Mallard Pass
Solar Farm

Mallard Pass Solar Farm

Environmental Statement Volume 2 Appendix 11.5: Water Resources and Ground Conditions - Flood Risk Assessment

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1 INTRODUCTION

1.1 Background

This Flood Risk Assessment (FRA) will be submitted as part of the Environmental Statement prepared on behalf of Mallard Pass Solar Farm Ltd (the Applicant) for the installation of a solar photovoltaic array (the Proposed Development) on land at Mallard Pass, Essendine, Lincolnshire (the "Order limits").

Arcus Consultancy Services Ltd (Arcus) has been commissioned to undertake a FRA, which is intended to meet the requirements of the:

- Environment Agency (EA);
- Rutland County Council (RCC) Strategic Flood Risk Assessment (SFRA)[1];
- RCC Local Plan 2018 – 2036, Strategic Flood Risk Assessment Update[2];
- RCC Local Flood Risk Management Strategy[3];
- Lincolnshire County Council (LCC), Preliminary Flood Risk Assessment[4];
- South Kesteven District Council (SKDC), SFRA[5];
- Construction Industry Research and Information Association (CIRIA);
- The Sustainable Drainage System (SuDS) Manual (C753)[6];
- BS 8533: Assessing and managing flood risk in development – code of practice (2017)[7];
- National Policy Statements (NPS) EN-1[8] and EN-3[9] and Draft NPS and EN-3[10];
- Planning Practice Guidance - Flood risk and coastal change[11]; and

[1] Rutland Strategic Flood Risk Assessment (2009). [Online]. Available at: https://www.rutland.gov.uk/my-services/planning-and-building-control/planning/the-local-plan/local-plan-withdrawn-2021/archived-local-plan-evidence-base/water-and-flooding/https://www.rutland.gov.uk/my-services/planning-and-building-control/planning/the-local-plan/local-plan-withdrawn-2021/archived-local-plan-evidence-base/water-and-flooding/

[2] Rutland County Council Local Plan 2018 – 2036, Strategic Flood Risk Assessment Update (2020). [Online]. Available at: https://www.rutland.gov.uk/my-services/planning-and-building-control/planning/the-local-plan/local-plan-withdrawn-2021/archived-local-plan-evidence-base/water-and-flooding/https://www.rutland.gov.uk/my-services/planning-and-building-control/planning/the-local-plan/local-plan-withdrawn-2021/archived-local-plan-evidence-base/water-and-flooding/

[3] Rutland County Council Local Flood Risk Management Strategy (2018). Available at: https://www.rutland.gov.uk/my-community/environment/flood-and-water-management/local-flood-risk-management-strategy/https://www.rutland.gov.uk/my-community/environment/flood-and-water-management/local-flood-risk-management-strategy/

[4] Lincolnshire County Council, Preliminary Flood Risk Assessment (2011). [Online]. Available at: Preliminary flood risk assessment report (lincolnshire.gov.uk)https://www.lincolnshire.gov.uk/downloads/file/4382/preliminary-flood-risk-assessment-report

[5] South KevestonKesteven, Strategic Flood Risk Assessment (2017). [Online]. Available at: Layout: POTRAIT - ADD TITLE:1 (southkesteven.gov.uk)http://www.southkesteven.gov.uk/index.aspx?articleid=8931

[6] [redacted]

[7] [redacted]

[8] Department of Energy and Climate Change (2011) Overarching National Policy Statement for Energy (EN-1) [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf

[9] Department of Energy and Climate Change (2011) National Policy Statement for Renewable Energy Infrastructure (EN-3) [online]. Available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

[10] Department of Energy and Climate Change (2021) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) [online]. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1015236/en-3-draft-for-consultation.pdf

[11] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2022) Flood risk and coastal change guidance [Online]. Available at: https://www.gov.uk/guidance/flood-risk-and-coastal-change

- Revised National Planning Policy Framework (NPPF)[12].

The Order limits is located within the jurisdiction of RCC and SKDC. Section 3.6 of the SKDC SFRA indicates that LCC are the Lead Local Flood Authority (LLFA) for the district. As such the LLFA is assessed to be LCC and RCC.

The outline layout of the Proposed Development can be found in Annex A of this FRA.

