The effect on the Mean Annual Flood (Q_{BAR}) is minimal and only equates to a 0.23% increase compared with the greenfield runoff.

VII. A sustainable drainage strategy, involving the implementation of SuDS in the form of interception swales, is proposed for managing surface water runoff on the Site. Interception swales are proposed at the low points of the Solar Farm Zone to intercept extreme flows, which may already run off-Site and provide runoff pathway management. The volume of storage provided within the proposed interception swales (398m^3) is greater than the additional runoff generated as a result of the extreme 1 in 100-year storm event, including an allowance for climate change (289.5m^3). The interception swales are therefore an appropriate form of mitigation given the 'temporary' nature of the Proposed Development, and a proportionate mitigation measure given the negligible hydrological effect of a Solar Farm and are a practical implementation of Natural Flood Management ('NFM').

VIII. A sustainable drainage strategy (SuDS) is proposed for managing the disposal of surface water runoff from the BESS area and Substation. It is proposed that runoff from the BESS area would be collected by perimeter filter drains. The filter drains would convey the runoff to two shallow detention basins (Basins 1 and 2). Runoff would be discharged at a controlled rate into the on-Site drainage ditches. Flow controls would be utilised to restrict runoff at each outfall to the lowest practical discharge rate of 1 l/s. The proposed drainage strategy would ensure that surface water arising from the BESS area and Substation would be managed in a sustainable manner to mimic the surface water flows arising from the Site prior to the Proposed Development, while reducing the flood risk to the site itself and elsewhere, taking climate change into account.

IX. Existing drainage features would be retained and the Site would remain vegetated throughout construction and operation of the Proposed Development to prevent soil erosion. The proposed interception swales would lead to an overall reduction in surface water flow rates from the Site and mitigate any increase in run-off due to the minor reduction in the overall permeable area of the

Site. On this basis, the Proposed Development would not increase flood risk on-Site or elsewhere and would preserve the Site's natural drainage regime.

X. The overall conclusions drawn from this Flood Risk Assessment are that future users of the Proposed Development would remain appropriately safe throughout the lifetime of the Proposed Development, and that subject to a DCO requirement requiring the drainage arrangements as indicated on plans E216/88 and E216/90-106 Rev B to be implemented and maintained in accordance with the procedures set out at Table L of this FRA and a Check Sheet attached as Appendix 21, the Proposed Development would not increase flood risk elsewhere and would reduce flood risk overall.

1. INTRODUCTION

1.1. This Flood Risk Assessment ('FRA') has been prepared on behalf of Enso Green Holdings D Limited in connection with proposals for the development of a renewable energy generating project on land to the south west of the village of Camblesforth and to the north of the village of Hirst Courtney in North Yorkshire, known as the Helios Renewable Energy Project (the 'Proposed Development'). This FRA supports an application for a Development Consent Order ('DCO').

1.2. The overall Site comprises approximately 475.68 hectares and encompasses a number of interconnected parcels of predominantly agricultural land, consisting of fields used for grazing and arable cropping. A Site location plan is contained in **Appendix 1.** The main part of the Site where solar PV panels and associated infrastructure is proposed (referred to as the 'Solar Farm Zone ') is situated to the south west of the village of Camblesforth, to the north of the village of Hirst Courtney and Hirst Road, to the south of the A1041 and to the east of the Selby Branch of the East Coast Mainline railway. The Site is located within the administrative area of North Yorkshire Council. The Underground Cable Corridor to the connection to the grid for the Proposed Development extends to the east of Drax Power Station. The location of the Site is shown on **Figure 1** below and a more detailed Site Location Plan is provided in **Appendix 1**.

1.3. The Proposed Development comprises the construction of a solar farm consisting of ground-mounted solar PV modules mounted on metal frames, with associated site infrastructure, ancillary control equipment, energy storage and an underground connection to the grid. The parameter plan is reproduced in **Appendix 2**. The modelled operational lifespan of the Proposed Development is up to 40 years.

1.4. The main purpose of this FRA is to provide sufficient flood risk information to support the Preliminary Environmental Information Report ('PEIR') stage of the Development Control Order ('DCO') application.

1.5. It should be noted that the proposals for the Helios Renewable Energy Project are currently being developed, assessed and refined. The information contained in this FRA is therefore preliminary only, and may be subject to change prior to the production of the ES to be submitted in support of the application for development consent. For the avoidance of doubt, the FRA would be updated to support the ES.

1.6. This FRA seeks to demonstrate that the Proposed Development would be appropriately safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where practicable, would reduce flood risk overall.

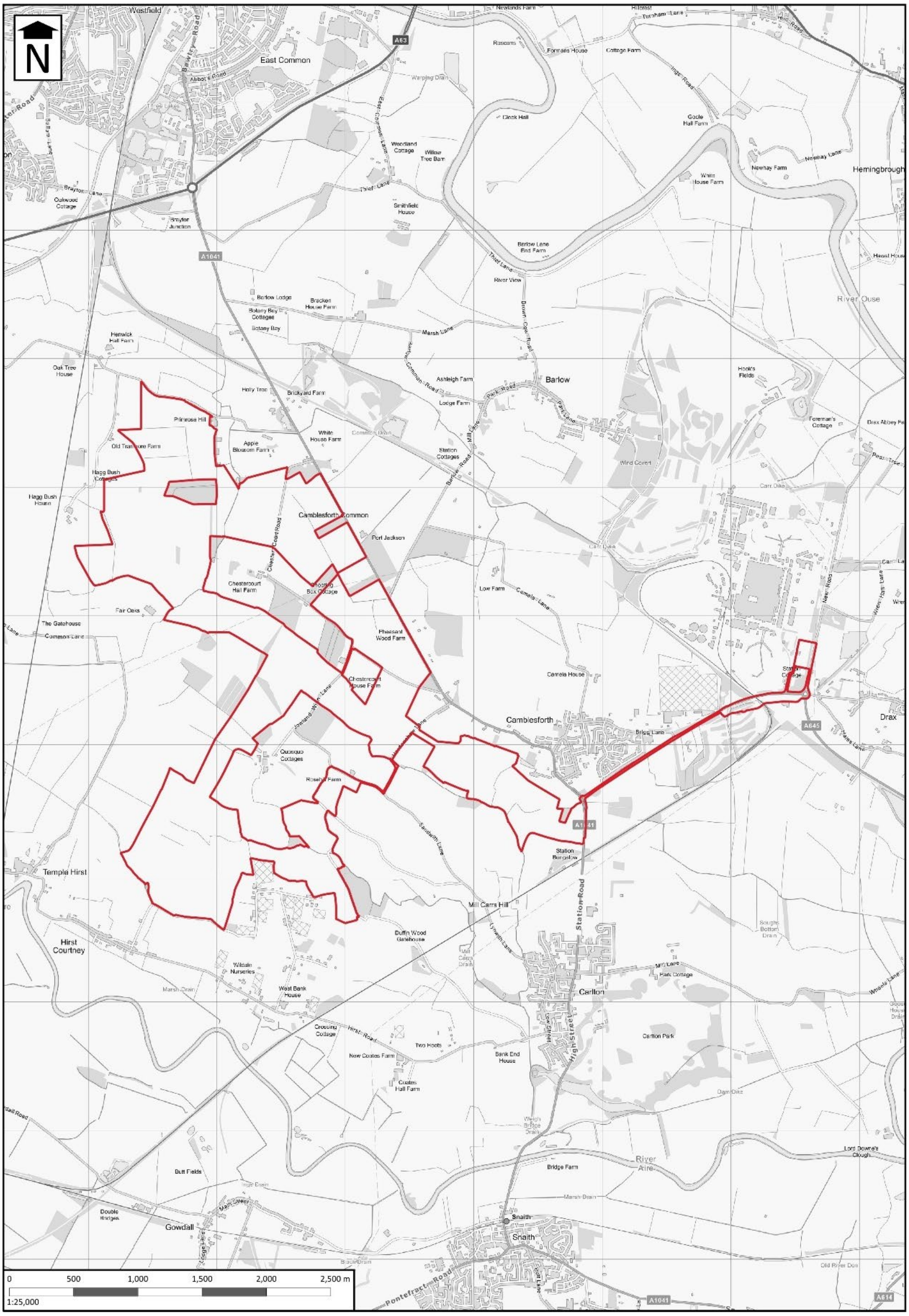

Figure 1: Site Location Plan

Contains OS data © Crown copyright [OS VectorMap® District] [2023]

2. SCOPE OF THE ASSESSMENT

National Planning Policy

National Policy Statements

2.1. The Proposed Development has an expected energy generating capacity in excess of the 50MW threshold for onshore generating stations in England and therefore constitutes a Nationally Significant Infrastructure Project ('NSIP') and the National Policy Statements ('NPS) 'therefore apply to the DCO application.

Designated National Policy Statements

2.2. NPSs are produced by Government. There are 12 NPSs, setting out government policy on different types of national infrastructure development. However, no designated NPS explicitly deals with solar or energy storage of the nature proposed as part of the Proposed Development.

2.3. In addition, a suite of draft revised energy NPSs (En-1 to EN-5) have been published for consultation and are discussed in the section below. In the event that the revised NPSs are not in place by the time the DCO application is submitted there are two current NPSs that are relevant to this assessment which include Overarching National Policy Statement for Energy (EN-1) (July 2011)[1] ('NPS EN-1') and NPS for Electricity Networks Infrastructure (EN-5) (July 2011)[2].

2.4. NPS EN-1 recognises the need for applications to be supported by a FRA in accordance with the guidance contained within national planning policy (formerly Planning Policy Statement 25 ('PPS25')[3] and its Practice Guide[4]). The FRA should also make appropriate arrangements to manage surface water including appropriate use of SuDS. It confirms that the Sequential and Exception Tests need to be satisfied for developments in Flood Zone 3.

2.5. Section 4.8 in EN-1 sets out policy on climate change adaptation over the lifetime of the development. The policy notes the need for the applicant to take into account the potential impacts of climate change and design appropriate mitigation or adaptation measures. It identifies the need to assess 'maximum credible scenarios' for critical infrastructure and paragraph 4.8.9 states:

> **'Where energy infrastructure has safety critical elements (for example parts of new fossil fuel power stations or some electricity sub-stations), the applicant should apply the high emissions scenario (high impact, low likelihood) to those elements. Although the likelihood of this scenario is thought to be low, it is appropriate to take a more risk-averse approach with elements of infrastructure which are critical to the safety of its operation.'**

2.6. The climate change scenarios set out in the latest Environment Agency's guidance are described in Section 3 below and require the assessment of the maximum credible (i.e. worst case) climate change scenario.

2.7. NPS for Electricity Networks Infrastructure (EN-5) (July 2011) requires development to assess the vulnerability and resilience of the development to climate change and the risk climate change poses to flooding. The increased risk of flooding would be covered in a FRA.

[1] Department of Energy and Climate Change (2011) Overarching National Policy Statement for Energy (EN-1).
[2] Department of Energy and Climate Change (2011) National Policy Statement for Renewable Energy (EN-3)
[3] Communities and Local Government (2010) Planning Policy Statement 25: Development and Flood Risk
[4] Communities and Local Government (2009) Planning Policy Statement 25: Development and Flood Risk Practice Guide

Emerging Draft National Policy Statements

2.8. The UK Government published for consultation a suite of draft revised energy NPSs (EN-1 to EN-5) most recently in March 2023 and these emerging draft NSPs are relevant to this assessment.

2.9. Revised (Draft) Overarching National Policy Statement for Energy EN-1[5] (March 2023) ('Revised (Draft) NPS EN-1') notes that the policy on climate change adaptation in Section 4.9 applies. Paragraph 4.9.11 states:

> **'Applicants should demonstrate that proposals have a high level of climate resilience built-in from the outset and should also demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario.'**

2.10. The climate change scenarios set out in the latest Environment Agency's guidance are described in Section 3 below and require the assessment of the maximum credible climate change scenario.

2.11. Revised (Draft) EN-1 recognises the need for applications to be supported by a FRA in accordance with the guidance contained in the Planning Practice Guidance Flood Risk and Coastal Change section[6] which accompanies the National Planning Policy Framework[7] ('NPPF') and the requirement for appropriate arrangements to manage surface water including appropriate use of SuDS. It confirms that the Sequential and Exception Tests need to be satisfied for developments in accordance with the NPPF and its Guidance. In general terms with respect to flood risk, paragraph 5.8.12 states:

> **'Development should be designed to ensure there is no increase in flood risk elsewhere, accounting for the predicted impacts of climate change throughout the lifetime of the development. There should be no net loss of floodplain storage and any deflection or constriction of flood flow routes should be safely managed within the site. Mitigation measures should make as much use as possible of natural flood management techniques.'**

2.12. Revised (Draft) National Policy Statement for Renewable Energy Infrastructure (EN-3)[8] (March 2023) ('Revised (Draft) NPS EN-3') sets out policy on solar PV schemes >50 MW in England. Revised (Draft) EN-3 identifies indicative impacts of solar schemes which could require assessment by the application. With respect to flood risk and drainage, paragraphs 3.10.75 – 3.10.79 state:

> **'Where a Flood Risk Assessment has been carried out this must be submitted alongside the applicant's ES. This will need to consider the impact of drainage. As solar PV panels will drain to the existing ground, the impact will not, in general, be significant.**
>
> **Where access tracks need to be provided, permeable tracks should be used, and localised Sustainable Drainage Systems (SuDS), such as swales and infiltration trenches, should be used to control any run-off where recommended.**
>
> **Given the temporary nature of solar PV farms, sites should be configured or selected to avoid the need to impact on existing drainage systems and watercourses.**
>
> **Culverting existing watercourses/drainage ditches should be avoided.**

[5] Department for Energy Security and Net Zero (2023) Overarching NPS for Energy (EN-1)
[6] Department for Levelling Up, Housing and Communities (2022) Guidance Flood risk and coastal change. Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change (Accessed on 22.05.23).
[7] Department for Levelling Up, Housing and Communities (2021) National Planning Policy Framework. Available from: https://www.gov.uk/guidance/national-planning-policy-framework (Accessed on 22.05.23).
[8] Department for Energy Security and Net Zero (2023) National Policy Statement for Renewable Energy Infrastructure (EN-3)

Where culverting for access is unavoidable, applicants should demonstrate that no reasonable alternatives exist and where necessary it will only be in place temporarily for the construction period.'

2.13. Revised (Draft) EN-3 sets out matters that could be relevant for the Secretary of State decision making. With respect to flood risk and drainage, paragraph 3.10.145 states:

'Water management is a critical component of site design for ground mount solar plants. Where previous management of the site has involved intensive agricultural practice, solar sites can deliver significant ecosystem services value in the form of drainage, flood attenuation, natural wetland habitat, and water quality management.'

NPPF

2.14. The NPPF sets out the Government's planning policies for England and how these should be applied. Policy on planning and flood risk in the NPPF is dealt with at paragraphs 159-169 in chapter 14 'Meeting the challenge of climate change, flooding and coastal change'. Chapter 14 was first published on 27 March 2012 and last updated on 20 July 2021.

2.15. The national planning practice guidance to the NPPF was launched as a web-based resource in March 2014. The category dealing with flooding is contained in Flood Risk and Coastal Change (Reference ID: 7) and last updated on 25 August 2022.

2.16. Paragraph 159 of the NPPF states that inappropriate development in areas at risk of flooding should be avoided by directing development away from areas at highest risk (whether existing or future), but where development is necessary, the development should be made safe for its lifetime without increasing flood risk elsewhere.

2.17. Paragraph 160 states that strategic policies should be informed by a strategic flood risk assessment ('SFRA'), and should manage flood risk from all sources.

2.18. A Level 1 SFRA[9] was prepared by AECOM on behalf of the former Selby District Council (now North Yorkshire Council), in August 2022, to support the development of their new Local Plan. The SFRA provides an overview of flood risk from all sources including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

2.19. As set out in paragraph 161 of the NPPF, all plans should apply a sequential, risk-based approach to the location of development - taking into account the current and future impacts of climate change – so as to avoid, where possible, flood risk to people and property. They should do this, and manage any residual risk, by applying the sequential test and then, if necessary, the exception test.

2.20. Paragraph 162 states that the aim of the sequential test is to steer new development to areas with the lowest probability of flooding from any source. The strategic flood risk assessment will provide the basis for applying the test. The sequential approach should be used in areas known to be at risk now or in the future from any form of flooding.

2.21. Paragraph 166 identifies that where appropriate; applications should be supported by a site-specific flood-risk assessment. Footnote 55 of the NPPF states that a site-specific flood risk assessment should be provided for all development in Flood Zones 2 and 3. In Flood Zone 1, an assessment should accompany all proposals involving: sites of 1 hectare or more.

[9] AECOM (2022) Selby District Level 1 Strategic Flood Risk Assessment.

2.22. Paragraph 167 of the NPPF states:

> **'When determining any planning applications, local planning authorities should ensure flood risk is not increased elsewhere. Where appropriate, applications should be supported by a site-specific flood risk assessment. Development should only be allowed in areas at risk of flooding where, in the light of this assessment (and the sequential and exception tests, as applicable) it can be demonstrated 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) it incorporates sustainable drainage systems, unless there is clear evidence that this would be inappropriate;**
>
> **d) any residual risk can be safely managed; and**
>
> **e) safe access and escape routes are included where appropriate, as part of an agreed emergency plan.'**

Flood Zones

2.23. A copy of the Environment Agency's Flood Map for Planning, obtained from the GOV.UK website, which shows the Flood Zones in the vicinity of the Site, is reproduced as **Figure 2** below.

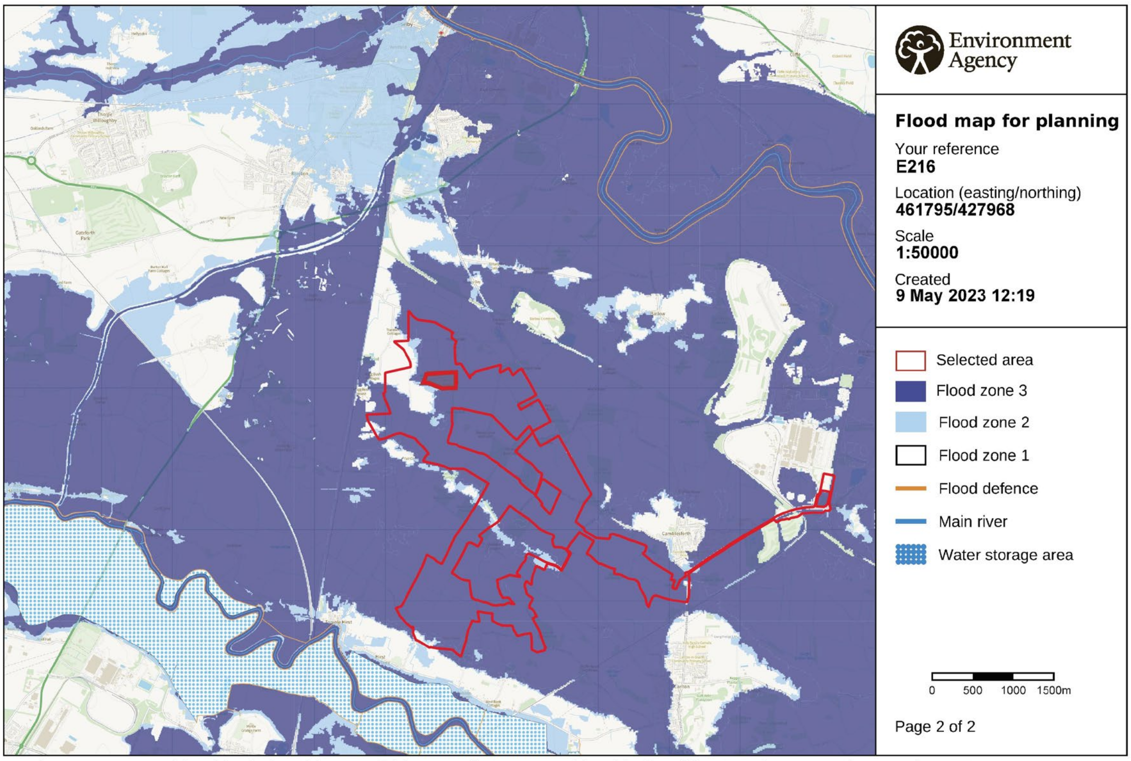

Figure 2: Flood Map for Planning

2.24. The Environment Agency's Flood Zones refer to the probability of river and sea flooding, ignoring the presence of defences, and show the extent of the natural floodplain and the additional extent of an extreme flood. The Environment Agency's Flood Map for Planning shows the area that could be affected by flooding, either from rivers or the sea, coloured dark blue corresponding to Flood Zone 3. The light blue area is Flood Zone 2 and shows the additional extent of an extreme flood from rivers or the sea. These two colours show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements. Where there is no blue shading, this shows the area where flooding from rivers and the sea is very unlikely corresponding to Flood Zone 1.

2.25. The orange lines on the Flood Map for Planning show flood defences that have been built to protect against flooding from rivers and the sea. The defences shown on the Flood Map for Planning provide different levels of flood protection and do not remove the risk of flooding and could be overtopped or fail. The effectiveness of the flood defences in protecting the Site from fluvial and tidal flooding are assessed in Section 4 below.

2.26. The red line Site boundary has been added to the Environment Agency's Flood Map for Planning on **Figure 2.** From an inspection of the Flood Map, it can be seen that the majority of the Site falls within Flood Zone 3 with smaller areas of Flood Zone 2 and Flood Zone 1.

2.27. The probability of flooding of the different flood zones is summarised below:

- Flood Zone 1 defined as land with a low probability of flooding, having a less than 0.1% (1 in 1000) annual probability of river or sea flooding.
- Flood Zone 2 Medium Probability is defined as land having between a 1% (1 in 100) and 0.1% (1 in 1000) annual probability of river flooding; or between a 0.5% (1 in 200) and 0.1% (1 in 1000) annual probability of sea flooding.
- Table 1 of the government's flood risk and coastal change guidance divides Flood Zone 3 into Zone 3a High Probability and Zone 3b The Functional Floodplain.
    - Flood Zone 3a is defined as a 'high probability' zone assessed as having a 1% (1 in 100) or greater annual probability of river flooding (>1%) in any year or having a 0.5% (1 in 200) or greater annual probability of sea flooding.
    - Flood Zone 3b is defined as where water from rivers or the sea has to flow or be stored in times of flood and is not separately distinguished from Zone 3a on the Flood Map for Planning and is identified in the SFRA.

2.28. The Level 1 SFRA defines Flood Zone 3b as the land area which would naturally flood during the 5% Annual Exceedance Probability ('AEP') (1 in 20 Return Period ('RP')) event or greater in any year and identifying land which is designed to flood (such as a flood attenuation scheme, washland or flood storage area). It should be noted that areas which would naturally flood during a 5% AEP (1 in 20 RP) event or greater but are prevented from doing so by existing infrastructure will not be defined as functional floodplain and this approach has been agreed by the Environment Agency. The extents of Flood Zone 3b on the Site are shown on Appendix A Figure 8 within the Level 1 SFRA and an extract of this mapping with the red line is reproduced in **Appendix 3**. Inspection of this mapping indicates that due to the presence of flood defences along the River Aire and River Ouse the areas of Flood Zone 3 on the Site are defined as Flood Zone 3a.

Flood Risk Assessment Planning Practice Guidance

2.29. For the purposes of applying the NPPF, paragraph 20 in the Flood Risk and Coastal Change Planning Practice Guidance advices that a site-specific flood risk assessment is carried out to assess the flood risk to and from a development site. The objectives of a site-specific flood risk assessment are to establish:

- whether a proposed development is likely to be affected by current or future flooding from any source;
- whether it will increase flood risk elsewhere;
- whether the measures proposed to deal with these effects and risks are appropriate;
- the evidence for the local planning authority to apply (if necessary) the Sequential Test, and;
- whether the development will be safe and pass the Exception Test, if applicable.

2.30. Paragraph 1 of the Guidance states "flood risk" is a combination of the probability and the potential consequences of flooding. Areas at risk of flooding are those at risk of flooding from any source, now or in the future. Sources of flood risk include rivers and the sea, direct rainfall on the ground surface, rising groundwater, overwhelmed sewers and drainage systems, reservoirs, canals and lakes and other artificial sources. Flood risk also accounts for the interactions between these different sources.

2.31. Paragraph 21 in the Guidance advises that the information provided in the flood risk assessment should be credible and fit for purpose. Site-specific flood risk assessments should be proportionate to the degree of flood risk and make optimum use of information already available, including information in a SFRA for the area, and the interactive flood risk maps. A flood risk assessment should also be appropriate to the scale, nature and location of development.

