Fair Oaks Renewable Energy Park
Flood Risk Assessment

10th November 2022
Version 3.0
RAB: 2913

Disclaimer

This document has been prepared solely as a Flood Risk Assessment for Ridge Clean Energy. RAB Consultants accepts no responsibility or liability for any use that is made of this document other than by the client for the purposes for which it was originally commissioned and prepared. No person other than the client may copy (in whole or in part) use or rely on the contents of this document, without the prior written permission of the Managing Director of RAB Consultants Ltd. Any advice, opinions, or recommendations within this document should be read and relied upon only in the context of the whole document.

Published by

RAB Consultants Limited
Second Floor
Cathedral House
Beacon Street
Lichfield
Staffordshire
WS13 7AA

Call: 01543 547 303
Email: enquiries@rabconsultants.co.uk
Visit: rabconsultants.co.uk

By viewing and saving this document digitally instead of printing it, you could save 4.6g of carbon emissions from double-sided printing on primary-sourced or 3.7g from 100% recycled A4 paper. Please only print this document if it is necessary.

Quality Control

Action	Name
Prepared	S. Bandali / T. Haskey
Checked	T. Haskey
Approved	G. M. Wilson

Revision History

Version	Date	Amendments	Issued to
1.0	22.07.2022	First Issue	Jonny Murphy
2.0	24.08.2022	Updated	Jonny Murphy
3.0	10.11.2022	Updated to reflect new plans	Jonny Murphy

Contents

1.0 Introduction

RAB Consultants has prepared this Flood Risk Assessment (FRA) in support of the proposed development of a renewable energy park at Fair Oaks near Ruddington, Nottinghamshire.

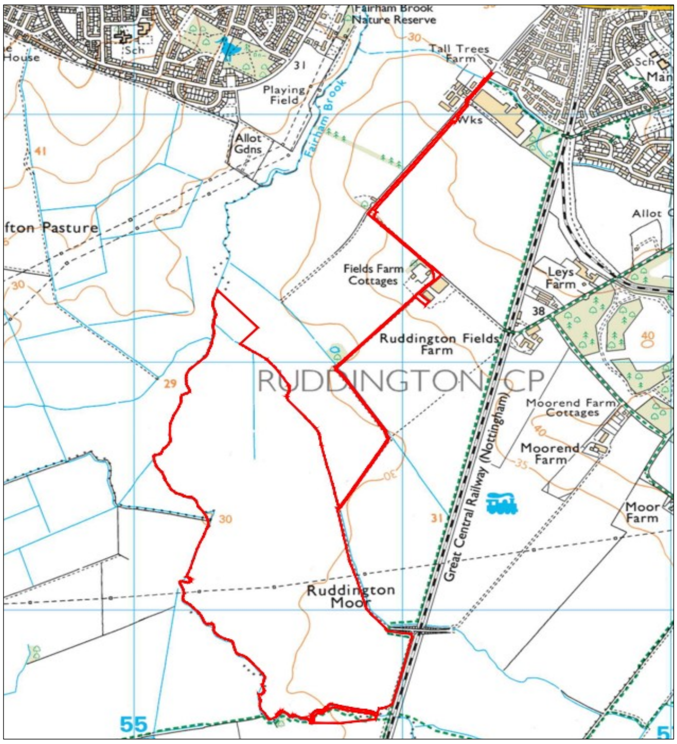
The development site is located partially in Flood Zone 3 according to the Environment Agency's Flood Map for Planning (Rivers and Sea). A Flood Risk Assessment for this site is required under the Planning Practice Guidance for the National Planning Policy Framework (NPPF) as it 'a major development located in Flood Zone 3'. A site-specific FRA is required to ensure that the development is safe from flooding and will not increase the risk of flooding elsewhere.

2.0 Site details

2.1 Site location

TABLE 1: SITE LOCATION

Site address:	Fairs Oak, land to the southwest of Ruddington, Nottinghamshire (closest postcode: NG11 6JS)
Site area:	83.80 ha
Existing land use:	Agricultural fields
OS NGR:	SK 55543 30729
Local Planning Authority:	Rushcliffe Borough Council



2.2 Site description

The proposed site is located 1.4km to the southwest of Ruddington and 1.6km to the northeast of Gotham. The existing site comprises agricultural fields and an access track and is therefore greenfield land. There are two pylons located towards the centre of the site and an additional pylon to the east of the site. The surrounding environment is predominantly greenfield or agricultural land.

Access to the site is from Asher Lane to the northeast of the proposed site.

2.3 Development proposal

A new renewable energy park is proposed with, solar panels, transformer stations, a customer cabin, a battery storage, a customer substation compound area, ecological mitigation area and ancillary infrastructure (Appendix A).

New access tracks within the site are also proposed. Access from the site will remain from Asher Lane to the northeast of the proposed site.

3.0 Flood Risk

3.1 Sequential test

According to the Environment Agency's Flood Map for Planning the site lies partially in Flood Zone 3, which is described in the NPPF as land having a 1 in 100 or greater annual probability of river flooding (1% or greater Annual Exceedance Probability, AEP).

The NPPF follows a sequential risk-based approach in determining the suitability of land for development in flood risk areas, with the intention of steering all new development to the lowest flood risk areas. NPPF Planning Practice Guidance (PPG) Table 2 confirms the 'Flood risk vulnerability classification' of a site, depending upon the proposed usage. This classification is subsequently applied to Table 3 'Flood risk vulnerability and flood zone compatibility' to determine whether:

- The proposed development is suitable for the flood zone in which it is located; and
- Whether an Exception Test is required for the proposed development.

The proposed development is classed as 'essential infrastructure' in accordance with NPPF PPG. The development is appropriate for the Flood Zone. Both a Sequential Test and Exception Test are required in accordance with Table 3 of the NPPF, PPG.

While part of the site lies within Flood Zone 3, detailed hydraulic modelling has been undertaken to assess site-specific risk. A sequential approach has been adopted to manage risk coupled with item-specific mitigation measures. Given a safe sustainable scheme is available within the site, as assessed in this FRA report, the proposed usage is appropriate.

The creation of a renewable energy park clearly aligns with the national and local net-zero Carbon plan. As such the proposed development provides wider sustainability benefits to the community that outweighs flood risk, in line with the requirement of an Exception Test.

3.2 Flood History

Nottingham City Council published the Greater Nottingham Strategic Flood Risk Assessment (SFRA) Addendum in September 2017. There is no indication of the site being affected by flooding in the 2017 SFRA.

The Environment Agency hold no record of flooding affecting the proposed site.

No information of floods affecting the site was found during internet searches.

3.3 Fluvial (Rivers)

The site is partially located in Flood Zone 3 and Flood Zone 2 according to the Environment Agency's Flood Map for Planning (Figure 1).

The nearest watercourse is Fairham Brook which flows from the southeast and adjacent to the western boundary of the site. There is also an unnamed watercourse which flows from the southeast and adjacent to the east boundary of the site. This unnamed watercourse discharges into Fairham Brook at a few meters north to the site. Fairham Brook eventually flows into the River Trent located approximately 4.5km to the northeast of the site. In addition to these main watercourses, there are numerous smaller watercourses and drainage channels across the surrounding area. An overview of these watercourses is shown in Figure 2.

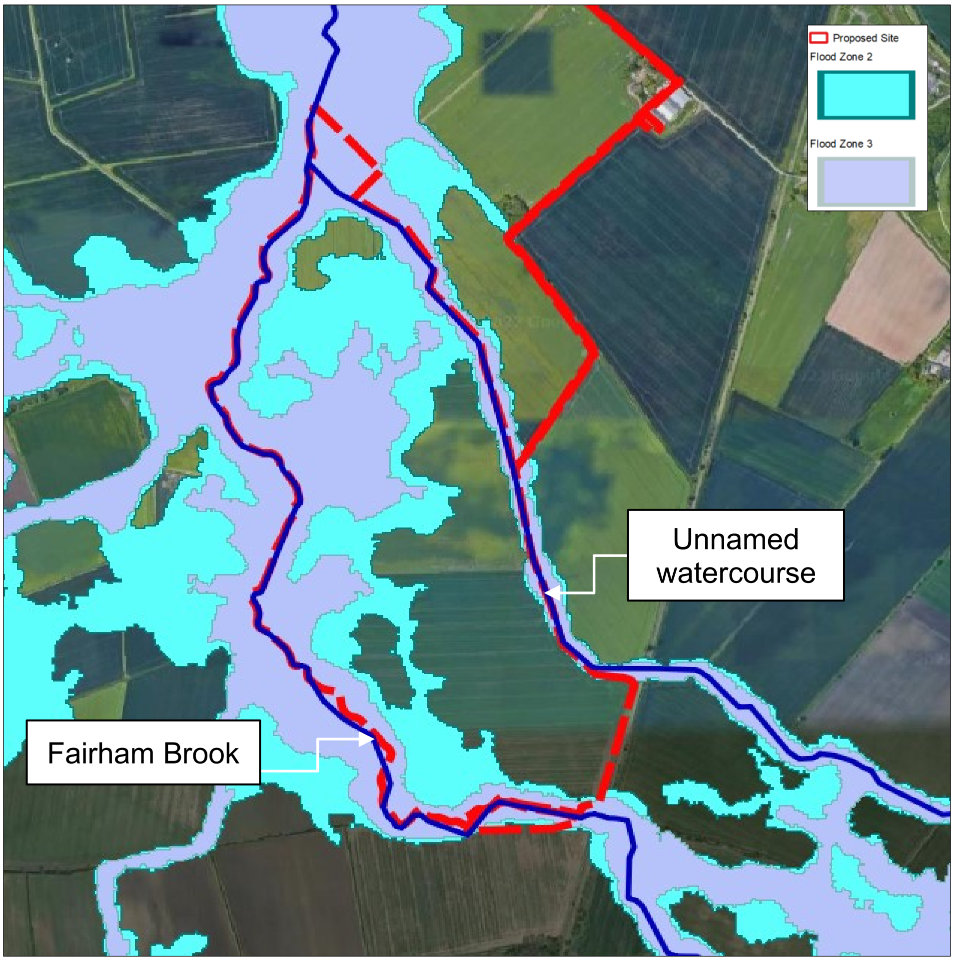


Figure 1: Screen shot of the Environment Agency's Flood Map for Planning with Google Map on 06.06.2022

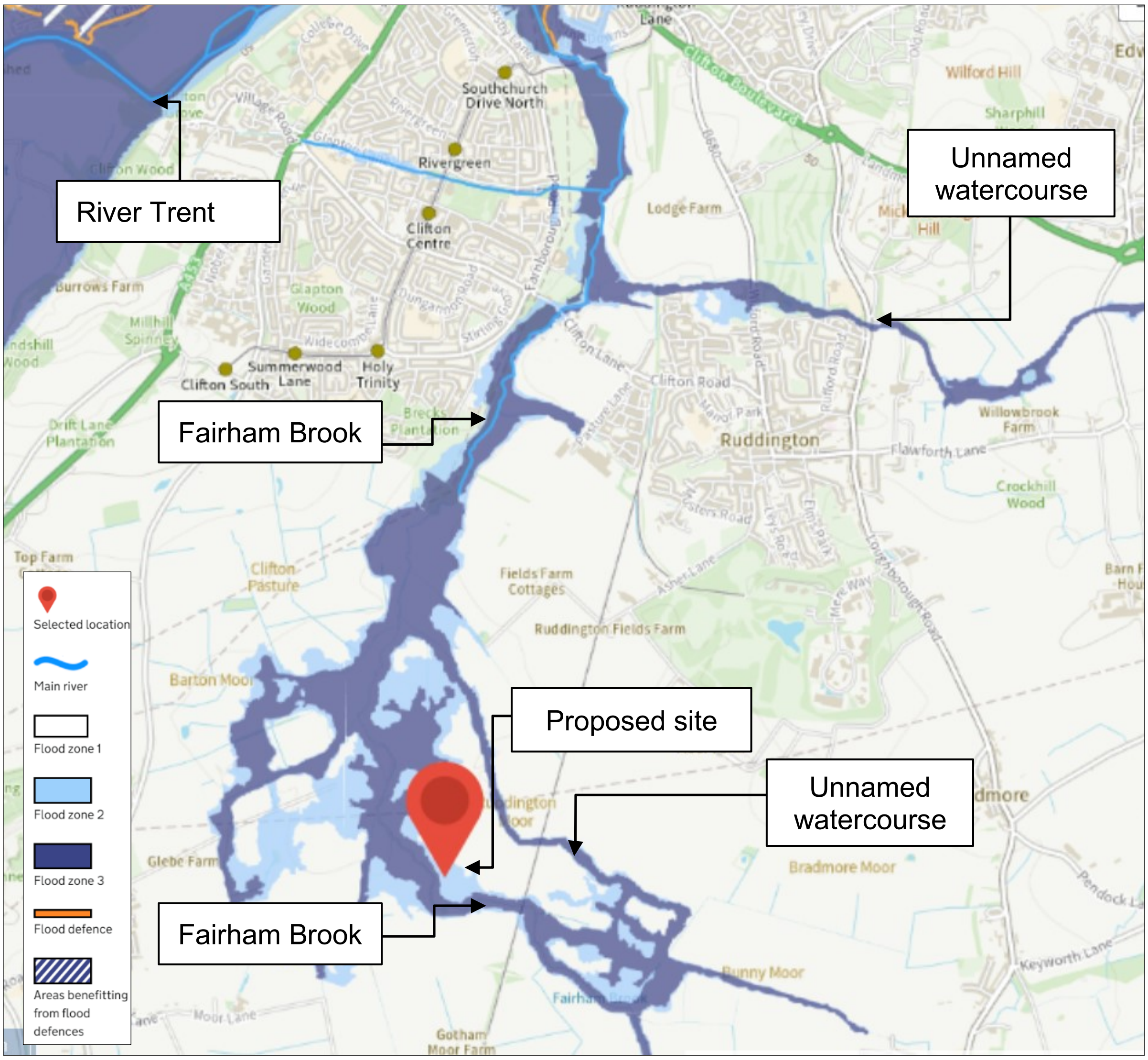


FIGURE 2: OVERVIEW SCREEN SHOT OF THE ENVIRONMENT AGENCY'S FLOOD MAP FOR PLANNING ON 08.06.2022

The Environment Agency have no modelled flood data for the Fairham Brook and the unnamed watercourse, therefore a 1D-2D linked Flood Modeller Pro / TUFLOW model was developed to assess fluvial risk at the proposed development site. Both LiDAR data and a topographic survey were used to create the cross sections of the two watercourses.

The modelled 1% AEP plus 23% climate change flood extent and flood depths are shown in Figure 3 with the full hydrology and hydraulic report included in Appendix B. The model shows that during this flood event the bridges beneath the railway at the upstream end of the model provide a constriction to flow, however the downstream channel capacity of both watercourses is eventually exceeded, resulting in flooding on the right bank of the Fairham Brook and on both banks of the unnamed watercourse. A 1.2m circular culvert near the north boundary of the site, on the unnamed watercourse, does provide a small degree of constriction, but the land surrounding this structure falls steeply toward Fairham Brook, so out of bank flood water at this location flows northeast into the Fairham Brook.

The modelled scenario indicates that the proposed customer cabin, battery storage area and customer substation compound area are not located within the fluvial flood extent (Figure 4). Four transformer stations are proposed to be located within the fluvial extent, with a maximum depth of 0.34m expected at the transformer station located to the north. In addition, several rows of solar panels towards the north of the site are proposed to be located within the modelled flood extents. Flood depths for the solar panels in the modelled extent range from 0.05m – 0.6m.