1.2 The Order limits

The Order limits are described in ***Chapter 3: Description of Order limits*** of the ES **[EN010127/APP/6.1].**

The Order limits comprise the Solar PV Site, the Grid Connection Route, Mitigation and Enhancement Areas, Construction Compounds, and Highways Works Site.

1.3 The Proposed Development

The Proposed Development is described in ***Chapter 5: Project Description*** of the ES.

1.4 Surrounding Hydrological Network

The EA Catchment Data Explorer[13] indicates that the Order limits is located within the River Glen operational catchment, Welland management catchment and Anglian River basin district.

The West Glen River bisects through the north and east of the Order limits and flows north-west to south-east.

The River Gwash is located approximately 50 metres (m) south of the Order limits at its nearest point flowing west to east and ultimately discharges into the River Welland approximately 1 kilometre (km) south of the Order limits.

Ordnance Survey (OS) mapping indicates land drains located in the north of the Order limits ultimately discharge into the West Glen River and land drains located in the south ultimately discharge into the Greatford Cut (Drain) located approximately 3.5 km east of the Order limits.

The A6121 dissects the center of the Order limits and is assumed to have a drainage system based on satellite imagery and Google Street View[14] mapping.

The Order limits are not shown to be located within the operational boundary (i.e. where IDB Byelaws would be applicable) of an Internal Drainage Board (IDB)[15] with the operational boundary of the nearest IDB, Welland and Deepings IDB, located approximately 680 m south-west of the Order Limits.

[12] Ministry of Housing, Communities & Local Government (2021). "Revised National Planning Policy Framework" [Online] Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2
[13] Environment Agency, Catchment Data Explorer. [Online]. Available at: https://environment.data.gov.uk/catchment-planning/
[14] Alphabet Inc., Google Maps, Street View. [Online]. Available at: [redacted]
[15] Association of Drainage Authorities, Internal Drainage Boards Map. [Online]. Available at: [redacted]

During consultations between Arcus and LCC[16] (see Table 1 of ***Appendix 11.3: Consultation*** of the ES Appendices **[EN010127/APP/6.2]**), it was highlighted that LCC hold a memorandum of understanding with IDBs that operate within Lincolnshire, with IDBs acting as agent to the LLFA. The Order limits are shown to fall within the extended operational boundaries of the Black Sluice and Upper Whitham IDBs[17].

1.5 Order limits Elevations

The topography within the Order limits is variable relative to the localised topography of the parcels of land which make up the Order limits.

The latest available LiDAR data (2020) at a 1 m resolution identifies elevations within the Order limits to range from 16 m Above Ordnance Datum (AOD) to 67 m AOD.

Elevations within localised land parcels are shown to fall towards existing surface watercourses which typically comprise agricultural land drains with some areas falling towards the West Glen River.

1.6 Flood Zone Categorisation

The EA Flood Map for Planning[18] shows that the majority of the Order limits is located within Flood Zone ('FZ') 1 as shown in Annex F.

Areas of the Order limits are located within FZ 2 and FZ 3a and 3b, areas described as 'Medium', 'High' probability of flooding and 'Functional Floodplain' in Table 1: Flood Zones of the 'Planning Practice Guidance to the National Planning Policy Framework'[19] and paragraph 5.92 of the National Policy Statement for National Networks[20], principally confined along stretches of the West Glen River towards to north and east of the Order limits. Flood Zones are shown in Annex F of this FRA.

Flood Zone 3a is categorised as having a high flood risk and comprises land assessed as having a 1:100 or greater annual probability of river or sea flooding in any year, which 3b is now defined as the 1:30 year event, however the 1:20 year event has historically been used to inform areas of Functional Floodplain and should be used where the 1:30 year event has not been modelled.

1.7 Flood Defences

The Flood Map for Planning indicates the Order limits do not benefit from the protection of flood defences.

[16] Email communications between R. Duff (Arcus) and I. Field (LCC) dated 18th January 2022 to 24th January 2022.
[17] https://www.blacksluiceidb.gov.uk/about/map-of-district/
[18] The EA Flood Map for Planning. [Online]. https://flood-map-for-planning.service.gov.uk/https://flood-map-for-planning.service.gov.uk/
[19] 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/.
[20] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/387223/npsnn-web.pdf 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/.

The EA Spatial Flood Defences dataset[21] and Asset Management dataset[22] indicates flood defences are located along the banks of the River Gwash and the West Glen River and have not yet been considered for the EA Flood Map for Planning.

