FLOOD RISK ASSESSMENT

SWEETBRIAR SOLAR FARM

JANUARY 2022

Prepared By:

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1 INTRODUCTION

1.1 Background

This document is a Flood Risk Assessment (FRA) that is submitted as part of a planning application made by Lightrock Power (the Applicant) for the installation of a ground mounted Solar Farm with associated cable route and substation (the Development) on land at Sweetbriar Farm, approximately 5.4 kilometres (km) north west of Immingham, North Lincolnshire (the Site).

This FRA is intended to meet the requirements of the:

- Environment Agency (EA);
- North and North East Lincolnshire Strategic Flood Risk Assessment ('SFRA')[1];
- North Lincolnshire Council Preliminary Flood Risk Assessment (PFRA)[2];
- North Lincolnshire Local Flood Risk Management Strategy (2016)[3]; and
- Revised National Planning Policy Framework (NPPF)[4].

The Site Layout Plan can be found in Appendix A of this Report.

1.2 Development Characteristics

The Development consists of the construction of a solar farm which includes the following elements:

- Solar photovoltaic (PV) modules on ground mounted metal racking;
- Fencing;
- Access gates;
- Inverter / Transformer stations;
- Storage containers;
- CCTV camera poles;
- Access tracks; and
- Substation.

The Site is approximately 44.58 hectares (ha) in area.

There will be a minimum clearance of 2.5 metres (m) between PV array rows.

1.3 Site Characteristics

1.3.1 Site location

The Development will be located on agricultural land north of Station Road (A1077) at National Grid Reference (NGR) E 511196 N 417199 as shown in Appendix B.

[1] North and North East Lincolnshire Strategic Flood Risk Assessment (2011). [Online]. Available at: http://www.planning.northlincs.gov.uk/PlanningReports/SFRA/2011/SFRA_November_2011.pdf
[2] North Lincolnshire Council Preliminary Flood Risk Assessment (2011). [Online]. Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20140328094437/http://www.environment-agency.gov.uk/research/planning/135526.aspx#15
[3] North Lincolnshire Local Flood Risk Management Strategy (2016). [Online]. Available at: https://www.northlincs.gov.uk/wp-content/uploads/2018/07/Local-Flood-Risk-Management-Strategy.pdf
[4] Ministry of Housing, Communities & Local Government, Revised National Planning Policy Framework (2021). [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1005759/NPPF_July_2021.pdf

1.3.2 Surrounding Hydrological Network

Skitter Beck is an EA designated Main River and is located approximately 360 m east of the Site flowing north east, ultimately discharging into the River Humber which is located approximately 6.2 km west of the Site.

Open land drains are located in the north west corner of the Site and approximately 100 m south of the Site, as shown in Appendix B.

A small-scale reservoir is located approximately 400 m north west of the Site.

A pond is located approximately 250 m west of the Site.

Flood defences are located along the River Humber and are approximately 6 km west of the Site. The Site is classified as not benefiting from the flood defences as per the EA Flood Map for Planning[5].

The Site is shown to be located within the operational boundary of the North East Lindsey Internal Drainage Board (IDB)[6].

1.3.3 Site Elevations

Site elevations as per 2 m resolution LiDAR data (2020) (the extant open source elevation data) range from 7.6 to 21.8 m AOD (Above Ordnance Datum). General topography is shown to fall from west to east of the Site.

1.3.4 Flood Zone Categorisation

The EA Flood Map for Planning shows that the Site is located within Flood Zone 1, an area described as "low probability" of flooding in Table 1: Flood Zones of the "Planning Practice Guidance to the National Planning Policy Framework"[7].

This zone is categorised as being the lowest flood risk and comprises land assessed as having a less than 1 in 1,000 annual probability of river or sea flooding in any year.

1.4 Historical Flooding

The EA's Historic Flood Map[8] shows that the Site is not located in areas with previous flooding history.

2 Flood Risk Assessment

As the Site is larger than 1 ha, a FRA has been undertaken in accordance with Footnote 55 of the revised NPPF[4].

2.1 Methodology

Flood risk will be classed as Negligible (where little or no risk is identified), Low (where theoretical risk is identified but mitigating factors may influence flood levels) or Moderate to High (where modelled levels or historical events show risk to the Site).