2.32. The Guidance provides a model checklist for a site-specific flood risk assessment.

2.33. With regard to what further advice is available on the preparation of a site-specific flood risk assessment, Guidance from the Department for Environment, Food & Rural Affairs ('DEFRA') and the Environment Agency, published on the Government's GOV.UK website, includes guidance on how to carry out a flood risk assessment entitled: 'Flood risk assessment in flood zones 2 and 3'[10]. This guidance provides information on the range of factors that need to be considered when assessing flood risk.

Local Planning Policy

2.34. The Proposed Development is located within the administrative area of North Yorkshire Council.

2.35. It should be noted that as of 1st April 2023, North Yorkshire County Council and seven district councils, including Selby District Council, comprise a new unitary authority known as North Yorkshire Council. Local planning policy still makes reference to the former Selby District Council.

Adopted Local Planning Policy

2.36. There are a number of adopted local plans that form the development plan for the former Selby district which include the Selby District Core Strategy Local Plan (2013)[11] and Selby District Local Plan (2005)[12].

[10] Environment Agency and Department for Environment, Food & Rural Affairs (2017) Guidance: flood risk assessment in flood zones 2 and 3. Available from: https://www.gov.uk/guidance/flood-risk-assessment-in-flood-zones-2-and-3 (accessed on 25.05.23).
[11] Selby District Council (2013) Selby District Core Strategy Local Plan
[12] Selby District Council (2005) Selby District Local Plan

2.37. The Selby District Core Strategy Local Plan was adopted in October 2013 and contains Policy SP15 'Sustainable Development and Climate Change' relevant to the Proposed Development.

2.38. Policy SP15 'Sustainable Development and Climate Change' states:

> **'A. Promoting Sustainable Development**
>
> **In preparing its Site Allocations and Development Management Local Plans, to achieve sustainable development, the Council will: …**
>
> > **d) Ensure that development in areas of flood risk is avoided wherever possible through the application of the sequential test and exception test; and ensure that where development must be located within areas of flood risk that it can be made safe without increasing flood risk elsewhere;**
> >
> > **e) Support sustainable flood management measures such as water storage areas and schemes promoted through local surface water management plans to provide protection from flooding; and biodiversity and amenity improvements. …**
>
> **B. Design and Layout of Development**
>
> **In order to ensure development contributes toward reducing carbon emissions and are resilient to the effects of climate change, schemes should where necessary or appropriate: …**
>
> > **c) Incorporate water-efficient design and sustainable drainage systems which promote groundwater recharge; … '**

2.39. The Selby District Local Plan was adopted in February 2005 and contains 'saved' policies relevant to this assessment. Policies ENV5 'Development in Flood Risk Areas', and ENV12 'River and Stream Corridors' are relevant to this assessment.

2.40. Policy ENV5 'Development in Flood Risk Areas' states:

> **'In areas with a high risk of flooding proposals for new development will only be permitted where:**
>
> > **1) Exceptionally, within functional flood plain areas, it relates to essential transport or utilities infrastructure which cannot be located in a lower risk area, and which is designed to remain operational even in times of flood.**
> >
> > **2) Within or adjacent to existing settlements, an appropriate standard of flood defence can be maintained or provided for the lifetime of the development, and proposals incorporate appropriate flood management and mitigation measures, including flood resistant construction, the provision of flood warning and evacuation procedures, laying out development to ensure that non-critical area flood first, and the incorporation of sustainable urban drainage systems.**
> >
> > **3) Elsewhere within undeveloped flood plains, proposals relate to agriculture, essential transport and utilities infrastructure, job related residential accommodation, or exceptionally, non-residential development with particular locational requirements for which an alternative lower risk location is not**

available, and for which associated compensatory flood storage measures are provided.

Development proposals which impede the functional flood plain and flood flows, adversely affect the stability and continuity of or access to flood defences, or which materially increase the risk of flooding elsewhere will not be permitted.

All proposals in areas subject to a risk of flooding must be accompanied by a flood risk assessment appropriate to the scale and nature of the development, prepared in consultation with the Environment Agency.'

2.41. Policy ENV12 'River and Stream Corridors' states:

'Proposals for development likely to harm the natural features of or access to river, stream and canal corridors will not be permitted unless the importance of the development outweighs these interests, and adequate compensatory measures are provided.'

Emerging Local Planning Policy

2.42. A new Selby Local Plan[13] is currently being prepared. The latest stage of the process the publication of a proposed submission documents for public consultation which was concluded in October 2022. It is anticipated that a formal submission of the new local plan will be made to the Secretary of State for independent examination in 2023 with adoption of the new Local Plan anticipated for 2024. The Local Plan publication version consultation 2022 contains emerging Policy SG9 'Design', Policy SG11 'Flood Risk' relevant to this assessment.

2.43. Emerging Policy SG9 'Design' states:

'… B. Development should where appropriate seek to: …

9. Incorporate multi-functional green infrastructure within sites to provide carbon storage and Sustainable Drainage Systems (SuDS); …'

2.44. Emerging Policy SG11 'Flood Risk' states:

'A. To enable communities to manage, be resilient and adapt to flood risk, development will only be supported where it can be demonstrated that:

1. The site falls within areas of lowest flood risk as set out in the most up-to-date Environment Agency flood risk maps and/ or Selby District's Strategic Flood Risk Assessment (SFRA) maps;

2. The site has been passed through a Sequential Test as set out in the National Planning Policy Framework (minus any exempt development); or

3. Where there are no sequentially preferable sites, the site has been assessed through the application of the Exception Test as set out in the National Planning Policy Framework (except any exempt development);

4. The proposal does not increase the risk of flooding off-site; and

[13] Selby District Council (2022) Local Plan Publication Version Consultation 2022.

5. In Flood Zone 3b (functional floodplain) essential infrastructure that has to be there and has passed the Exception Test, and water-compatible uses, should be designed and constructed to:

i. remain operational and safe for users in times of flood;

ii. result in no net loss of floodplain storage;

iii. not impede water flows and not increase flood risk elsewhere.

B. If a site has passed the Sequential and Exception Tests the following criteria will need to be applied where viable and feasible to make it acceptable in detail:

1. Where the development is located in areas of flood risk such as Flood Zone 2 (or higher) and does not constitute minor development or a change of use the development layout within the site will be subject to the sequential approach, with the highest vulnerability development located in areas at lowest flood risk within the site;

2. Relevant flood resilience construction methods identified through an up to date site-specific Flood Risk Assessment (FRA) should be implemented to reduce the impact and likelihood of a flood event;

3. Where the development has existing trees, woodland and/or hedgerows these should be retained where the risk of flooding from surface water has been identified and it is possible, and if not retained the developer must agree a tree planting scheme in line with Policy NE6 where determined to be the best option to help reduce identified flood risk from surface water;

4. The features that manage surface water are commensurate with the design of the development in terms of size, form and materials and make a positive contribution to reducing flood risk. More specific development control guidance should incorporate comments from the Lead Local Flood Authority;

5. Sustainable Drainage Systems (SuDS) where appropriate are incorporated in accordance with the National Planning Policy Framework and the non-statutory technical standards, but taking advice from those organisations that provide input through the planning process including the Lead Local Flood Authority, and in relevant areas the Internal Drainage Boards;

6. Hard surfaces on developments should be permeable where practicable in line with highways guidance from the Local Highways Authority unless proven not to be possible by site investigation;

7. Watercourses are not culverted and any opportunity to remove culverts is taken. We also encourage that developments are suitably located away from watercourses (including culverts). This helps to ensure ongoing maintenance, inspections can be undertaken; and also any future repairs / replacement / improvement opportunities are not limited by development being located too close to those watercourses;

8. All developments planning work in, on, under or near ordinary watercourses (including piped ordinary watercourses), or discharging surface water into a

watercourse within the defined Drainage District require consent from the Internal Drainage Board and need to have regard to all relevant byelaws;

9. In terms of mitigation, sites should follow the relevant guidance detailed within the Strategic Flood Risk Assessment(s), including:

i. Setting of finished floor levels;
ii. Management of residual depths, hazards, etc.;
iii. Consideration to the design flood event;
iv. Access and egress requirements.

10. In some developments (for example, commercial/industrial), raising floor levels may not be possible due to operational requirements. In these instances alternative measures should be considered and agreed with the Environment Agency before implementation.

C. Where required by the National Planning Policy Framework (NPPF) and set out in Planning Practice Guidance, proposals for development should be accompanied by a site-specific Flood Risk Assessment (FRA). The need for a FRA is described in the NPPF, however Footnote 50 of the NPPF also refers to the need for the SFRA to provide guiding details for sites where a FRA will be necessary; and not just relying on the Environment Agency flood zones.

D. Development allocated will not be subject to the Sequential/Exception Tests identified in part A as it is already been determined through the Local Plan process that they have passed the Sequential Test.'

Summary of Scope

2.45. The scope of this Flood Risk Assessment is therefore to provide sufficient information to satisfy the relevant requirements of the designated and emerging NPSs, the NPPF and its associated guidance, local planning policy and guidance from the Department for Environment, Food & Rural Affairs and Environment Agency.

3. DEVELOPMENT SITE CONTEXT

The Development Proposals

3.1. The Proposed Development comprises the proposed construction, operation, maintenance and decommissioning of a renewable energy project. The full description of the Proposed Development is set out in Chapter 3 Site and Development Description of the PEIR.

3.2. Arrays of solar PV panels would be situated in rows running on a north to south axis with an approximate 3m – 4m separation between lines of panels. The technology utilised would change the angle of the solar PV panels along a central axis by approximately 60° degrees from the horizontal to track the movement of the sun and maximise energy generation potential. The rows of solar PV panels are separated by a horizontal 'rainwater' gaps. These gaps and movement of the panels allows rainwater to drain freely to the ground beneath and between the solar PV panels, replicating the existing greenfield scenario. The lower edge of the panels would be approximately 1.0m above ground level at the maximum rotation. Grass would continue to grow underneath the panels and between rows which would continue to delay surface water runoff and prevent soil erosion. **Figure 3** shows a typical cross section of the proposed solar array.

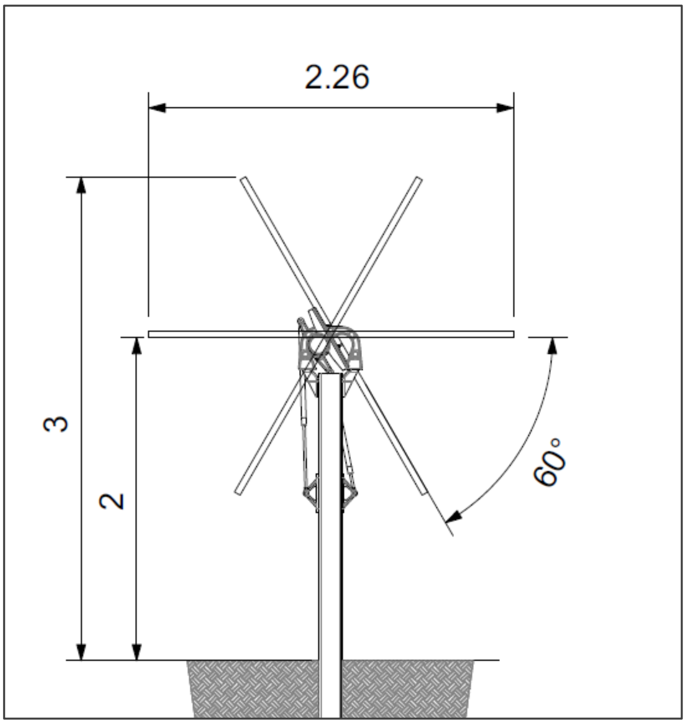

Figure 3: Rotational Solar Panel (Extract from Drawing No. DX-01-P03)

3.3. The supporting frames have a minimal cross-sectional area and would be 'pile driven' or 'screw anchored' into the ground to a typical depth of 1.5-2.5m below ground level, depending on ground condition surveys to be completed prior to construction activities commencing.

3.4. The piling for the solar PV arrays has the potential to damage historical agricultural land drains and detailed site design should take their presence into account and/or the land drains should be reinstated on decommissioning of the development (unless agreed otherwise with the landowner).

3.5. Archaeologically sensitive areas are identified on the Site and to mitigate disturbance of below ground features alternative foundation types are to be used in these areas. Concrete ballast foundations (2.5m x 0.5m) are proposed at these discrete locations.

3.6. String inverter boxes for combining multiple strings of solar PV panels would be located underneath or adjacent to the tracker structures and elevated above ground level.

3.7. The Proposed Development does not involve any change in ground levels other than the provision of earth flood defence bunds and associated compensatory floodplain storage discussed in Section 4 and the provision of interception swales discussed in Section 5 of this report.

3.8. The majority of the Site would be converted to permanent pasture underneath the solar panels.

3.9. Any access tracks would be formed using semi permeable materials (open graded stone) so as to avoid creating impermeable areas across the Site.

3.10. Ancillary equipment would be contained in small buildings, typically container units distributed across the Site. Ancillary equipment includes Inverter Cabinets which contain an Inverter, Transformers and associated switch gear, a separate Control Room, and a Sub-substation. Due to their small size and remote rural locations, it is proposed that roof water from these buildings would discharge directly onto the surrounding ground. Minimum floor levels for buildings and all sensitive control equipment on the Site would be set at least 300mm above ground level to prevent the ingress of water.

3.11. The proposals also include provisions for energy storage, such as batteries, to reinforce the power generation of the solar PV panels. The BESS facility comprises shipping containers or similar, with each unit measuring approx. 12m x 2.4m x 2.9m on supports above a 300mm deep gravel sub-base within a defined energy storage area.

3.12. Electrical cabling is required to connect the rows of solar PV panels to the inverters / transformers and to the sub-station and the grid connection. These cables would be installed underground in trenches and ducts. The dimensions of the trenches will vary depending on the amount of cabling they contain and would be typically up to a depth of 1.5m. The cable routes are below ground and due to their nature would be waterproofed and resistant to all sources of flooding. The below ground cabling has minimal flood risk or drainage implications.

3.13. Cable trenches have the potential to act as land drains and convey any water falling on the Site which infiltrates into the ground to the lower parts of the Site (particularly on sloping sites). To prevent this occurring, clay 'stanks' should be provided at intervals within the cable trenches. The entry point of any cable or ducting into chambers should also be sealed to prevent water ingress.

3.14. The Proposed Development includes an on-Site Substation and grid connection cabling with a maximum voltage of 132 kilovolts ('kV'). The 132kV Substation compound would be crushed stone which is considered to be permeable.

3.15. Any electrical plant which contains oil would be designed to be suitably bunded in accordance with the Control of Pollution (Oil Storage) (England) Regulations 2001 and the Environment Agency and Department for Environment, Food & Rural Affairs guidance entitled 'Oil storage regulations for businesses'[14].

[14] Environment Agency (2023) Oil storage regulations for businesses. Available from: https://www.gov.uk/guidance/storing-oil-at-a-home-or-business (Accessed on 25.05.23).

Site Description

Onsite Watercourses and Existing Drainage Arrangements

3.16. The Ordnance Survey map of the area shows geographical features including watercourses and other bodies of water.

3.17. The Site lies predominately within the catchment of the River Aire. The River Aire runs to the south of the Site to the south of Hirst Road and the villages of Temple Hirst and Hirst Courtney and flows predominately from west to east. At its closest point, the River Aire is located approximately 700m south of the area of the Site where solar panels and associated infrastructure is proposed (the 'Solar Farm Zone'). The River Aire is a tributary of the River Ouse and flows into the River Ouse approximately 7.5km to the east of the Solar Farm Zone.

3.18. The northern part of the Solar Farm Zone (to the north of Fair Oaks) lies within the wider catchment of the River Ouse. At its closest point, the River Ouse is located approximately 2.2km northeast of the Solar Farm Zone and flows predominately from the north west to the south east.

3.19. Due to the Site's position in the lower catchment of the River Ouse, there are a number of tributaries in the vicinity of the Site that are relevant to this assessment. The River Derwent joins the River Ouse approximately 4.5km to the north east of the Solar Farm Zone and to the north east of Drax Power Station. The Dutch River flows into the River Ouse to the south of Goole approximately 10.4km to the south east of the Solar Farm Zone. The last major tributary of the River Ouse in the vicinity of the Site is the River Trent, which flows into the river approximately 21.6km to the south east of the Solar Farm Zone. At this location, the River Ouse becomes the River Humber/ Humber Estuary and flows into the North Sea.

3.20. The River Aire and River Ouse are tidally influenced in the vicinity of the Site. The River Ouse tidal limit is located at Naburn Weir significantly upstream of the Site and the River Aire tidal limit is the lock and weir at Chapel Haddlesey, west of the Site.

3.21. The River Ouse, River Aire, River Derwent, Dutch River, and River Trent are all classified as 'Main Rivers'.

3.22. Numerous drainage ditches cross the Site which drain ultimately into the River Aire or River Ouse. The drainage ditches are located within the boundary of the existing fields and are classified as 'ordinary watercourses'.

3.23. The Site falls within the area administered by the Selby Area Internal Drainage Board ('IDB'). The Selby Area IDB's purpose is to manage water levels within the low-lying catchments of the River Aire and River Ouse with the aim of protecting people and their property. A number of the 'ordinary watercourses' which cross the Site are managed by the IDB and their byelaws apply, controlling activities along these watercourses. The locations of these watercourses are shown on **Figure 4** below. The ordinary watercourses drain into the River Aire and River Ouse via a gravity outfalls or pumping stations.

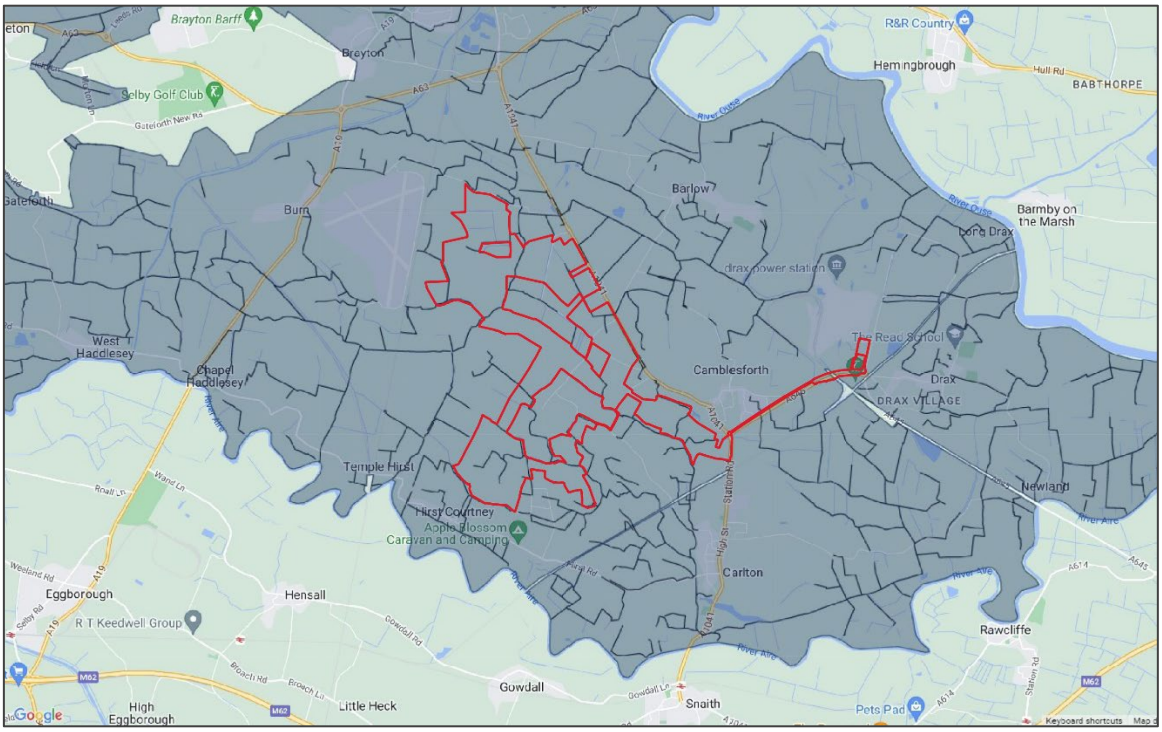

Figure 4: Extent of Selby Area IDB Area and managed Ordinary Watercourses (extract from Selby Area IDB website[15])

3.24. The existing surface water drainage arrangements, including locations of watercourses, are indicated on Drawing No. E216/107-127 copies of which are included in **Appendix 4**. Potential existing overland flow routes have been identified based on the Site's topography.

3.25. The geophysical survey has identified extensive agricultural land drains through large parts of the Solar Farm Zone. These systems are likely to consist of mole drains or tile drains (clay or plastic perforated pipes) installed to improve the agricultural quality of the land and reduce waterlogging.

3.26. Currently the Site naturally drains by a combination of overland flow towards the low points and the ordinary watercourses / drainage ditches which cross the Site and infiltration into the underlying ground.

Site Levels

3.27. The topography across the Solar Farm Zone is relatively flat and low lying. Site levels range between approximately 3.0m Above Ordnance Datum ('AOD') to 6m AOD. The western area of the Solar Farm Zone and along the southernmost boundary are at the highest elevation and levels fall predominately towards the northeast boundary. The lowest part of the Solar Farm Zone is the easternmost area. The general elevation across the Site is presented on **Figure 5** below.

[15] Selby Area IDB (2023) Selby Area IDB. Available from: https://www.shiregroup-idbs.gov.uk/idbs/selby/ (Accessed on 25.05.23).

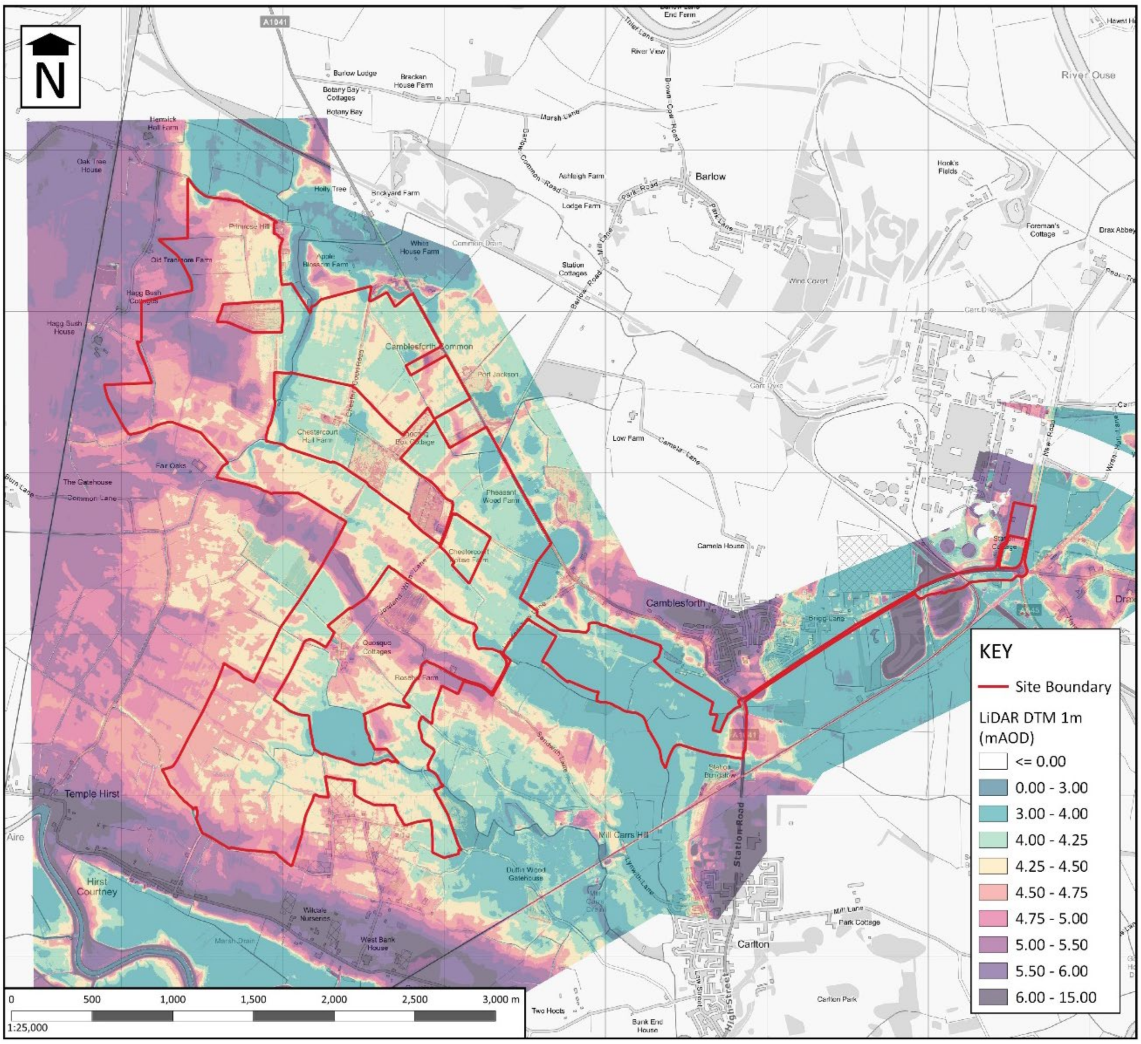

Figure 5: LiDAR

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3.28. The gradient across the Solar Farm Zone varies and typically ranges between 1 in 100 to 1 in 150. The area with the steepest gradients is located in the north western area and along the southern boundary; gradients typically range between 1 in 20 and 1 in 50. The area with the shallowest gradients is located in the eastern area where gradients are typically 1 in 200.