Defences along the River Gwash are located approximately 600 m west of the Order limits and comprise privately owned engineered high ground. The flood defence is shown to have crest levels in the range of approximately 19.1 m to 29.5 m AOD and a Standard of Protection (SoP) of 25 years.

Defences were observed parallel the West Glen River through the centre of the Order limits and comprise privately owned natural high ground. The flood defence is shown to have crest levels in the range of approximately 13.6 m to 21.8 m AOD and a SoP of 50 years.

Neither of the flood defences along the River Gwash and West Glen River are considered within the EA Flood Map for Planning.

Acknowledging the SoP and location of the West Glen River flood defences within the Order limits it is assessed that the Order limits benefits from protection associated with such defences.

During a walkover of the Order limits conducted by Arcus in March 2022 flood defences along the River Gwash and West Glen River were assessed and are shown to comprise constant vegetated embankments along the watercourses providing a topographical barrier between the riparian land and watercourses. Examples of the embankments along the River Gwash and West Glen River are shown in Plates 1 and 2 respectively.

[21] Department for Environment, Food and Rural Affairs (DEFRA). Spatial Flood Defences. [Online]. Available at: https://environment.data.gov.uk/DefraDataDownload/?mapService=EA/SpatialFloodDefencesIncStandardisedAttributes&Mode=spatial

[22] https://environment.data.gov.uk/asset-management/index.html?element=http%3A%2F%2Fenvironment.data.gov.uk%2Fasset-management%2Fid%2Fasset%2F156901&layer=all-assets

Plate 1: River Gwash Embankments

Plate 2: West Glen River Embankments

1.8 Historical Flooding

The EA's Historic Flood Map[23] shows that the Order limits is not located in areas with recorded previous flooding history.

The SFRAs for RCC, LCC and SKDC do not provide record of flooding history within the Order limits.

Evidence from local stakeholders, outlined in ***Appendix 11.3*** of the ES Appendices, has been provided during the Stage 1 (informal) Consultation which indicates parts of villages surrounding the Order limits have previously been impacted by surface water flooding associated with periods of intense rainfall leading to overland flows inundating occupied areas.

Consultations have identified the village of Greatford, hydrologically downstream of the Solar PV Site, as having a historical flood risk associated with surface water and fluvial flooding from the West Glen River. Table 5-1 of the SKDC SFRA indicates Greatford was impacted by fluvial flooding associated with the West Glen River in 1998. Anecdotal evidence during consultations indicates Greatford has been subject to surface water flooding over multiple years with recent events occurring in December 2020 and January 2021.

2 FLOOD RISK ASSESSMENT

As the Order limits is located within FZ 2 and FZ 3, an FRA has been undertaken in accordance with footnote 55 of the revised NPPF, paragraph 5.7.4 of NPS EN-1, paragraph 5.8.6 of the Draft NPS EN-1 and BS8533.

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 Order limits). This methodology is separate from the EIA methodology presented within the ES chapter.

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

- Depth of flooding;
- Flooding extent / ingress into site;
- Type of infrastructure affected; and
- Intervening structures / flood protection.

A 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

The EA Flood Map for Planning shows that the majority of the Order limits are within FZ 1 and minor sections are located within FZ 2 and FZ 3a and FZ 3b, an

[23] Environment Agency, Historic Flood Map. [Online]. Available at: https://data.gov.uk/dataset/76292bec-7d8b-43e8-9c98-02734fd89c81/historic-flood-map

area described as 'high probability' of flooding from the West Glen River, which runs through the centre of the Order limits.

The EA has provided the Applicant with its West Glen Hydraulic Modelling Report (August 2016) and associated modelled flood level results for a range of return periods through the product request service.

2.2.1 Modelling Approach

The study area for the West Glen model encompasses the West Glen from Boothby Pagnell to Shillingthorpe, covering a distance of approximately 30 km. The modelling approach within the study consists of a hydrodynamic 1D MIKE 11 model covering the West Glen River, River Tham and Holywood Brook.

The model simulated flows for a range of return periods from 50 % Annual Exceedance Probability (AEP) to 0.1 % AEP plus a 20 % allowance to account for increases in rainfall intensity and fluvial flows associated with climate change. The climate change allowance is based on DEFRA 2006 guidance however the source of this guidance could not be found through a literature review.