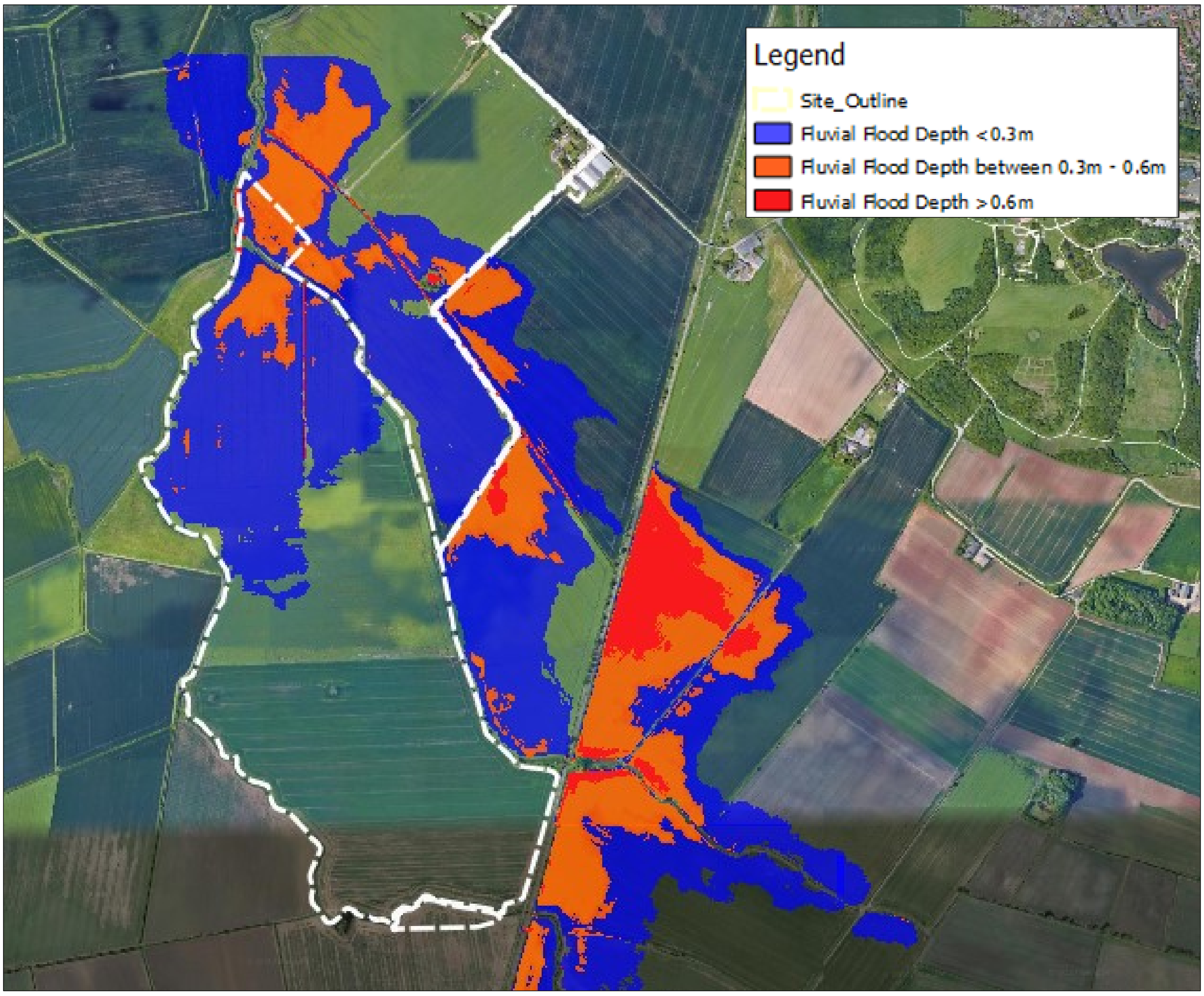


Figure 3: Flood depth and extent from the 1% AEP plus 23% climate change scenario

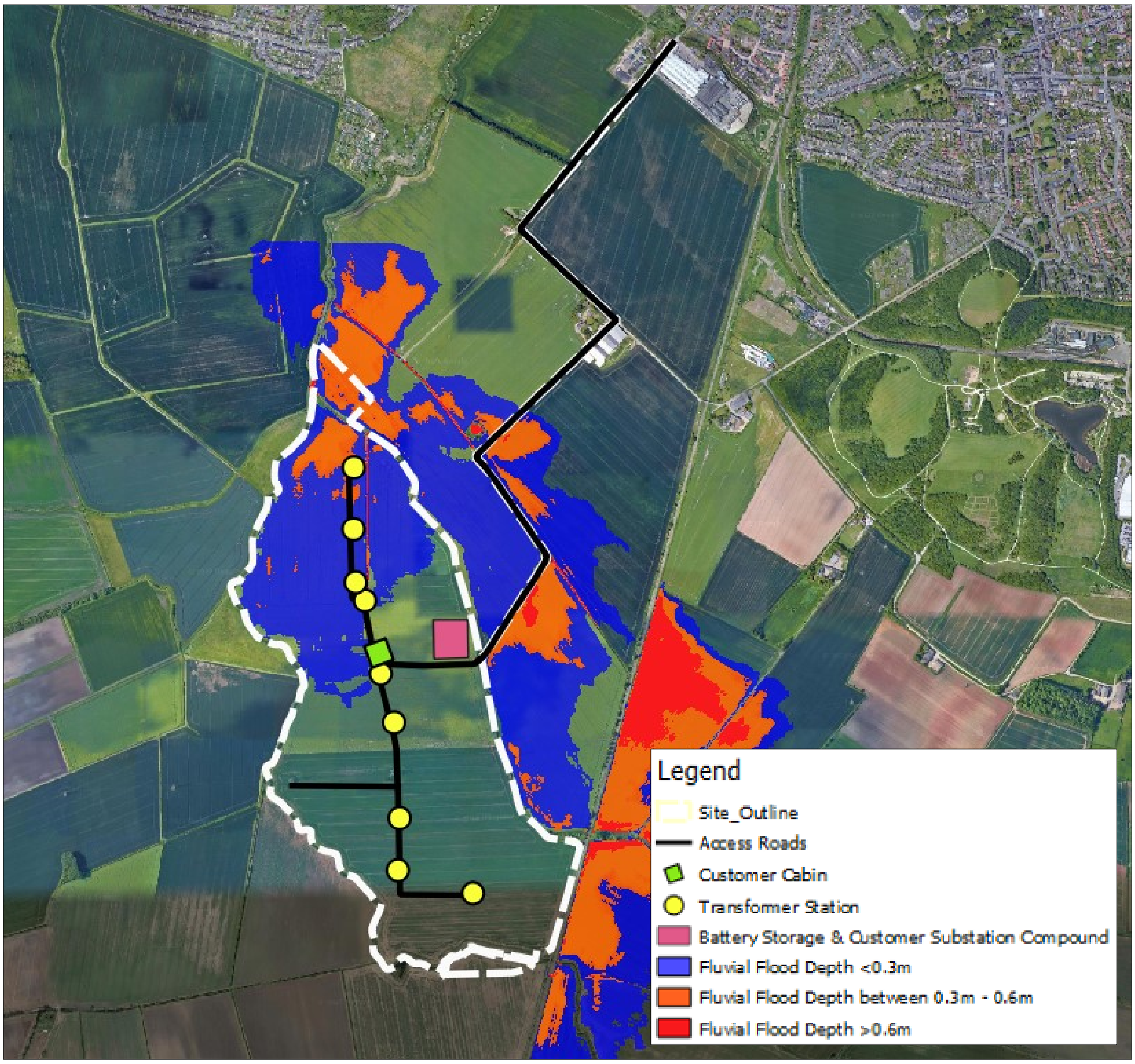


FIGURE 4: 1% AEP PLUS 23% CLIMATE CHANGE SCENARIO WITH THE PROPOSED PLANS

A blockage scenario of the downstream 1.2m diameter culvert was also tested. During this scenario the cross-sectional area of the culvert was reduced by 50%. The results of this are shown in Figure 5 below. There is a negligible impact on flood extent at the site. Locally around the structure flood levels see a small increase of 0.01 – 0.02m, but this is very localised around the structure. General flood levels across the site are unchanged.

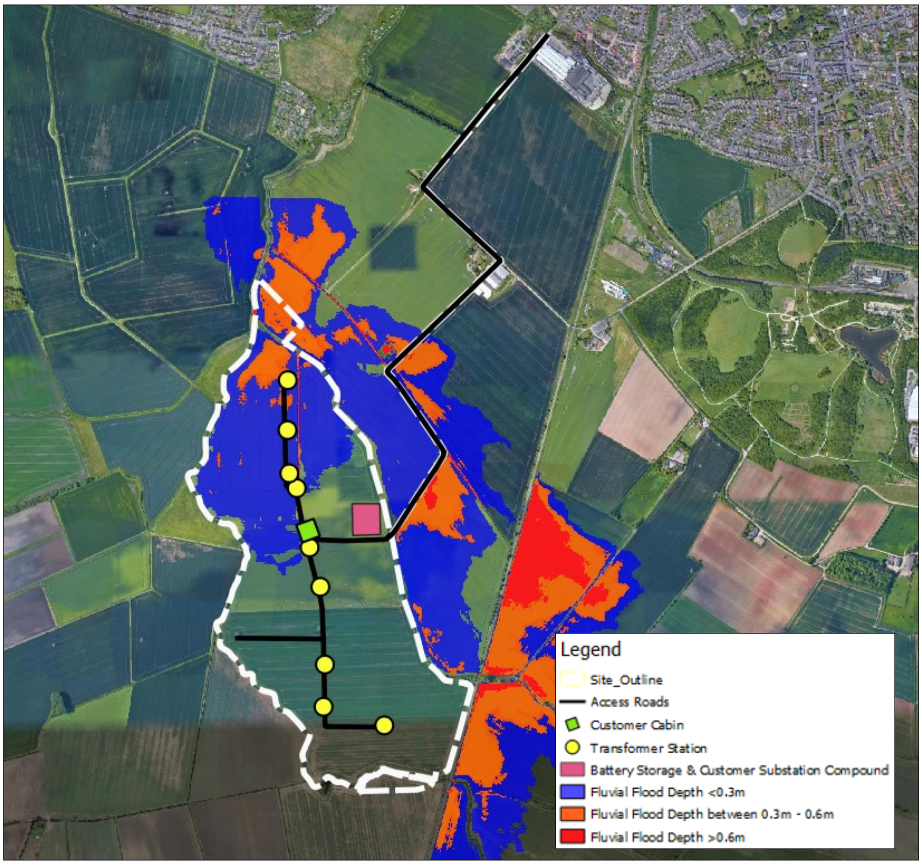


FIGURE 5: 1% AEP PLUS 23% CLIMATE CHANGE SCENARIO WITH 50% DOWNSTREAM CULVERT BLOCKAGE - WITH PROPOSED PLANS

3.3.1 Climate Change Impact on Fluvial Risk

The Environment Agency guidance document 'Flood risk assessments: climate change allowances' was released in February 2016 and updated in July 2021. It includes statistical increases on peak fluvial flows by Management Catchment and allowance categories based on epochs and development vulnerability classification. Referring to the NPPF PPG, the development is classified as 'essential infrastructure' and has an expected lifetime of 40 years therefore the 'higher central' allowance category applies for development in Flood Zone 3a. This equates to an increase of 23% on modelled flow for the Lower Trent and Erewash Management Catchment in the 2050s.

This climate change allowance has been included in the model.

The guidance also relates to peak rainfall intensity allowance, which is relevant for surface water flooding. For the '2050s' it is recommended the 'central' allowance of 20% is used for both the 1% AEP and 3.3% AEP rainfall events for the Lower Trent and Erewash Management Catchment.

3.4 Flood defence breach or overtopping

3.4.1 Breach Risk

The site does not benefit from flood defences, so there is no breach risk for the site.

3.4.2 Overtopping Risk

The site is not protected by flood defences and as such there is no risk of overtopping.

3.5 Coastal/Tidal

The site is not affected by coastal or tidal flood risk.

3.6 Pluvial (Surface water)

The Environment Agency Surface Water Flood Map (Figure 6) identifies the majority of the proposed site to be at 'very low' risk from surface water flooding. There are small areas of localised flooding to the north and centre of the site, which form areas of standing water caused by topographic low spots. In addition, there is a small drainage ditch at the north of the site which connects to the unnamed watercourse. Flood depths for these localised areas are expected to be less than 0.3m according to the Environment Agency Surface Water Flood Map.

Small sections of the access road to the northeast are at a combination of 'low', 'medium' and 'high' risk from surface water flooding. A maximum flood depth of 0.9m and a velocity of over 0.25 m/s is expected.

The areas of 'low' risk from surface water flooding shown to the south, west, and east boundary are associated with the natural flow route of Fairham Brook and the unnamed watercourse which is principally a fluvial risk and has already been assessed in Section 3.3.

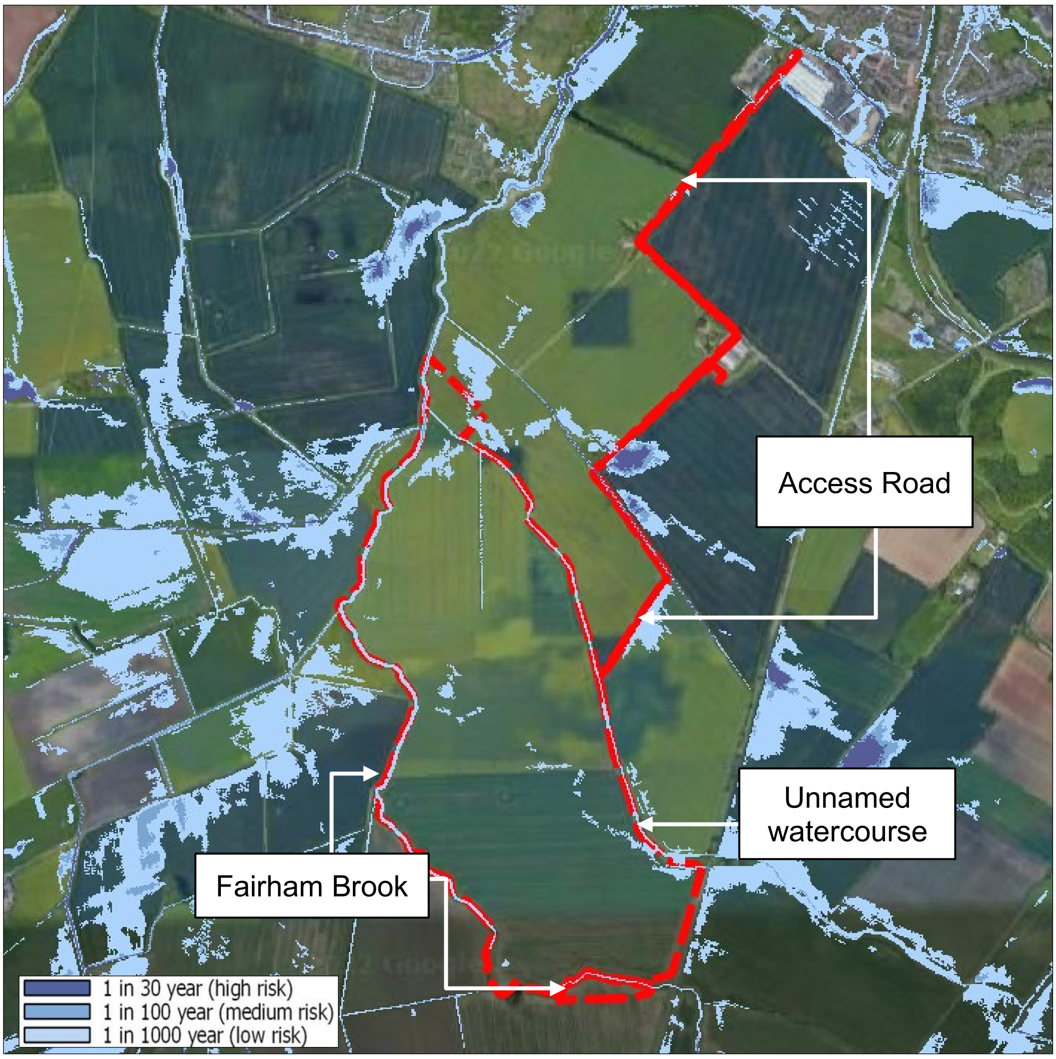


Figure 6: Screen shot of the Environment Agency's Risk of Flooding from Surface Water overlayed with Google Map on 06.06.2022

Figure 7 shows the proposed plan with the surface water risk map overlain. The map indicates that the transformer stations, the customer cabin, battery storage area and customer substation compound are not located in an area at risk from surface water flooding. A small number of solar panels are located in the identified topographic low spots with an expected depth below 0.3m. An easement around the small drainage ditch in the centre of the site has also been provided.