Several factors will be taken into account when attributing the residual risk of flooding to the Site, including:

- Depth of flooding;
- Flooding extent / ingress into Site;

[5] The EA Flood Map for Planning. [Online]. https://flood-map-for-planning.service.gov.uk/summary/450582/439435
[6] Association of Drainage Authorities, Internal Drainage Boards Map. [Online]. Available at: https://www.ada.org.uk/idb-map/.
[7] Department for Communities and Local Government (DCLG) (2014). "Planning Practice Guidance". [Online]. Available at: http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/.
[8] Environment Agency, Historic Flood Map. [Online]. Available at: https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

- Type of infrastructure affected; and
- Intervening structures / flood protection.

A flood risk table is provided in the conclusion of this FRA and will provide comment and justification for the risk category using professional judgement and experience of assessing similar types of scenarios.

2.2 Fluvial Flood Risk

As discussed in Section 1.3.2, Skitter Beck is located approximately 360 m east of the Site. LiDAR data identifies Skitter Beck at a maximum elevation of 3 m, in comparison the nearest Site boundary which has an elevation of approximately 11 m. The raised topography of the Site between Skitter Beck and nearest Site boundary would prevent the Site from being inundated during a flood event.

In the absence of modelled data, the EA Flood Risk from Surface Water map has been consulted in order to address the fluvial flood risk at the Site related to the surrounding land drainage. The 1:1,000-year surface water event is assessed in order to represent a 1:100-year event including climate change uplift event and is a conservative proxy data source.

The land drainage located on the north boundary of the Site is shown to overtop for a 1:1,000-year fluvial event to a depth of 0.3 m, as shown in Appendix C.

The base of PV arrays will be at approximately 0.8 m above ground level as per industry design. Therefore, during such an event the base of the PV arrays will be raised above any flood waters associated with the open land drain network, as shown in Plate 1.

Acknowledging the raised elevations of the Site above the surrounding fluvial hydrological network, the fluvial flood risk at the Site is Negligible.

2.3 Pluvial Flood Risk

The EA Risk of Flooding from Surface Water Map indicates that the Development has minimal risk of surface water flooding during 1:100-year pluvial event.

The western boundary of the Site indicates a maximum depth of 0.9 m however no infrastructure is located in this area. The maximum depth associated with the Development infrastructure is 0.3 m where PV arrays will be located as shown in Appendix D. The base of PV arrays will be at approximately 0.8 m above ground level as per industry design.

Surface water flooding is also shown to be present in the north of the Site, however these are contained within the land drainage located on the Site.

The electrically sensitive infrastructure (i.e., transformers, inverters and substations) are to be located outside the 1:100-year pluvial flooding modelled areas.

The mount brackets which the PV sits upon shall be installed into the ground via narrow legs limiting any footprint of the PV array units. As such the PV array units shall not displace pluvial flood waters.

The electrical connections on the PV arrays will be located on the upper edge of the panels and therefore well above ground level and would still function should areas of the Site be underwater following such an extreme rainfall event.

The onsite pluvial flood risk will be mitigated through the implementation of a surface water drainage regime, discussed further in Section 3 of this report.

Acknowledging the location of any sensitive infrastructure outside of modelled pluvial flood risk areas and the raised nature of the PV arrays, the surface water flood risk is Negligible.

Plate 1: Typical PV Array Racking Set Off Saturated Grounds

2.4 Tidal Flood Risk

Skitter Beck is a tidally influenced watercourse within the vicinity of the Site however as mentioned in Section 2.2, the Site elevation is 11 m AOD compared to the Skitter Beck elevation at 3 m AOD.

The EA Flood Risk from Rivers or the Sea Map indicates the Site is not at risk of tidal flooding.

As such, the onsite tidal flood risk is Negligible.

2.5 Groundwater Flood Risk

A British Geological Society (BGS) borehole record located approximately 230 m west of the Site[9] shows that underlying strata consisted of 2.7 m boulder clay, 1.2 m loose chalk and 33 m chalk. The borehole reached a depth of approximately 38.1 m below ground level (bgl) and the rest level of water was 19.8m bgl. The presence of clay underneath the Site reduces the risk of groundwater flooding.

The North Lincolnshire PFRA[10] identifies the Site as having a greater than 25% but less than 50% susceptibility to groundwater flooding as shown in Appendix E.