3.29. A copy of the Topographical Survey, conducted by Above Surveying Ltd. in May 2022. Drawing reference: 'Drax Linework ("CAD") Rev 1.0' is reproduced in **Appendix 5**.

Ground Conditions

3.30. The British Geological Survey© NERC (2023) online geological mapping[16] indicates that the Site is wholly underlain by Sherwood Sandstone Group (Sandstone) bedrock.

[16] British Geological Survey (2023) Geology Viewer. Available from: geologyviewer.bgs.ac.uk. (Accessed on 25.05.23)

3.31. Superficial deposits are present across the Site and are shown on **Figure 6** below. Hemingbrough Glaciolacustrine Formation (clay, silty) deposits are found towards the south-western and eastern parts of the Solar Farm Zone. Breighton Sand Formation (sand) deposits are found through the central and northern areas of the Solar Farm Zone. Small isolated areas of Alluvium (clay, silt, sand and gravel) deposits are present along watercourse corridors bisecting the northern and southern areas of the Solar Farm Zone where solar PV panels and associated infrastructure is proposed.

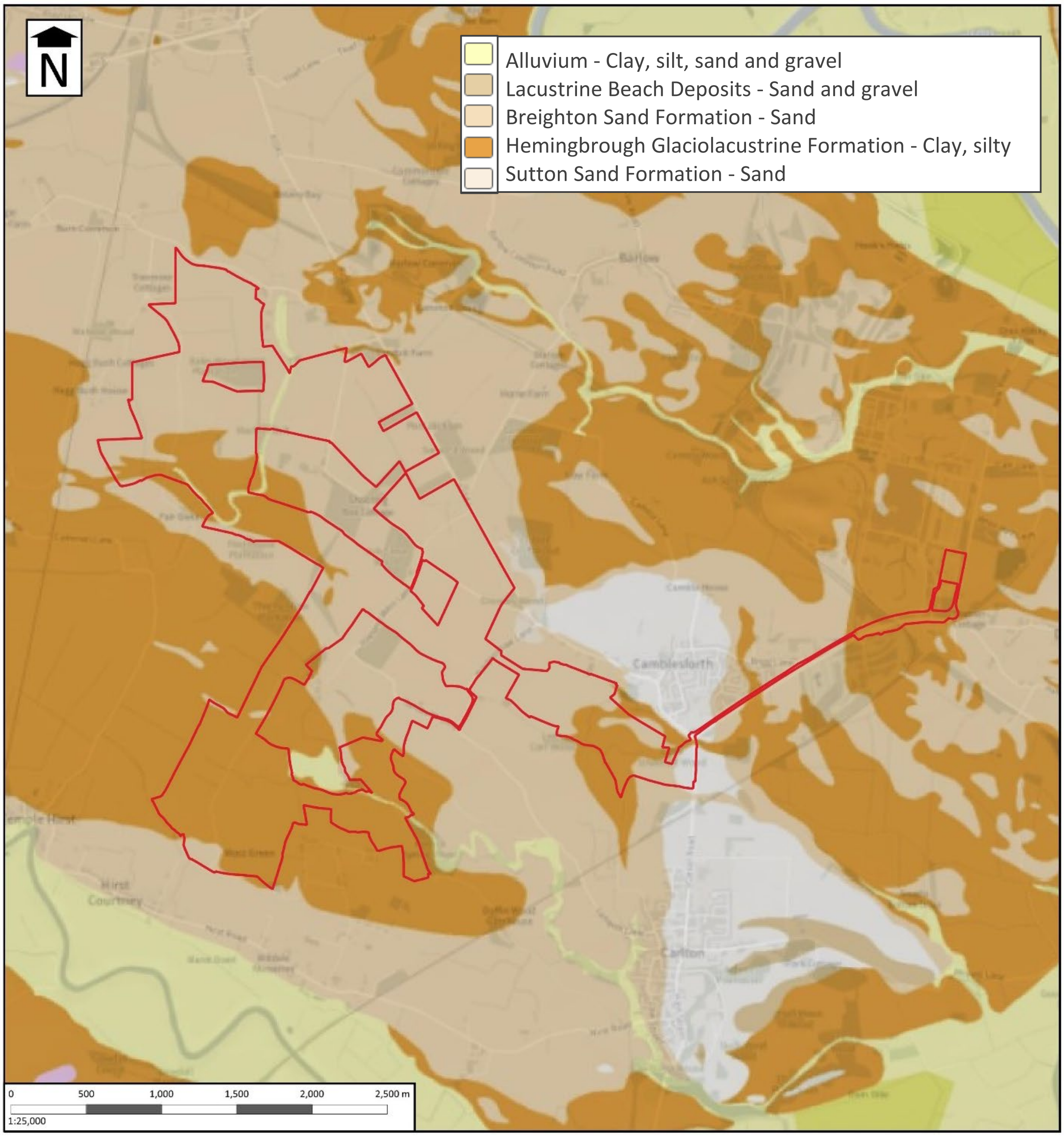

Figure 6: Superficial Deposits
Contains British Geological Survey materials ©NERC [2023]

3.32. From an inspection of the Environment Agency's Aquifer Designation Map dataset held on Natural England's MAGIC website[17] the Site's Sherwood Sandstone Group (Sandstone) bedrock is classified

[17] Natural England (2023) MAGIC Map. Available from: https://magic.defra.gov.uk/MagicMap.aspx (accessed on 25.05.23)

as a Principal Aquifer. The extent of bedrock aquifers in the vicinity of the Site is shown on **Figure 7** below. A 'Principal' Aquifer is classified as layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

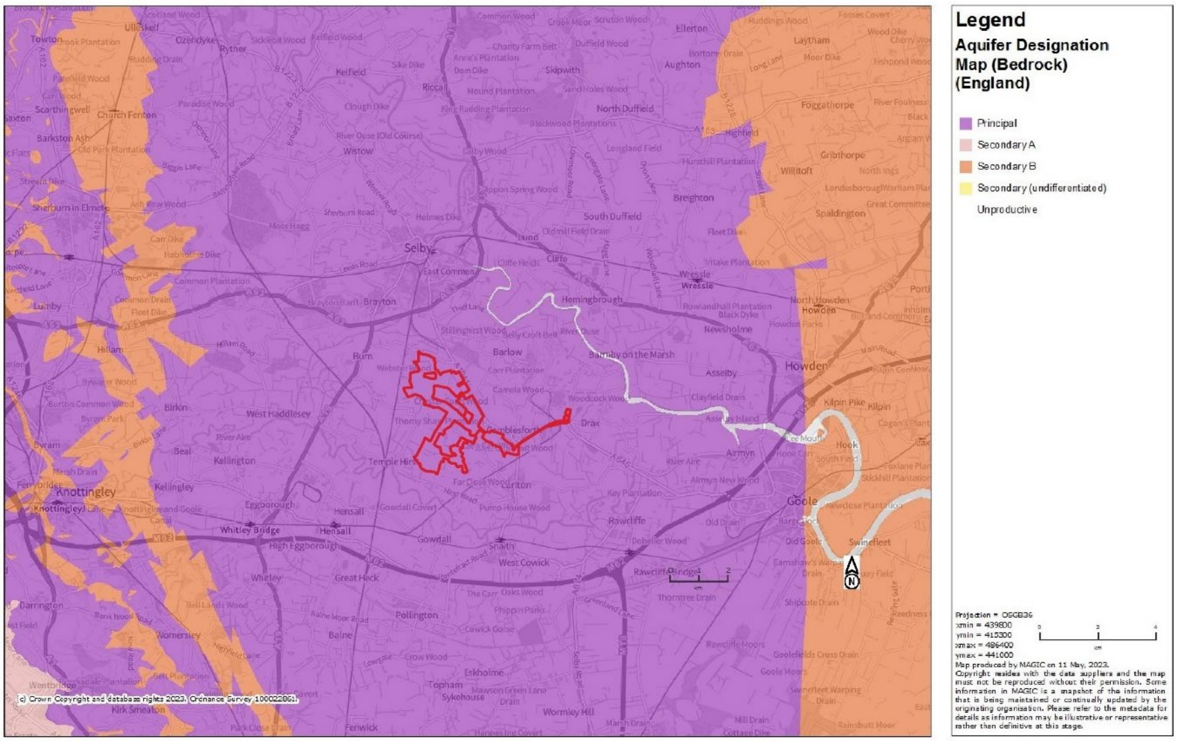

Figure 7: Environment Agency's Aquifer Designation Map (Bedrock)

3.33. The Breighton Sand Formation (sand) superficial deposits are classified as a Secondary A aquifer. A 'Secondary A' Aquifer is classified as 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. The other superficial deposits are classified as unproductive strata. The extent of superficial aquifers in the vicinity of the Site is shown on **Figure 8** below.

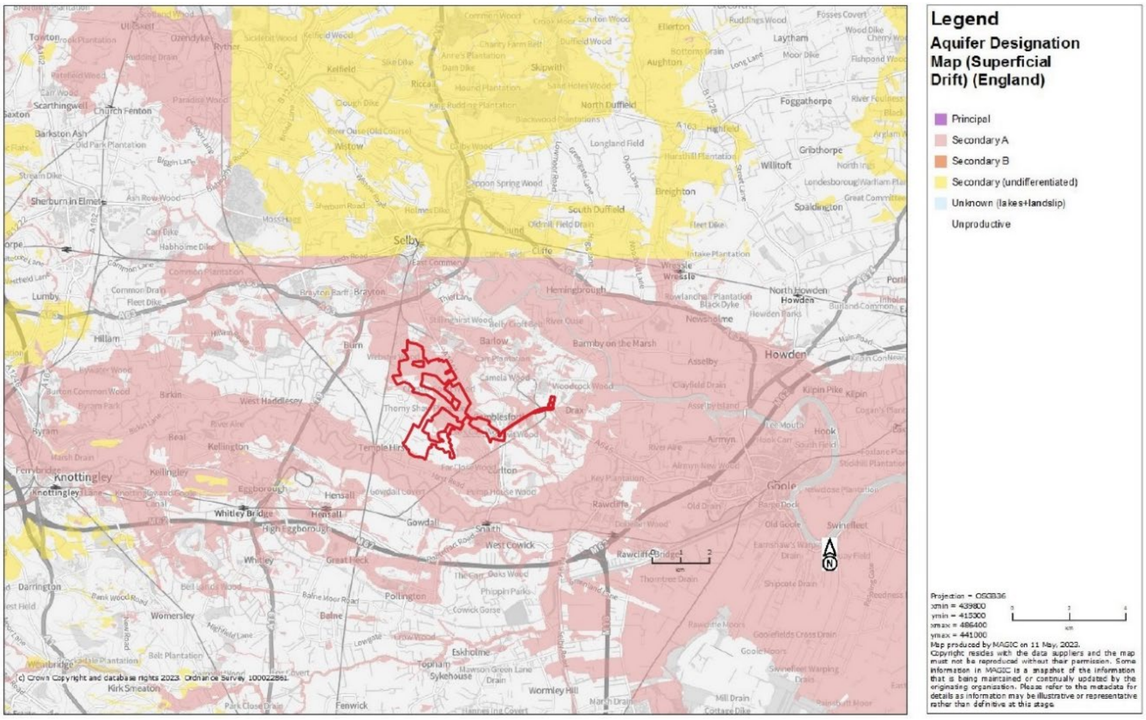

Figure 8: Environment Agency's Aquifer Designation Map (Superficial Drift)

3.34. Based on the Flood Studies Report ('FSR') Winter Rainfall Acceptance Potential ('WRAP') Map, as shown on Drawing No. E216/82 reproduced in **Appendix 6**, the Site is located in a 'Soil Index Class 2' area. Soil Index Class 2 has the second highest Winter Rainfall Acceptance Potential and therefore the second lowest standard percentage runoff. This suggests the underlying soil has relatively good permeability.

3.35. The Cranfield Soil and AgriFood Institute ('CSAI'), incorporating the National Soil Resources Institute (NSRI,) at Cranfield University maintains soil reports and maps for England and Wales. The Soilscapes dataset map[18] is shown on **Figure 9** below and is reproduced from the MAGIC website. Inspection of **Figure 9** indicates that soils in the central and northern area of the Solar Farm Zone are classified as 'Naturally wet very acid sandy and loamy soils' and are described as naturally wet. Naturally wet soils are permeable soils in low lying areas often affected by high ground water that has drained from the surrounding landscape. The central and southern area of the Solar Farm Zone is underlain by soils described as 'Loamy soils with naturally high groundwater' and are naturally wet.

3.36. A small band of 'Freely draining slightly acid loamy soils' is present running along the southern edge of the Site near the village of Hirst Courtney. Freely draining soils absorb rainfall readily and allow it to drain through to underlying layers. The easternmost area of the Solar Farm Zone is underlain by 'Freely draining slightly acid sandy soils'.

3.37. The area of the Underground Cable Corridor in the vicinity of Drax Power Station crosses areas underlain by 'Slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils' which are described as having impeded drainage. Soils with impeded drainage refer to soils with a tight, compact deep subsoil that impedes downward water movement; after heavy rainfall, particularly during the winter, the subsoil becomes waterlogged and can result in very wet ground conditions.

[18] Cranfield University (2023) Soilscapes Map. Available from: https://www.landis.org.uk/soilscapes/ (accessed on 25.05.23).

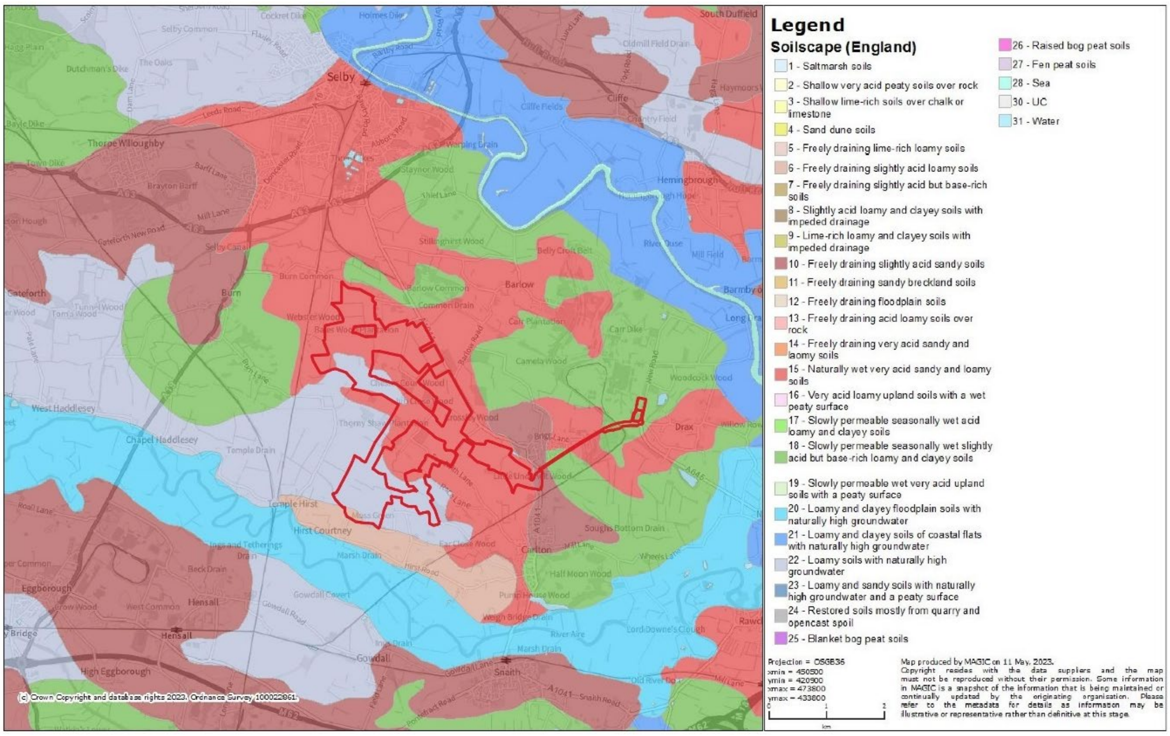

Figure 9: Soilscapes Dataset

3.38. Based on the available information the underlying ground conditions appear to have variable permeability. However, due to the low-lying nature of the Site and presence of superficial and principal aquifers high groundwater is likely to be present.

Groundwater Source Protection

3.39. From an inspection of the Environment Agency's Source Protection Zones dataset the Site lies within a Groundwater Source Protection Zone. A copy of the Environment Agency's Groundwater Source Protection Zone Map is reproduced in **Figure 10** below.

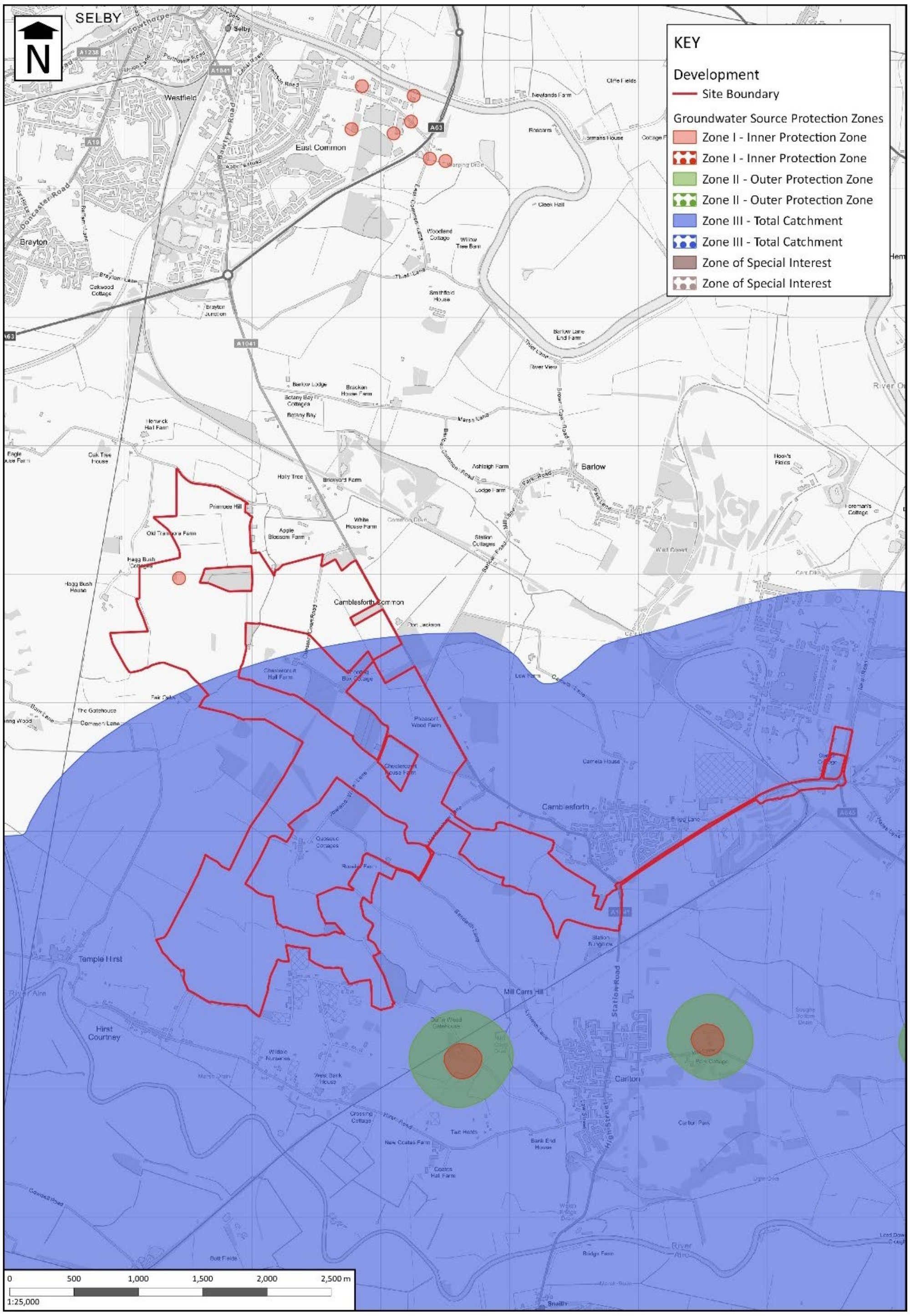

Figure 10: Groundwater Source Protection Zone

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3.40. The southern, central and western areas of the Solar Farm Zone and areas of the Underground Cable Corridor fall within a Groundwater Source Protection Zone – Zone III Total Catchment ('SPZ3'). The northern area of the Solar Farm Zone falls predominately outside of a Groundwater Source Protection Zone. However, a small isolated Groundwater Source Protection Zone – Zone I Inner Protection Zone ('SPZ1') is present in the northern area of the Solar Farm Zone approximately 100m to the west of Bales Wood and approximately 400m to the east of Hagg Bush Cottages.

3.41. The inner zone – SPZ1 is defined as the zone with a 50 day travel time of pollutant to source and have a 50m default minimum radius. Whereas the total catchment – SPZ3 is defined as the area around a supply source within which all the groundwater ends up at the abstraction point.

3.42. The Environment Agency's Groundwater Vulnerability Maps dataset is held on Natural England's MAGIC website and reproduced as **Figure 11** below. The dataset shows the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within 1km^2. Inspection of this dataset shows areas of 'medium-high' vulnerability are present associated with the area of Breighton Sand Formation (sand) superficial deposits. Areas of 'low' vulnerability are associated with the Hemingbrough Glaciolacustrine Formation (clay, silty) superficial deposits which would act as barrier to the bedrock aquifer below. The Underground Cable Corridor crosses areas of 'medium-high', 'medium', 'medium-low' and 'low' vulnerability.

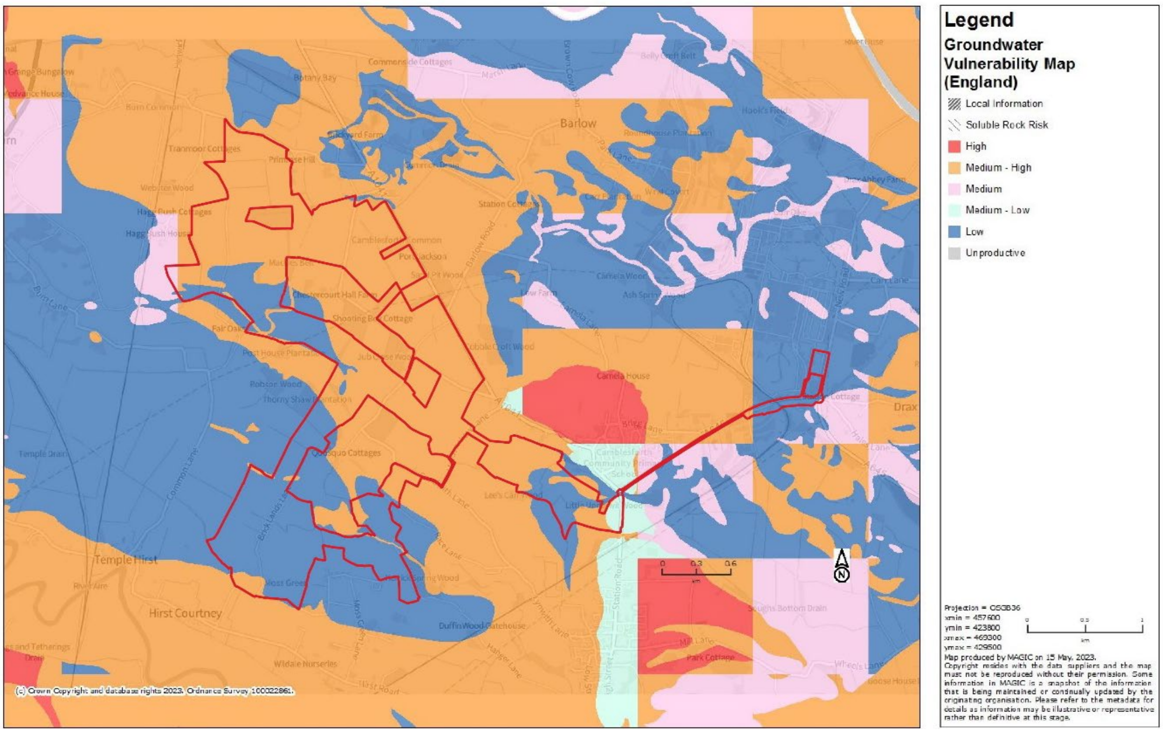

Figure 11: Groundwater Vulnerability Map

3.43. The 'Environment Agency Approach to Groundwater Protection' (February 2018) offers guidance on designing an appropriate surface water discharge system within a source protection zone. The relevant section of this document is Section G: 'Discharge of Liquid effluents into the ground' which applies to sewage effluent, surface water run-off, and industrial effluent and waste waters.