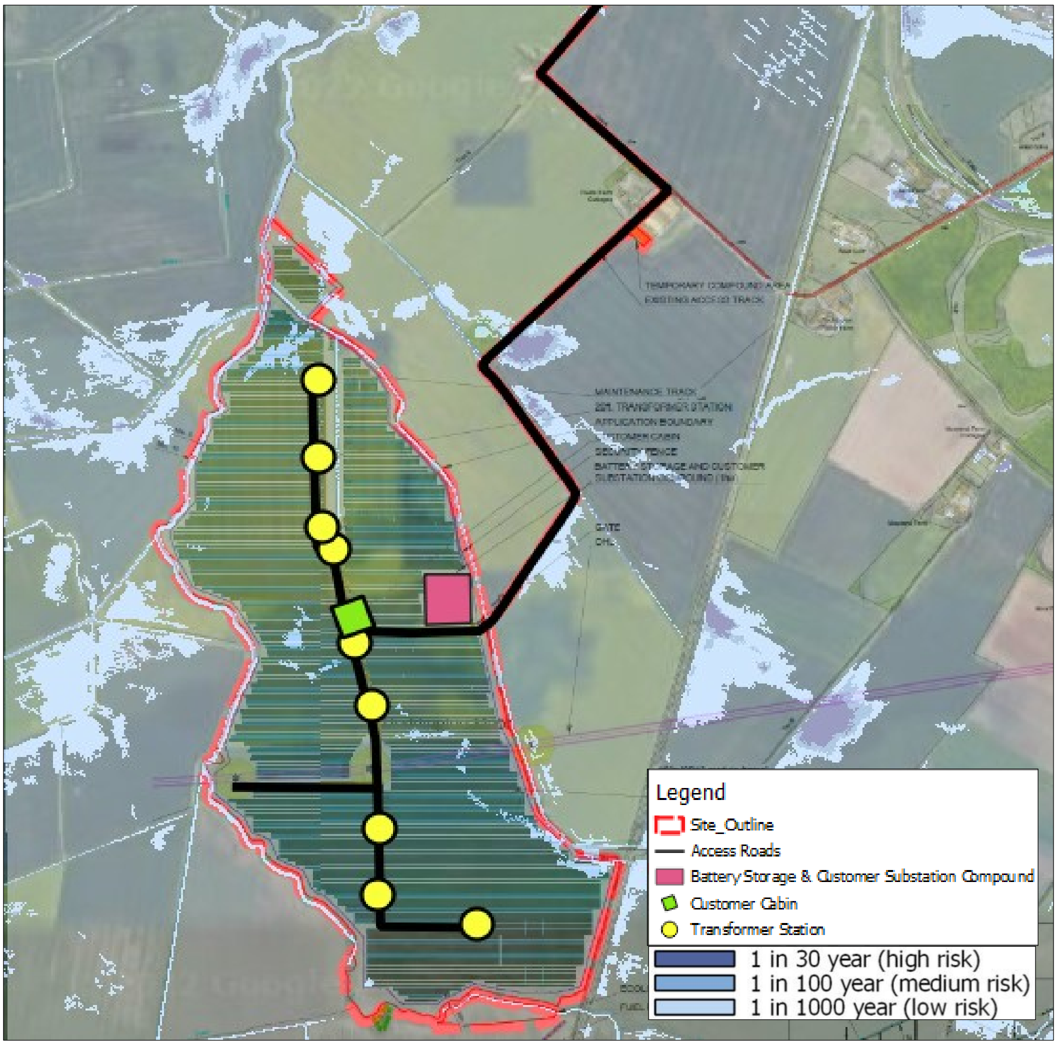


FIGURE 7: Environment Agency's Risk of Flooding from Surface Water with the Proposed Plans

TABLE 2: ENVIRONMENT AGENCY SURFACE WATER RISK CATEGORIES

Surface Water Risk Category	Surface water flooding Annual Exceedance Probability
Very Low	< 0.1%
Low	Between 1% and 0.1% (1 in 100 years and 1 in 1000 years)
Medium	Between 1% and 3.3% (1 in 100 years and 1 in 30 years)
High	> 3.3% (1 in 30 years)

3.7 Artificial water bodies

The Environment Agency Reservoir Flood Map identifies that the site is not at risk of flooding from this source.

There are no canals near the site that could pose a risk.

3.8 Groundwater

The groundwater susceptibility map provided in the online 2017 SFRA GIS database indicates that the site is located in an area classified as being >75% susceptible to groundwater flooding.

With the site being so close to Fairham Brook and the unnamed watercourse floodplains, groundwater is expected to be closely linked to fluvial water. Any groundwater is expected to match river levels for which the risk has been assessed in Section 3.3 of this report.

Based on this information, a further assessment of groundwater flooding is not appropriate.

3.9 Sewers

There is no indication of the site being affected by sewer flooding in the 2017 SFRA.

Given the rural nature of the proposed site, no sewers are expected to be present. From this initial review no issue has been identified to warrant a more detailed assessment of risk from this source.

4.0 Mitigation Methods

4.1 Risk to buildings

4.1.1 Finished floor levels

The proposal includes the construction of a renewable energy park with, solar panels, transformer stations, a customer cabin, a battery storage, customer substation compound, access tracks and ancillary infrastructure throughout the site. As mentioned in Section 3.3 and Section 3.6, the customer cabin, battery storage and customer substation compound are not proposed to be located in an area at risk from surface water or fluvial flooding.

As discussed above, the solar panels located to the north are at risk of fluvial flooding to a peak depth of 0.6m. Solar panels located within the topographic low spots, which is highlighted as being at risk of flooding from surface water, could see a maximum flood depth of 0.3m. The cross section drawing of the solar panels provided (Figure 8) shows the structures to be mounted such that the lowest edge of the panel will be a minimum of 0.9m above the ground. Therefore a minimum ‘freeboard’ of 0.3m will be provided. This is expected to offer reasonable mitigation for the identified risk; however, this should be confirmed by the manufacturer.

In addition, four transformer stations are located within the modelled fluvial extent with a maximum depth of 0.34m expected. These transformers will be raised 0.6m above the flood level identified at each transformer station as indicated by Figure 9. Again, this is expected to offer reasonable mitigation for the identified risk; however, as before this should be confirmed by the manufacturer.

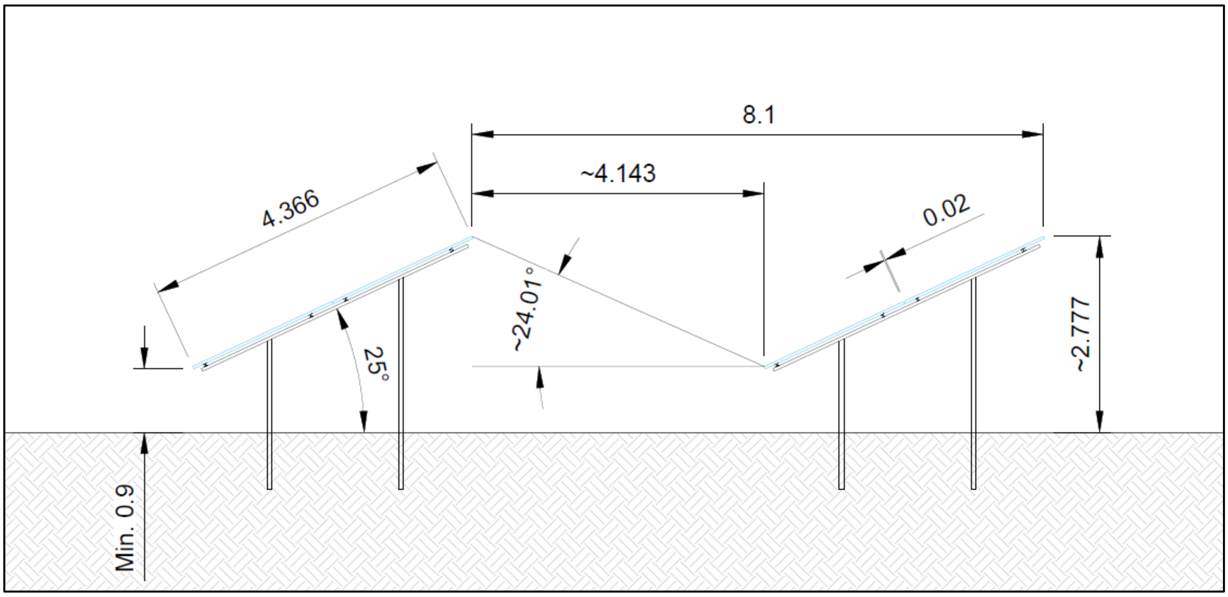


FIGURE 8: CROSS SECTION OF THE PROPOSED SOLAR PANEL

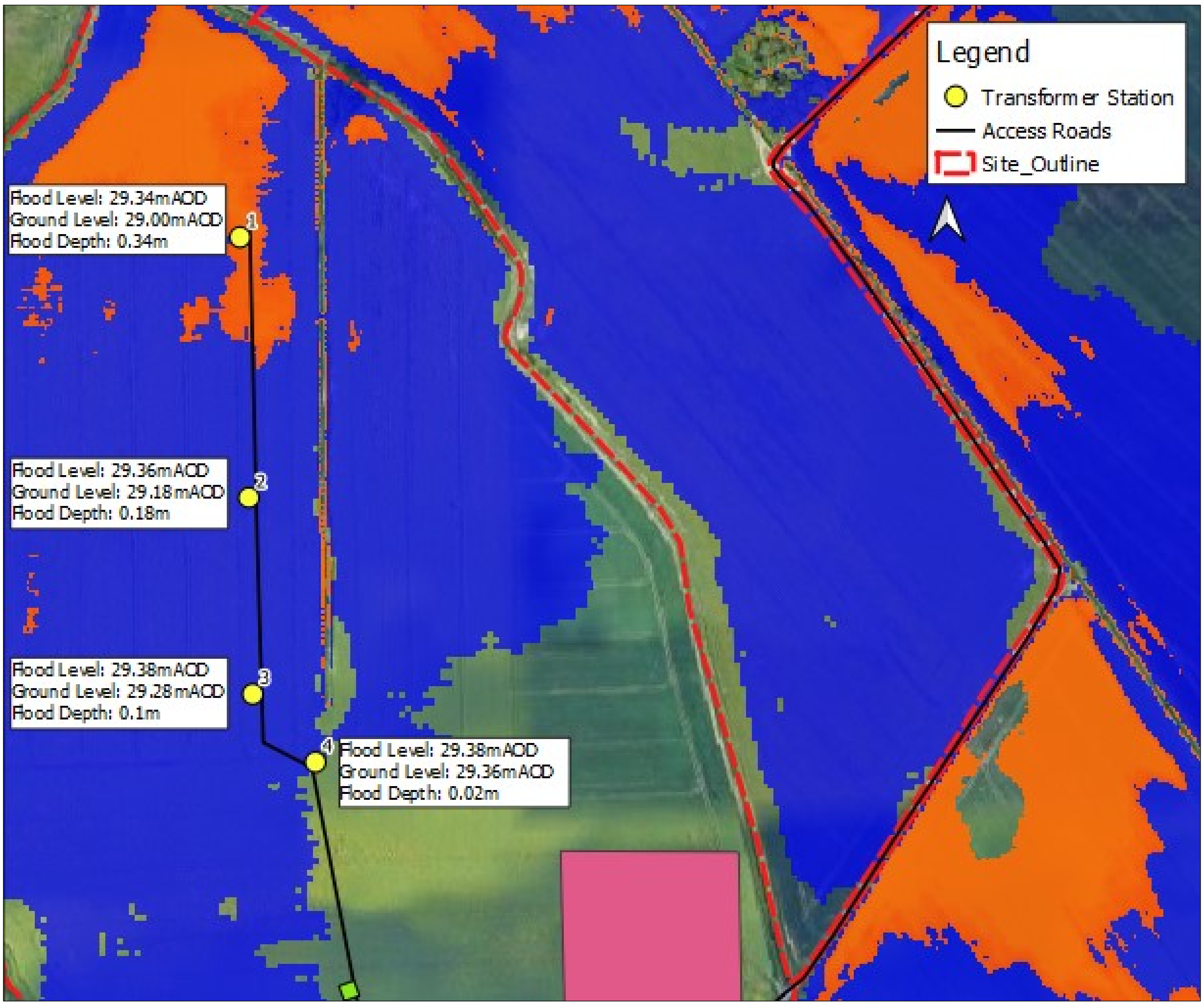


FIGURE 9: FLOOD LEVEL AND DEPTH AT EACH TRANSFORMER SUBSTATIONS AT RISK

4.1.2 Flood resistance

Flood resistance is a strategy of temporary or permanent measures taken to reduce the amount of flood water that will enter buildings. The use of flood resistance measures is not appropriate given the nature of the development and the assessed risk.

4.1.3 Flood resilience

Flood resilience measures are intended reduce damage to a building such that, in the event of a flood, it could be quickly brought back into use without significant refurbishment. Attention should be paid to the infrastructure supporting the four raised transformer units so as to be flood resilient – such as flood compatible supports, access stairs and electrical system.

4.2 Risk to occupiers

4.2.1 Safe access/egress

The northern access track within the site and Asher Lane to the northeast of the proposed site is at risk from fluvial and surface water flooding (Figure 10), with both fluvial and surface water flood depths at these locations typically no more than 0.3m and a velocity no greater than 0.25m/s. In accordance with Table 13.1 of the Flood Risk Assessment Guidance for New Development – R&D Technical Report FD2320/TR2, the danger to people is classified as ‘danger for some’.

The site will be an unmanned facility with routine inspections, general maintenance and repair work undertaken throughout the site when required. This risk to people should be managed by a flood plan which will include a map of potential flood-affected areas (Figure 10). In addition, as part of the plan, the site manager and staff should monitor Met Office Severe Weather Warnings and the 5-day flood risk (see Section 4.2.2) and Environment Agency flood alerts (Section 4.2.2). This will enable them to make an appropriate decision on whether site visits can be undertaken safely during severe weather.

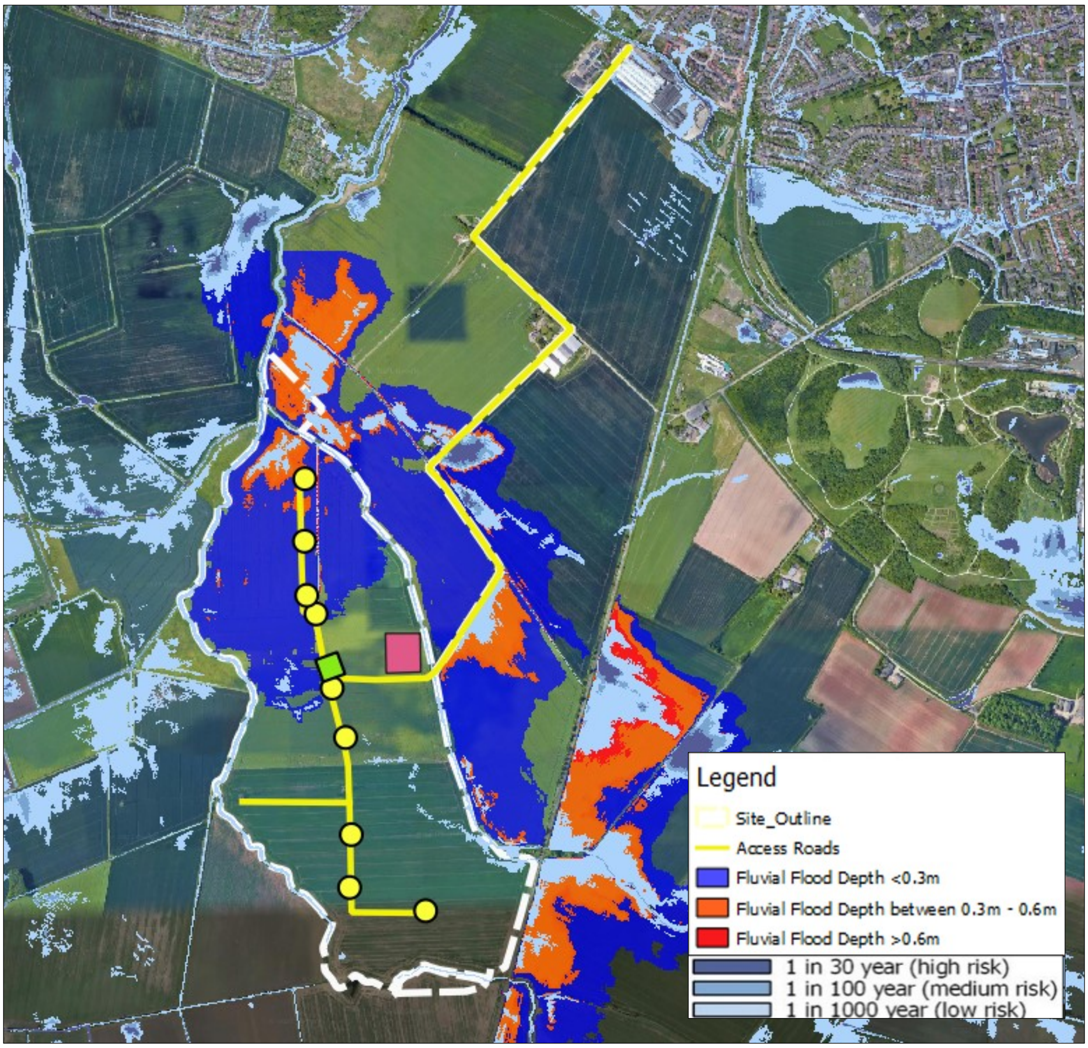


FIGURE 10: EXISTING AND PROPOSED ACCESS ROADS AT RISK FROM FLUVIAL AND SURFACE WATER FLOODING

4.2.2 Flood warning and evacuation plan

The Environment Agency does not provide a Flood Warning for the site. Given the unmanned nature of the site, a bespoke detailed flood warning and evacuation plan is not considered appropriate. As mentioned in section 4.2.1 above, a basic flood plan including a map showing potential flood-affected areas (Figure 10) should be implemented triggered by staff monitoring Met Office Severe Weather Warnings and the 5-day flood risk and registering to receive the Environment Agency Flood Alerts.