As the Proposed Development is classed as Essential Infrastructure, as per Annex 3: Flood risk vulnerability classification: of the National Planning Policy Framework[24], and whilst the DCO is not time limited, this assessment has assumed an operational lifetime of 40 years (for the purpose of the Environmental Impact Assessment), as per the approach taken by Cleve Hill Solar Park, the higher central band for the 2050's is assessed as the appropriate climate change allowance.

The revised 'flood risk assessments: climate change allowance'[25] peak river flow allowances for the Welland Management Catchment for the Higher 2050s is 10 %. The Proposed Development lifespan is assumed to be approximately 40 years; therefore the 20 % climate change allowance used in this FRA is a conservative approach as agreed during consultations with the EA, as outlined in Table 1 of Appendix 11.3 to the ES.

2.2.2 Modelling results

Elevations for the Order limits have been incorporated into ArcGIS software along with the in channel West Glen River water levels for the 100-year plus 20 % climate change event. The Thiessen polygons tool in ArcGIS was utilised to extrapolate the areas of the Order limits associated to the in-channel nodes.

The difference in the in-channel 1 in 100-year plus 20 % water level and topography sourced from 1 m LiDAR data was used to derive flood depths for the Order limits. This approach adopts a conservative method in calculating flood depths as it assumes all land below the modelled in channel water level is flooded without accounting for the potential of flood waters to disperse across a floodplain.

[24] Department for Levelling Up, Housing and Communities and Ministry of Housing, Communities & Local Government (2022) Flood risk and coastal change guidance [Online]. Available at: https://www.gov.uk/guidance/national-planning-policy-framework/annex-3-flood-risk-vulnerability-classification
[25] Flood Risk Assessments: climate change allowances (2021). [Online]. Available at: https://www.gov.uk/guidance/flood-risk-assessments-climate-change-allowances

The maximum 1 in 100-year plus 20 % flood depths for the Order limits are approximately 0.8 m as shown in Annex C.

The only element of the Proposed Development located within the 1 in 100-year plus 20 % modelled extent is the Mitigation and Enhancement Area. All PV Array areas, ancillary infrastructure and the compound are located outside the 1 in 100-year event plus 20 % climate change allowance.

The PV Arrays within the 1 in 1,000-year extent are limited to a section of PV Arrays north of Browne's Oaks woodland in the east of the Order limits and a section of PV Arrays south of Heath Farm in the north of the Order limits.

DPV Arrays will be mounted on narrow footings approximately 0.8 m above ground level. Therefore, the PV Arrays will not displace flood water during the 1 in 100 year event (plus climate change).

Acknowledging the level of the minimal extent of PV Arrays within the modelled extent the fluvial risk is Negligible.

2.3 Drainage Ditches

The Flood Estimation Handbook ("FEH") web service shows that the drainage ditches north of the railway line within the Order limits drain an area of 1.4 km^2, whilst the drainage ditches south of the railway line are split into two distinct catchments, each draining 0.71 km^2.

The ReFH2 method has been used to develop flood hydrographs for the catchment in which the Development is located, with catchment descriptors imported from the FEH web service for a number of return periods (as a 100 % rural model).

ReFH2 method, indicates that the peak flow for the 1 in 100-year summer flood event over the 1.4 km^2 catchment is 0.95 m^3/s with the addition of a 20 % climate change allowance.

The peak flow for the 1 in 100-year summer flood event over the 0.71 km^2 catchments is 0.23 m^3/s with the addition of a 20 % climate change allowance.

Given the low peak flows, the number of drainage ditches within the Oder Limits, the dimensions of the ditches, the flat nature of the land within the Order limits, even in the event that the ditches overtop it is likely that the out of channel flows would extend over a wide area and to shallow depths. The PV Array would be installed 0.8 m above ground level and will prevent the Proposed Development being damaged should these ditches overtop.

As such, the risk of the Proposed Development flooding from fluvial sources is Negligible.

2.4 Pluvial Flood Risk

The EA Risk of Flooding from Surface Water Map[26] indicates that areas within the Solar PV Site are at risk of surface water flooding during the 'medium' risk 1 in 100-year pluvial event.

The electrically sensitive infrastructure (the Onsite Substation) is not located within the 1 in 100-year pluvial event, as shown in Annex D.