3.44. It should be noted that no discharge of sewage effluent or trade effluent is proposed as part of the Proposed Development. No deep excavation (>3m) is anticipated on the Proposed Development which could create a pathway to groundwater.

3.45. Rainwater falling on solar PV panels or associated control equipment will be clean and remain uncontaminated by the presence of the solar farm. As such, position statements G12 and G13 apply. The approach to surface water management is set out in Section 5 below.

3.46. The detailed site design would ensure that no fluid filled cables pass through the small area of SPZ1 on the Site. Position statement C5 refers to fluid filled cables in SPZ1 and SPZ2. The areas of the Site where high voltage fluid filled cables could be used would be classified as SPZ3 and therefore acceptable in this location subject to standard pollution control measures.

3.47. It is recognised that a risk of spillages during the construction and decommissioning phases of the Proposed Development could occur. However, these are sufficiently mitigated through the application of construction best practice guidance and good site management secured through the Construction Environmental Management Plan ('CEMP').

3.48. Due to the nature of the Proposed Development, measures proposed in the CEMP and detailed site design, it is considered that no new pathways would be created for pollutants to groundwater during the operation, construction or decommissioning of the Proposed Development. The Proposed Development would not pose a risk to groundwater resources and groundwater quality and complies with the terms of the Environment Agency's Groundwater Protection Policy.

Climate Change Allowances

3.49. The NPPF and its guidance requires development to take account of the impacts of climate change. The allowances to be made for climate change effects when assessing flood risk are related to the lifetime of the development.

3.50. Guidance on the lifetime of development is provided at paragraph 6 in the Flood Risk and Coastal Change Planning Practice Guidance. The lifetime of a non-residential development depends on the characteristics of that development.

3.51. The modelled operational lifespan of the Proposed Development is up to 40 years, after which the infrastructure would be removed, and the Site returned to agricultural use.

3.52. For the purposes of this assessment, it is presumed that a decision will be made in 2025, procurement and construction will be concluded by 2028 and the 40 year operational lifespan will run to 2068 with decommissioning anticipated to be concluded by 2069/70.

3.53. Under heading 4 in the Site-Specific Flood Risk Assessment Checklist in the Flood Risk and Coastal Change Planning Practice Guidance, it asks how is flood risk at the Site likely to be affected by climate change and states that further advice on how to take account of climate change in flood risk assessments is available from the Environment Agency. Guidance published by the Environment Agency, entitled 'Flood risk assessments: climate change allowances'[19], sets out the climate change allowances to be used for peak river flow, peak rainfall intensity, sea level rise, offshore wind speed and extreme wave height. This guidance was last updated on 27 May 2022.

3.54. There are a range of climate change allowances for each river basin district and epoch for sea level rise which are expressed as percentiles. A percentile describes the proportion of possible scenarios that fall below an allowance level. The higher central allowance is based on the 70th percentile (only 30% of projections would exceed this allowance) whereas the upper end allowance is based on the 95th percentile (only 5% of projections would exceed this allowance).

Maximum Credible Climate Change Scenario

3.55. The Environment Agency climate change guidance states:

> **'if you develop NSIPs you may need to assess the flood risk from a credible maximum climate change scenario. Check the relevant national policy statement.'**

3.56. NPS EN-1 identifies that safety critical elements require assessment of the high emissions scenario.

3.57. Whereas the Revised (Draft) NPS EN-1 notes identifies the need to demonstrate how proposals can be adapted over their predicted lifetimes to remain resilient to a credible maximum climate change scenario.

3.58. The purpose of the assessment of the credible maximum climate change scenario is to understand the sensitivity of the proposed development and inform the approach to climate change adaptation over its lifetime; the Environment Agency recommends an 'adaptative approach' to allow for additional or revised mitigation measures over the lifetime of the development.

Peak River Flow Allowance

3.59. Peak river flow allowances are based on management catchments rather than river basin districts, and the appropriate allowance to use depends on the flood zone and the flood risk vulnerability classification of the development.

3.60. The higher central allowance should be used for essential infrastructure in Flood Zone 3a. The 2050s epoch covers the period 2040 to 2069 which is the design life of the development.

3.61. The Site lies across two management catchments, the Aire and Calder Management Catchment to the south and the Wharfe and Lower Ouse Management Catchment to the north. The proposed change of use falls into the 'Essential Infrastructure' flood risk vulnerability classification. Based on the flood zone and flood risk vulnerability classification of the Proposed Development, the higher central allowance needs to be used when assessing peak river flows.

3.62. The high central allowance should be used to assess safe access, escape routes and places of refuge; off-site impacts; and calculate floodplain storage compensation for essential infrastructure.

[19] Environment Agency (2022) Guidance: Flood risk assessments: climate change allowances. Available from: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances (accessed on 25.05.23).

3.63. The upper end allowance should be used when assessing the 'credible maximum scenario' sensitivity test (as discussed above).

3.64. **Table A** below summarises the different peak river flow allowances for the different Management Catchments.

Table A: Summary of Peak River Flow Allowances

Management Catchment	Higher Central 'Design Flood'	Upper End 'Sensitivity Test'
	2050s Epoch	2050s Epoch
Wharfe and Lower Ouse (Northern area of the Site)	18%	29%
Aire and Calder (Southern area of the Site)	18%	31%

Note: 2050s Epoch = 2040-2069

Peak Rainfall Intensity Allowances

3.65. With respect to the peak rainfall intensity allowance, once again the Site lies across the two management catchments; the Aire and Calder Management Catchment to the south and the Wharfe and Lower Ouse Management Catchment to the north.

3.66. The guidance states:

> **'For flood risk assessments and strategic flood risk assessments assess the upper end allowances. You must do this for both the 1% and 3.3% annual exceedance probability events for the 2070s epoch (2061 to 2125).**
>
> **Design your development so that for the upper end allowance in the 1% annual exceedance probability event:**
>
> - **there is no increase in flood risk elsewhere**
> - **your development will be safe from surface water flooding'**

3.67. The guidance states:

> **'For development with a lifetime between 2061 and 2100 take the same approach but use the central allowance for the 2070s epoch (2061 to 2125).'**

3.68. The total potential change anticipated for 2070s epoch (2061 to 2125) is +30% for the central allowance in the 1% AEP rainfall event in both management catchments.

Sea Level Allowances

3.69. For sea level allowances, Table 1 of 'Flood risk assessments: climate change allowances' gives a range of allowances for each river basin district and epoch for sea level rise. Table 2 gives the offshore wind speed and extreme wave height allowances.

3.70. The Site lies within the Humber river basin district and as such the 'Humber' sea level rise allowances apply. For flood risk assessments, it is necessary to assess both the higher central and upper end allowances. Table 1 of the guidance is replicated below as **Table B**.

Table B: Sea Level Allowances for Humber River Basin District for each epoch in mm for each year (based on a 1981 to 2000 baseline) – the total sea level rise for each epoch is in brackets

Area of England	Allowance	2000 to 2035 (mm)	2036 to 2065 (mm)	2066 to 2095 (mm)	2096 to 2125 (mm)	Cumulative rise 2000 to 2125 (metres)
Humber	Higher central	5.5 (193)	8.4 (252)	11.1 (333)	12.4 (372)	1.15
Humber	Upper end	6.7 (235)	11.0 (330)	15.3 (459)	17.6 (528)	1.55

3.71. The cumulative rise from 2000 to the end of 2070 will be between +0.501m (Higher Central) and +0.642m (Upper end) which covers the 40 year modelled operational lifespan of the Proposed Development.

3.72. The guidance states that where it is appropriate to apply a credible maximum scenario, use the H++ allowance. For the change to relative mean sea level use the H++ scenario of 1.9m for the total sea level rise to 2100. The H++ scenario is derived from UKCP09 and the UKCP18 Factsheet: Sea level rise and storm surge[20] co-published by the Environment Agency in 2018 notes the H++ scenario is still a reasonable plausible high-end scenario based on our current interpretation of the evidence. The Environment Agency's guidance entitled 'adapting to climate change: advice for flood and coastal erosion risk management authorities'[21] (dated 2016) reproduces H++ scenario sea level rise allowances based on UKCP09. This information (Table 5) is reproduced in **Table C** below.

Table C: H++ Scenario Sea Level Allowance (compared to 1990 baseline, includes land movements)

Change to relative mean sea level	Sea level rise (mm/yr)				
	1990 to 2025	2026 to 2050	2051 to 2080	2081 to 2125	Cumulative rise 1990 to 2100 (metres)
H++ scenario	6	12.5	24	33	1.9

3.73. Based on **Table C** above the H++ Scenario sea level allowance up to 2070 would be +1002.5mm / +1.0m compared with 1990 levels.

3.74. The EA guidance also covers offshore wind speed and extreme wave height. Wave heights may change because of increased water depths and changes to the frequency, duration and severity of storms. The guidance states:

> **'If your development lifetime is beyond 2056, use the allowance for the 2056 to 2125 epoch. The allowances are not cumulative across the epochs.'**
>
> **'Use the sensitivity test allowances in addition to the offshore wind speed and extreme wave height allowances for assessments where it is appropriate to apply a credible maximum scenario.'**

[20] Met Office, Environment Agency, DEFRA & DBEIS (2018) UKCP18 Factsheet: Sea level rise and storm surge.
[21] Environment Agency (2016) Adapting to climate change: advice for flood and coastal erosion risk management authorities.

3.75. The offshore wind speed and extreme wave height allowance allowances are summarised in **Table D** below.

Table D: Offshore Wind Speed and Extreme Wave Height Allowance (based on a 1990 baseline)

Applies all around the English coast	2056 to 2125
Offshore wind speed allowance	10%
Offshore wind speed sensitivity test	10%
Extreme wave height allowance	10%
Extreme wave height sensitivity test	10%

Standard of Protection

3.76. In terms of providing an acceptable standard of protection against flooding for new development, where development is necessary in flood risk areas, the development should be made safe for its lifetime without increasing flood risk elsewhere. The Site-specific flood risk assessment checklist makes reference to the assessment of the 'design flood'.

3.77. Paragraph 2 in the Flood Risk and Coastal Change Planning Practice Guidance defines a "design flood" as follows:

'This is a flood event of a given annual probability, which is generally taken as:

- **river flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year); or**
- **tidal flooding with a 0.5% annual probability (1 in 200 chance each year); or**
- **surface water flooding likely to occur with a 1% annual probability (a 1 in 100 chance each year),**

plus an appropriate allowance for climate change.

3.78. Therefore, in terms of providing an acceptable standard of protection against flooding for new development, the development should be appropriately safe without increasing flood risk elsewhere in the 'design flood'.

3.79. The Government published its 'Non-statutory technical standards for sustainable drainage systems' in March 2015. They should be used in conjunction with the NPPF and planning practice guidance. Standard S7 states that the drainage system must be designed so that flooding does not occur on any part of the Site for a 1 in 30 year rainfall event. Standard S8 goes on to state that the drainage system must be designed so that flooding does not occur during a 1 in 100 year rainfall event in any part of a building (including a basement); or in any utility plant susceptible to water within the development.

4. FLOOD RISK ASSESSMENT

4.1. In addition to flooding from rivers and the sea it is also necessary to consider the potential consequences of flooding from all other sources, which include directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

Sources of Information

4.2. A Level 1 SFRA was produced by AECOM Limited on behalf of Selby District Council in August 2022. This provides an overview of flood risk from all sources including from rivers and the sea, directly from rainfall on the ground surface and rising groundwater, overwhelmed sewers and drainage systems, and from reservoirs, canals and lakes and other artificial sources.

4.3. The Government's GOV.UK website contains 'Long Term Flood Risk Information'[22] which includes interactive maps showing 'Flood risk from rivers or the sea' and 'Flood risk from surface water'. These maps show the chance of flooding in one of four risk categories: High risk means that each year this area has a chance of flooding of greater than 3.3% (1 in 30); Medium risk between 1% and 3.3% (1 in 100 and 1 in 30); Low risk between 0.1% and 1% (1 in 1000 and 1 in 100); and Very low risk less than 0.1% (1 in 1000). The 'Flood risk from surface water' map indicates the extent, depth and velocity of water for High, Medium and Low risk scenarios. The Long Term Flood Risk Information also includes a 'Flood risk from reservoirs' map.

4.4. Enquiries have been made to the Environment Agency to obtain: the detailed Flood Map of the area; the latest available modelled flood levels for the watercourses in the vicinity of the Site; the modelled flood extents; flood defence locations; details of historic flood events; and local flood history data from all sources of flooding. A copy of the initial Environment Agency ('EA') consultation response is contained in **Appendix 7**.

Baseline Site Specific Flood Risk

Flooding from Watercourses and Tidal Sources

4.5. The tidal estuary and the rivers flowing into it, including the Rivers Aire and Ouse, are the primary sources of flood risk in the vicinity of the Site.

4.6. The effect of a high astronomical tide combined with a fluvial event and or storm surge could pose a flood risk to the surrounding land resulting in exceedance of the capacity of the channel of the River Ouse and Rive Aire and overtopping of flood defences.

4.7. Accordingly, the Level 1 SFRA states:

> **'The main source of fluvial flood risk in the District arises from the tributaries of the Rivers Aire and Ouse, in the southeast of the District around the areas of Burn, Camblesforth and Drax. The majority of these areas are defined as Flood Zone 3a, though they are also areas which have been identified as benefitting from flood defences.'**

Flood Zones

4.8. As stated in paragraphs 2.23 - 2.28 above the majority of the Site falls within Flood Zone 3a with smaller areas of Flood Zone 2 and Flood Zone 1. The Environment Agency's Flood Zones do not take into account the presence of flood defences.

[22] Environment Agency (2023) Check your long term flood risk. Available from: https://check-long-term-flood-risk.service.gov.uk/map (accessed on 25.05.23)

Flood Defences

4.9. The Asset Map contained in **Appendix 7** shows the location of flood defences on the River Aire and River Ouse in the vicinity of the Site. Inspection of this plan indicates the presence of embankments along the northern bank of the River Aire and southern bank of the River Ouse which would provide some protection to the Site.

4.10. With respect to flood defences the Level 1 SFRA states:

> **'The flood defences around the River Aire benefit the areas to the north of the river, from Birkin eastwards towards Burn, Camblesforth and Newland, close to the boundary of the District. The flood defences around the River Ouse benefit areas south of the river, along the upper Humber Estuary from Drax, northwest to Wistow.'**

4.11. The Environment Agency has published its Spatial Flood defences layer as open data. An extract from this dataset showing the design standard of protection ('SoP') for the flood defences in the vicinity of the Site is shown on Drawing No. E216/84 Rev B contained in **Appendix 8**. A design SoP has not been attributed to the flood defences along the River Ouse; the design SoP for the embankments along the River Aire are predominately 1 in 50 on the land south of the Site, increasing to 1 in 200 on land to the east near Newland.

4.12. The Environment Agency conducts regular inspections of the flood defences that it is responsible for maintaining (typically every six months). The Environment Agency attribute a grade to assess the flood defence condition as follows:

- 1: Very Good –Cosmetic defects that will have no effect on performance
- 2: Good – Minor defects that will not reduce the overall performance of the asset
- 3: Fair – Defects that could reduce the performance of the asset.
- 4: Poor – Defects that would significantly reduce the performance of the asset. Further investigation required.
- 5: Very Poor - Severe defects resulting in complete performance failure.

4.13. The Environment Agency's consultation response states that its aim is to improve all assets below '3: Fair' to an acceptable standard.

4.14. Review of the Environment Agency's Spatial Flood defences layer indicates that the current condition of the flood defences along the southern bank of the River Ouse, to the north of the Site, range between '2: Good' and '4: Poor'. The current condition of the flood defences along the northern bank of the River Aire, to the south of the Site, range between '2: Good' and '3: Fair' although large sections have not been attributed a condition grade.

4.15. The presence of the embankments along the River Aire and River Ouse disconnects the rivers from their natural floodplain.

4.16. The Ouse Catchment Flood Management Plan[23] ('CFMP') was published by the Environment Agency in December 2010. The CFMP is a strategic planning document providing an overview of the main sources of flood risk (inland flooding, from rivers, ground water, surface water and tidal flooding) and how they can be managed over the next 50 – 100 years. The Site falls in to 'Sub-area 6: Tidal Ouse and Wharfe' of the River Ouse CFMP. It is noted that flooding comes from both fluvial/tidal combinations and surface water and that extensive defences and pumping are used to reduce the risk of flooding in this area.

4.17. Policy Option 4 from the River Ouse CFMP has been selected as the most appropriate approach to managing flood risk for Sub-area 6 where the Site is located. Policy Option 4: 'take action to sustain the current scale of flood risk to the future' states:

> **'Areas of low, moderate or high flood risk where we are already managing the flood risk effectively but where we may need to take further actions to keep pace with climate change.**
>
> **This policy will tend to be applied where the risks are currently deemed to be appropriately-managed, but where the risk of flooding is expected to significantly rise in the future. In this case we would need to do more in the future to contain what would otherwise be increasing risk. Taking further action to reduce risk will require further appraisal to assess whether there are socially and environmentally sustainable, technically viable and economically justified options.'**

4.18. The CFMP notes the need to locally upgrade current defences and review the pumping regime to keep pace with future increases in fluvial flows.

4.19. The Aire Catchment Flood Management plan[24] was also published by the Environment Agency in December 2010. The relevant catchment area of the River Aire CFMP is Sub-area 8: Lower Aire. This section states that the sources of flooding are the River Aire, the Aire and Calder Navigation and tidal influences of the Humber Estuary in addition to surface water and sewers.

4.20. The selected policy for the Lower Aire sub-area within the River Aire CFMP is Policy 6: 'take action with others to store water or manage runoff in locations that provide overall flood risk reduction or environmental benefits, locally or elsewhere in the catchment' and states:

> **'Areas of low to moderate flood risk where we will take action with others to store water or manage run-off in locations that provide overall flood risk reduction or environmental benefits.**
>
> **This policy will tend to be applied where there may be opportunities in some locations to reduce flood risk locally or more widely in a catchment by storing water or managing run-off. The policy has been applied to an area (where the potential to apply the policy exists), but would only be implemented in specific locations within the area, after more detailed appraisal and consultation.'**

4.21. The use of the washlands as flood storage areas is important within the River Aire Catchment.

[23] Environment Agency (2010) Ouse Catchment Flood Management Plan Summary Report December 2010.
[24] Environment Agency (2010) Aire Catchment Flood Management Plan Summary Report December 2010

4.22. Environment Agency maintained flood defences are present in the vicinity of the Site on both the River Ouse and River Aire. The flood defences provide a level of protection which could be overwhelmed in the design flood and actions are required to ensure the standard of protection can be maintained to mitigate the effect of climate change. Having regard to the policies contained in the CFMPs, the strategic flood defences are likely to be maintained and improved over the lifetime of the Proposed Development.

Strategic Flood Model

4.23. The Environment Agency has provided details of two strategic flood models for the vicinity of the Site. These are the 2016 Upper Humber Study and 2017 Lower Aire Model.

4.24. The area of assessment covered by the 2017 Lower Aire Model[25] extends to the railway line in the vicinity of Temple Hirst. This is upstream of the Proposed Development and as such model outputs are not relevant to this assessment.

4.25. The 2016 Upper Humber Study[26] was published by JBA Consulting in July 2018 on behalf of the Environment Agency. The model includes the upper Humber Estuary and its major tributaries where flood risk is influenced by fluvial and tidal conditions and considers both defended and undefended conditions and a joint probability assessment. The tributaries models include the Rivers Ouse, Aire, Don and Trent and the model extents extend to the railway bridges in Selby and Temple Hirst. The combined upstream catchments of these watercourses are approximately 14% of mainland England. The 2016 Upper Humber Study is therefore the most relevant strategic flood model and, at the time of writing, the best available information for this assessment.

4.26. The Upper Humber Study identified that the tidally influenced reaches are located downstream of Goole and the fluvial dominated reaches are upstream of Selby. The reaches of the River Aire and River Ouse in the vicinity of the Site are at most at risk from a combined fluvial and tidal event. As such the implications of joint probability need to be considered.

4.27. The Upper Humber Study identified that the impact of climate change increasing flows and tidal levels (sea level rise) will increase flood extents across the wider floodplain.

4.28. The Humber Extreme Water Levels[27] ('HEWL') (2020) is the third Environment Agency strategic flood model in the vicinity of the Site. The HEWL provides additional assessment of the joint probability of tidal and fluvial conditions and maximum water levels are produced at identified locations. It should be noted that the HEWL model is 1D only so that no maximum flood extents are available from the modelling outputs. As such the Level 1 SFRA states:

> **'Downstream of Temple Hirst rail bridge and the Selby A63 road bridge the Upper Humber (2016) should be used in the Selby LLFA at present to define flood extents.'**

4.29. For the purposes of this assessment, in the absence of a site-specific flood model taking into account the HEWL boundary conditions, the outputs from the Upper Humber Study strategic flood model are used as a proxy for the design flood to assess the effect of floodwaters overtopping flood defences and floodwaters spilling onto the floodplain.

[25] JBA Consulting (2017) Northern Forecasting Package: Lower Aire Model Final Report V1.0
[26] JBA Consulting (2018) Upper Humber Flood Risk Mapping Study Final Report
[27] Jacobs (2020) Humber 2100+ Extreme Water Levels.

4.30. The climate change allowances used in the Upper Humber Study strategic flood model was a +20% increase in peak river flows and +0.61m increase in tidal water levels. These were the climate change allowances at the time of the Upper Humber Study. **Table E** below compares the climate change allowances in the Upper Humber Study strategic flood model to the latest Environment Agency climate change allowances. It should be noted that the joint probability assessment contained in the Upper Humber Study strategic flood model did not allow for climate change on the tidal or fluvial elements.

Table E: Comparison of Climate Change Allowances

Climate Change Scenario	Design Flood	Credible Maximum Scenario Sensitivity Test	Upper Humber Study
Peak River Flow Wharfe and Lower Ouse (Northern area of the Site)	+18%	+29%	20%
Peak River Flow Aire and Calder (Southern area of the Site)	+18%	+30%	
Sea Level Rise	+0.501m (Higher Central) +0.642m (Upper end)	Approx. +1.00m	+0.610m

Notes: Assumed the 40 year design life (including consenting, construction, operation and decommissioning) extends to 2069/70 as a precaution.

4.31. Inspection of **Table E** above shows that the climate change allowances in the Upper Humber Study differ from those that require assessment under the current Environment Agency guidance. For the purposes of this assessment, in the absence of a site-specific flood model, the outputs from the Upper Humber Study strategic flood model are used as a proxy for the design flood.

4.32. A site-specific flood model for the Site is being commissioned to determine the design flood and provide a credible maximum scenario sensitivity test; this will inform the ES in support of the application for development consent for the Proposed Development. At this stage, the scope of the site-specific flood model has yet to be agreed with the Environment Agency and is subject to ongoing consultation.