The racking systems supporting the PV arrays at the Development are to be driven into the ground by circa 1 to 1.5 m and – given the aforementioned groundwater depths - are unlikely to interact with, displace or develop surface pathways for groundwater beyond the baseline scenario.

Acknowledging the above, the likelihood of groundwater flooding impacting the Development is Negligible.

[9] British Geology Survey. [Online]. Available at: http://scans.bgs.ac.uk/sobi_scans/boreholes/461504/images/14724392.html

[10] North Lincolnshire Preliminary Flood Risk Assessment. [Online]. Available at: https://webarchive.nationalarchives.gov.uk/ukgwa/20140328094437/http://www.environment-agency.gov.uk/research/planning/135526.aspx#15

2.6 Reservoir Flood Risk

The EA Flood Risk from Reservoirs Map[11] shows that the Site is not located in an area modelled to be at risk of flooding from reservoirs.

As discussed in Section 1.3.2, a pond is located approximately 400 m north west of the Site and is excavated into the ground removing the chance of a structural failure resulting in a breach of the pond inundating the Site. Surface water flooding through heavy precipitation resulting in the pond overtopping could be possible however the EA Risk of Flooding from Surface Water Map indicates no such risk. In addition, neighboring agricultural land would intercept any overtopping and therefore would not impact the Site.

The risk of the Development flooding from reservoirs is Negligible.

3 SURFACE WATER RUNOFF

The impermeable areas within the Development are limited to the substation, transformers and storage containers with a total impermeable area equating to approximately <0.1% of the total Site area.

Acknowledging the limited extents of impermeable areas, the Site will comprise of surface water management techniques to control runoff based on Rural Sustainable Drainage Systems ('RSuDS'[12]).

Permeable or semi-permeable surfaces will be implemented where possible, with new access tracks to comprise permeable surfaces. As such the surface water run-off rates will not increase substantially from the baseline scenario, with an example of permeable grounds shown in Plate 3.

The proposed substation, transformer and storage containers are to be underlain or bounded by permeable material to intercept and limit the rate of any surface water runoff emanating from such areas.

Installation of the PV arrays does not involve the introduction of hardstanding at ground level meaning the superficial cover will remain the same as the baseline. The surface water run-off rates and infiltration potential will remain largely the same as the baseline. Additionally, the PV array tables will have regular rainwater gaps to prevent water being concentrated along a single drip line, as shown in Plate 4.

[11] Environment Agency, Flooding from Reservoirs Map. [Online]. Available at: https://flood-warning-information.service.gov.uk/long-term-flood-risk/map.

[12] Environment Agency, Rural Sustainable Drainage Systems (2012). [Online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/291508/scho0612buwh-e-e.pdf

Plate 3: Typical Permeable Grounds

Plate 4: Typical PV Drip Line

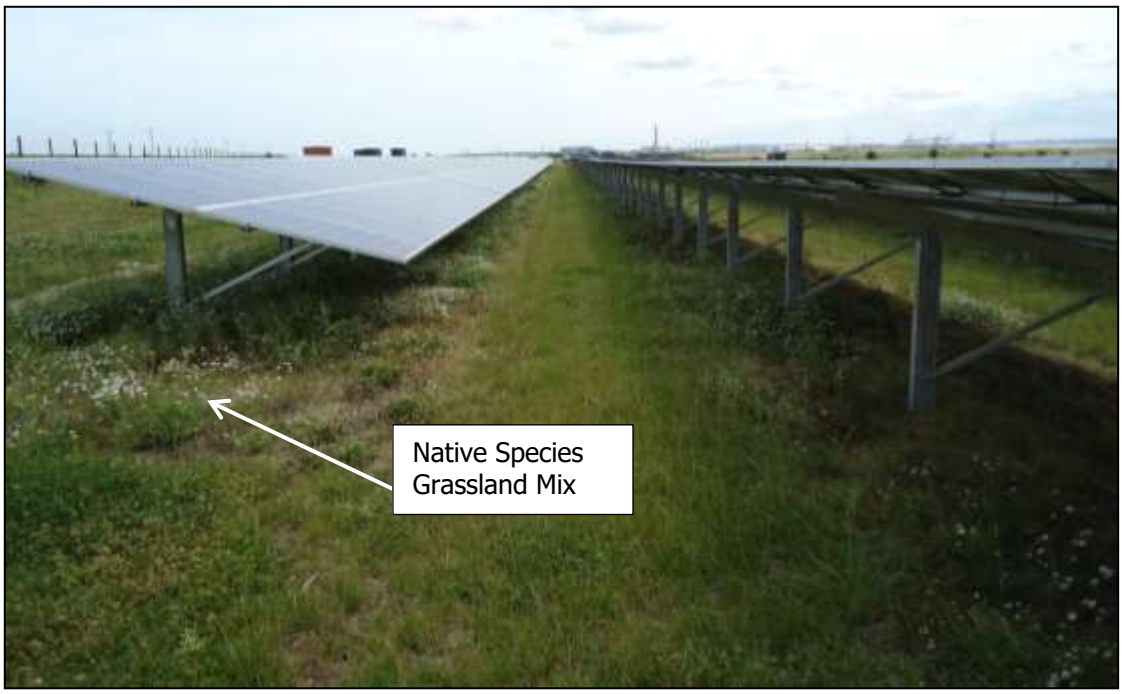
As such rainfall landing on the solar panels will drain through rainwater gaps and infiltrate into the ground beneath and between each row of panels, with no significant increase in surface water runoff flows compared to the baseline scenario.