The 1 in 100-year pluvial depths data highlights pluvial flooding to the north and center of the Order limits. The pluvial depths for these areas are predominately less than 0.3 m; however, the with maximum modelled depths of 0.6 m.

PV Arrays will be located in areas where pluvial depths are 0.3 m or less with the base of PV Arrays at a height of 0.8 m above ground level providing significant freeboard above the maximum pluvial depths. No elements of the Proposed Development will be located in areas with pluvial depths of 0.6 m or more during the 1 in 100-year event.

The Mounting Structures which the PV Modules sit upon will be installed into the ground via narrow legs limiting the PV Table surface footprint of the PV Arrays. As such the PV Arrays will not displace pluvial flood waters to any significant extent.

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 Solar PV Site be under water following such an extreme rainfall event .

Where required, the electrically sensitive infrastructure will be located within contained units upon ground mounted platforms within aggregate based embankments which will lift the infrastructure above ground level by approximately 200 to 300 mm and provide additional protection from surface water flooding as shown in Plate 4.

[26] Environment Agency, Risk of Flooding from Surface Water data. [Online]. Available at: https://data.gov.uk/dataset/b391e876-4571-44f9-85c5-3485ddf6333a/risk-of-flooding-from-surface-water-depth-0-1-percent-annual-chance

Plate 3: Electrical Infrastructure Raised Above Ground[27]

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

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.

2.5 Tidal Flood Risk

There are no tidally influenced watercourses within the vicinity of the Order limits which is at an elevation range 16 m to 67 m AOD.

As such, the onsite tidal flood risk is Negligible.

2.6 Groundwater Flood Risk

British Geological Society (BGS) borehole records[28] located across the Order limits show clay-based strata to an approximate depth of 23 m followed by

[27] South Lowfield Solar Farm (2021).
[28] British Geology Society (BGS) borehole records, BGS ID 467042. Available at:

approximately 23 m of Lincolnshire limestone. Water was encountered between 12 m to 24 m below ground level. Due to the structure of the underlying strata at the Order limits, it is unlikely that water would rise through the ground and inundate the Order limits, as passage through clay strata is impeded.

The Mounting Structures supporting the PV Arrays are to be driven into the ground by approximately 1 m to 2.5 m and given the aforementioned groundwater depths, are unlikely to interact with, displace or develop surface pathways for groundwater beyond the baseline scenario.

The RCC SFRA update[29] highlights in the presence of limestone bedrock, groundwater flooding may be possible but the risk is considered to be low, given the superficial clay layers limiting the potential for upward movement of groundwater.

Acknowledging the low susceptibility and the infrastructure's unlikely interaction with ground water, flooding of the Proposed Development as a result of groundwater fluctuations is unlikely and the risk is Negligible.

2.7 Reservoir Flood Risk

The EA Flood Risk from Reservoirs Map[30] indicates the Order limits is modelled to flood should there be a breach or failure at the nearest reservoir Rutland Water. The main areas identified at risk are located towards the centre of the Order limits.

The maximum extent of flooding from the reservoir for both scenarios, 'when river levels are normal' and 'when river there is also flooding from rivers' is shown in Annex E.

The risk of flooding from the reservoir is reduced through regular maintenance by the operating authority and owner (Anglian Water), with reservoirs in the UK having an extremely good safety record with no incidents resulting in the loss of life since 1925.

The Reservoirs Act 1975 requires all large reservoirs to be regularly inspected and supervised by reservoir panel engineers.

As such, the residual risk of flooding associated with reservoirs is Negligible.

2.8 Highway Drainage Flood Risk

The impact of Highway Drainage is mainly associated with over exceedance of drainage infrastructure along roads comprising drainage infrastructure during extreme rainfall events. The Order limits is located within a rural area with the A6121 dissecting through the centre in a general north-east to south-west direction and is assumed to have a drainage system based off satellite imagery and observations during the site walkover conducted in March 2022.

[29] Rutland County Council, Rutland Local Plan 2018-2036, Strategic Flood Risk Assessment Update (2020). [Online]. Available at: https://www.rutland.gov.uk/my-services/planning-and-building-control/planning/the-local-plan/local-plan-withdrawn-2021/archived-local-plan-evidence-base/water-and-flooding/

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

PV Arrays are located approximately 40 m north of the A6121 with a woodland located between the highway and PV Arrays. Surface runoff that is not contained within the highway drainage system will be intercepted by the neighbouring woodland and will therefore not impact the PV Arrays. In addition, the base of PV Modules Arrays are located at a minimum height of 0.8 m and therefore will not impacted if surface runoff from the highway were to reach the Proposed Development infrastructure.