4.33. The preliminary scope of the site-specific flood model is subject of ongoing discussions with the Environment Agency (Ref: ENVPAC/1/YOR/00412 RA/2023/145101). The scope of the site-specific flood model has been updated to take account of comments received from the Environment Agency in its response dated 16th May 2023. A copy of the 'Revised Scoping Document' prepared by Aegaea is contained in **Appendix 9**. It is requested that the Environment Agency review this FRA and 'Revised Scoping Document' to inform the Statement of Common Ground and provide certainty to the site-specific flood model which will inform the ES.

Undefended Scenario

4.34. Due to the low-lying nature of the Site and tidal levels, large areas of the surrounding land, including the majority of the Site, would be affected in undefended flood scenarios.

4.35. It is considered that the undefended scenario is unlikely to be a true representation of residual risk having regard to the Environment Agency's ongoing responsibility for maintaining flood defences over the 40-year modelled operational lifespan of the Proposed Development.

4.36. In the response to the preliminary scope for the site-specific flood model prepared by Aegaea, JBA Consulting's response on behalf of the Environment Agency contained in Appendix 9 agreed with this approach, stating '*it is exceptionally unlikely that all flood defences along the subject rivers would fail simultaneously*'.

4.37. This assessment therefore focuses on the defended scenario which is considered to be representative of the flood risk to the Site. The residual risk of defence failure is assessed in the sections below.

4.38. Although the combined effect of fluvial and tidal sources is the predominate flood hazard to the Site it is important to consider the individual effects of tidal and fluvial sources in isolation to more comprehensively understand the flood mechanisms and the sensitivity of the Site to the different flood sources.

Defended Tidal

4.39. The risk of a tidal storm surge increasing water levels and resulting in overtopping of flood defences has been assessed as part of the Upper Humber Study. The flood extents and depths behind the raised defences is determined by the volume of water overtopping the defences.

4.40. During the 0.5%AEP plus climate change (1 in 200 RP) tidal flood event (a proxy for the design flood) the Site is shown to be flood free and flood extents are restricted to the areas behind the flood defences on the River Ouse and River Aire. Drawing No. E216/09 Rev B contained in **Appendix 10** shows the modelled flood depths during this event. This does not take into account the combined effect from fluvial and tidal sources.

Defended Fluvial

4.41. The River Aire and River Ouse have large upstream catchments which extend as far as the Yorkshire Dales. High peak river flows as a result of rainfall over the wider upstream hydrological catchment can result in overtopping of flood defences and has been assessed as part of the Upper Humber Study.

4.42. The modelled flood depths during the 1%AEP plus 20% climate change (1 in 100 RP) are shown on Drawing No. E216/26 Rev B contained in **Appendix 11**.

4.43. Inspection of this drawing shows that during the 1%AEP+20%CC (1 in 100 RP) the flood mechanism is from overtopping of flood defences along the River Aire and flood waters spreading out over the low lying areas. The flood defences along the River Ouse are locally overtopped but the flood extents from this watercourse do not affect the Site.

4.44. Due to the large size of the upstream catchments of the River Aire and River Ouse, the flood hydrographs are likely to be prolonged resulting in a significant volume of flood water overtopping flood defences. The flood extents and depths behind the raised defences are determined by the volume of water overtopping the defences and the capacity of the floodplain.

4.45. As such, the flood risk for this event varies across the Site. The Solar Farm Zone on land to the east of Hagg Bush Lane and west of the Bales Wood is shown to be flood free. Another area of the Solar Farm Zone shown to be flood free is to the south of Rosehill Farm and Sandwith Lane. The flood depths in the central southern area and central northern area of the Solar Farm Zone are predominately <0.6m deep. Localised deeper areas of flooding are identified associated with isolated low spots and the channels of on-Site ordinary watercourses. Areas of deeper flooding are identified on the eastern area of the Solar Farm Zone to the southwest of Camblesforth and Selby Road. Flood depths in this area are predominately <1.2m with areas of deeper flooding up to 1.4m deep in the low-lying areas on the eastern boundary. Areas of deeper flooding in the eastern area of the Solar Farm Zone are associated with isolated low spots and the channels of on-Site ordinary watercourses.

Defended Joint Probability Tidal and Fluvial

4.46. Due to the combined effect of tidal and fluvial flooding at the location of the Site, it is necessary to undertake a joint probability analysis to determine the flood risk to the Site and define the design flood.

4.47. The Environment Agency's Upper Humber Study strategic flood model assessed up to a combination of eight scenarios to produce combined joint probability scenarios for a range of return periods. A combined results grid was produced for a range of flood events including 10% AEP (1 in 10 RP), 3.33% AEP (1 in 30), 1.33% AEP (1 in 75 RP), 1%AEP (1 in 100 RP), 0.5% AEP (1 in 200 RP) and 0.1% AEP (1 in 1000 RP).

4.48. The range of scenarios assessed in the 0.5% AEP (1 in 200 RP) joint probability event are summarised in **Table F** below.

Table F: Joint Probability Chi Matrix (Extract from Table 5-4 of Upper Humber Study)

Design AEP (%)	Joint Probability Scenario	Ouse AEP (%)	Aire AEP (%)	Don AEP (%)	Trent AEP (%)	Tidal AEP (%)
0.5	A	0.5	0.5	0.5	0.5	>100
	B	1	0.5	1	1	>100
	C	5	0.5	5	5	>100
	D	10	0.5	10	10	>100
	E	20	1	20	20	100
	F	>100	40	>100	>100	3.33
	G	>100	100	>100	>100	1
	H	>100	>100	>100	>100	0.5

Notes: >100% AEP = mean flow in the watercourse rather than flood flow.

4.49. Inspection of **Table F** indicates that for the 0.5% AEP (1 in 200 RP) joint probability event the 0.5%AEP fluvial flood on the River Aire has been assessed in four of the scenarios (A-D) and the 0.5% AEP tidal flood event has been assessed in one of the scenario (H). The joint probability analysis does not account for climate change. As the primary flood mechanism affecting the Site is from the fluvial flows from the River Aire overtopping the flood defence, the 0.5% Aire AEP event listed above will be used as a proxy for the 1% AEP plus climate change fluvial event (the fluvial design flood). As such the 0.5% AEP joint probability event is a suitable proxy for both the fluvial and tidal design flood for this assessment in the absence of a site-specific flood model.

4.50. The modelled flood depths for the 0.5% AEP (1 in 200 RP) joint probability event are shown on Drawing No. E216/21 Rev B contained in **Appendix 12**.

4.51. Inspection of this drawings shows that during the 0.5% AEP (1 in 200 RP) joint probability event the flood mechanism is from overtopping of flood defences along the River Aire and flood waters spreading out over the low lying areas. The flood defences along the River Ouse are locally overtopped but the flood extents from this watercourse do not affect the Site. The flood extent is similar to the 1%AEP plus 20% climate change (1 in 100 RP) fluvial flood.

4.52. The flood risk in during the 0.5% AEP (1 in 200 RP) joint probability event varies across the Site. The Solar Farm Zone on land to the east of Hagg Bush Lane and west of the Bales Wood is shown to be flood free. Another area of the Solar Farm Zone shown to be flood free is to the south of Rosehill Farm and Sandwith Lane. The flood depths in the central southern area and central northern area of the Solar Farm Zone are predominately <0.6m deep. Localised deeper areas of flooding are identified associated with isolated low spots and the channels of on-Site ordinary watercourses. Areas of deeper flooding are identified on the eastern area of the Solar Farm Zone to the southwest of Camblesforth and Selby Road. Flood depths in this area are predominately <1.2m with areas of deeper flooding up to 1.4m deep in the low-lying areas on the eastern boundary. Areas of deeper flooding in the eastern area of the Solar Farm Zone are associated with isolated low spots and the channels of on-Site ordinary watercourses.

Breach Event

4.53. There is a risk of a flood event occurring as a result of the structural failure of a raised flood defence. The flow and extent of flooding from a breach event is determined by the head gradient, flood mechanism (tidal cycle) and response (emergency repair).

4.54. The Environment Agency's Upper Humber Study contained an assessment of the breach of flood defences. The effect of a 50m breach width for earth embankments and 20m for hard defences over a 72 hour period for the 1% AEP (1 in 100 RP) fluvially dominated water levels and 0.5% (1 in 200 RP) tidally dominated levels was assessed. The Upper Humber Study breach locations 3 and 4 are located on the River Ouse to the north of the Site and the flood extents do not affect the Site.

4.55. Additional breach modelling was conducted on the Upper Humber strategic flood model by JBA Consulting on behalf of the Environment Agency published in April 2017[28]. A further 18 locations were considered. Breaches A – C are located in the vicinity of the Site. However, the flood extents do not affect the Site.

4.56. No breach events along the River Aire were assessed as part of the Upper Humber Study.

4.57. The Upper Humber Study indicates that during a breach event along the River Ouse the flood extents are localised and restricted to the areas around the breaches. Due to the distance from the Site to the River Ouse, it is concluded that the effect of breaches of flood defences on the River Ouse on the Site would be negligible and does not require further assessment.

4.58. It should be noted that the Level 1 SFRA includes additional breach analysis during the 1%+CC (1 in 100 RP) event. Breach 3 in Selby results in a small flood extent extending on to the northern area of the Solar Farm Zone south of Common Lane along the Common Drain. No details of the modelling methodology are provided in the Level 1 SFRA and the extensive areas of flooding suggest it is more precautionary than the assumptions made in the Upper Humber Study.

[28] JBA Consulting (2017) Upper Humber – Additional Breach Modelling.

4.59. The effect of breaches of flood defences along the River Aire are likely to be minimised as the flood defences are already overtopped in the proxy design flood. The effect of a breach increasing the volume of floodwaters spilling onto the floodplain is likely to be minimal in the context of the overtopping volume that would occur during the proxy design flood.

4.60. The site-specific flood model will consider the residual risk of a breach event on the Site. The scope of the breach modelling to be assessed by the site-specific flood model is still to be agreed with the Environment Agency.

4.61. Due to the Environment Agency's maintenance regime for the flood defences in the vicinity of the Site, the risk of flood defence failure should be minimised and the effect of a breach should be considered a residual risk to the Site.

Summary of Pre-Development Flooding from Watercourses and Tidal Sources

4.62. The pre-development risk of flooding from combined fluvial and tidal sources ranges between 'high' and 'very low' on the Site. Flood defences along the River Aire are overtopped once the effects of climate change on peak river flows and tidal levels are taken into account. Floodwaters spread out over the floodplain and flood depths and extent vary across the Site.

4.63. A site-specific flood model is being commissioned to determine the design flood and will inform the ES to be submitted in support of the application for development consent for the Proposed Development. At this stage, the joint probability 0.5% AEP (1 in 200) from the Upper Humber Study is used as a proxy for the design flood.

Flooding from Surface Water

4.64. The GOV.UK's Flood risk from surface water map indicates where surface water may be expected to flood or pond. Surface water flooding happens when rainwater does not drain away through the normal drainage systems or soak into the ground, but lies on or flows over the ground instead. The GOV.UK website advises that flooding from surface water is difficult to predict as rainfall location and volumes are difficult to forecast. In addition, local features can greatly affect the chance and severity of flooding. The information shown is a general indicator of an area's flood risk. A copy of the GOV.UK's Flood risk from surface water map is reproduced in **Figure 12** below.

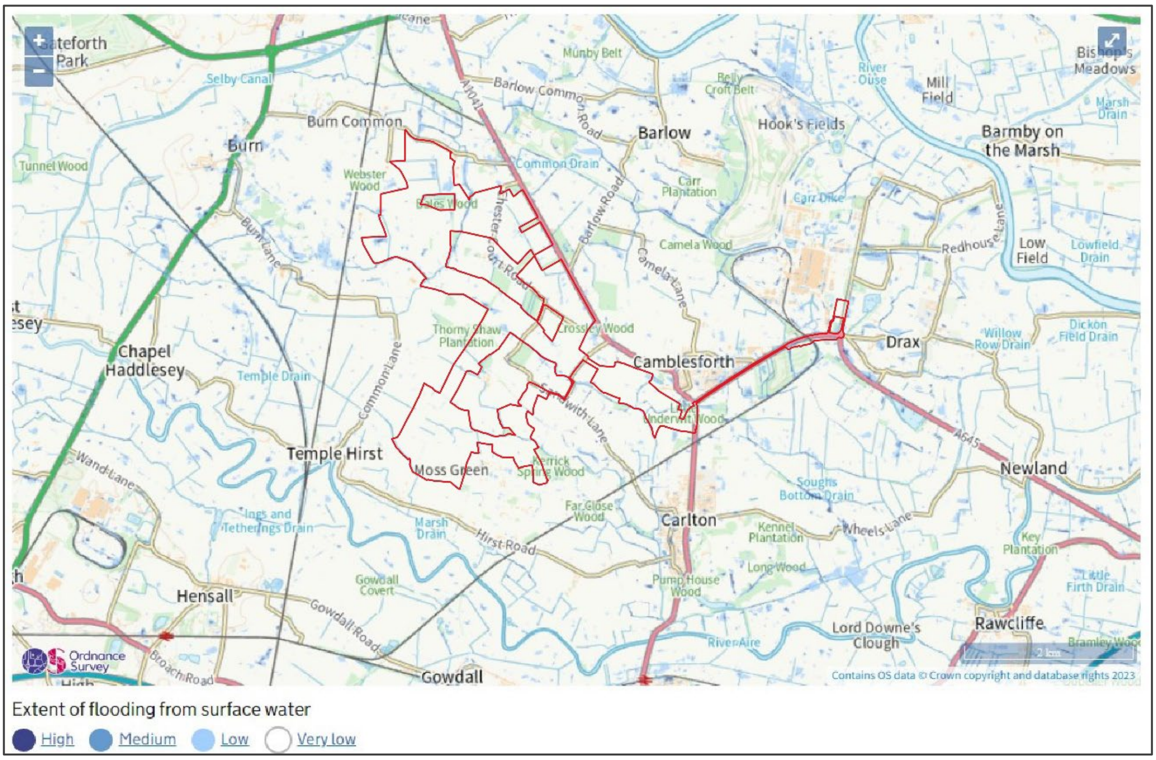

Figure 12: Flood Risk from Surface Water Map

4.65. The GOV.UK's Flood risk from surface water map shows that the majority of the Site is at 'very low' risk (less than 0.1%). Smaller isolated areas of 'low' risk (between 0.1% and 1%), 'medium' risk (between 1% and 3.3%) and 'high' risk (greater than 3.3%) are present. The areas of elevated surface water flooding are associated with low points on the Site where surface water runoff could collect and routes of ordinary watercourses.

4.66. The extent of the low risk surface water flood event is shown on Drawing No. E216/02 Rev B contained in **Appendix 13**. The flood depths over 600mm deep are restricted to the channels of onsite watercourses. Areas of flooding with depths below 600mm are located at isolated areas throughout the Site. These are associated with lower lying areas of topography. Modelled velocities in the low risk event in the isolated areas are less 0.25 m/s, indicating the surface water flooding is associated with surface waters collecting rather than an overland flow route. Areas with modelled velocities over 0.25 m/s are associated with the routes of ordinary watercourses.

Summary of Pre-Development Flooding from Surface Water

4.67. The pre-development risk of flooding from surface water is assessed as predominately 'very low' with areas of elevated risk associated with isolated low points and the route of on-Site ordinary watercourses where surface water could collect.

Flooding from Groundwater

4.68. Groundwater flooding is most likely to occur in low-lying areas underlain by water-bearing permeable rocks termed aquifers. These may be extensive regional aquifers in chalk or sandstone, or localised sands or river gravels in valley bottoms underlain by less permeable rock. Groundwater flooding occurs as a result of water rising from the underlying rocks or from water flowing from abnormal springs. This tends to occur after long periods of sustained high rainfall. Higher rainfall means more water will infiltrate into the ground and cause the water table to rise above normal levels. In low-lying areas, the water table is usually at shallower depths, so during very wet periods, the additional groundwater flowing towards these areas can cause the water table to rise to the surface causing groundwater flooding which may follow overland flow paths or pond at local topographic depressions. The rate of groundwater emergence depends upon the pressure head on the groundwater body, and the permeability of soils and near surface geology which can be locally variable.

4.69. The Selby District Level 1 SFRA uses the Environment Agency’s dataset ‘Areas Susceptible to Groundwater Flooding’ (‘AStGWF’) which indicates where groundwater may emerge due to geological and hydrogeological conditions. This information is shown as a proportion of 1km grid squares where there is potential for groundwater emergence. The mapping shows that the Site covers a range of groundwater flooding susceptibilities.

4.70. The areas of elevated risk are associated with the areas of the Site where superficial and bedrock aquifers are present. The general pattern for the majority of the Solar Farm Zone is an increasing susceptibility towards groundwater flooding from the south western area of the Site (‘<25%’) towards the north eastern boundary of the Site aligning with the A1041 (‘>=75%’). The exception to this is the very south western corner, where the susceptibility level is ‘>=25% <50%’.

4.71. The Level 1 SFRA notes that groundwater flood risks are highly localised and dependent upon geological interfaces between permeable and impermeable subsoils.

Summary of Pre-Development Flooding from Groundwater

4.72. The pre-development risk of flooding from groundwater is assessed as ‘very low’ to ‘high’ for the Site based on the available information, due to the presence of groundwater bearing superficial and bedrock deposits and low lying nature of the Site increasing its vulnerability to shallow groundwater levels.

Flooding from Overwhelmed Sewers and Drainage Systems

4.73. Flooding from sewers and drainage systems occurs when the sewer or drainage system is overwhelmed as a result of a blockage or excessive flow exceeding its capacity and/or when sewers cannot discharge properly to watercourses due to high water levels.

4.74. Historical incidences of sewer flooding are recorded by water and sewerage companies on the DG5 register which records incidents of internal and external flooding relating to public foul, combined or surface water sewers and displays which properties suffered flooding. For confidentiality reasons, this data is provided at the postcode level. This data does not identify whether flooding incidences were caused by general exceedance of the sewer system design, or by operational issues such as blockages. This dataset is a snapshot in time and may become outdated following asset improvement works by the water and sewerage company and future rainfall events.

4.75. The Level 1 SFRA makes reference to the DG5 Flood Register. The dataset provides the number of properties affected within a postcode area within the last 10 years. It should be noted that the DG5 register only records those incidences reported to Yorkshire Water Services Limited. In addition, it does not take into account any maintenance or improvement works undertaken by Yorkshire Water Services Limited to resolve flooding issues. The Level 1 SFRA shows 0-2 external sewer flooding records reported within the vicinity of the Site.

Summary of Pre-Development Flooding from Overwhelmed Sewers and Drainage Systems

4.76. The pre-development risk of flooding from overwhelmed sewers and drainage systems is considered to be ‘low’ to ‘very low’ due to the Site’s rural location with limited sewerage infrastructure.

Flooding from Artificial Sources

Reservoirs

4.77. Flooding from reservoirs may occur as a result of partial or complete failure of the control structure designed to retain water in the artificial storage area.

4.78. The GOV.UK’s Flood risk from reservoirs map indicates the Site would be affected in the event of reservoir failure. The reservoir flood map shows two flooding scenarios known as ‘dry-day’ and ‘wet-day’. The ‘dry-day’ scenarios predict the extent of flooding that would occur if a dam or reservoir failed when river levels are at normal levels. The ‘wet day’ scenario predicts how much worse the extent of flooding might be if the river is already experiencing the effects of an extreme flood event. A copy of the Risk of flooding from reservoirs map is reproduced as **Figure 13** below.

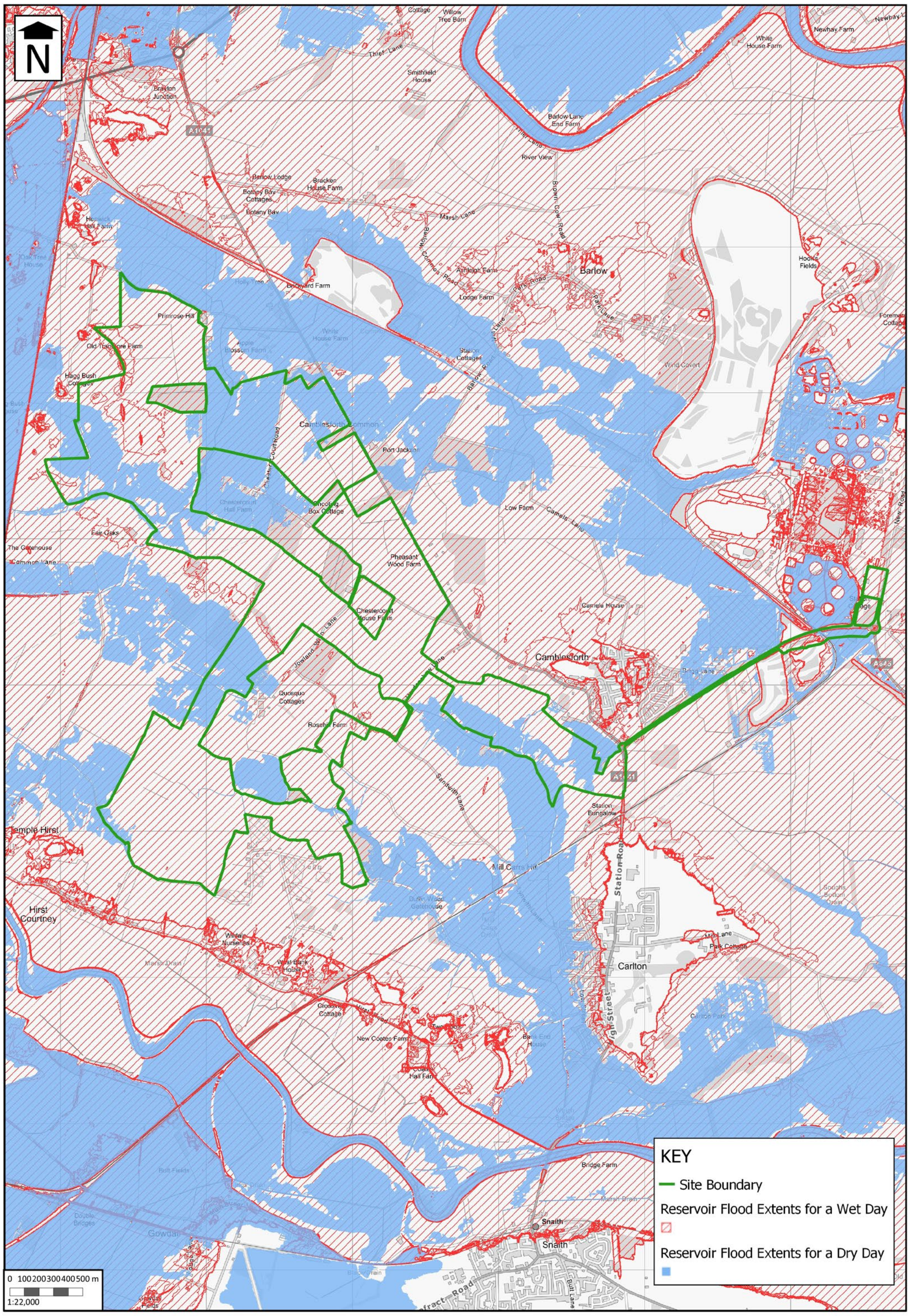

Figure 13: Risk of Flooding from Reservoirs

4.79. When the rivers are at normal levels, the risk of reservoir flooding is present in the north western area of the Solar Farm Zone south and east of Bales Wood, in the northern area of the Site to the southwest of Selby Road and in the south eastern corner to the south west of Camblesforth. Limited areas of risk are present in the southern area of the Solar Farm Zone. The Selby Branch of the East Coast Mainline railway appears to protect much of the Site in the event of reservoir flooding in the 'dry-day' scenario. In the case of a 'wet-day' scenario, flooding occurs across the whole of the Site.

4.80. The GOV.UK website advises that while there is a risk in this area, flooding from reservoirs is extremely unlikely. Also, since this is a worst case scenario, it is unlikely that any actual flood would be this large. Current reservoir regulation has been further enhanced by the Flood and Water Management Act 2010, which amends the Reservoirs Act 1975, and aims to ensure that all reservoirs are properly inspected and supervised by reservoir panel engineers, maintained and monitored in order to detect and repair any problem. Reservoirs therefore present a low but managed risk.

4.81. The Level 1 SFRA notes that to date there have been no recorded incidents of reservoir flooding within Selby District.

Canals

4.82. The Selby Canal runs approximately 1km north of the Site at its closest point, flows to the north-east and is located on a small embankment. The Selby Canal is formed from the northern branch of the Aire and Calder navigation.