The site is included in the Environment Agency Flood Alert area ‘River Trent Tributaries in Nottinghamshire’ which would provide useful information about local flood conditions. The free service offers a minimum of 2 hours lead time before the onset of flooding at the site. The site manager and staff should register to receive a Flood Alert for this area from the Environment Agency by the channels identified in Table 3. A choice is given on how they are to be contacted by the Environment Agency in the event of a flood, such as an automated telephone call, fax or email.

TABLE 3: FLOOD ALERT INFORMATION

Channel	Details
Register for Flood Warnings / Alerts	https://www.gov.uk/sign-up-for-flood-warnings
Floodline	0345 988 1188 **(Quick Dial Code: 206020)** **Dialling Floodline:** After a receipt of a alert, you are recommended to call the Environment Agency Floodline 'dial and listen' service to hear further information. After dialling Floodline you will be given the option of entering a quick dial code for the flood alert area that relates to you. The quick dial code that relates to you is **206020**. This will give you an automated response regarding any flood alerts that have been issued for this area. If you wish to speak to someone about flooding in relation to this area you need to state that it is the **River Trent Tributaries in Nottinghamshire**.
Typetalk	0845 602 6340
Live Flood Alert information	https://flood-warning-information.service.gov.uk/

Table 4 includes a list of useful links the site manager and staff can use to monitor flood risk and weather warnings.

TABLE 4: USEFUL WEBSITE LINKS

USEFUL WEBSITE LINKS	
Description	**Website Link**
Weather Warning Guide	https://www.metoffice.gov.uk/weather/guides/warnings
EA Live Flood Alert information	https://flood-warning-information.service.gov.uk/
Flood Guidance Statement User Guide	http://www.ffc-environment-agency.metoffice.gov.uk/services/FGS_User_Guide.pdf
Guide to email alert service	https://www.metoffice.gov.uk/about-us/guide-to-emails

5-day flood risk for England and Wales	https://flood-warning-information.service.gov.uk/5-day-flood-risk
5-day flood risk for England and Wales – What the Risk Types Mean	https://flood-warning-information.service.gov.uk/5-day-flood-risk/things-you-should-do
Severe Weather Warning Service including weather warning impacts and what they mean	https://www.metoffice.gov.uk/weather/guides/severe-weather-advice
Met Office Live Severe Weather Warnings	https://www.metoffice.gov.uk/weather/warnings-and-advice/uk-warnings#?date=2020-10-02
BBC Weather	https://www.bbc.co.uk/weather

4.3 Risk to others

4.3.1 Floodplain compensation

The site is expected to experience fluvial and surface water flooding. The development of the site for a renewable energy park is proposed to include the construction of some solar panels in areas at risk of flooding, so some solar panel stanchions will interact with flood flow paths and standing water areas. However, given the stanchions will have a relatively small cross-section, with a separation between units any impact on surface water and fluvial flows and storage volume will be minimal and localised to each panel.

The customer cabin, five transformer stations and battery storage and customer substation compound are proposed to be located outside flood risk areas.

The four transformer stations within the fluvial extent will be raised 0.6m above the flood level using open framing and will therefore have little impact on the fluvial flows and storage volume.

4.3.2 Surface water run-off

The existing site is entirely greenfield. The development proposal, of a renewable energy park will create a large impermeable area with the potential to increase surface water runoff from the site. The scheme will however include gaps between individual panels throughout all of the arrays. Research has shown that *'solar panels themselves should not have a significant impact on runoff volumes, peak rates or time to peak rates, provided the ground beneath the panels remains* vegetated' (Cook, L. M., & McCuen, R. H. (2011). Hydrologic response of solar farms, Journal of Hydrologic Engineering, 18(5), 536-541).

5.0 Drainage strategy

5.1 SuDS applicable policies

The 2019 Nottingham City Council Greater Nottingham Strategic Flood Risk Assessment (SFRA) Addendum has been used to assist with this drainage strategy along with CIRIA's SUDS Manual and

LASOO Non-Statutory Technical Standards for Sustainable Drainage, Practice Guidance have also been used.

5.2 Existing drainage

The existing site comprises an 83.80ha greenfield land. No topographic survey is available however, freely available LiDAR data indicates that ground level generally falls to the northwest. Runoff is therefore generally expected to flow towards the northwest (Figure 11) as greenfield into Fairham Brook.

FIGURE 11: EXISTING SITE DRAINAGE

Pre-development runoff rates have been calculated using the IH124 method (based on the interim Code of Practice of Sustainable Drainage Systems given the small site area).

IH124 parameters:

- Area = 83.80 ha (total site area)
- SOIL = 0.450

- SAAR = 600mm
- Region = 4

TABLE 5: ESTIMATE OF PRE-DEVELOPMENT PEAK RUNOFF RATES

Annual Exceedance Probability (AEP)	Peak Runoff Rate
QBAR	290.4l/s
100% (1 year)	241.0/s
3.33% (30 year)	569.0l/s
1% (100 year)	746.4l /s
1% (100 year) plus 23% for climate change*	918.1 l/s

**2050s Higher Central Allowance for the Lower Trent and Erewash Management Catchment*

5.3 SuDS feasibility

The SuDS Manual (2015), discusses the SuDS approach to managing surface water runoff which is intended to mimic the natural catchment process as closely as is possible. The approach sets out the design objectives in respect of SuDS:

- Use of surface water runoff as a resource;
- Manage rainwater close to where it falls (at source);
- Manage runoff on the surface (above ground);
- Allow rainwater to soak into the ground (infiltration);
- Promote evapotranspiration;
- Slow and store runoff to mimic natural runoff rates and volumes;
- Reduce contamination of runoff through pollution prevention and by controlling the runoff at source; and
- Treat runoff to reduce the risk of urban contaminants causing environmental pollution.

Depending on the characteristics of the site and local requirements, these may be used in conjunction and to varying degrees. Table 6 presents the functions of the SuDS components (from which a management train can be created) and their feasibility in respect of the site.

Table 6: Feasibility of SuDS techniques at the development site

Technique	Description	Feasibility Y / N / M (Maybe)
Good building design and rainwater harvesting	Components that capture rainwater and facilitate its use within the building or local environment.	**N –** There is no requirement for water to be used within the site
Porous and pervious surface materials	Structural surfaces that allow water to penetrate, thus reducing the proportion of runoff that is conveyed to the drainage system (green roofs, pervious paving).	**Y –** Porous surfaces could be used on the access tracks constructed around the renewable energy park.
Infiltration Systems	Components that facilitate the infiltration of water into the ground. These often include temporary storage zones to accommodate runoff volumes before slow release to the soil.	**M –** There is scope to incorporate infiltration systems, however the extent to which infiltration is possible would need to be confirmed via ground testing.
Conveyance Systems	Components that convey flows to downstream storage systems (e.g. swales, watercourses).	**M –** There is scope to incorporate some conveyance systems into the development.
Storage Systems	Components that control the flows and, where possible, volumes of runoff being discharged from the site, by storing water and releasing it slowly (attenuation). These systems may also provide further treatment of the runoff (eg ponds, wetlands, and detention basins).	**Y –**There is scope to incorporate small surface water storage features into the development.
Treatment Systems	Components that remove or facilitate the degradation of contaminants present in the runoff.	**Y -** There is scope to incorporate small SuDS features that would provide water treatment.

5.4 Proposed drainage

The proposed development and drainage strategy has been split into 3 main parts:

1. The formation of the solar panel farm.
2. The transformer stations, a customer cabin, a battery storage and a customer substation compound area.

3. The access tracks throughout the site.

(1) The proposed development primarily constitutes a matrix of permanently fixed, south facing solar panels arranged on racks with gaps between each panel. It is not proposed to formally drain the solar panels but to allow rain to simply fall onto the adjacent ground where it has opportunity to infiltrate, collect and flow overland as existing.

Given each rack has a maximum vertical capacity of three panels, rainwater will fall to the ground below in three main concentrated drip lines beneath the bottom edge of each solar panel. The proposed panel arrangement will enhance water dispersion across the site, minimising localised runoff concentration and as such is expected to reasonably mimic greenfield condition without further measures. The use of vegetation below the panels will also enhance infiltration, retention, detention and soil erosion protection, while also promoting evapotranspiration.

(2) The transformer stations, customer cabin, battery storage and a customer substation compound area will be created using a crushed stone / gravel base so that rain falling on this area will act as greenfield condition.

(3) Finally, it is not proposed to formally drain the access tracks that will be constructed around the site. They will be created with permeable materials (e.g. gravel, grass-crete) such that rain falling on these areas will act as greenfield condition.

The soil condition will improve from the existing state as the land will be taken out of intensive agriculture use during the lifetime of the proposal. The effects of compaction during the construction process should be mitigated. This will aid with infiltration of water through the top level of soil.

Water quantity and **quality** will be managed by moving away from intensive agricultural use and ploughing such that the land will re-naturalise to some extent. **Amenity** and **Biodiversity** will be enhanced through the creation of an ecological mitigation area and will be further developed by the planting of wildflowers / grass meadows throughout the site. Excess runoff will behave as greenfield, by following the natural topography of the land.

6.0 Conclusion

Planning permission is sought for the development of a renewable energy park at Fair Oaks near Ruddington.

The site is identified as being partially in Flood Zone 3, according to the Environment Agency's Flood Map for Planning.

While part of the site lies within Flood Zone 3, detailed hydraulic modelling has been undertaken to assess site-specific risk. A sequential approach has been adopted to manage risk coupled with item-specific mitigation measures. Given a safe sustainable scheme is available within the site, as assessed in this FRA report, the proposed usage is appropriate. The creation of a renewable energy park clearly aligns with the national and local net-zero Carbon plan. As such the proposed development provides wider sustainability benefits to the community that outweighs flood risk, in line with the requirement of an Exception Test

An assessment of flood risk to the site from all sources has been made from available data. In addition, fluvial flood modelling was undertaken to assess site specific flood risk from Fairham Brook and an unnamed watercourse. This has confirmed that the majority of vulnerable structures will be located outside the fluvial flood extent. The majority of the site is shown to be at very low risk of surface water flooding, however there are some low-lying areas across the site at risk of flooding from standing water.

Risk to a small number of solar panels located within the identified affected areas will be mitigated by suitably raising the vulnerable elements of the panels. Risk to a number of the transformer stations will be mitigated by raising them sufficiently above the flood level.

Risk to staff during site visits can be managed by monitoring weather warnings and the implementation of a basic flood plan. The site is an unmanned facility and therefore will rarely impact people.

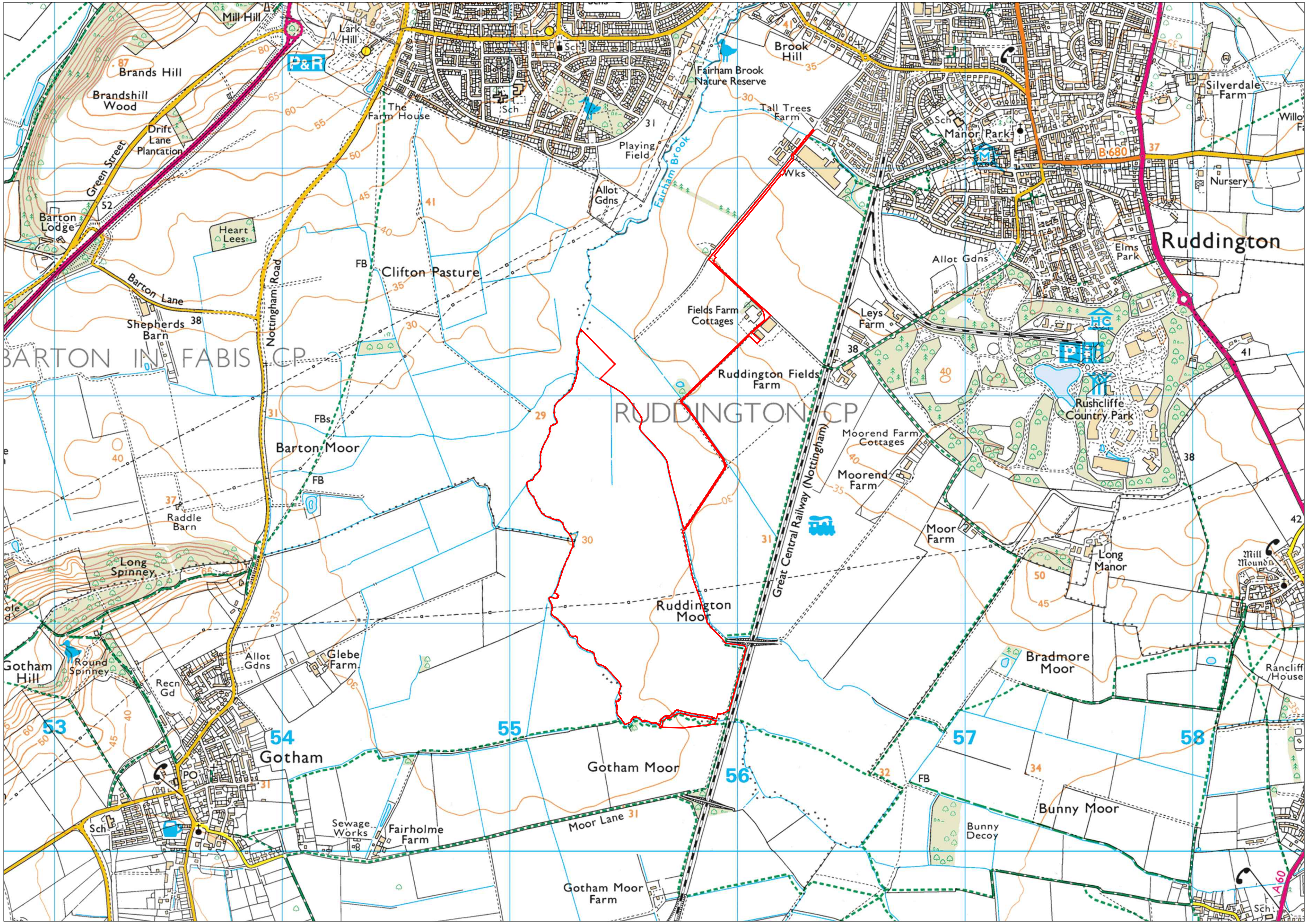
The proposed scheme will introduce a large impermeable area into the site, however this will comprise of a large number of small panels. Separations between individual panels will allow water to fall onto the undeveloped ground below. The impact on site runoff will therefore be negligible. Local effects will be managed through the use of suitable vegetation beneath the solar panels

It is concluded that the site offers scope to deliver the proposed development such that it will be appropriate for the flood risk and is not expected to increase the risk of flooding elsewhere.