The PV arrays have the potential to concentrate rainfall under the drip line. To limit possible channelisation from surface water from PV arrays and promote interception and infiltration potential throughout the Solar Development, the grounds surrounding and between the PV arrays will be planted with native species rich grassland and wildflower mix which will act as dripline planting as shown in Plate 5. This will allow surface water which falls from the drip line across the face of PV arrays to be intercepted by the vegetation and limit the potential of surface water to concentrate and run across the surface and into the surrounding hydrological network.

Whilst the Site is unlikely to generate run-off rates beyond the current greenfield rates, gravel filled filter drains to c. 1 m in depth installed every 5th PV row along existing topography will intercept surface water and ensure run-off is managed through providing an additional layer of interception and storage. An example filter drain system is shown in Plate 6.

A Surface Water Management Strategy (SWMS) can be sought through an appropriately worded planning condition which will outline the impermeable areas within the Development and the appropriate RSuDS measures to be applied to intercept surface water runoff throughout the Site.

Plate 5: Established Native Species Grassland Meadow Mix under PV Drip Line[13]



[13] Malmaynes Solar Farm – Arcus As-built drainage review

Plate 6: Shallow Filter Drains

3.1 Substation

The substation for the Development is a bricked structure with a tiled roof situated on permeable pavement with a footprint of approximately 121 m^2. The layout has been specifically designed to locate this building out with the 1 in 1,000 year surface water flood zone. A Surface Water Management Strategy (SWMS) for the substation can be sought through an appropriately worded planning condition which will outline the impermeable areas within the Development and the appropriate SuDS measures to be applied to intercept surface water runoff throughout the Site.

3.2 Construction Phase

During the construction phase a temporary construction compound will be installed. The drainage measures implemented within the temporary construction compound will be the responsibility of the appointed contractor and/or developer.

This area will comprise aggregate underlain by a permeable membrane. The contractor shall implement temporary construction drainage measures in accordance with best practice guidance which will prevent any significant runoff in relation to the compaction of soils during construction (e.g., spill kits, drip trays, plant nappies, designated refuelling points, emergency response plans). Following the construction of the Development, the temporary construction compound shall be decommissioned and overlain with PV panels with grassland beneath.

Therefore, the temporary construction compound will not contribute to a significant increase in surface water runoff rates and need not be served by a formal drainage network.

Further details of the exact measures to limit soil compaction during the construction and operational phases of the development can be provided within any conditioned SWMS.

4 NPPF SEQUENTIAL AND EXCEPTION TEST

The Development is located within Flood Zone 1 and therefore satisfies the criteria of the NPPF Sequential and Exception Tests.

5 MITIGATION

The use of vegetation under the PV array drip line and shallow filter drains every 5th row will reduce the potential for surface water run-off rates to increase at the Development Site.

Acknowledging the negligible flood risk at the Site, further mitigation measures are deemed neither necessary nor appropriate.