4.83. Canals are regulated waterbodies under the jurisdiction of the Canal and River Trust (‘CRT’). As canals are managed waterbodies, they are unlikely to flood unless there is a failure of a raised embankment or a large ingress of water from an adjacent river. Embankment failure can be caused by animal burrowing, culvert collapse, subsidence, overtopping or adjacent works affecting the embankment. The flooding from a breach of a canal embankment is dependent on the canal and adjacent ground levels, embankment construction, nature of the breach and impounded length of canal which determines the volume that can be discharged.

4.84. The Level 1 SFRA records one incident of flooding from the Aire and Calder navigation at Ferrybridge Lock on 26th June 2007. This is located approximately 13km to the south west of the Site in the town of Ferrybridge.

4.85. The Selby Canal is located some distance from the Site and if a breach of the embankment were to occur at the location closest to the Site, ground levels adjacent to the Selby Branch of the East Coast Mainline railway which is located on embankment in the vicinity of the Site would be likely to prevent any floodwaters from extending over a significant distance.

4.86. It is therefore concluded that the chance of flooding from canals is ‘very low’.

Summary of Pre-Development Flooding from Artificial Sources

4.87. The pre-development risk of flooding from artificial sources is considered to be ‘low’ to ‘very low’. Reservoirs are present in the upstream catchment which could pose a risk to the Site. However, due to the management regime of the reservoirs, the risk of failure is considered to be extremely unlikely and a managed risk.

Historical Flooding

4.88. The SFRA states that:

> **'There is a long history of flooding within Selby District and several large events have occurred in the last 60 years, with the main sources of flooding being predominantly from fluvial and surface water sources.'**

4.89. The Environment Agency's publicly available datasets 'Historic Flood Map' and 'Recorded Flood Outlines' are presented on **Figure 14** below.

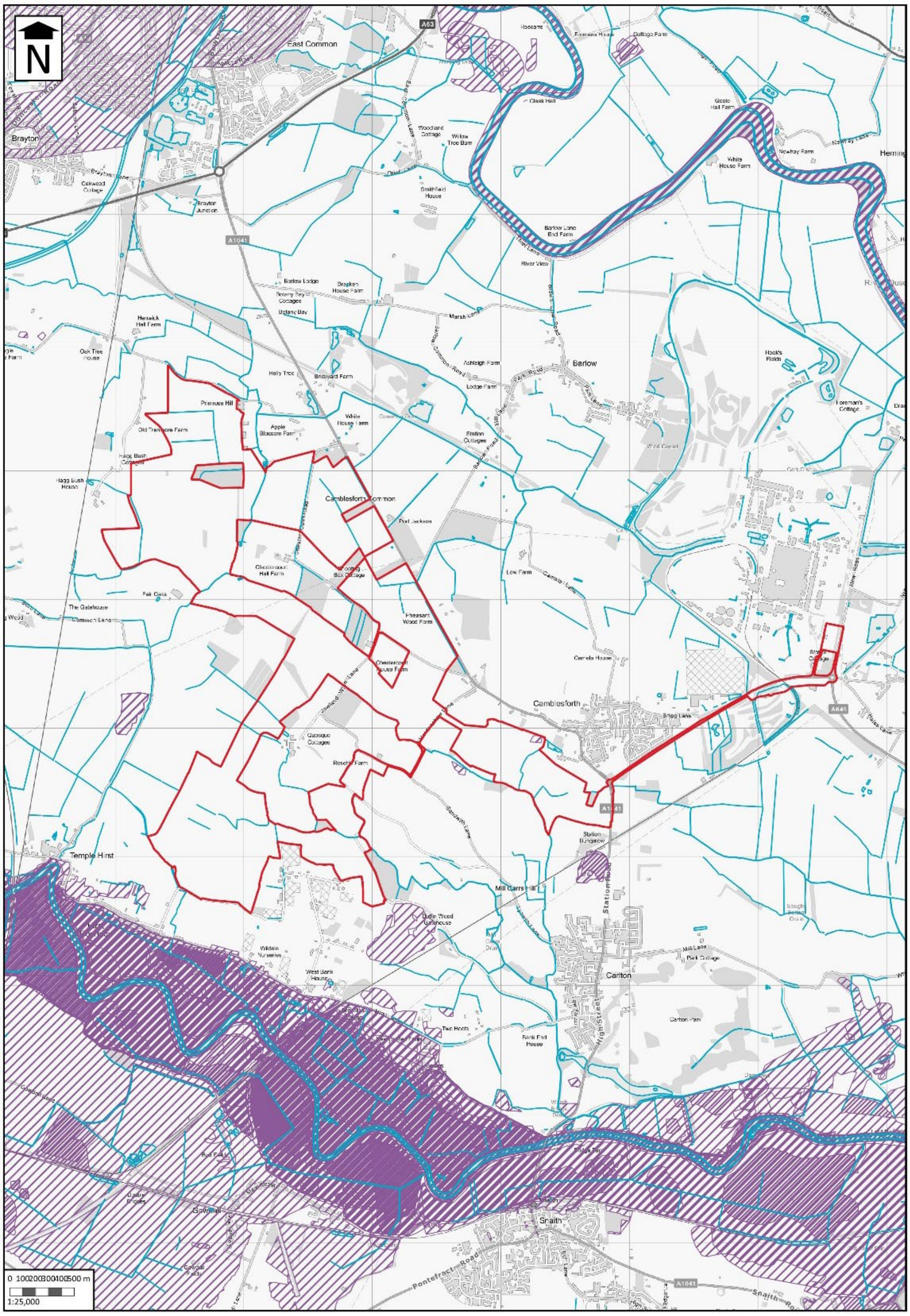

Figure 14: Environment Agency's Recorded Flood Outlines

4.90. A small area historic flooding recorded within the Site boundary is located to the west of Camblesforth. This occurred in February 2020 and is attributed to Storm Dennis.

4.91. A larger area of historic flooding is recorded to the west of Carlton in February 2020 and is associated with Storm Ciara and is located to the south of the Site. Further areas of historic flooding are recorded within 100m of the Site boundary including the capacity exceedance of the River Aire. The flooding events occurred in February 2020 as a result of the combined effect of successive storms (Ciara and Dennis).

4.92. There are further historic records of the River Aire exceeding its channel capacity in December 1978, March 1981, January and March 1982, February 1995, Autumn 2000, June 2007, and December 2015. In these cases, the flood extent is mainly constrained to the washland areas surrounding the River Aire and the historic flood outlines do not extend onto the Site.

4.93. In summary, historical incidences of flooding are recorded in the vicinity of the Site attributed to the combined effect of watercourse and surface water flooding.

Summary of Baseline Flood Risk

4.94. A summary of the potential flood risk from all sources of flooding associated with existing pre-development conditions is shown in **Table G** below.

Table G: Pre-development Potential Flood Risk from All Sources of Flooding

Flood Source	Potential Risk	Description
Watercourses & Tidal	High – Very Low	Flood defences along the River Aire are overtopped once the effect of climate change on peak river flows and tidal levels are taken into account in the 1% AEP (1 in 100 RP) plus climate change fluvial flood event and 0.5% AEP (1 in 200 RP) joint probability event. Floodwaters spread out over the floodplain and flood depths and extents vary across the Site.
Surface Water	High - Very Low	The majority of the Site is at very low risk, with areas of elevated risk associated with isolated low points and the route of onsite ordinary watercourses where surface waters could collect.
Groundwater	High – Very Low	Due to the presence of groundwater bearing superficial and bedrock deposits and the low-lying nature of the Site shallow groundwater may be present.
Overwhelmed Sewers	Low - Very Low	Due to the Site's rural location limited sewerage infrastructure is likely to be present and the Site is located in an area with a low number of historic records.
Artificial Sources	Low – Very Low	Reservoirs are present in the upstream catchment which could pose a risk to the Site. However, due to the management regime for the reservoirs, a failure is considered to be extremely unlikely and a managed risk.

4.95. The pre-development potential flood risk to the Site from overwhelmed sewers and artificial sources is considered to be 'low' to 'very low'. There are areas of elevated risk ('high' – 'medium') associated with the combined risk of flooding from watercourse and tidal sources due to the proximity of the Site to the River Aire and River Ouse, low points where surface waters could collect and the likely presence of shallow groundwaters in underlying superficial and bedrock deposits.

Flood Risk Mitigation Measures

4.96. This section of the report sets out the flood mitigation measures required to ensure the Proposed Development is appropriately safe for its lifetime taking account of the vulnerability of its users, without increasing flood risk elsewhere, and, where possible, would reduce flood risk overall.

4.97. The Site layout has been devised using a sequential approach to locate sensitive equipment in areas of lowest flood risk where possible, taking into account other material planning considerations and operational requirements.

4.98. For the development in areas of elevated flood risk, flood resilience and resistance measures have been considered to manage the residual flood risk to the Proposed Development. The Proposed Development has been designed to be compatible with the risk of flooding on the Site.

4.99. The flood mitigation measures are discussed in more detail below; application of these measures would ensure that the Proposed Development would remain operational and safe for users in times of flood, result in no significant loss of floodplain storage, and would not significantly impede water flows or increase flood risk elsewhere.

Environment Agency Flood Alerts

4.100. Solar farm developments are not ‘occupied’ and only occasional maintenance visits are required for landscape maintenance and equipment repairs. These maintenance visits can be scheduled to avoid periods of elevated flood risk. The Proposed Development will be remotely monitored, and faulty modules can be shut down as required. Through the design mitigation measures outlined below (raising and protecting equipment), the Proposed Development would continue to operate safely during flood conditions with no need for maintenance operatives to be on-Site.

4.101. The Site lies within the ‘Flood Alert Area’ of the ‘Tidal River Aire catchment’. The construction contractor and operating staff would register to receive flood alerts from the Environment Agency. When a flood alert is issued, the Site would be evacuated as a precautionary measure using the local highway network.

4.102. An agreed flood warning and evacuation plan would be put in place for the Proposed Development and be displayed so that users would be fully aware of the procedure to follow. This would include reference to the Environment Agency’s available Flood Alerts, and suitable warning notices would be displayed in the site office/sign in location to inform occupants of the degree of flood risk and the action to be taken in the event of a flood including routes for safe access and egress. Safe access and egress routes would be available for vehicles and pedestrians via the local highway network (Selby Road A1041).

4.103. The proposed flood warning and evacuation plan can be covered by a suitably worded DCO requirement requiring the submission of details to be submitted to and approved by the Local Planning Authority.

Solar Arrays

4.104. Non-flood sensitive infrastructure (solar PV arrays) has been designed to be resistant and resilient to flood waters in the combined fluvial and tidal design flood event.

4.105. During times of elevated tidal and fluvial flood risk, the solar PV arrays within the areas of elevated flood risk would be rotated to the horizontal position ('the stow position') to ensure the solar PV panels are raised above the flood level. When an Environment Agency flood alert is issued, solar PV arrays in areas of elevated flood risk would return to their stow position as a precaution. This action would be performed remotely, and no operatives would be required on-Site during periods of elevated flood risk.

4.106. From an inspection of **Figure 3,** it can be seen that when the solar PV arrays are rotated to a horizontal position, the solar PV panels would be approximately 2m above ground level. The maximum depth of flooding in the 0.5% AEP (1 in 200 RP) joint probability event (a proxy for the design flood) is up to 1.4m. These measures would ensure the solar PV panels are safe from flooding and could continue to operate safely during a design flood.

4.107. The design of the equipment will be finalised following the results of the site-specific flood modelling and this FRA will be updated to inform the ES to be submitted in support of the application for development consent for the Proposed Development. It is proposed to provide a minimum of a 0.3m freeboard between the combined fluvial and tidal design flood level and the stow position of the solar arrays. Solar PV arrays would be locally raised where this is not achieved by default.

4.108. The 0.3m uplift between the design flood level and the stow position is to protect the equipment and avoid displacing flood water whilst accounting for uncertainty within the modelling and the potential for wave action and debris. The 0.3m minimum uplift is considered to be suitably precautionary.

4.109. From an inspection of Figure 3, it can be seen that when the solar PV arrays are in their operating (rotating) position, the lower edge of the solar PV panel is a minimum of 1.0m above ground level. Therefore, the solar PV panels in the stow or operating (rotating) positions will be raised above the deepest low risk surface water flood level, and so would not be vulnerable to surface water flooding. The solar PV arrays are therefore compatible in areas of elevated surface water flood risk.

Solar Array Support Structures and Security Fence

4.110. Solar PV panel supports in flood risk areas would be securely piled into the ground and designed to allow for the effect of flowing water pressures and be resistant to inundation during a flood event.

4.111. The minimal cross sectional area and spacing of the solar PV panel supports and equipment framework would allow the free flow of flood waters around the base of the structures. The shape of the panels' supports would be designed to allow the free passage of water around the support. The presence of the panel supports in flood risk areas would not materially impede water flows due to their small size, cross sectional profile and wide spacing (typically one panel support on a solar PV array for every 8-9m).

4.112. It is proposed that the mesh size of any security fencing within flood risk areas would be increased to a minimum of 0.15m to minimise the risk of it collecting debris and allow flood waters to flow around and through the structure.

4.113. Due to the nature of the proposed equipment in the area of elevated flood risk, the volume of flood water displaced by the solar PV panel supports and fence posts is negligible in the context of the wider floodplain and flood waters could flow freely around the panel supports, base of the structures, and security fence.

Control Equipment

4.114. Ancillary control equipment would be contained in small buildings, typically container units distributed across the Site. Ancillary control equipment includes Inverter Cabinets which contain an Inverter, Transformers and associated switch gear.

4.115. The location of ancillary control equipment will be preferentially located in areas of very low surface water flood risk.

4.116. To achieve the required level of protection from the combined fluvial and tidal design flood, suitably designed earth flood defence bunds are proposed around ancillary control equipment located in areas of elevated tidal and fluvial flood risk. The proposed earth flood defence bunds would be raised at least +0.6m above the combined fluvial and tidal design flood level to protect the equipment from inundation. An increased freeboard compared with the solar panels is proposed to manage the residual risk of defence failure and provide a higher standard of protection to the sensitive equipment.

4.117. Routine maintenance access to ancillary control equipment would be infrequent and would be undertaken on foot over the earth flood defence bunds. If more significant maintenance activities or replacement is required, the transformers would be removed using a crane. The presence of the earth flood defence bunds around the ancillary control equipment is not considered to be a hindrance to routine maintenance.

4.118. In line with normal building practice, it is proposed that any on-Site buildings would have floor levels raised at least 0.3m above existing ground level with appropriate damp proof course protection. This would ensure that the interior of any such building is kept suitably dry.

4.119. The detailed design of the scheme may utilise string inverters located on the back of the frames of the solar arrays. If string inverters are proposed, they should be situated a minimum of 0.3m above the combined fluvial and tidal design flood level.

4.120. The design of the equipment will be finalised following the results of the site-specific flood modelling and this FRA will be updated to inform the ES to be submitted in support of the application for development consent for the Proposed Development.

BESS Facility and 132kv Substation

4.121. The BESS facility and 132kv Substation are located in the central area of the Site and in an area of elevated tidal and fluvial flood risk.

4.122. The BESS facility and 132kv Substation will be situated to avoid areas of elevated surface water flood risk.

4.123. To ensure the BESS facility and 132kv Substation are safe for their lifetime, it is proposed to protect the equipment with a suitably designed earth flood defence bund. The height of the earth flood defence bund would be at least +0.6m above the combined fluvial and tidal design flood level to protect the equipment from inundation.

4.124. The earth flood defence bund would incorporate a suitably designed access over the bund to allow for occasional maintenance access. Alternatively, a suitably designed flood gate could be considered.

4.125. Battery Energy Storage units would be raised 0.3m above ground which provides additional protection from the ingress of surface water within the bunded area.

Floodplain Compensation

4.126. The inclusion of earth flood defence bunds around the ancillary control equipment, BESS facility and 132kv Substation would displace floodwaters.

4.127. To ensure this does not increase flood risk elsewhere 'level for level' floodplain compensation would be provided on the Site.

4.128. Guidance on Floodplain Compensation is set out in section A3.3.10 of CIRIA's report 'Development and flood risk – guidance for the construction industry'[29] (CIRIA C624, 2004). The guidance advocates that for compensatory flood storage to be effective at the same point in a flood event, it should be the same volume and be at the same level relative to the flood level as the lost storage. This requirement is referred to as level for level compensation.

4.129. Level for level compensation is achieved by regrading land to a lower level in order to replace the volume lost due to the proposals. The guidance advises that losses of flood storage volume should typically be calculated for level bands so that at least five levels bands represent the depth of flooding on the floodplain during the design flood, although level bands of less than 100mm should not be used.

4.130. Level for level floodplain compensation would be provided to mitigate the effect of the earth flood defence bunds on flood storage volume. A preliminary floodplain compensation scheme is set out on Drawing No. E216/134 contained in **Appendix 14**. The calculation is based on 200mm level bands and an assumed flood level of 4.614m AOD at this location. The assumed flood level is extracted from the Upper Humber Study joint probability 0.5% AEP (1 in 200) scenario as a proxy for the design flood. Inspection of this plan indicates that in all level bands the volume of floodplain compensation provided is greater than the volume lost as a result of the BESS facility and 132kv Substation. The preliminary floodplain compensation scheme ensures the proposed development will result in no net loss of floodplain storage, will not increase flood risk elsewhere and flood risk betterment will be provided.

4.131. The floodplain compensation calculation and design will need to be revised following the completion of the site-specific flood model which will inform the ES to be submitted in support of the application for development consent for the Proposed Development.

4.132. In addition to level for level floodplain compensation calculations, the effect of the flood defence bund earthworks will be assessed as part of the site-specific flood model.

On-Site Watercourses

4.133. On-Site watercourses would be retained within the Proposed Development. The following minimum buffer zone distances have been established for all infrastructure (with the exception of fence crossings, culverts and access tracks) and ordinary watercourses on the Site:

- No development within 7m from the edge of a bank of any IDB managed ordinary watercourses.

4.134. The 7m watercourse buffer and areas where additional consents (land drainage consent) are required are shown on Drawing No. E216/06 Rev C contained in **Appendix 15.**

4.135. The internal access track would utilise existing watercourse/hedgerow crossings where possible.

[29] CIRIA (2004) Development and flood risk – guidance for the construction industry, CIRIA C624.

4.136. It is proposed that opportunities are sought within the development parcels for crossings of ordinary watercourses to be formed from single span structures, clear of the watercourse channels, wherever feasible. Where this is not possible, oversized box culverts should be utilised such that existing bed and bank profiles can be retained or reinstated in order to provide ecological benefits and maintain the existing hydrological characteristics of the water environment.

4.137. Any new watercourse crossings (site accesses) which require culverting of an ordinary watercourse would require consent from Selby Area IDB under Section 23(1) of the Land Drainage Act 1991 (as amended by the FWMA 2010). Land drainage consent is a separate process from the DCO process and would be undertaken following the approval of the DCO.

4.138. The Proposed Development would require below ground electricity and data cables to cross on-Site watercourses. To minimise effects, service crossings of watercourses would be rationalised to minimise the number of crossings. Crossings of IDB maintained ordinary watercourses would be installed by directional drilling techniques under the channel of the watercourse and be based on the following design parameters:

- The service crossing is within 10 degrees of perpendicular to the direction of flow in the watercourse.
- The service crossing is at least 1.5m below the bed of the watercourse along its whole length, and the same height is maintained for at least 5m beyond each bank (measured from the top).
- The service crossing does not pass through any bank, culvert, formal flood defence or other structure.
- Appropriate permanent hazard markers on both banks should be installed.
- Works do not disturb the bed and banks of the watercourse.

4.139. If alternative construction methods for service crossings of IDB maintained ordinary watercourses are utilised, it is likely that IDB Byelaw consent would be required, and construction methods should be approved by the Selby Area IDB.

4.140. Landscape planting is required to screen the Proposed Development and would consist of the reinforcement of existing hedgerows and planting of new hedgerows and trees. Landscape planting is predominately 7m from the top of bank of the ordinary watercourses on the Site. To provide a comprehensive landscape scheme sympathetic to existing vegetation new landscape planting is proposed within 7m of an ordinary watercourse at a number of locations on the Site. Where this is proposed, at least a 7m area free of development or landscape planting is retained on the opposite side of the ordinary watercourse to ensure maintenance access to the ordinary watercourse is retained. The areas of landscape planting within 7m of an ordinary watercourse will be subject to IDB Section 66 (Byelaw) Consent. The proposed landscape planting scheme and areas where landscape planting is within 7m of an ordinary watercourse is shown on Drawing No. 012006.00001.101 Rev 0 reproduced in **Appendix 16**.

Summary of Flood Mitigation Measures

4.141. The Proposed Development extends into areas of elevated flood risk from the combined fluvial and tidal flood. The Proposed Development will be designed to appropriately safe in the combined fluvial and tidal design flood without increasing flood risk elsewhere. The following design flood mitigation measures are proposed:

- The construction contractor and operating staff will register to receive flood alerts / warnings from the Environment Agency and follow site evacuation procedures during periods of elevated flood risk;
- During times of elevated tidal and fluvial flood risk the solar PV arrays within the areas of elevated flood risk will be rotated to the horizontal stow position which will be a minimum of a 0.3m above the combined fluvial and tidal design flood level;
- Panel supports and security fencing in flood risk areas will be securely piled into the ground and designed to allow for the effect of flowing water pressures and to be resistant to inundation during a flood event;
- Security fencing mesh size in flood risk areas is increased to 0.15m square to minimise the risk of it collecting debris;
- Ancillary equipment, BESS facility and 132kv Substation in areas of elevated flood risk will be protected by a suitably designed earth flood defence bunds. The height of the proposed earth flood defence bunds will be raised at least +0.6m above the combined fluvial and tidal design flood level to protect the equipment from inundation;
- Level for level floodplain compensation will be provided on the Site to mitigate the effect of the earth flood defence bunds;
- On-Site watercourses are retained and existing watercourse crossings are utilised where possible within the Proposed Development;
- Where possible all development (including security fencing) is at least 7m from the on-Site ordinary watercourses in accordance with Selby Area IDB byelaws. Additional consents may be required for watercourse crossings (site access or services) and landscape planting where this is not achieved.

4.142. These flood mitigation measures would ensure that the Proposed Development would remain operational and safe in times of the design flood and can be secured by a suitably worded DCO requirement requiring the submission of details to be submitted to and approved by the Local Planning Authority.

Development and Flood Risk

4.143. This section summarises the Site-specific flood risk from all sources of flooding when both the Proposed Development and flood mitigation measures are taken into account.

4.144. The design of the equipment will be finalised following the results of the site-specific flood modelling and this FRA will be updated to inform the ES to be submitted in support of the application for development consent for the Proposed Development.

Flooding from Watercourses and Tidal Sources

4.145. As set out above, in terms of providing an acceptable standard of protection against flooding for new development, the Proposed Development has been designed to remain operational and safe during the fluvial and tidal design flood without increasing flood risk elsewhere.

4.146. For the purposes of this assessment and in the absence of a site-specific flood model, the 0.5% AEP joint probability event is considered to be a suitable proxy for the combined fluvial and tidal design flood. The modelled flood depths for the 0.5% AEP (1 in 200 RP) joint probability event are shown on Drawing No. E216/21 Rev B contained in **Appendix 12**.

4.147. The maximum depth of flooding in the 0.5% AEP (1 in 200 RP) joint probability event for the Solar Farm Zone is up to 1.4m. Taking into account the design mitigation measures, the stow position of the solar panels will be at least 0.3m above the combined fluvial and tidal design flood level, with much larger freeboard achieved across the majority of the Proposed Development. The proposed solar PV panels would therefore be raised above the combined fluvial and tidal design flood level when design and management mitigation measures are taken into account. The solar PV panels would continue to operate safely in times of flooding and would not displace floodwaters.

4.148. The ancillary control equipment, BESS facility and 132kv Substation would be protected by suitably designed earth flood defence bunds at least +0.6m above the design flood level. The earth flood defence bunds would protect the equipment from inundation and would continue to operate safely in times of flooding.

4.149. The provision of level for level floodplain compensation to mitigate the effect of the flood defence earth bunds displacing flood waters would ensure that the Proposed Development would not increase flood risk elsewhere.

4.150. Where built development is proposed, the post-development risk of flooding from combined and tidal sources are the same as the pre-development risk and ranges between ‘high’ and ‘very low’ on the Site. The design and management flood mitigation measures ensure that the Proposed Development would remain operational and safe during the combined fluvial and tidal design flood without increasing flood risk elsewhere; this assessment will be refined in due course based on the site-specific flood modelling.