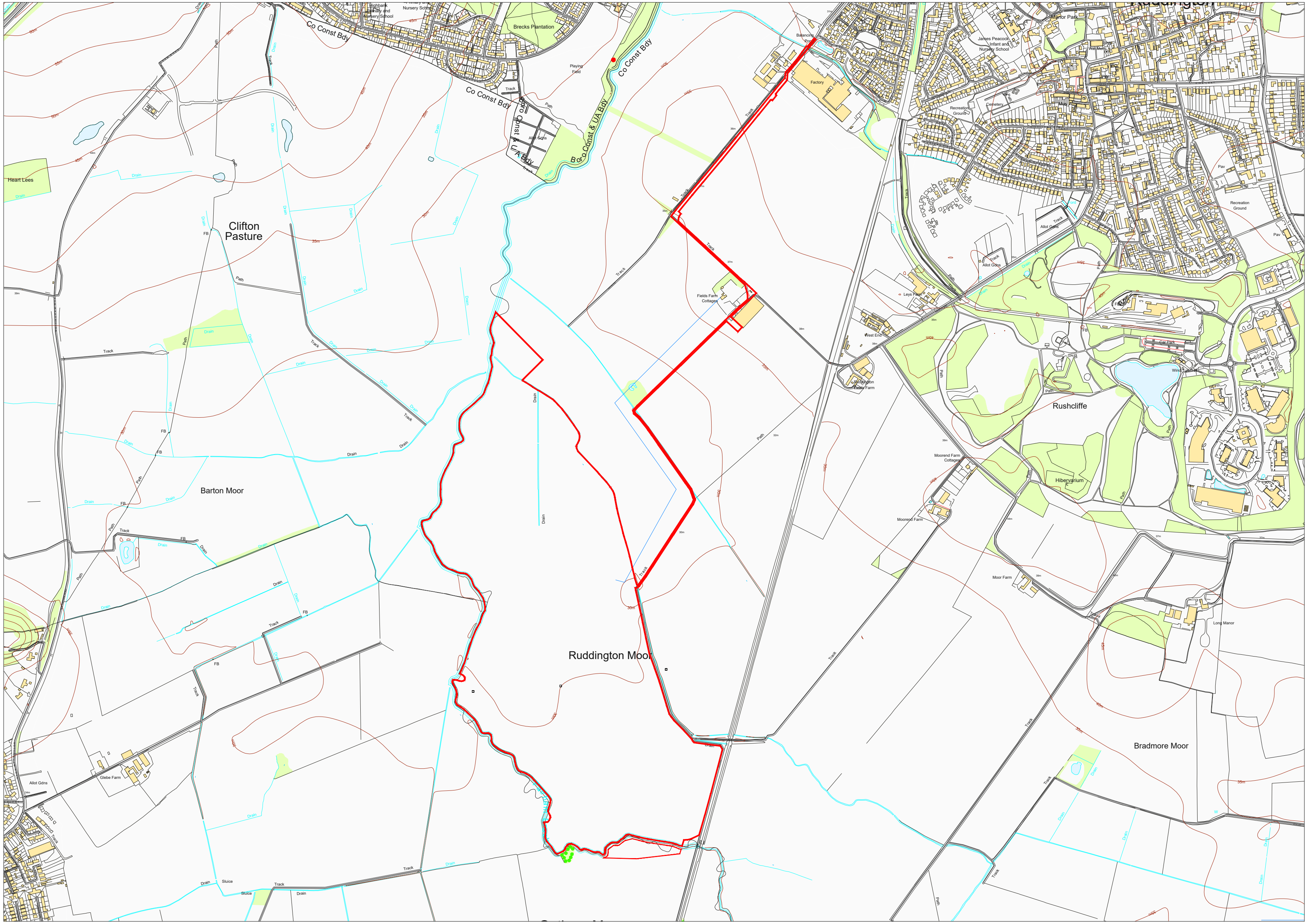
7.0 Recommendations

- Mount solar panels such that the lowest edge of the panel will be set a minimum of 0.9m above the ground giving 0.3m 'freeboard' above the deepest flood water. Confirm with supplier that this offers a suitable flood mitigation. The minimum height of the solar panels can be confirmed by way of a condition.
- Mount the four flood-affected transformer units on suitably raised stands in line with Figure 9. Confirm with supplier that this offers a suitable flood mitigation.
- Use flood resilient support infrastructure for the four flood-affected, raised transformer units (Figure 9).
- The site manager and staff should register to receive the Environment Agency's Flood Alerts and implement a flood plan as outlined in Section 4.2.1 and 4.2.2. The Flood plan can be secured by way of a condition.
- Implement suitable post-construction decompaction and vegetation across the site and beneath solar panels to enhance local infiltration, retention and detention.
- *Construction (Design and Management) Regulations 2015*
    - *The revised CDM Regulations came into force in April 2015 to update certain duties on all parties involved in a construction project, including those promoting the development. One of the Designer's responsibilities is to ensure that the Client organisation, in this instance Engena Limited, is made aware of their duties under the CDM Regulations.*

Appendix A – Proposed Drawing

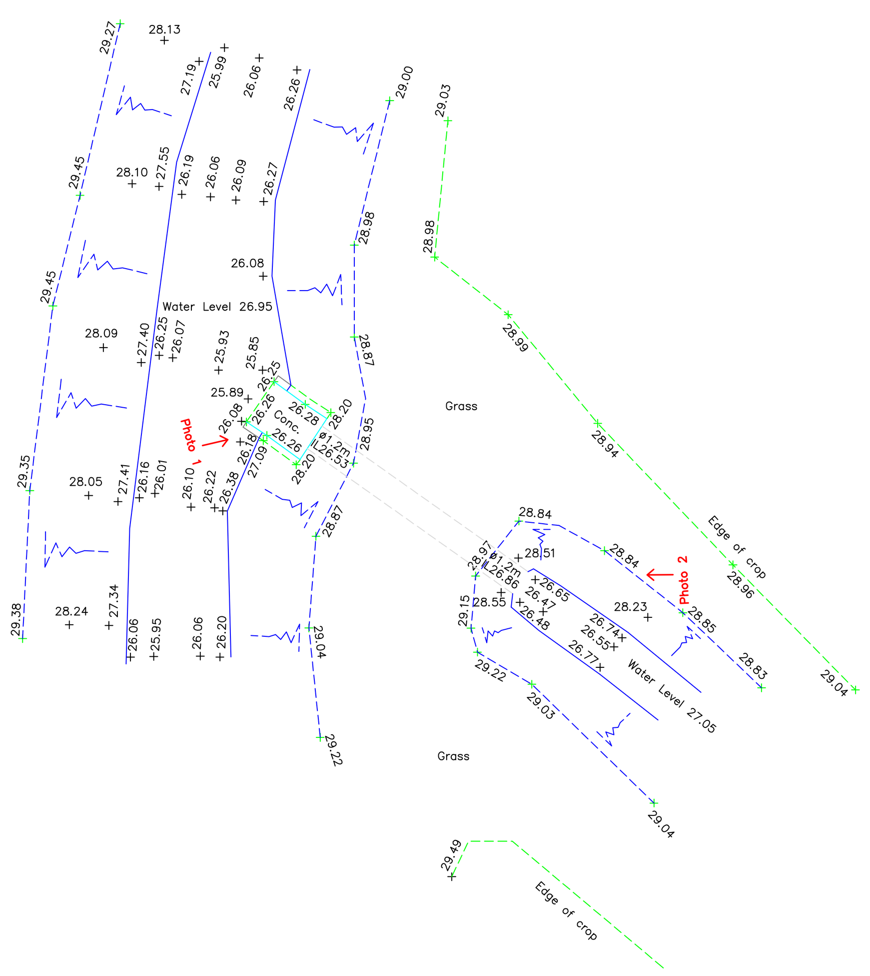


Mill Hill
Lark Hill
P&R
Brands Hill
Brandshill Wood
Drift Lane Plantation
Green Street
Barton Lodge
Heart Lees
Barton Lane
Shepherds Barn
Nottingham Road
Clifton Pasture
The Farm House
Playing Field
Allot Gdns
Fairham Brook
Fairham Brook Nature Reserve
Brook Hill
Tall Trees Farm
Wks
Manor Park
B 680
Silverdale Farm
Nursery
Ruddington
Elms Park
Allot Gdns
Fields Farm Cottages
Leys Farm
Ruddington Fields Farm
Rushcliffe Country Park
BARTON IN FABIS CP
RUDDINGTON CP
Barton Moor
Raddle Barn
Moorend Farm Cottages
Moorend Farm
Great Central Railway (Nottingham)
Moor Farm
Long Manor
Mill Mound
Long Spinney
Ruddington Moor
Gotham Hill
Round Spinney
Recn Gd
Allot Gdns
Glebe Farm
Bradmore Moor
Rancliff House
Gotham
Gotham Moor
Bunny Moor
Bunny Decoy
Sewage Works
Fairholme Farm
Moor Lane
Gotham Moor Farm
Sch
PO
A 60
53
54
55
56
57
58

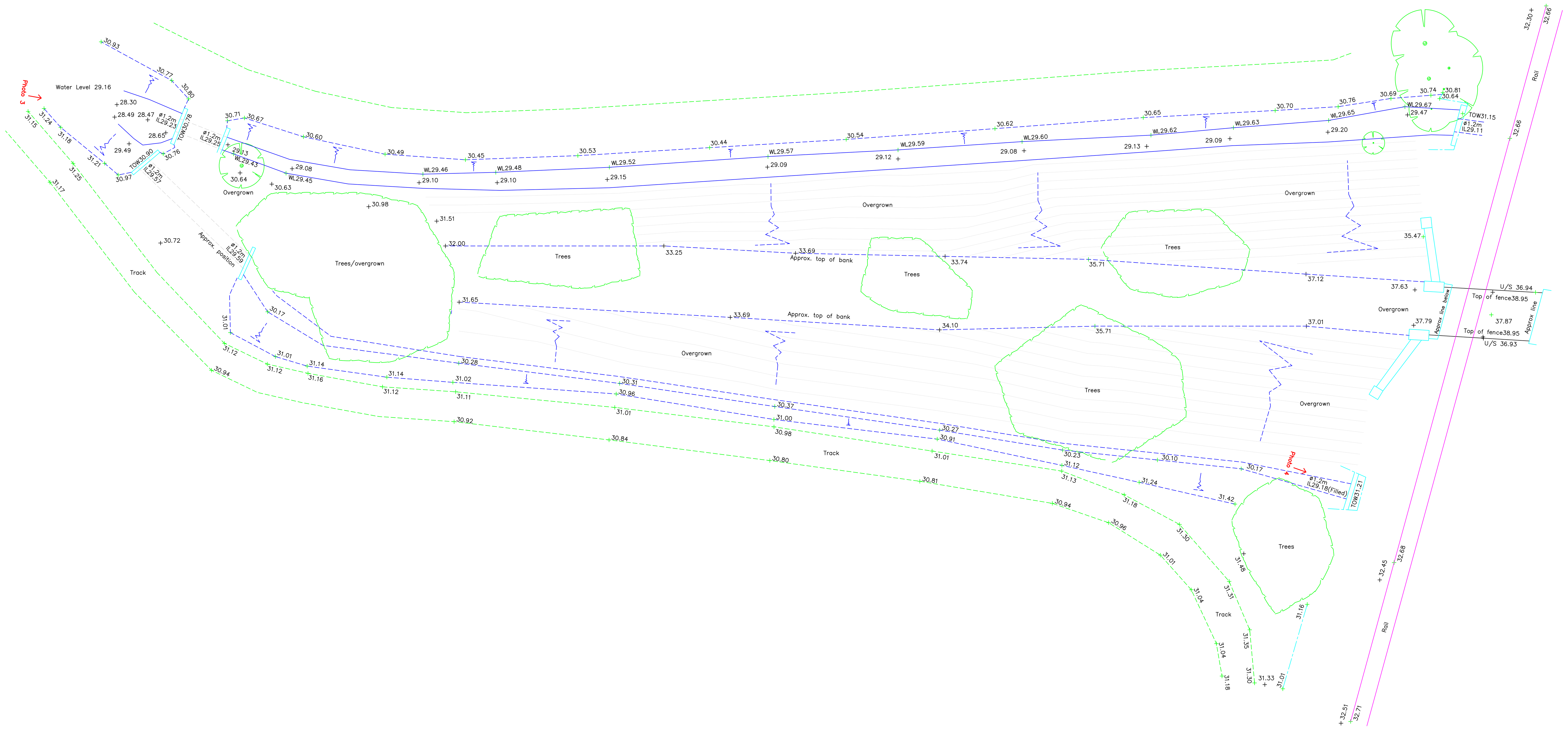


Brecks Plantation
Co Const Bdy
Playing Field
Boro Const & UA Bdy
Factory
Heart Lees
Clifton Pasture
Barton Moor
Ruddington Moor
Fields Farm Cottages
Leys Farm
West End
Rushcliffe
Moorend Farm Cottages
Moorend Farm
Moor Farm
Long Manor
Bradmore Moor
Glebe Farm
Allot Gdns
Recreation Ground
Cemetery
Pav
Track
Drain
Path
FB
Sluice

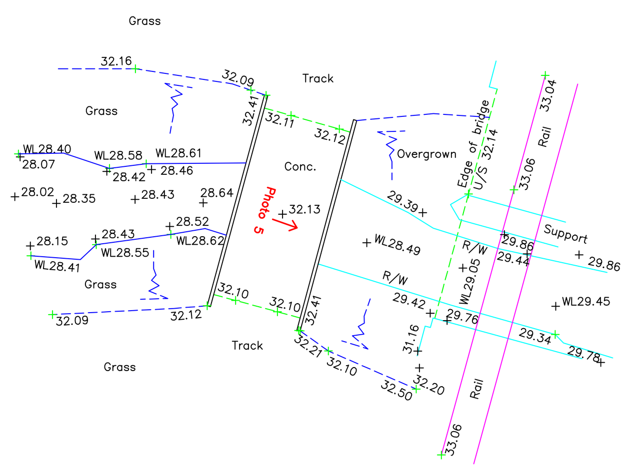
Survey Location 1



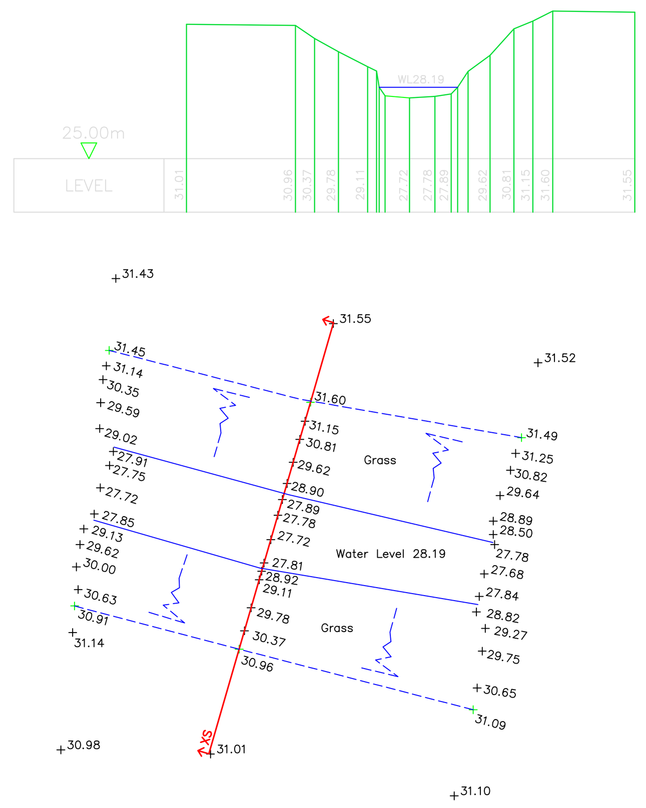
Survey Location 2 to 3



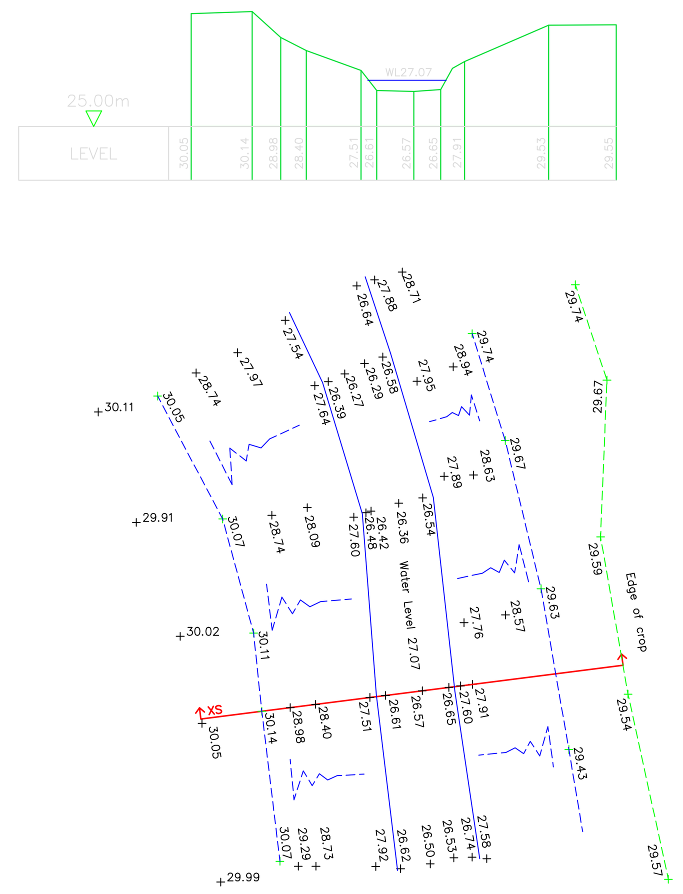
Survey Location 4



Survey Location 5



Survey Location 6



Project

Topographical Survey
Ruddington Moor

Client

Ridge Clean Energy Limited
Noah's Ark
Market Street
Charlbury
OX7 3PL

Notes

Visible features in the vicinity of the boundaries, as shown on this survey, may not represent the extent of legally conveyed ownership.