6 CONCLUSION

This report has been written to meet the requirements of the NPPF and the EA.

The Development is located in Flood Zone 1, an area assessed as having a less than 1:1,000 annual probability of river or sea flooding in any year.

The Development has a maximum pluvial depth of 0.3 m for a 1:100-year pluvial event.

The use of vegetation under the PV array drip line will reduce the potential for surface water run-off rates to increase at the Development Site.

Table 1 shows that the residual risk of the Development flooding from all sources is Negligible.

Table 1: Risk of Development Flooding

Flooding Source	Potential Risk	Comment
Fluvial (River)	Negligible	The Skitter Beck is located approximately 360 m east of the Site. The nearest Site boundary elevation is 11m AOD compared to the Skitter Beck elevation at 3 m AOD. The 1:1,000-year pluvial event is considered a suitable conservative proxy for the 1:100 climate change fluvial event. The event does show overtopping of the land drainage on Site however the maximum depth is 0.3 m. PV arrays are at a minimum height of 0.8 m and therefore unaffected.
Pluvial (Surface Water)	Negligible	The 1:100-year pluvial event does highlight localised flooding on the Development with maximum depths of 0.3 m. PV arrays are located within the localised flood areas however are set at a minimum height of 0.8 m above ground and therefore unaffected. String inverters will be located on the upper edge of the panels and therefore well above ground level and pluvial flood depths.
Groundwater	Negligible	Grounds at the nearest borehole comprise 2.7 m boulder clay, 1.2m loose chalk and 33m chalk. Groundwater was struck at 19.8 m bgl. The racking systems supporting the PV arrays are driven into the ground by circa 1 to 1.5 m and therefore will not interact with any possible groundwater. In addition, the North Lincolnshire PFRA identifies the north of the Site as having a 25% to 50% susceptibility to groundwater flooding.
Reservoirs	Negligible	The EA Flood Risk from Reservoirs Map shows that the Site is not located in an area modelled to be at risk of flooding from reservoirs. The EA Risk of Flooding from Surface Water Map identifies no flood risk associated the pond approximately 400 m north west of the Site.
Tidal	Negligible	The EA Flood Risk from Rivers or the Sea Map indicating the Site is not at risk of tidal flooding. The Skitter Beck is a tidally influenced watercourse however the Site elevation is 11m AOD compared to the Skitter Beck elevation at 3m AOD.

APPENDIX A – SITE LAYOUT

PDA 1

PDA 2

PDA 3

PDA 4

PDA 5

PDA 6

PDA 7

PDA 8

PDA 9

PDA 10

PDA 11

PDA 12

PDA 13

LIGHTROCKPOWER

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KEY

- Site Boundary
- Land Ownership Boundary
- Potential Developable Area
- Proposed Full Table
- Proposed Half Table
- Proposed Substation Compound
- Proposed Perimeter Fencing
- Proposed Perimeter Fence Gate
- Proposed Inverters / Transformers
- Proposed Container Storage
- Proposed CCTV Location
- Proposed Temporary Construction Compound
- Proposed Access Tracks
- Existing Onsite Roads
- Existing Public Roads
- Overhead Wooden Line (11kV)
- Overhead Wooden Line (33kV)
- Overhead Power Lines (400kV)
- Public Right of Way (PRoW)
- National Grid Gas Pipeline
- Existing Vegetation Edge
- Existing Tree Spread
- 5m Contours
- 6m Buffer of Ditches
- 10m Buffer of Public Rights of Way
- 10m Buffer of Roads
- 12.2m Buffer of National Grid Gas Pipeline
- 100m Buffer of Residential Dwellings
- 250m Buffer of GCN Pond
- Flood Zone 2
- Flood Zone 3
- 6m Buffer of 33kV Overhead Line
- 14m Buffer of 400kV Overhead Line
- Proposed Underground 11kV Power Line