Flooding from Surface Water

4.151. Solar PV arrays, security fencing, and access tracks extend into areas of elevated surface water flood risk.

4.152. Solar PV arrays, security fencing, and access tracks would not be vulnerable to the shallow depths and flow of the surface water. Due to the depth of surface water flooding being less than the combined fluvial and tidal design flood, the height of the solar PV arrays above the highest risk and level of surface water accumulation, and the nature of the equipment, the Proposed Development is appropriate in these areas, would continue to operate safely and would not increase flood risk elsewhere.

4.153. The ancillary control equipment, BESS facility and 132kv Substation would be preferentially located in areas of very low surface water flood risk.

4.154. Overland flows would be intercepted by the proposed interception swales described in Section 5 below which would ‘slow the flow’ providing flood risk betterment.

4.155. Where built development is proposed, the post-development risk of flooding from surface water sources is the same as the pre-development risk and ranges between ‘high’ and ‘very low’ on the Site. The design and management flood mitigation measures would ensure that the Proposed Development would remain operational and safe during the periods of elevated surface water flood risk and is compatible in these areas without increasing flood risk elsewhere.

Flooding from Groundwater

4.156. The solar PV panels would be elevated above ground level and all control equipment would be raised at least 0.3m above ground level and would therefore be unaffected by shallow emergent groundwater and overland surface water flows.

4.157. The post-development risk of flooding from groundwater is assessed as 'very low' to 'high' for the Site based on the available information due to the presence of groundwater bearing superficial and bedrock deposits and low-lying nature of the Site. The design and management flood mitigation measures ensure the Proposed Development is resilient to shallow emergent groundwater and overland surface water flows and can operate safely in these conditions.

Flooding from Overwhelmed Sewers and Drainage Systems

4.158. No change compared with pre-development risk and no significant foul water drainage infrastructure is required to serve the Proposed Development.

Flooding from Artificial Sources

4.159. Reservoirs are present in the upstream catchment which could pose a risk to the Site. The post development risk of flooding from artificial sources is considered to be a 'low' residual risk. However, due to the management regime for the reservoirs, a failure is considered to be extremely unlikely and a managed risk.

4.160. The design and management flood mitigation measures required to ensure the Site is safe from the combined tidal and fluvial flood event provide additional resilience for the risk of flooding from reservoir failure.

Residual Risk

4.161. Residual risks are those remaining after applying the sequential approach to the location of development and after the flood risk management and mitigation measures are implemented. Examples of residual risk include:

- a breach of a raised flood defence, blockage of a surface water conveyance system or failure of a pumped drainage system;
- failure of a reservoir; and
- a flood event that exceeds a flood management design standard, such as a flood that overtops a raised flood defence, or an intense rainfall event which the drainage system cannot accommodate.

4.162. The Proposed Development is not 'occupied' and therefore there is no risk to users of the Proposed Development. Construction or occasional maintenance activities would be scheduled to avoid periods of elevated flood risk. During times of elevated flood risk, no personnel would be onsite and access to the Proposed Development would be restricted. Therefore, due to its 'unoccupied' nature, the Proposed Development would be safe for users in times of flood. Sensitive plant would be able to be shut down and restarted remotely in response to a flood alert. When a flood alert / warning is issued the Proposed Development would be evacuated as a precautionary measure using the local highway network in accordance with the Proposed Development's flood warning and evacuation plan.

4.163. Due to the Site's position in the lower catchment of the River Ouse and River Aire, the risk of an extreme combined fluvial and tidal flood can be readily forecast. This is as a result of the cyclical nature of tides required to combine with a tidal surge (which can also be forecast) and the lag between excessive rainfall in the upper fluvial catchment resulting in increased peak river flows at the Site. As such, there would be sufficient warning to evacuate the Proposed Development if a flood warning is issued when on-Site maintenance activities are being undertaken before a flood event would occur at the Site.

4.164. The residual risk of breach of an Environment Agency strategic flood defence along the River Aire will be considered as part of the site-specific flood model. There is a residual flood risk if the Environment Agency's strategic flood defences were to fail which is above the standard of protection for new development and a commercial risk to the developer.

4.165. The residual risk of the credible maximum climate change scenario will be assessed as part of the site-specific flood model. Appropriate adaptation measures in the form of additional or revised design or management mitigation measures will be identified if required.

4.166. There is a residual risk of earth flood defence bunds protecting ancillary control equipment, BESS facility and 132kv substation overtopping or failing. The residual risk of overtopping is significantly reduced by incorporating a 0.6m freeboard above the design flood level. This significantly increases the standard of protection of the earth flood defence bunds. The sensitivity of the design mitigation measures to the maximum credible climate change scenario will be assessed as part of the site-specific flood model. The failure of the earth flood defence bunds is a commercial risk. The risk of failure would be reduced by regular inspections by site operatives as part of their site-wide maintenance activities. If areas of erosion or deterioration are identified these would be reported to the site manager and appropriate remedial measures actioned to ensure the integrity of the earth flood defence bund is maintained.

4.167. A summary of the potential risk from all sources of flooding post-development with the various development flood mitigation measures incorporated is shown in **Table H** below.

Table H: Post-development Potential Flood Risk from All Sources of Flooding

Flood Source	Potential Risk	Description
Watercourses	High – Very Low	No change compared with pre-development risk. Flood defences along the River Aire are overtopped once the effect of climate change on peak river flows and tidal levels are taken into account. The design and management flood mitigation measures ensure the Proposed Development is appropriately flood resilient and resistant and can remain operational and safe during the fluvial and tidal design flood without increasing flood risk elsewhere. Site staff will adhere to site evacuation procedures if an Environment Agency flood warning is issued which protects the operatives from the residual risk. The assessment will be refined on the basis of the site-specific flood modelling.
Surface Water	High - Very Low	No change compared with pre-development risk. Majority of the Site is at very low risk with areas of elevated risk associated with isolated low points where surface waters could collect and the route of onsite ordinary watercourses. The sequential approach to the layout restricts ancillary control equipment, BESS facility and 132kv Substation to areas of very low risk. All sensitive equipment is raised above ground level or protected by suitably designed earth flood defence bunds and would not be susceptible to shallow overland flows. Overland flows would be intercepted by proposed interception swales providing a degree of betterment downstream.
Groundwater	High – Very Low	No change compared with pre-development risk. All sensitive equipment is raised above ground level and is resilient to shallow emergent groundwater and overland surface water flows and can operate safely in these conditions.
Overwhelmed Sewers	Low - Very Low	No change compared with pre-development risk and no significant foul water drainage infrastructure is required to serve the Proposed Development.
Artificial Sources	Low	No change compared with pre-development risk. The design and management flood mitigation measures required to ensure the Proposed Development is safe from the tidal and fluvial flood event would improve the resilience of the Proposed Development to the residual risk of flooding from reservoir failure.
Off-site Impacts	Low	The effect of the earth flood defence bunds on floodwaters will be mitigated with level for level floodplain compensation and assessed as part of the site-specific flood model.

4.168. Based on the above, it is considered that the proposed design flood mitigation measures would safely manage any residual risks from flooding during the design flood and the Proposed Development would remain operational and safe.

4.169. Residual risk to the operatives in event of defence failure is managed through restricting access to the Site and following site evacuation procedures during periods of elevated tidal flood risk. Residual risk to the Proposed Development in event of defence failure is above the standard of protection required for new development and therefore a commercial risk for the developer.

4.170. The design of the equipment and flood mitigation measures will be refined and finalised following the results of the site-specific flood modelling and this FRA will be updated to inform the ES to be submitted in support of the application for development consent for the Proposed Development.

Additional Consents

4.171. Additional consents would potentially be required for any works to watercourses in addition to securing approval of the DCO application.

4.172. Culverting of ordinary watercourses (drainage ditches) could require consent from Selby Area IDB under Section 23 of the Land Drainage Act 1991.

4.173. Selby Area IDB Byelaw 10 states:

> **'No person without the previous consent of the Board shall erect any building or structure, whether temporary or permanent, or plant any tree, shrub, willow or other similar growth within 7 metres of the landward toe of the bank where there is an embankment or wall or within 7 metres of the top of the batter where there is no embankment or wall, or where the watercourse is enclosed within 7 metres of the enclosing structure.'**

4.174. The Parameters plan avoids development within 7m of ordinary watercourses on the Site except where access track watercourse crossings are required. Where works or landscape planting are within 7m of the bank of an ordinary watercourse the requirement for IDB Section 66 (Byelaw) Consents should be assessed.

NPPF Planning Policy Requirements

Flood Risk Vulnerability and Flood Zone 'Compatibility'

4.175. Annex 3 of the NPPF sets out the Flood Risk Vulnerability Classification of development and categorises different types of development according to their vulnerability to flood risk. Paragraphs 77-78 of the Flood Risk and Coastal Change Planning Practice Guidance refer to two Flood Zone and Flood Risk Tables. Table 1: Flood Zones provides a definition of each Flood Zone. Table 2: Flood risk vulnerability and flood zone 'compatibility' maps the vulnerability classes against the flood zones to indicate where development is appropriate and where development should not be permitted.

4.176. The Environment Agency's Flood Map for Planning[30] indicates that a large proportion of the Site falls within Flood Zone 3 and as set out in paragraph 2.15, these areas are classified as Flood Zone 3a. Smaller areas of Flood Zones 1 and 2 are present on the Site.

4.177. With reference to Annex 3 of the NPPF, solar farms are classified as Essential Infrastructure.

[30] Environment Agency (2023) Flood Map for Planning. Available from: https://flood-map-for-planning.service.gov.uk/

4.178. With reference to Table 2, Essential Infrastructure is appropriate in Flood Zones 1 and 2, and is also appropriate in Flood Zones 3a and 3b if the Exception Test is passed.

4.179. The Notes to Table 2 state that in Flood Zone 3a Essential Infrastructure should be designed and constructed to remain operational and safe in times of flood.

4.180. Notes to Table 2 states that the table does not show the application of the Sequential Test which should be applied first to guide development to the lowest flood risk areas.

Sequential Test

4.181. As set out in paragraph 162 of the NPPF, the aim of the Sequential Test is to steer new development to areas with the lowest risk of flooding from any source.

4.182. A solar farm of the scale proposed requires an appropriate connection to the National Electricity Grid where there is available capacity. The area in the vicinity of the Site is at predominately high risk of flooding and areas of lower risk of flooding are limited when other material planning considerations (landscape, agricultural land quality etc) and design considerations (slope of site and aspect) have been taken into account which also have implications for the suitability of sites for renewable energy schemes. Chapter 4 Alternatives and Design Evolution of the PEIR provides the supporting evidence for the Sequential Test and the appropriateness of the Site, taking into account other material planning considerations and land availability.

4.183. By locating development in areas of Flood Zone 3a, the Proposed Development maximises the renewable energy generation potential of the Site and makes use of available capacity in the National Electricity Grid at this location taking into account other material planning and design considerations.

4.184. On this basis, it is considered the Sequential Test is satisfied and a solar farm is compatible at this location subject to satisfying the requirements of the Exception Test as discussed below.

Exception Test

4.185. The Proposed Development is located within Flood Zone 3a. Essential Infrastructure is appropriate in this zone provided the Exception Test is passed.

4.186. Paragraph 163 of the NPPF states:

> **'If it is not possible for development to be located in areas 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 exception test will depend on the potential vulnerability of the site and of the development proposed, in line with the Flood Risk Vulnerability Classification set out in Annex 3.'**

4.187. Paragraph 164 of the NPPF states:

> **'The application of the exception test should be informed by a strategic or site-specific flood risk assessment, depending on whether it is being applied during plan production or at the application stage. To pass the exception test it should be demonstrated that:**
>
> **a) the development would provide wider sustainability benefits to the community that outweigh the flood risk; and**

b) 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.'

4.188. Paragraph 165 of the NPPF goes onto state:

'Both elements of the exception test should be satisfied for development to be allocated or permitted.'

4.189. With respect to part a of the Exception Test it is clear that renewable energy has wider sustainability benefits by reducing reliance on carbon-based fuels and meeting UK carbon emission and 2050 net zero targets. The nature of the Proposed Development satisfies part a of the Exception Test.

4.190. With respect to part b of the Exception Test, this FRA demonstrates that the proposed mitigation measures would ensure that the Proposed Development would be appropriately safe without increasing flood risk elsewhere.

4.191. The Proposed Development would not be occupied and therefore there would be no risk to users of the development. During times of flood risk, no personnel would be onsite or have access to the Site. Accordingly, the Proposed Development and its users would be safe.

4.192. Design flood mitigation measures are proposed to either raise sensitive equipment above the design flood level or protect the sensitive equipment from the combined fluvial and tidal design flood. These measures protect the equipment during the design flood, with an appropriate climate change allowance, and the appropriate design of support structures to withstand flood waters would ensure that the development would remain operational and safe in times of flood.

4.193. Level for level floodplain compensation will be provided to mitigate the effect of the earth flood defence bunds displacing flood waters. These measures would ensure the risk of flooding elsewhere is not increased and would be assessed as part of the site-specific flood model.

4.194. The provision of interception swales, discussed in Section 5 below, would have a minor benefit in reducing overland flows during extreme rainfall events. On this basis, the Proposed Development would not increase flood risk on-Site or elsewhere and would preserve the Site's natural drainage regime.

4.195. It is considered that the Proposed Development satisfies both the Sequential Test and the Exception Test, and that development within Flood Zones 3a is compatible with respect to flood risk.

5. SURFACE WATER DRAINAGE ASSESSMENT

Hydrological Effect of Solar Farm Developments

5.1. It is generally accepted that solar farm developments have a minimal effect on runoff rates as long as permanent vegetation is maintained under and around the solar PV panels. The area of the Site where a solar farm development is located remains a predominately permanently grassed field with discrete control equipment distributed across its area. This general view is supported by guidance, as summarised below, and quantified in the sections below.

5.2. The Building Research Establishment ('BRE') published its 'Biodiversity Guidance for Solar Developments'[31] in 2014. The report recognises that for most solar farm developments:

> **'normally only 25-40% of the surface is over-sailed by panels' and 'because panels are raised above the ground on posts greater than 95% of a field utilised for solar farm development is still accessible for plant growth …'**

5.3. Natural England's 'Technical Information Note TIN101: Solar Parks: Maximising Environmental Benefits'[32] states:

> **'The key to avoiding increased run-off and soil into watercourses is to maintain soil permeability and vegetative cover. Permeable land surfaces underneath and between panels should be able to absorb rainfall as long as they are not compacted and there is some vegetation to bind the soil surface.'**

5.4. In addition, Cook and McCuen's (2013) 'Hydrologic Response of Solar Farms'[33] research paper concludes that provided grass cover is maintained, the addition of solar panels over a grassy field has a limited effect on runoff volumes, the peak runoff and the time to peak. A copy of the research paper's abstract (with our emphasis added) is reproduced below:

> **'Because of the benefits of solar energy, the number of solar farms is increasing; however, their hydrologic impacts have not been studied. The goal of this study was to determine the hydrologic effects of solar farms and examine whether or not storm-water management is needed to control runoff volumes and rates. A model of a solar farm was used to simulate runoff for two conditions: the pre- and post paneled conditions. Using sensitivity analyses, modeling showed that the solar panels themselves did not have a significant effect on the runoff volumes, peaks, or times to peak. However, if the ground cover under the panels is gravel or bare ground, owing to design decisions or lack of maintenance, the peak discharge may increase significantly with storm-water management needed. In addition, the kinetic energy of the flow that drains from the panels was found to be greater than that of the rainfall, which could cause erosion at the base of the panels. Thus, it is <u>recommended that the grass beneath the panels be well maintained or that a buffer strip be placed after the most downgradient row of panels</u>. This study, along with design recommendations, can be used as a guide for the future design of solar farms.'**

5.5. It follows that the majority of the 'developed' site for the proposed solar farm development will remain as 'soft' surface, with grassland around and underneath the solar PV panels, which in itself will minimise runoff from the Site.

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[31] BRE (2014) Biodiversity Guidance for Solar Developments. Eds G E Parker and L Greene.
[32] Natural England (2011) Natural England Technical Information Note TIN101 Solar parks: maximising environmental benefits.
[33] Cook & McCuen (2013) Hydrologic Response of Solar Farms, Journal of Hydrologic Engineering, 18(5), 536-541.

5.6. For a typical solar farm development, the solar PV arrays are spaced to avoid any shadowing effect from one panel to another, with topography dictating the exact row spacing, which usually ranges between 3m and 4m. Between each row of solar PV panels is typically a 3m to 4m vegetated buffer strip, which contributes to slowing the flow of runoff across the development site.

5.7. **Figure 15** shows a typical scene from an operational solar farm with vegetation cover between and under the solar PV arrays, which delays surface wate runoff and prevents soil erosion.

Figure 15: A Typical Operational Solar Farm (Credit: Energy Guide UK[34])

5.8. Soil compaction is limited during construction, operation and decommissioning of solar farm developments. During construction, only light machinery is required to install the solar PV arrays and vehicle movements would be minimised. Low ground pressure vehicles are recommended during wet weather working. Any HGVs are usually restricted to a temporary construction compound near the site’s entrance.

5.9. If necessary, to alleviate the effects of any compaction during the construction process, any affected areas are harrowed and seeded.

5.10. During operation of a solar farm development, maintenance of the solar PV panels is usually infrequent, minimal and requires only light machinery. Thus, the infiltration rate of the underlying ground is unlikely to be changed by the Proposed Development.

5.11. During the operation of a typical solar farm development, the areas under and around the solar PV array will be suitable for grazing by livestock, typically sheep.

5.12. At present, the Site is used for arable agriculture which requires periodic ploughing. Exposed soil is at a greater risk of erosion compared with a field with covering vegetation and can result in greater runoff. Upon completion of the Proposed Development, the Site will be permanently grassed thereby reducing the risk of soil erosion and reducing potential runoff compared with the existing condition.

[34] Energy Guide UK (2023) Solar Panel Trackers. Available from: https://energyguide.org.uk/solar-trackers/ (Accessed on 22.05.23)

5.13. Taking into account the above, the proposed surface water management measures for the Proposed Development need to be proportionate to the minimal hydrological effect of solar farm developments. The effect of the Proposed Development on runoff rates and volumes is assessed below.

Sustainable Drainage Systems Guidance

5.14. The Proposed Development has an expected energy generating capacity in excess of the 50MW threshold for onshore generating stations in England and therefore constitutes a NSIP and the NPS therefore apply to the DCO application.

5.15. NPS EN-1 notes the FRA should also make appropriate arrangements to manage surface water and priority is given to the use of SuDS. NPS EN-3 does not reference drainage matters, whereas Revised (Draft) NPS EN-1 includes the requirement for appropriate arrangements to manage surface water, including the use of SuDS.

5.16. Furthermore, paragraph 3.10.76 of the Revised (Draft) NPS EN-3 states:

> **'Where access tracks need to be provided, permeable tracks should be used, and localised Sustainable Drainage Systems (SuDS), such as swales and infiltration trenches, should be used to control any run-off where recommended.'**

5.17. Whereas paragraph 3.10.145 of the Revised (Draft) NPS EN-3 states:

> **'Water management is a critical component of site design for ground mount solar plants. Where previous management of the site has involved intensive agricultural practice, solar sites can deliver significant ecosystem services value in the form of drainage, flood attenuation, natural wetland habitat, and water quality management.'**

5.18. Paragraph 55[35] in the Flood Risk and Coastal Change planning practice guidance advises that SuDS are designed to control surface water runoff close to where it falls and mimic natural drainage as closely as possible. SuDS can contribute to reducing the causes and impacts of flooding and deliver a wider range of additional biodiversity and environmental net gains.

5.19. Guidance on the design and construction of SuDS is provided in Ciria C753 'The SuDS Manual'[36].

5.20. The principles of the sustainable drainage strategy for the Proposed Development, involving the implementation of SuDS as promoted by the designated and draft NPSs and NPPF, are discussed below.

Natural Flood Risk Management Guidance

5.21. Paragraph 64 of the Flood Risk and Climate Change planning practice guide states:

> **'Natural flood management techniques work with natural processes to protect, restore and emulate the natural functions of catchments, floodplains, rivers and the coast. They aim to manage the sources and pathways of flood waters whilst providing wider benefits to people, wildlife and the environment.'**

[35] Department for Energy Security and Net Zero (2023) Guidance Flood risk and coastal change - Sustainable drainage systems. Available from: https://www.gov.uk/guidance/flood-risk-and-coastal-change#para55 (Accessed on 22.05.23).
[36] CIRIA (2015) The SuDS Manual (Version 6 including 2016, 2018, 2019) CIRIA C753.

5.22. Ciria published the Natural Flood Management Manual (C802)[37] in 2022 which provides further background information and guidance on the different NFM measures that can be implemented to reduce flood risk. NFM measures can be used across the landscape to protect, restore or mimic the natural hydrological process that occur. These include increasing infiltration of water, slowing the flow of water across the landscape, storing water and holding back sediment. NFM can also deliver co-benefits such as habitat creation and biodiversity enhancement, soil improvement and retention and water quality improvements.

5.23. Natural Flood Management Manual (C802) divides NFM into 13 broad categories of which soil and land management, runoff management, and runoff storage are particularly relevant to solar farm developments.

5.24. Soil and land management techniques include changes to land management practices to reduce soil compaction, and encourage more natural habitats to restore or enhance the ability of the soil to infiltrate and store water. Additional vegetation will increase interception and evapotranspiration and an improved soil structure can increase evaporation from the near-surface soil and this can be achieved through the use of cover crops and reduced till techniques (reduced ploughing). Permanent vegetation cover therefore increases surface roughness and maintains soil structure, slowing the flow of runoff.

5.25. Runoff management techniques include buffer strips to interrupt or divert overland flow pathways across the landscape and encourage infiltration into the ground, slowing the flow and diverting water away from problematic locations. As described above, vegetation in buffer strips will increase onsite interception and evapotranspiration. Encouraging areas of temporary standing water and waterlogged ground stores water on the land surface, increasing the potential for evaporation losses.

5.26. Runoff storage techniques include scrapes, bunds and swales to store water on overland flow pathways to reduce the flow towards a watercourse and encourage infiltration. As well as increasing the potential for evaporation losses, these techniques can be used to lengthen the flow pathway, slowing the progress of runoff across the landscape. In addition, infiltration losses increase with increased residence time and even on sites with relatively impermeable ground conditions, long residence time will still encourage infiltration losses.

5.27. The use of both multifunctional SuDS and NFM techniques to manage flood risk from development sites is recognised in paragraph 49 of the Flood Risk and Coastal Change planning practice guidance.

5.28. The nature of solar farm developments in rural locations with minimal impact on runoff rates or volumes mean that NFM techniques are an appropriate means of managing surface water runoff from the Proposed Development that would contribute to delivering flood risk betterment and reducing flood risk overall. NFM techniques are considered in the section below in addition to SuDS techniques.

Proposed Surface Water Management Measures

5.29. A sustainable drainage strategy, involving the implementation of SuDS and NFM techniques, is proposed for managing the surface water runoff from the Proposed Development.

[37] CIRIA (2022) The natural flood management manual CIRIA C802.

Management of Runoff from Solar PV Panels and Ancillary Control Equipment

Runoff Rate Assessment

5.30. The Proposed Development would have a very limited extent of impermeable ground cover. The area beneath the solar PV panels would remain grassed and the post development infiltration rate would not adversely change. The excavation of cable trenches, which are backfilled with a granular surround to the cables and then backfilled with excavated material, potentially increases the infiltration capacity of the Site as the cable trenches act as land drains. Nonetheless, rainwater falling onto each panel would drain freely onto the ground beneath the panel and infiltrate into the ground at the same rate as it does in the Site's existing greenfield state, as indicated in TIN101. Thus, the total surface area of the solar PV array will not be considered an impermeable area in this assessment, only the area taken up by the panel supports. Similarly, it can be assumed that any rainwater falling onto the semi-permeable access tracks would soak into the ground beneath or adjacent to the tracks at the same rate that it presently does. The effect of the BESS facility and 132kv Substation are considered separately in the sections below.