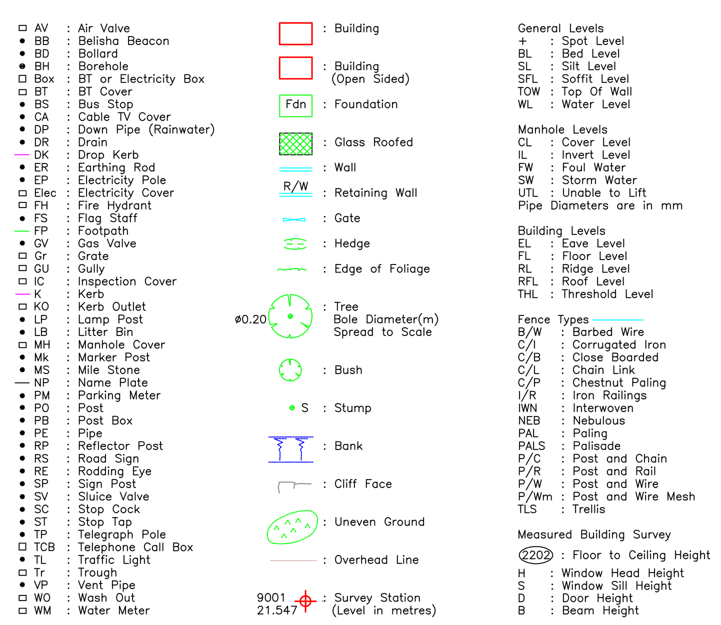
Whilst every effort has been made to achieve accuracy on this plan, critical clearance dimensions, levels and invert levels should be checked prior to design and construction.

Drainage pipe sizes (where shown) have been gauged from the surface for safety reasons and should be regarded as approximate only.

Although this is a digital survey the accuracy is only commensurate with the graphical scale of mapping as specified – care should be exercised "on screen" if working to larger scales.

WL28.58: Water levels taken on 11/03/22

Legend



Iss	Date	Comments
A	14/03/22	Site Survey

Survey Three Limited
Chartered Land Surveyors
113a Nottingham Road
Stapleford
Nottingham
NG9 8AT
Tel 0115 922 2469
info@surveythree.co.uk

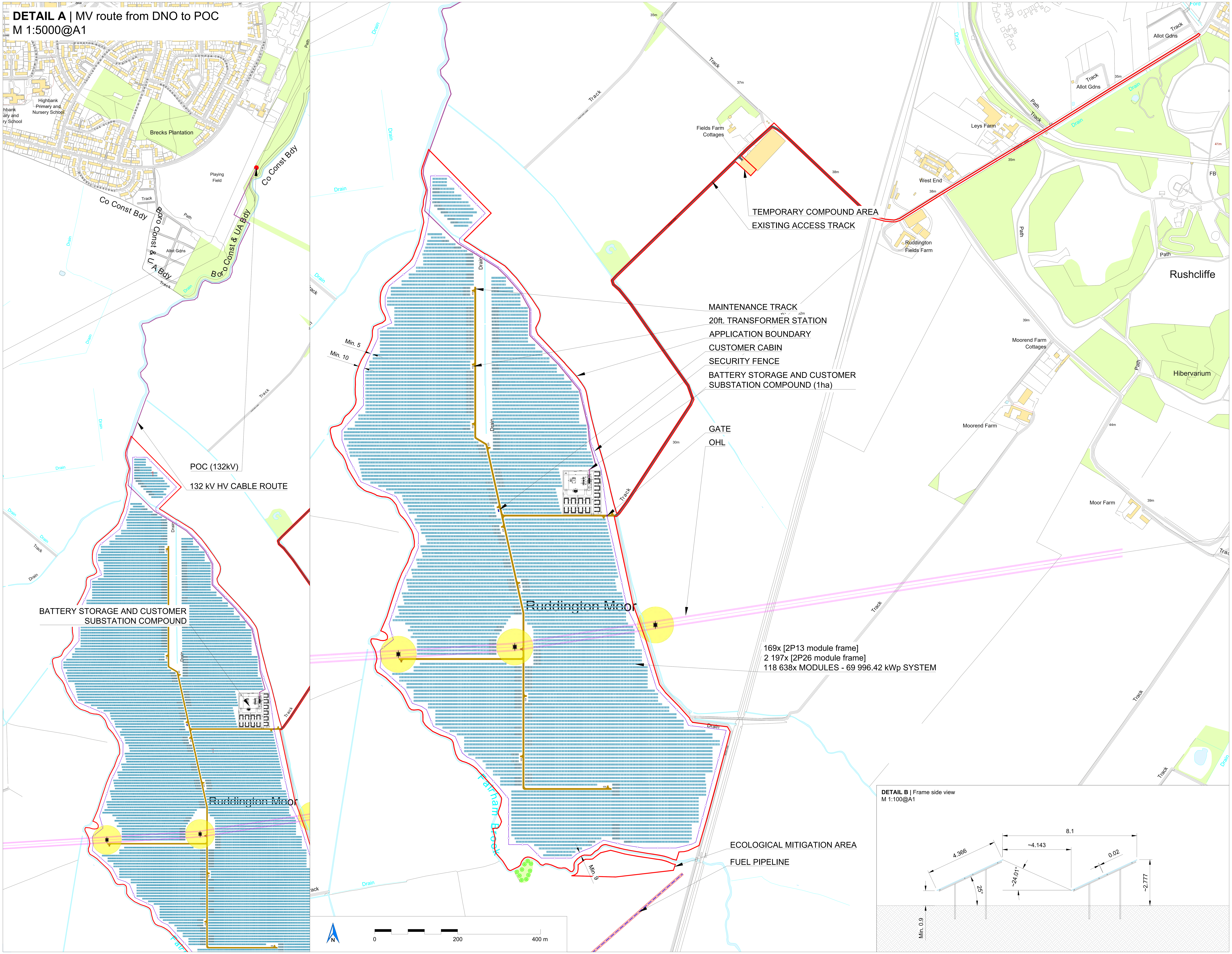
RICS

Plan Datum: Local Metric Grid referenced to OSGB36(15)

Height Datum: OSGB36(15)

Job No: 4590 | Scale: 1:200

Drg No: 1 of 1 | DWG: 4590ia



Proposal only

Notes:

1. All dimensions to be confirmed on site prior to installation.
2. All dimensions are indicative only and in m unless otherwise specified.
3. Drawing based on:
"OS_VectorMap_Local.dwg"
"Fair Oaks - Option Areas & Site Plan.pdf"
"Fair Oaks Boundary & Crossing.kml"
"LIDAR_2m_DTM_-_EA_737084_953524.dwg"

Legend:

- Application boundary
- Perimeter fence
- Overhead line
- Gas pipeline
- 132kV HV Cable route
- Maintenance track
- Existing access track
- Customer cabin
- 20ft. transformer station
- 20ft. Customer substation
- 40m clearance from pylons
- 6m clearance around fuel pipeline
- Temporary construction compound area
- Battery storage unit
- Customer substation compound area

System description:

DC Power kWp:	69 996.42
AC Power kVA:	49 980 @215kVA
No. of modules:	118 638
Module type:	Canadian Solar CS7L-590MB
Dimensions:	2173x1305x35
Substructure type:	2 modules in portrait
Tilt angle:	25°
Shading angle:	~24.01°
Azimuth from South:	Due south
Pitch distance:	8 100mm
Row to row distance:	~4 143mm
No. of inverters:	232
Inverter type:	Huawei SUN2000-215KTL-H0
Power ratio:	1.36 / 1.43 @215kVA
No. of AC combiners:	-
No. of Transformers	10
Fence area:	~75.25 ha
Fence length:	~4 410m
Total area:	~83.80 ha

Proposed location:

Revisions:

Rev	Date	Comments	Drawn
A	21/11/19	Battery storage area updated	RU
B	21/12/21	Pylons added	MG
C	03/05/22	Battery storage area relocated, mod. moved from South to North, pitch changed	MC
D	23/05/22	Fence adjusted	MC
E	08/07/22	Substation compound adjusted	RU

Project:	Fair Oaks Renewable Energy Park
Location:	Fields Farm, Asher Lane, Ruddington, Nottingham, NG11 6JX, UK 52°52'58.83"N 1°10'44.65"W
Title:	PV Layout

Drawn:	DETRA / RU	Checked:	JF
Scale:	1:4000@A1	Date:	08/07/22
Drawing No:	ENGN1008-100	Rev:	E

engena

Engena Limited
The Old Stables
Bosmere Hall
Creeting St Mary
IP6 8LL

www.engena.co.uk

Do not scale from this drawing. Site verify all dimensions prior to construction. Report all discrepancies to the drawing originator immediately. This drawing is to be read in conjunction with all relevant documents and drawings.

Appendix B – Model Report

Hydrological Assessment

Fairham Brook flows from the southeast, adjacent to the west boundary of the site. The brook eventually flows into the River Trent approximately 4.5km to the northeast of the site. In addition, an unnamed watercourse flows from the southeast, adjacent to the east boundary and discharges into the Fairham Brook at the north boundary of the site. Towards the northwest of the site there is also a small tributary that feeds into the Fairham Brook. Both the Fairham Brook and unnamed watercourse pass through culverts and these locations are detailed in Figure 12 below.

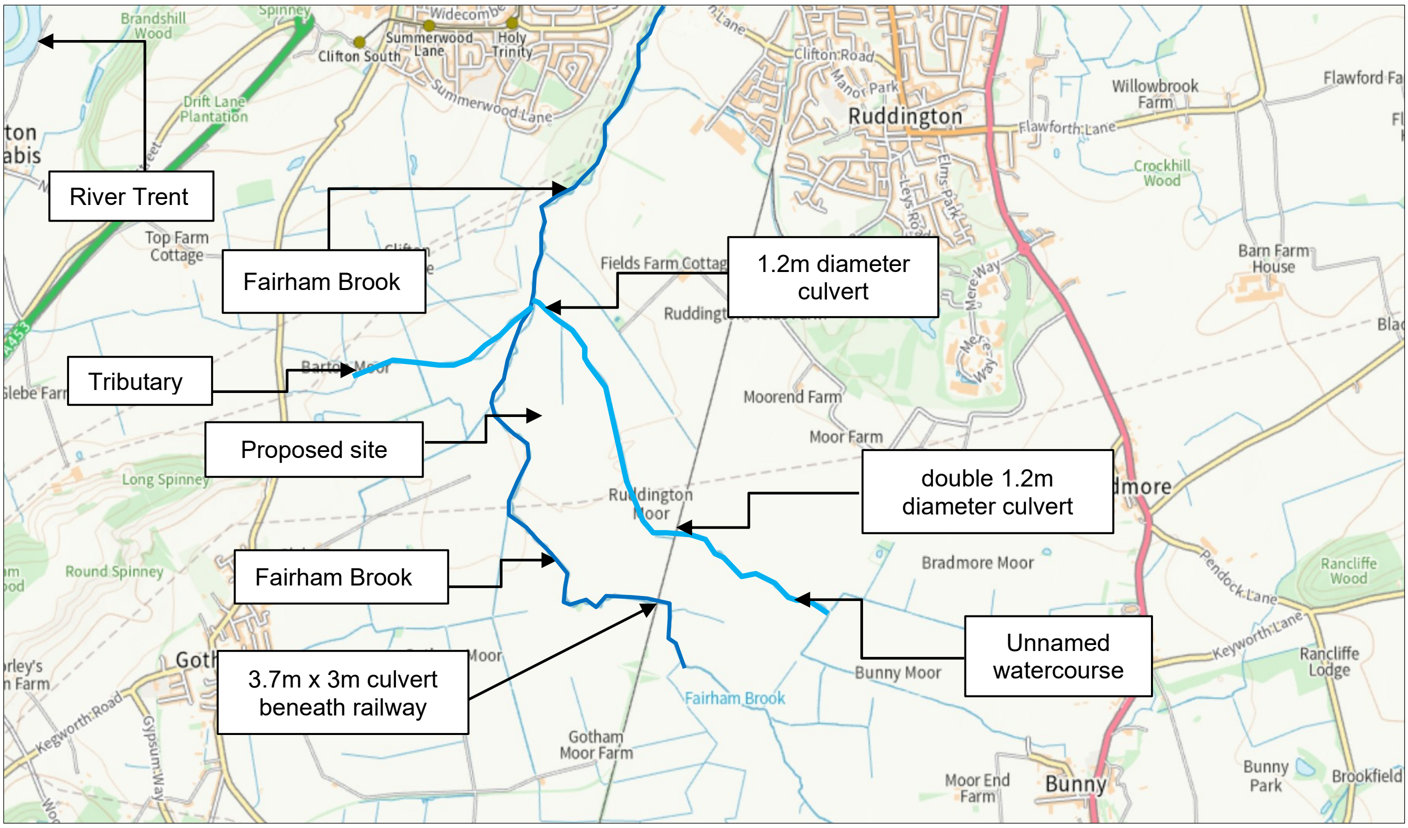


FIGURE 12: MAP SHOWING THE ROUTE OF THE WATERCOURSES WITH LOCATION OF STRUCTURES

Both the Fairham Brook and the unnamed watercourse are open channel for several kilometres upstream of the site. Both watercourses pass beneath a railway line at the southeast boundary of the site.

FIGURE 13: PICTURE OF THE FAIRHAM BROOK, WITH RAILWAY CROSSING AND VEHICLE CROSSING.

Both watercourse flow along the east and west boundary of the proposed site in open channel for approximately 2km. The channels of the watercourses are very well defined and free from dense vegetation. Figure 14 and Figure 15 below show some photographs of the channel throughout the site.

Figure 14: Picture of the Fairham Brook flowing adjacent to west boundary of the site.

Figure 15: Picture of the unnamed watercourse flowing adjacent to east boundary of the site.

At the north boundary of the proposed site the unnamed watercourse flows through a 1.2m diameter culvert (Figure 16), which outfalls into the Fairham brook. Following this Fairham Brook flows north in open channel for a further 1.8km before it reaches the town of Clifton.

FIGURE 16: IMAGINE OF THE 1.2M DIAMETER CULVERT WHICH CONNECTS THE UNNAMED WATERCOURSE TO THE FAIRHAM BROOK.

FEH Statistical Method

The purpose of this work is to estimate peaks flows for the catchment relevant to the development site. The calculated flows have then been used to model flood levels at the proposed site.

The catchment area and catchment descriptors were obtained from the FEH Web service for a location adjacent to the site and are show below in Figure 17 and Figure 18.

The FEH Web service identifies a 58.94km^2 catchment area. A review of the catchment against OS contour maps and freely available LiDAR data was made to ensure that the selected catchment area was reasonable and that there were no obvious man-made structures or embankments that would alter the catchment area. Following this review, it was deemed that the FEH Web service was reasonable and no alterations to the area were needed. The catchment area itself is almost entirely rural, dominated by agricultural land, with only a few small villages, such as Gotham, Bradmore, Bunny and Widmerpool. There are no lakes or reservoirs in the area that would provide a flow attenuation effect (as evidenced by a FARL value of 0.9950), which would need to be accounted for, or would impact on the choice of flow estimation method. The ground levels in the catchment fall from approximately 150mOAD in the far south (near Old Dalby) to around 30mAOD at the site. As this distance is around 15km this gives a general brook slope of 1:125. The bedrock geology of the wider catchment is generally mudstone with, although close to the proposed site is predominantly sandstone, with glaciofluvial superficial deposits of sand and gravel.