1:2,000 Scale @ A1

0 40 80m

NORTH

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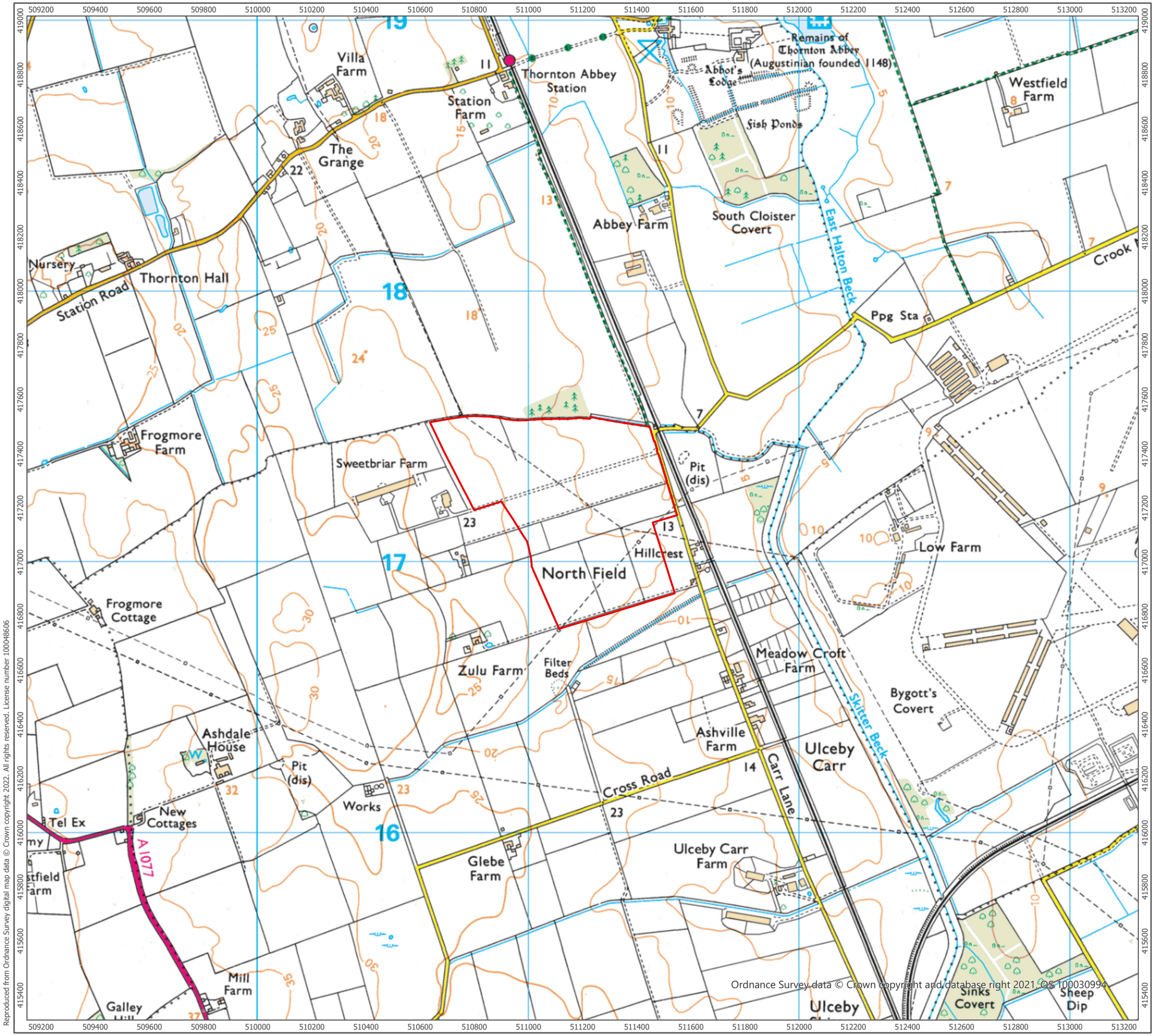
Checked By: JM	Date: 20.01.2022

Indicative Site Layout
Planning Drawing 2

Sweetbriar Solar Farm
Planning Application

N:\CAD\4157 SWEET BRIAR FARM\01-WORKING\01_01-DRAWINGS\4157_DR_P_0001I

APPENDIX B – SITE LOCATION



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Site Boundary

1:13,500 Scale @ A3

0 250 500 m

NORTH

Produced By: CH	Ref: 4157-REP-039
Checked By: RD	Date: 26/01/2022

Site Location

Sweetbriar Solar Farm
Flood Risk Assessment

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APPENDIX C – 1:1,000-YEAR SURFACE WATER FLOOD DEPTHS