5.31. The extent of impermeable area created as a result of the solar farm is summarised in **Table I** below.

Table I: Created Impermeable Areas

	Quantity	Unit Area (m^2)	Total Area (m^2)
Piles	54,875	0.0044	241.45
Concrete Ballast Foundations	1,421	2.50 x 0.50 = 1.25m	1,776.25
Inverters/Transformer Stations	28	12.20 x 2.40 = 29.28	819.84
Total Impermeable Area			2,837.54
Solar Farm Zone Area (within security fence)			2,977,387.51
Total Impermeable Area = 0.10% of Total Site Area			

Notes: Calculations exclude the BESS facility which is assessed separately below.

5.32. In a greenfield state, the Site is considered to be 100% undeveloped. As a result of the Proposed Development, the extent of impermeable area would be approximately 2,838 m^2 or 0.10 % of the total Solar Farm Zone area.

5.33. The Environment Agency's report Rainfall Runoff Management for Developments [Report – SC030219][38] published in October 2013 provides advice on the management of stormwater drainage for developments including the calculation of greenfield runoff. The report states:

> **'The Environment Agency will normally require that, for the range of annual flow rate probabilities, up to and including the 1% annual probability (1 in 100 year event) the developed rate of runoff into a watercourse should be no greater than the undeveloped rate of runoff for the same event based on the calculation of Q_{BAR} or Q_{MED} and the use of FSSR growth curves.'**

[38] Environment Agency (2013) Rainfall Runoff Management for Developments [Report – SC030219]

5.34. Table 1 of that Report states that for developments between 0ha and 50ha, the Institute of Hydrology (IH) Report 124 Flood Estimation for Small Catchments (1994)[39] method (the 'IH 124 Method') can be used to estimate the greenfield site flow rate, Q_{BAR} (the Mean Annual Flood).

5.35. By examining the maps contained in Volume V of the Flood Studies Report – NERC:1975[40], the Standard Average Annual Rainfall ('SAAR') and Winter Rain Acceptance Potential ('WRAP') can be used to determine in which Soil Index Class a given site is located, and the corresponding Soil Index value is then used to calculate Q_{BAR} using the IH 124 Method.

5.36. The FSR WRAP Map, shown in **Appendix 6**, indicates that the Site is located in 'Soil Index Class 2', and a corresponding Soil Index value of 0.3 has been used to calculate Q_{BAR} using the IH 124 Method.

5.37. Q_{BAR} has been calculated for the Site in both undeveloped 'greenfield' and post-development site states. Copies of the Micro Drainage greenfield runoff calculations are included in **Appendix 17**. A summary of the pre and post development runoff rates for the various return period events is shown in **Table J**. The mean annual peak rate of runoff, referred to as Q_{BAR} in IH 124 Method, for the pre-development greenfield Site is 390.5 l/s; for the post-development Site Q_{BAR} is calculated as 391.4 l/s.

Table J: Solar Farm Runoff Rates Assessment

Return Period (Years)	1	Q_{BAR}[a]	30	100
Greenfield Runoff Rates (l/s)	335.9	390.5	686.5	812.3
Post Development Unmitigated Runoff Rate (l/s)	336.6	391.4	687.9	813.8

[a] Q_{BAR} = Mean Annual Flood with an approximate return period of 2.3 years.

5.38. The calculations contained in **Appendix 17** quantify the effect of the proposed solar farm on greenfield runoff rates. These calculations demonstrate that the effect of the Proposed Development on Q_{BAR} runoff rates would be negligible and only equates to an increase of 0.9 l/s of the greenfield runoff rate across the 297.739ha of the Site where solar PV arrays are proposed (or 0.23 % of the greenfield runoff rate).

Runoff Volume Assessment

5.39. The Depth-Duration-Frequency ('DDF') Model function was used in the Flood Estimation Handbook ('FEH') web service[41] to calculate the depth of rainfall from a 24-hour, 100-year storm event at the Site. The results of this calculation are shown on **Figure 16** below. The rainfall depth is uplifted to take into account the effect of climate change over the lifetime of the Proposed Development. Thus, the 24-hour, 100-year plus climate change design rainfall for the Site is 101.56mm (or 0.102m) (78.12 x 1.3). The total extent of impermeable area created as a result of the Proposed Development would be 2,838 m^2. The volume of runoff generated by this rainfall event falling on 2,838 m^2 impermeable area calculated by this method equates to 289.48 m^3.

5.40. On this basis, the additional runoff generated in the extreme 24-hour duration, 1 in 100 year storm event, including an allowance for climate change, would amount to approximately 289.5 m^3.

[39] Institute of Hydrology (1994) Report No. 124 Flood Estimation for Small Catchments.
[40] Natural Environment Research Council (1975) Flood Studies Report
[41] UK Centre for Ecology & Hydrology (2023) Flood Estimation Handbook Web Service. Available from: https://fehweb.ceh.ac.uk/ (Accessed on 22.05.23)

Figure 16: Depth-Duration-Frequency (DDF) Modelling Outputs

Conversion to Permanent Pasture

5.41. The proposed conversion to permanent pasture is a key mitigation measure for reducing runoff from the Proposed Development and would be a significant improvement on the existing situation which requires periodic ploughing, exposing soil and temporarily increasing runoff rates.

5.42. Vegetation cover would be maintained in the areas around the solar PV panels and field margins throughout the lifetime of the Proposed Development to minimise the risk of soil erosion and reduce runoff rates. Between each row of solar PV panels and around the margins of the Site a 3 – 10m vegetated buffer strip is proposed which would contribute to slowing the flow across the Solar Farm Zone in accordance with the good practice suggested by Cook and McCuen.

5.43. Natural England's 'Technical Information Note TIN101: Solar Parks: Maximising Environmental Benefits' encourages existing land drainage to be maintained. Existing on-Site drainage ditches or features will therefore be retained in their existing state and will continue to intercept overland flows from the Site.

5.44. The majority of the Site lies in relatively low gradient land. The proposed conversion to permanent pasture and maintaining vegetation cover would reduce the risk of soil erosion.

Interception Swales

5.45. As discussed above, the mitigation of runoff from solar PV panel areas and areas of discrete control equipment would primarily be achieved by the conversion of the Site to permanent pasture. Nonetheless, interception swales are provided as part of the Proposed Development to intercept runoff, 'slow the flow' and provide flood risk betterment in accordance with industry best practice.

5.46. Whilst it is considered that the solar PV panels oversailing permanent pasture would not result in a material increase in surface water runoff, it is proposed to provide a SuDS arrangement by way of interception swales in the lower areas of the Site to intercept extreme flows which may already run off-Site. It is emphasised that the swales do not form part of a formal drainage scheme for the Proposed Development but are provided as a form of 'betterment' intercepting existing overland flows. The proposed interception swales are designed to have a significantly larger capacity than the increase in runoff volume created by the discrete control equipment distributed around the 475.68ha area of the Site.

5.47. The approach is considered a practical implementation of Rural Sustainable Drainage Systems ('RSuDS') [42] as a means of intercepting runoff and 'slow down flow' with the aim to form 'micro-wetlands' for the benefit of farmland biodiversity and encourage localised recharge of groundwater whilst providing a degree of flood risk betterment. The concept of RSuDS has evolved into the broader field of NFM and Working With Natural Processes methodology (WWNP). The Environment Agency's WWNP evidence base, published in February 2018, lists swales as a form of 'runoff pathway management'. These techniques aim to delay and even flatten the hydrograph and reduce peak flow locally for small events by intercepting, slowing and filtering of surface water runoff and encouraging infiltration and soil water storage. The use of interception swales is a practical implementation of a NFM runoff storage technique.

5.48. The proposed drainage arrangements, showing the indicative interception swale locations which are situated having regard to overland flow routes, are shown on Drawing No. E216/90-106 Rev B contained in **Appendix 18**.

5.49. The purpose of the interception swales is simply to intercept runoff and encourage depression storage within the feature during the extreme storm event, promoting interception losses by infiltration or evapotranspiration and providing runoff pathway management. As such no specific overflow mechanism is proposed for the Proposed Development. Interception swales would overtop as sheet runoff and overland flow would follow the natural topography as per the pre-development situation. This 'simplified' approach to runoff management is considered appropriate and proportionate to the type of development and magnitude of the effect discussed above and is readily reversible at the end of the design life of a solar farm development, during the Proposed Development's decommissioning phase.

5.50. The interception swales are proposed around the perimeter and at low points of the Site as a series of discrete 'stepped' units parallel to the Site's contours and perpendicular to the slope to ensure flows are not concentrated or conveyed downhill.

5.51. Interception swales are typically formed by creating shallow depressions a minimum of 0.2m deep, with 1 in 3 side slopes, and a base width of 0.5m along the lower boundaries of the Site as shown on the typical details in **Appendix 18**.

5.52. The interception swales have no formal discharge arrangements but would gradually empty by a process of infiltration, evaporation, and evapotranspiration and provide runoff pathway management. Exceedance flows would be managed by overland flow routing which mimic the natural greenfield response of the Site.

5.53. The storage volume of the interception swales has been calculated on the basis that the swales will be 1/2 full (incorporating a 0.1m freeboard). The interception swales provide a total storage volume of approximately 398m^3. This is greater than the volume of additional runoff generated as a result of the 24 hour, 100 year plus climate change rainfall event (289.5m^3). It is therefore considered that the interception swales would adequately mitigate any increase in runoff volume generated as a result of the minor increase in impermeable area created by the discrete control equipment and would be beneficial in reducing the potential runoff from the Site in more extreme storm events.

[42] Environment Agency (2012) Rural Sustainable Drainage Systems (RSuDS)

5.54. Interception swales would be sown with the appropriate seed mix upon construction and vegetation would be maintained by the landowner thereafter for the lifetime of the Proposed Development.

5.55. The interception swales would be located outside of any Root Protection Zones, would not be located within 7m of any ordinary watercourses or drainage ditches and would respect the natural topography in accordance with local bye-laws.

5.56. Considering the above, the designed volume of depression storage provided in the interception swales for the Proposed Development would be more than sufficient to mitigate the change in runoff rates and volumes created by the ancillary control equipment distributed across the Site.

5.57. Where ancillary control equipment is located in an area of elevated fluvial and tidal flood risk it would be protected by a suitably designed earth flood defence bund. As such, the negligible additional runoff volume generated by this equipment would be retained in the bunded area and would naturally infiltrate into the ground. The presence of earth flood defence bunds further mitigates the effect of the Proposed Development on runoff rates.

Management of Runoff From BESS Facility and 132kv Substation

5.58. The Proposed Development includes a BESS facility and 132kv Substation. The BESS area consists of a series of GRP kiosks or shipping containers which contain the necessary equipment. This concentrates development into a small area of the Site which increases the effect of the equipment on runoff rates requiring additional mitigation measures to ensure surface water is appropriately managed and flood risk is not increased elsewhere.

Runoff Rate Assessment

5.59. The ICP SuDS module in the Micro Drainage design software enables the calculation of greenfield runoff rates based on the IH Report 124 estimation method with pro-rata values for sites smaller than 50ha. Copies of the Micro Drainage greenfield runoff calculations for the Substation and BESS area are included in **Figure 17** below.

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                    ICP SUDS Mean Annual Flood

                              Input

Return Period (years)      1 SAAR (mm)    650         Urban     0.000
            Area (ha)  0.340      Soil  0.300 Region Number Region 3

                          Results   l/s

                        QBAR Rural  0.6
                        QBAR Urban  0.6

                           Q1 year  0.5

                           Q1 year  0.5
                         Q30 years  1.0
                        Q100 years  1.2
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Figure 17: BESS Area and Substation Greenfield Runoff Rate

5.60. It is proposed that the outflow from the proposed surface water drainage measures is constrained to 1 l/s which is considered to be the practical minimum discharge rate (taking into account the enhanced blockage risk at low flow rates).

5.61. This equates to 3 l/s/ha. It is acknowledged that the Selby Area IDB has a restriction of 1.4 l/s/ha. However, this would be below the practical minimum discharge rate taking blockage risk into account.

5.62. By limiting the developed rate of runoff to 1 l/s for all rainfall events up to the 100 year return period event, including an allowance for climate change, the Proposed Development would reduce flood risk overall when compared to existing greenfield rates in the more extreme events (1 in 100 year return period).

Proposed Surface Water Management Measures

5.63. A sustainable drainage strategy (SuDS) is proposed for managing the disposal of surface water runoff from the Proposed Development associated with the BESS area and Substation. It is proposed that the runoff from the BESS area would be collected by a perimeter filter drain. Filter drains would then convey runoff to two shallow detention basins. Runoff would be discharged at a controlled rate into the onsite drainage ditches. Flow controls would be utilised to restrict runoff to the lowest practical discharge rate of 1 l/s. The Preliminary BESS and Substation Drainage Strategy is shown on Drawing No. E216/88 reproduced in **Appendix 19**.

5.64. The flow controls would be provided in the form of HydroBrakes (48mm diameter for Attenuation Basin1, 54mm diameter for Attenuation Basin 2).

5.65. The proposed drainage strategy would ensure that surface water arising from the Proposed Development would be managed in a sustainable manner to mimic the surface water flows arising from the Site prior to the Proposed Development, while reducing the flood risk to the Site itself and elsewhere, taking climate change into account.

5.66. To demonstrate the detention basin is appropriately sized to attenuate the runoff from the BESS area and Substation, a Micro Drainage Network model has been created. The effect of the 1 in 100-year storm event including a 30% allowance for climate change has been simulated. Inspection of the Micro Drainage simulation results contained in **Appendix 20** demonstrate that the detention basins are suitably sized and runoff would be restricted to the lowest practical discharge rate of 1 l/s. The Micro Drainage results output are summarised in **Table K** below.

Table K: BESS Area and Substation Modelling Results Summary

Catchment	Attenuation Basin No.	Greenfield Runoff (l/s)		1:1 Return Period			1:100 + 30%CC Return Period		
		Q_1	Q_{100}	Outflow Rate (l/s)	Max Attenuation Storage Volume (m^3)	Flood	Outflow Rate (l/s)	Max Attenuation Storage Volume (m^3)	Flood
Battery Storage Area	1	0.3	0.7	0.9	~27	No Flooding	0.9	~109	No Flooding
DNO Substation and Battery Storage Area	2	0.2	0.5	0.9	~16	No Flooding	1	~69.	No Flooding

5.67. From an inspection of **Table K** and the Micro Drainage results output in **Appendix 20**, it can be seen that there would be no flooding during the 1 in 100 year storm events, including an appropriate allowance for climate change, and that the outflow rate would be equivalent to the greenfield runoff rate which accords with good practice advice. Therefore, on the basis of the preliminary calculations, suitably designed detention basins could accommodate runoff from impermeable areas of the BESS area and Substation.

5.68. Consent would need to be obtained for the construction of the various outfalls to the watercourse and ditch system under Section 23 of the Land Drainage Act 1991 from the Selby Area IDB.

5.69. Byelaw consent would be required for the outflows into the onsite drainage ditches.

Summary of Surface Water Management Measures

5.70. The proposed solar farm development and mitigation measures described in this FRA are compatible with NFM and retain existing ditch / watercourse network that crosses the Site. Through conversion to permanent pasture and the introduction of interception swales creating significant amount of onsite depression storage, the Proposed Development would restore and enhance natural hydrological processes to 'slow the flow', providing a benefit in reducing overland flows during extreme rainfall events. Shallow detention basins utilising flow controls would provide attenuation storage mitigating the effect of the BESS area and Substation on surface water runoff. On this basis, the Proposed Development would not increase flood risk on-Site or elsewhere and would preserve the Site's natural drainage regime; and is considered a proportionate approach to surface water management on a rural solar farm development and is a practical implementation of NFM.

SuDS Construction and Maintenance

5.71. The interception swales and detention basins would be maintained throughout the design lifetime of the Proposed Development by the land owner generally in accordance with the recommendations in CIRIA C753 '*The SuDS Manual*'. The maintenance procedures are set out in **Table L.**

Table L: SuDS Maintenance Procedures

Maintenance Schedule	Required Action	Frequency
Interception Swales		
Regular Maintenance	Litter and debris removal.	As required.
	Grass cutting or animal grazing – to retain grass height to site owner's specification.	As required.
	Manage other vegetation and remove nuisance plants.	Monthly (as stated, then as required)
Occasional Maintenance	Check for poor vegetation growth due to lack of sunlight or dropping of leaf litter, and cut back adjacent vegetation where possible.	Annually
	Re-seed areas of poor vegetation growth. Alter plant types to better suit conditions, if required.	Annually, or if bare soil is exposed over 10% or more of the swale treatment area.
Remedial Actions	Repair erosion or other damage by re-turfing or reseeding.	As required.
	Re-level uneven surfaces and reinstate design levels.	As required.
	Scarify and spike topsoil layer to improve infiltration performance, break up silt deposits and prevent compaction of the soil surface.	As required.
	Remove build-up of sediment on upstream gravel trench, flow spreader or at top of filter strip.	As required.
Monitoring	Inspect infiltration surfaces for ponding, compaction, and silt accumulation. Record areas where water is ponding for > 48 hours.	Monthly, or when required.
	Inspect surface for silt accumulation. Establish appropriate silt removal frequencies.	Half yearly.
Detention Basins		
Regular Maintenance	Remove litter and debris	Monthly
	Cut grass – for spillways and access routes	Monthly (during growing season, or as required
	Cut grass – meadow grass in and around basin	Half yearly (spring – before nesting season, and autumn
	Manage other vegetation and remove nuisance plants	Monthly (at start, then as required)
	Inspect inlets, outlets and overflows for blockages, and clear if required.	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and facility surface for silt accumulation. Establish appropriate silt removal frequencies.	Monthly (for first year), then annually or as required
	Check any penstocks and other mechanical devices	Annually
	Tidy all dead growth before start of growing season	Annually
	Remove sediment from inlets, outlet and forebay	Annually (or as required)

Maintenance Schedule	Required Action	Frequency
	Manage wetland plants in outlet pool – where provided	Annually (as set out in Chapter)
Occasional Maintenance	Reseed areas of poor vegetation growth	As required
	Prune and trim any trees and remove cuttings	Every 2 years, or as required
	Remove sediment from inlets, outlets, forebay and main basin when required	Every 5 years, or as required (likely to be minimal requirements where effective upstream source control is provided)
Remedial Actions	Repair erosion or other damage by reseeding or Re-turfing	As required
	Realignment of rip-rap	As required
	Repair/rehabilitation of inlets, outlets and overflows	As required
	Relevel uneven surfaces and reinstate design levels	As required

Construction of SuDS

5.72. Elsewhere, the Environment Agency has recommended the use of a single check sheet to ensure that any drainage issues are picked up at an early stage. Accordingly, a check sheet in the format suggested by the Environment Agency is reproduced in **Appendix 21**.

5.73. In circumstances where little vegetation cover is present on commencement of construction, it is recommended that the swales are provided at the outset. Similarly, if during construction it is evident that the surface of the Site is becoming significantly disturbed, then implementing swales immediately would act to restrict potential runoff and act as silt traps.

5.74. If, however, the Site remains “clean” and vegetated during construction, it would be advisable to leave the construction of the swales to the end of the construction programme so as to maximise the benefits of the existing vegetation cover.

5.75. The timing of the provision of the swales is therefore a matter for the construction site manager to determine.

6. CONCLUSIONS

6.1. This Flood Risk Assessment ('FRA') has been prepared on behalf of Enso Green Holdings D Limited in connection with proposals for the development of a renewable energy generating project on land to the south west of the village of Camblesforth and to the north of the village of Hirst Courtney in North Yorkshire, known as the Helios Renewable Energy Project (the 'Proposed Development'). This FRA supports an application for a Development Consent Order ('DCO') for the Proposed Development.

6.2. The main part of the Site, known as the Solar Farm Zone is situated to the south west of the village of Camblesforth, to the north of the village of Hirst Courtney and Hirst Road, to the south of the A1041 and to the east of the Selby Branch of the East Coast Mainline railway. The Site is located within the administrative area of North Yorkshire Council. The Underground Cable Corridor for the Proposed Development's grid connection extends to the east of Drax Power Station. The overall Site comprises approximately 475.68 hectares and encompasses a number of interconnected parcels of predominantly agricultural land, consisting of fields used for grazing and arable cropping.

6.3. The Proposed Development comprises the construction of a solar farm consisting of ground-mounted solar PV modules mounted on metal frames, with associated site infrastructure, ancillary control equipment, energy storage and an underground connection to the local electricity grid.

6.4. With reference to the GOV.UK's Flood Map for Planning (Rivers and Sea), the majority of the Site falls within Flood Zone 3 with smaller areas of Flood Zone 2 and Flood Zone 1. This is due to the River Ouse to the north and the River Aire to the south, which converge to the east of the Site. Due to the presence of flood defences along the River Aire and River Ouse, the areas of Flood Zone 3 on the Site are defined as Flood Zone 3a.

6.5. A site-specific flood model for the Site is being commissioned to determine the design flood, and provide a credible maximum scenario sensitivity test; this will inform the ES to be submitted in support of the application for development consent for the Proposed Development. At this stage, the scope of the site-specific flood model has yet to be agreed with the Environment Agency and is subject to ongoing consultation.

6.6. The majority of the Site is at 'very low' risk (less than 0.1%) of surface water flooding. Smaller isolated areas of 'low' risk (between 0.1% and 1%), 'medium' risk (between 1% and 3.3%) and 'high' risk (greater than 3.3%) are present.

6.7. The location of ancillary control equipment would be preferentially located in areas of very low surface water flood risk. Solar PV arrays, security fencing and access tracks extend into areas of elevated surface water flood risk.

6.8. The lower edge of the proposed solar PV panels would be a minimum of 1.0m above ground level at full tilt. The solar PV panels would be raised above the deepest low risk surface water flood level, and so would not be vulnerable to surface water flooding. The panel supports and security fence would be resistant to shallow flood depths and would be securely anchored into the ground.

6.9. The pre-development potential flood risk to the Site from groundwater is assessed as 'very low' to 'high'. The pre-development potential flood risk to the Site from other sources is assessed as 'low' to 'very low'.

6.10. With respect to surface water runoff, the solar PV panels are raised above the existing ground allowing a permanent grass sward to be maintained underneath the panels. Rainfall falling onto the panels would runoff directly to the ground beneath the panels and infiltrate into the ground at the same rate as it does in the Site's existing greenfield state. Access tracks will be semi permeable in nature. The extent of impermeable cover as a result of the solar farm amounts to only 0.1 % of the Solar Farm Zone area. The effect on the Mean Annual Flood (Q_{BAR}) is minimal and only equates to a 0.23% increase compared with the greenfield runoff.

6.11. A sustainable drainage strategy, involving the implementation of SuDS in the form of interception swales, is proposed for managing surface water runoff on the Site. Interception swales are proposed at the low points of the Solar Farm Zone area to intercept extreme flows, which may already run offsite and provide runoff pathway management. The volume of storage provided within the proposed interception swales (398m^3) is greater than the additional runoff generated as a result of the extreme 1 in 100-year storm event, including an allowance for climate change (289.5m^3). The interception swales are therefore an appropriate form of mitigation given the 'temporary' nature of the Proposed Development, and a proportionate mitigation measure given the negligible hydrological effect of a solar farm and are a practical implementation of NFM.

6.12. A sustainable drainage strategy (SuDS) is proposed for managing the disposal of surface water runoff from BESS area and Substation. It is proposed that runoff from the BESS area would be collected by perimeter filter drains. The filter drains would convey the runoff to two shallow detention basins (Basins 1 and 2). Runoff would be discharged at a controlled rate into the on-Site drainage ditches. Flow controls would be utilised to restrict runoff at each outfall to the lowest practical discharge rate of 1 l/s. The proposed drainage strategy would ensure that surface water arising from the BESS area and Substation would be managed in a sustainable manner to mimic the surface water flows arising from the Site prior to the Proposed Development, while reducing the flood risk to the Site itself and elsewhere, taking climate change into account.

6.13. Existing drainage features would be retained, and the Site would remain vegetated throughout construction and operation of the Proposed Development to prevent soil erosion. The proposed interception swales would lead to an overall reduction in surface water flow rates from the Site and mitigate any increase in run-off due to the minor reduction in the overall permeable area of the site. On this basis, the Proposed Development would not increase flood risk on-Site or elsewhere and would preserve the Site's natural drainage regime.

6.14. The overall conclusions drawn from this Flood Risk Assessment are that future users of the development would remain appropriately safe throughout the lifetime of the Proposed Development, and that subject to a DCO requirement requiring the drainage arrangements as indicated on plans E216/88 and E216/90-106 Rev B to be implemented and maintained in accordance with the procedures set out at Table L of this FRA and a Check Sheet attached as Appendix 21, the Proposed Development would not increase flood risk elsewhere and would reduce flood risk overall.