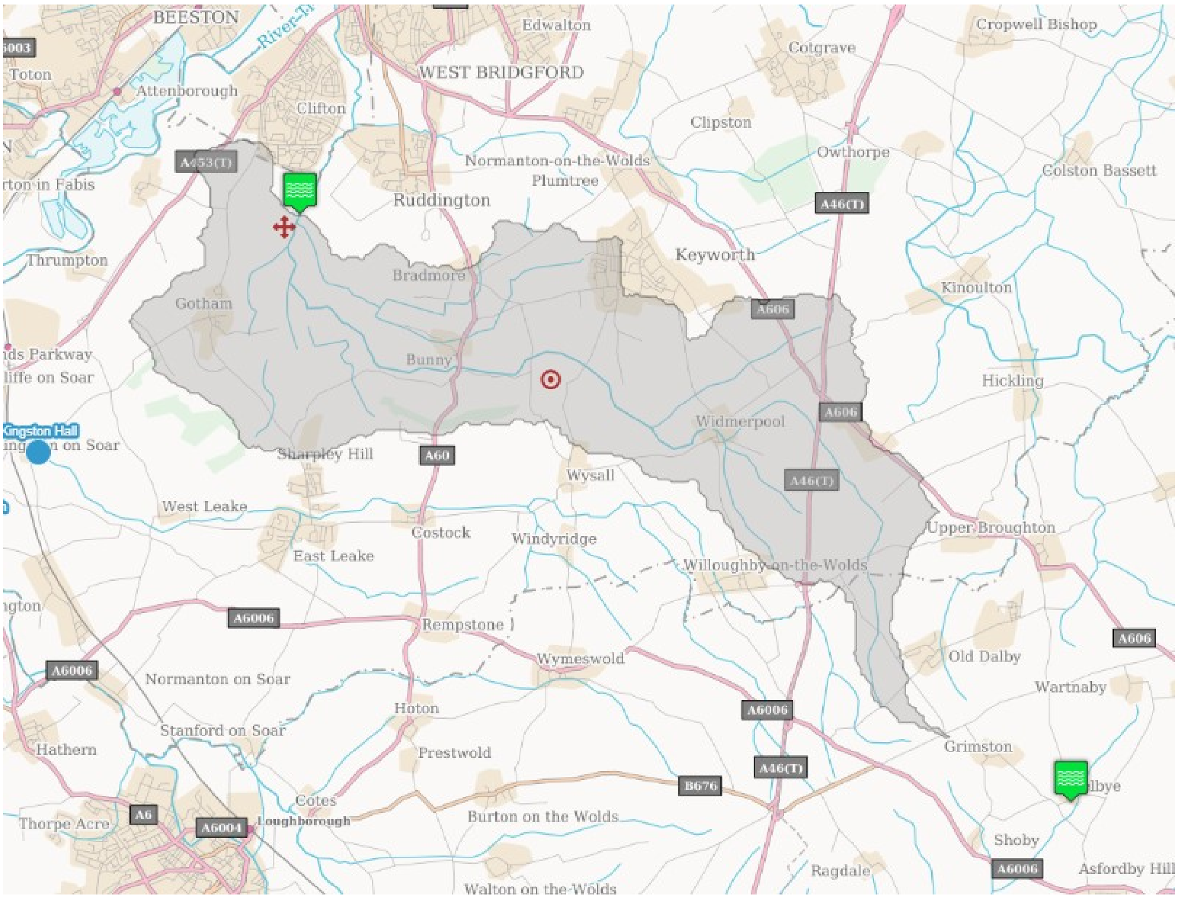


FIGURE 17: FEH WEB SERVICE CATCHMENT AREA

Outlet	455300, 332200
NGR	SK 55300 32200
Area	58.94 km²
Altbar	64 m
Aspbar	304 degrees
Aspvar	0.14
Bfihost	0.402
Bfihost19	0.394
CentroidEasting	460,090 m
CentroidNorthing	329,083 m
Dplbar	9.23 km
Dpsbar	32.60 m/km
Farl	0.9950
Fpext	0.1810
Fpdbar	1.116 cm
Fploc	0.549
Ldp	23.26 km
Propwet	0.280
Rmed1H	10.4 mm
Rmed1D	30.2 mm
Rmed2D	38.2 mm
Saar6190	597 mm
Saar4170	601 mm
Sprhost	42.54 %
Urbconc1990	0.6990
Urbext1990	0.0233
Urbloc1990	0.7440
Urbconc2000	0.7940
Urbext2000	0.0196
Urbloc2000	0.7250
CatchmentRainC	-0.025
CatchmentRainD1	0.341
CatchmentRainD2	0.335
CatchmentRainD3	0.228
CatchmentRainE	0.306
CatchmentRainF	2.365
GridRainD1	0.343
GridRainD2	0.348
GridRainD3	0.218

FIGURE 18: CATCHMENT DESCRIPTORS

As there are no gauging stations on the watercourses at or near the site, the ‘single site’ and ‘enhanced single site’ analysis methods are not possible, consequently the ‘pooled method’ was used.

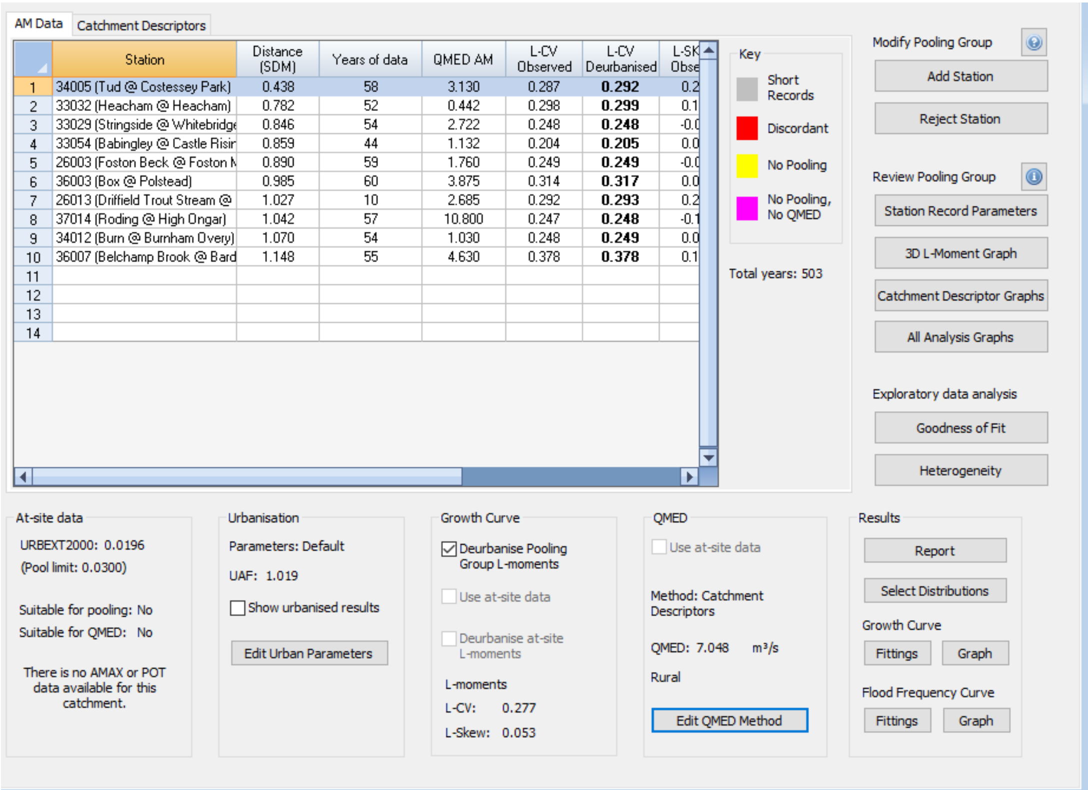
QMED was estimated from the catchment descriptors using the latest equation captured in WINFAP 5:

$QMED_{rural} = 7.048 m^3/s$

The derived QMED value was adjusted using the latest donor site procedure (using the top 6 donor sites identified with WINFAP 5) and the updated urbanisation adjustment.

A pooling group was created from all available gauging stations (omitting those tagged as unsuitable for QMED and pooling), with in excess of 500 years of records.

A growth curve was produced from the pooling group using a Generalised Logistical distribution and applied to QMED to give a flood frequency curve given in Table 7 below.



	Station	Distance (SDM)	Years of data	QMED AM	L-CV Observed	L-CV Deurbanised	L-SK Obse
1	34005 (Tud @ Costessey Park)	0.438	58	3.130	0.287	0.292	0.2
2	33032 (Heacham @ Heacham)	0.782	52	0.442	0.298	0.299	0.1
3	33029 (Stringside @ Whitebridge	0.846	54	2.722	0.248	0.248	-0.0
4	33054 (Babingley @ Castle Risin	0.859	44	1.132	0.204	0.205	0.0
5	26003 (Foston Beck @ Foston N	0.890	59	1.760	0.249	0.249	-0.0
6	36003 (Box @ Polstead)	0.985	60	3.875	0.314	0.317	0.0
7	26013 (Driffield Trout Stream @	1.027	10	2.685	0.292	0.293	0.2
8	37014 (Roding @ High Ongar)	1.042	57	10.800	0.247	0.248	-0.1
9	34012 (Burn @ Burnham Overy)	1.070	54	1.030	0.248	0.249	0.0
10	36007 (Belchamp Brook @ Bard	1.148	55	4.630	0.378	0.378	0.1
11							
12							
13							
14							

Figure 19: Pooling Group

TABLE 7: FEH STATISTICAL METHOD FREQUENCY CURVES

Annual exceedance probability (AEP)	Peak flood flow rate (m^3/s)			
	Stat method (derived from catchment descriptors)		Stat method (donor adjusted)	
	No urban adjustment	With urban adjustment	No urban adjustment	With urban adjustment
50%	7.1	7.2	8.4	8.6
10%	11.7	11.9	14.0	14.2
5%	13.4	13.6	16.1	16.3
2%	15.7	15.9	18.8	19.1
1%	17.4	17.7	20.9	21.2
1 % AEP + 23% CC	21.4	21.8	25.7	26.1

Revitalised FSR/FEH rainfall runoff method

The catchment descriptors were also entered into the FEH ReFH2 software package (Version 3.2.7650), using the default model parameters. The default 60 min timestep and 15-hour rainfall duration were used. The flood frequency curve from the ReFH2 method is given in Table 8 below.

TABLE 8: REFH2 FLOOD FREQUENCY CURVES

Annual exceedance probability (AEP)	Peak flood flow rate (m^3/s) ReFH2 method
50%	9.9
10%	14.9
5%	17.5
2%	22.4
1%	27.0
1% AEP + 23% CC	33.6

Assessment of data

The purpose of this hydrological study is to assess flood risk to support a planning application for a large renewable energy park. The statistical method is generally the preferred approach for estimating flood frequency curves as it is based on a much larger data set of flood events compared to the other methods. In this case however the ReFH2 results were chosen for hydraulic modelling over the statistical method as they provide a more conservative estimate, given there is no flow gauge information with which to calibrate / validate the model.

The above calculations provide peak flows for the whole catchment, which is a combination of the Fairham Brook, the unmanned watercourse and a small tributary of the Fairham brook. The peak flow for each watercourse sub-catchment was determined by proportioning the total flow estimate for the whole catchment in line with the sub-catchment areas, determined from the FEH Web service:

Total catchment area = 58.94km^2 (100%)

Fairham Brook catchment area = 48.07km^2 (81.5%)

Unnamed watercourse catchment area = 7.77km^2 (13.2%)

Small tributary catchment area = 3.10km^2 (5.3%)

The 3 sperate sub-catchments are shown in Figure 20 below.

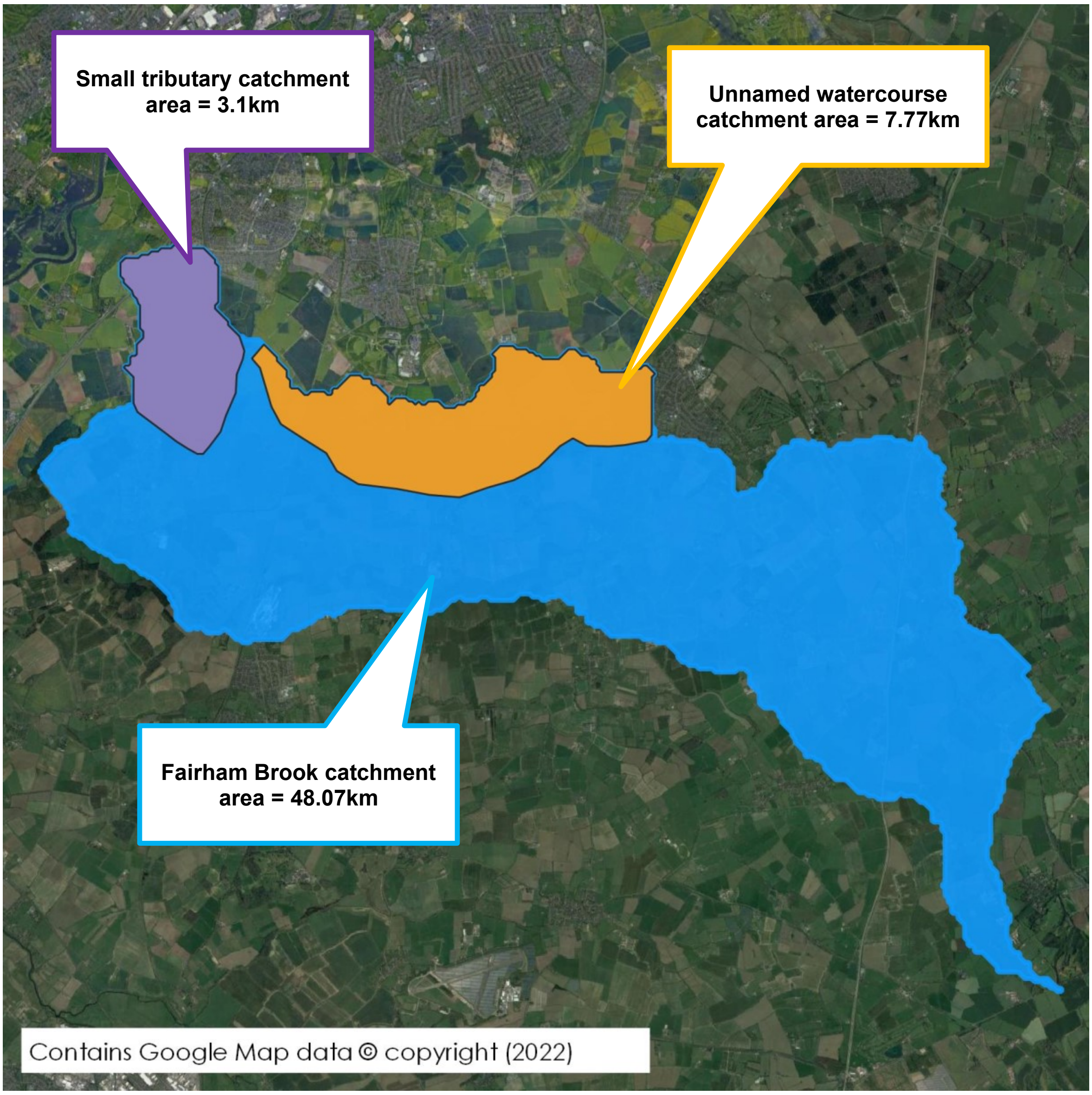


Figure 20: Imagine showing the catchment areas

Hydraulic Modelling

The hydraulic model was developed using Flood Modeller Pro / TUFLOW. The hydraulic model included a 3.3km stretch of Fairham Brook and 2.5km stretch of the unnamed watercourse. The upstream extent was approximately 900m upstream of site boundary and the downstream extent was the 450m downstream of the site. Given the nature of the study area, a combined 1D – 2D hydrodynamic model has been selected as the most appropriate method to generate the best estimate of flood depth. This approach simulates flow within the channel and flow on the floodplain during flood events, representing the extent of flooding that is likely to occur in the area. Data is required to define the model bathymetry and boundary data with which to drive the model. Additional data is also required to define crest levels of weirs and walls, and for bridges, soffit levels etc.

The topography of the Fairham Brook and unmade watercourse was assessed via a river cross section survey (Appendix A). 1m resolution LiDAR has been used to provide additional cross sections and data for the floodplain. (LIDAR-DTM-1m-2020-SJ90nw). Figure 21 shows the 1D scheme of the model.

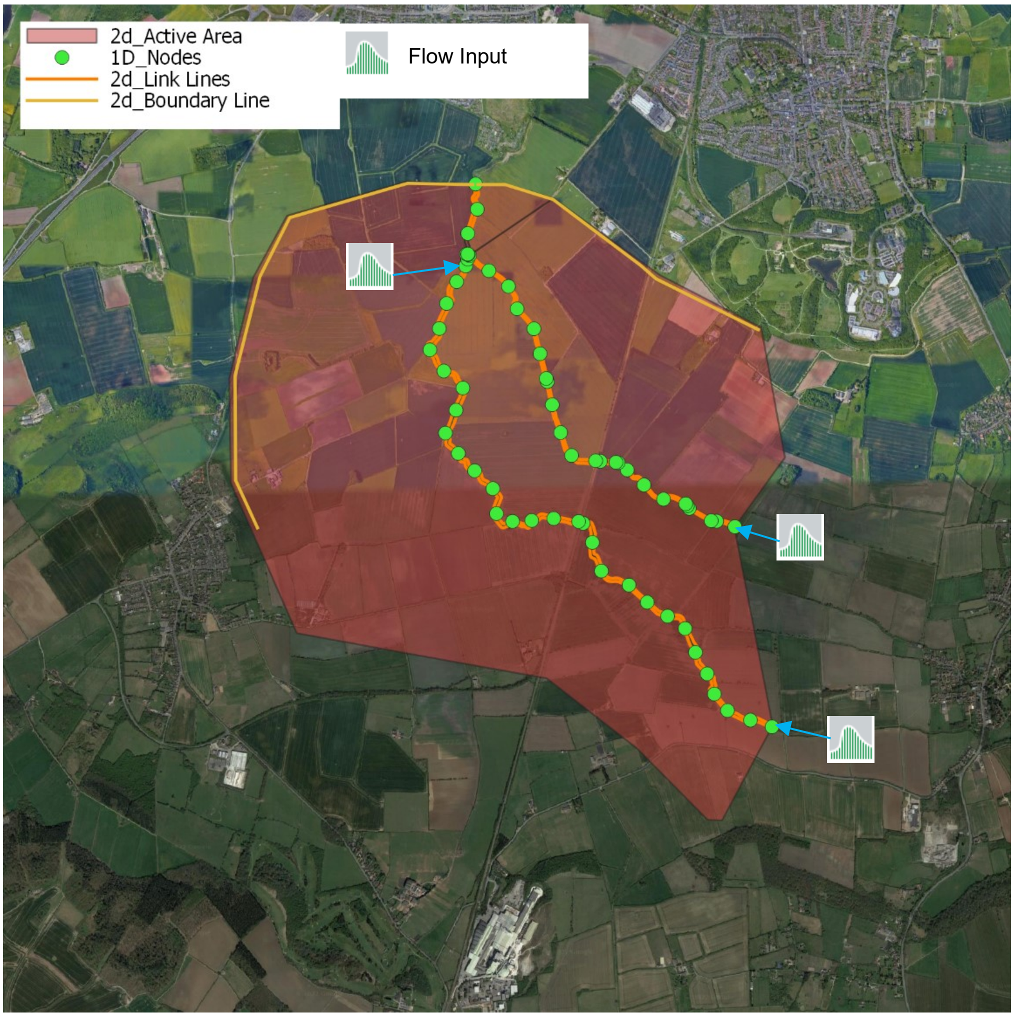


Figure 21: Model schematisation

The River channel and floodplain were assigned a roughness value with reference to standard values (Chow, V.T., 1959, Open-channel hydraulics, New York: McGraw-Hill). A variety of Mannings n values were assigned for different sections of the channel and flood plain. In-channel sections of the brook were assigned a mannings n value of 0.035 and 0.025 for structures. Mannings value in the flood plain was globally set at 0.05.

A model grid size of 4m was selected to provide adequate representation of all flow paths while still resulting in reasonable run times. A level link was used to connect the 1D and 2D elements. The link lines were set along the bank tops using data extracted from both the cross section topographic survey and LiDAR. The link line was aligned with the active area shown in Figure 21. Inflow to the model was provided by three flow time boundaries. The inflow hydrographs are based on the ReFH2 hydrographs derived for the catchment adjacent to the site, as discussed in the hydrological assessment. The 1D downstream boundary was represented by a Normal Depth boundary unit for the baseline runs (set to a gradient of 1:530). A boundary line was also included at the downstream end of the active area (set to a gradient of

1:530), set as normal depth, to provide a 2D boundary. The time step for the linked model runs was set at 1D = 2s and 2D = 1s. The bridges were all assumed to be unblocked in the baseline model, but the impact of blockage was investigated as a scenario. Model sensitivity testing was also undertaken.

A hydraulic model review checklist is included at the end of this section which summarises key parameters and choices made within the model.

Model Results Analysis:

The model shows that during the 1%+CC design flood event the bridges beneath the railway at the upstream end of the model provide a constriction to flow, however the downstream channel capacity of both watercourses is eventually exceeded, resulting in flooding on the right bank of the Fairham Brook and on both banks of the unnamed watercourse. A 1.2m circular culvert near the north boundary of the site, on the unnamed watercourse, does provide a small degree of constriction, but the land surrounding this structure falls steeply toward Fairham Brook, so out of bank flood water at this location flows northeast into the Fairham Brook.

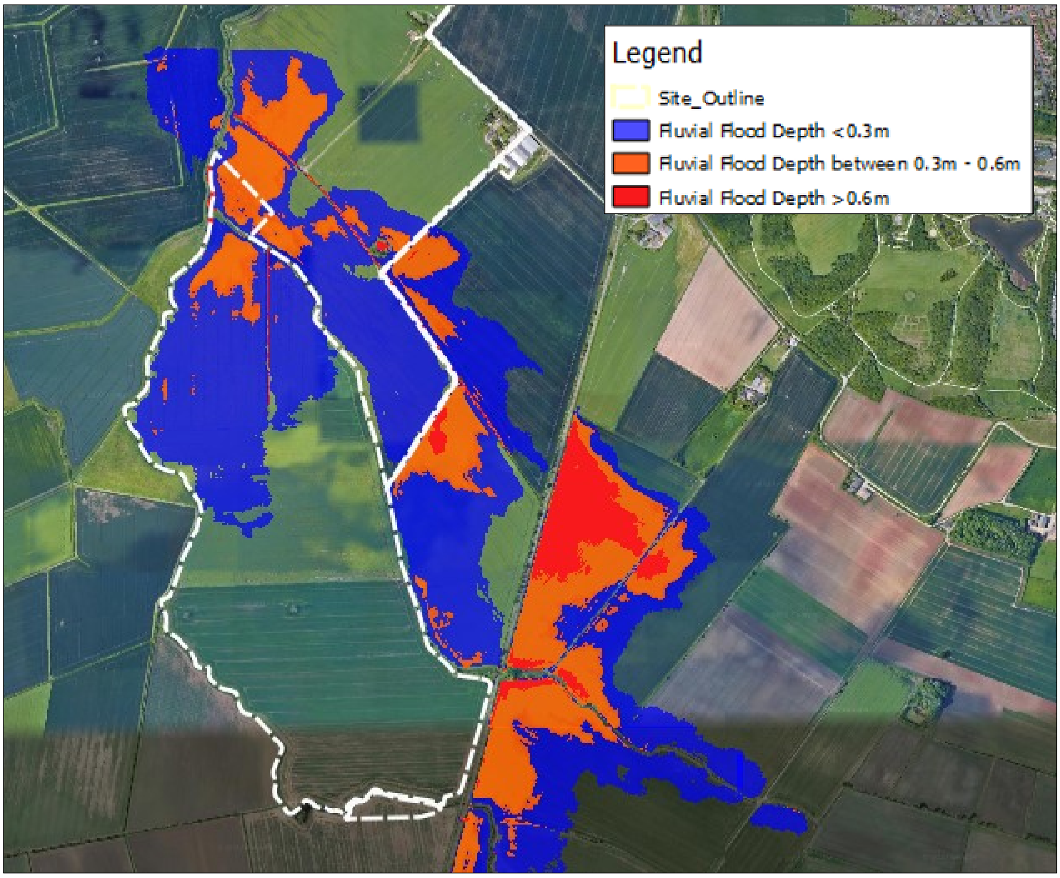


FIGURE 22: FLOOD DEPTH AND EXTENT FROM THE 1% AEP PLUS 23% CLIMATE CHANGE SCENARIO

A blockage scenario was also tested. During this scenario the cross-sectional area of the 1.2m culvert near the north boundary of the site was reduced by 50%. The results of this are shown in the figure below. There is a negligible impact on flood extent at the site. Locally around the structure flood levels see a small increase of 0.01 – 0.02m, but this is very localised around the structure. General flood levels across the site are unchanged.

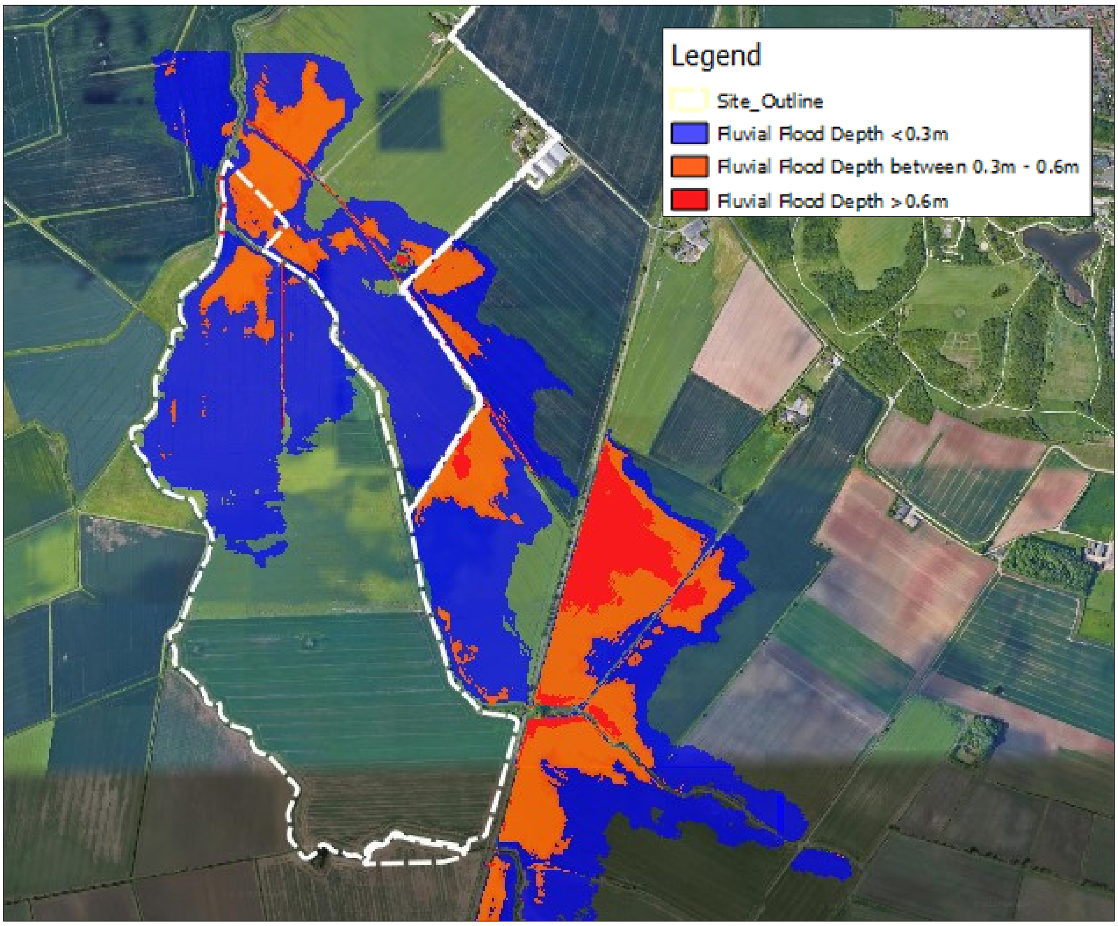


FIGURE 23: 1% AEP PLUS 23% CLIMATE CHANGE SCENARIO WITH 50% DOWNSTREAM CULVERT BLOCKAGE

Model Calibration:

There are no NRFA FEH gauges at this location and no flow / level data from which the model can be formally calibrated or validated. Uncertainty of modelled results will therefore be judged based on model sensitivity testing.

Model Sensitivity:

Sensitivity testing is the process of adjusting key parameters within the hydraulic model to assess the impact on the modelled outcome. In the absence of formal calibration, model uncertainty will be assessed by sensitivity testing. According to the Environment Agency's Fluvial Design Guide, the main parameters that should be tested are:

- Mannings n increased by 20% globally
- Mannings n decreased by 20% globally
- Adjusted gradient at the downstream boundary

The sensitivity tests were run with the 1% AEP+ CC (23%) event as the baseline event. Peak flood level results were extracted from the 2D domain at 3 specific (and relevant) locations within the proposed site (locations shown in Figure 24).

Table 9: Model Sensitivity Results

Modelled Scenario	Flood level (mAOD) at 2D point 1	Flood level (mAOD) at 2D point 2	Flood level (mAOD) at 2D point 3
1 % AEP + 23% CC	29.34	29.39	29.36
1 % AEP + 23% CC & mannings increase (20%)	29.35	29.41	29.37
1 % AEP + 23% CC & mannings decrease (20%)	29.31	29.35	29.33
1 % AEP + 23% CC & downstream boundary increase (20%)	29.34	29.39	29.36
1 % AEP + 23% CC & downstream boundary decrease (20%)	29.34	29.39	29.36
1 % AEP + 23% CC & downstream culvert blockage (50%)	29.34	29.39	29.36

FIGURE 24: LOCATION OF CELLS RELEVANT TO SENSITIVITY TESTING

Manning's n

As a result of decreasing Mannings 'n' by 20% there were small peak level changes across the site of between 0.03 – 0.05m. As a result of increasing Mannings 'n' by there were small peak level increases of between 0.01 – 0.02m across the site. Minor changes of level are expected when modifying the Mannings 'n', as this influences the flow profile of the channel and overland flows. The recorded results show the model is not particularly sensitive to changes in Manning's n.

Downstream Boundary adjustments

Normal depth is the depth of flow in a channel or culvert when the slope of the water surface and channel bottom is the same and the water depth remains constant. In Flood Modeller, the Normal Depth Boundary (NCDBDY) unit is a downstream boundary which automatically generates a flow-head relationship based on section data; it applies a normal depth from the Manning's equation. Both decreasing and increasing the gradient made no change to the modelled flood levels. This shows the model has very low sensitivity to downstream boundary condition.

Hydraulic Model Review Checklist:

General Information and Modelling Approach	
Item	**Comments**
General Information & Modelling Approach	
Software choice?	Flood Modeller Pro / TUFLOW
Modelling Approach?	1D-2D linked
Modelling Scenarios Used?	• 1% AEP + 23% CC • 1% AEP + 23% CC & Mannings increase (20%) • 1% AEP + 23% CC & Mannings decrease (20%) • 1% AEP + 23% CC & downstream boundary increase (20%) • 1% AEP + 23% CC & downstream boundary decrease (20%) • 1% AEP + 23% CC & downstream culvert blockage (50%)
1D Model / Network	
How have roughness values been determined?	Roughness values have been chosen based on visual inspection from web searches.
Are all structures included or exclusions documented?	Yes – In line with provided survey and suppled photographs
Are spill units included?	Yes
Is the model geo-references?	Yes
Have bank / bed markers been used?	Yes
1D Boundary Conditions	
What 1D Boundaries have been applied?	Flow Time Boundary & Normal Downstream Boundary
Has an appropriate location been chosen for the downstream model extents?	Yes. The downstream boundary is 450m north of the site, which is far enough away to have minimal impact. (As verified by the sensitivity results).
1D structures	
Are all structures included or exclusions documented?	Yes – In line with provided survey information and supplied imagines
1D Run Parameters	
What time step has been used for the 1D model?	1 seconds
What initial conditions have been used?	Time 0, Steady State.
Have any of the parameters and advanced parameters been changed from the default. If so, has it been justified?	No changes to default parameters made

2D Model Build	
Number of domains?	One
What dataset has been used to define the DTM elevations?	1m LiDAR
What grid resolution has been used?	4m
How have buildings been represented within the DTM?	No buildings within the modelled area
2D Boundary and Roughness	
Have any boundaries been used in the 2D domain?	Yes – a 2D normal depth boundary outflow
Is the model boundary suitably large?	Yes - the 2D area is large enough to prevent glass walling
What manning's n values have been used to define floodplain roughness?	A default global roughness has been applied within the 2D, chosen to best represent the pastureland.
2D Run Parameters	
What time step has been used for the 2D model?	2 seconds
Have initial water levels been applied?	No
What initial conditions have been used?	Time 0, Steady State
Are the other 2D model parameters reasonable	Default setting
1D/2D model Links	
How have the 1D/2D models been coupled?	Using 2D HX / CN link lines.
Have any default link parameters been changed?	No
Model Stability	
What warnings / errors are present on the logs?	No errors or warning that would affect results
Is mass balance within tolerable limits?	Yes, mass below 0.4%. error is shown to peak at 1.4%
Does a basic check of animations and graphed outputs give an indication of good model stability?	Yes, animations show no oscillation.
Do the 2D extents / outputs look sensible?	Yes, although no flood history to calibrate results.
Model Sensitivity	
Have appropriate model parameters been chosen for sensitivity testing?	• 1% AEP + 23% CC • 1% AEP + 23% CC & Mannings increase (20%) • 1% AEP + 23% CC & Mannings decrease (20%) • 1% AEP + 23% CC & downstream boundary increase (20%) • 1% AEP + 23% CC & downstream boundary decrease (20%) •
Do the results of the tests show the models to be particularly sensitive to certain parameters?	No