The Onsite Substation is not within proximity of any Highway Drainage infrastructure identified during the site Walkover.

As such, flood risk from drainage is Negligible.

2.9 Artificial Sources

OS Mapping and conclusions of a site walkover indicate the only surrounding artificial watercourses within the vicinity of the Order limits are a network of ponds served by the existing hydrological network.

A large pond is located approximately 10 m east of the Order limits off Banthorpe Lodge and is hydrologically connected to the West Glen River. In the event of water overtopping the pond topography shows exceedance would fall away from the Solar PV Site and towards the West Glen River.

The EA surface water flooding map shows that any exceedance of the ponds located towards the north-east boundary of the Order limits would flow away from the Order limits and therefore would not impact the Proposed Development.

As such the flood risk from artificial sources is Negligible.

2.10 Sewer Flood Risk

It is not envisaged that the construction of the Proposed Development will increase the existing sewers flooding risk. The Onsite Substation will be served by a surface water drainage system as detailed within ***Appendix 11.6: Outline Surface Water Drainage Strategy*** of the ES.

The surface water drainage network serving the Onsite Substation is designed to attenuate and discharge surface without surcharge in up to and including a 1 in 100-year plus climate change event. In exceedance events any surface water emanating from the system would disperse within the Order limits with no impact on surrounding infrastructure.

It is proposed the Construction Compound and the Onsite Substation will utilise private (closed) foul drainage systems, such as septic tanks, which will be periodically emptied and disposed of offsite by a licensed waste carrier.

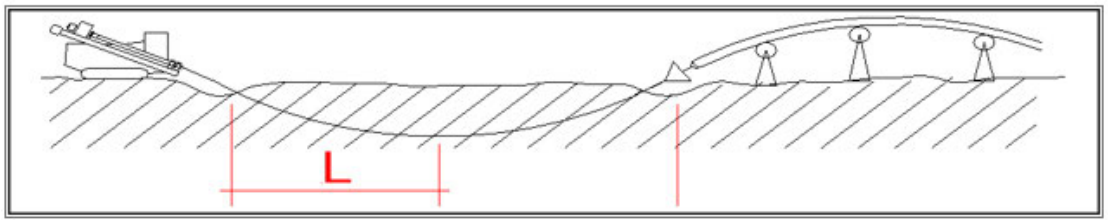
As such sewer flood risk is Negligible.

2.11 Horizontal Directional Drilling

As part of the Cable Grid Connection, Horizontal Directional Drilling (HDD) beneath the West Glen River may be required.

The HDD method will enable cabling to be installed beneath the West Glen River without the need to clear vegetation, grade banks and excavate in channel trenches through a 'no dig' methodology. A cross section of an example directional drilling approach is shown in Plate 4.

Plate 4: Example Direction Drilling Cross Section[31]



The drilling equipment is self-contained machinery which will penetrate the surface through a 'no dig' method whereby the drill head will work through the sub surface grounds to form a designated 'launch pit'. There will be temporary support vehicles onsite (e.g., delivery vehicles), with the drilling equipment the only infrastructure kept onsite during the operational period of the works.

The exact location of directional drilling launch pits is yet to be confirmed, with the HDD works to be confined within the Order limits.

The launch pits will comprise a shallow excavation to enable the utilization of grounds. Should any pits be located with the floodplain and a flood event occur during the HDD works displacement would be limited to the extent of the launch pits and excavated material which will be bounded by rural land. Therefore, any displacement of floodwaters will not be of a significant volume and will disperse within the surrounding grounds in accordance with the topographic characteristics of the floodplain.

The HDD method will limit the need for infrastructure to be located immediately adjacent to watercourses, therefore limiting the potential flood depths at the location of the infrastructure and is the approach which will result in the smallest displacement of floodwaters.

The contractor will consult the EA flood warning service leading up to the HDD works to limit the potential of works taking place during a flood event.

3 SURFACE WATER MANAGEMENT

Appendix 11.6: Outline Surface Water Drainage Strategy of the ES outlines the design philosophy to manage the surface water runoff associated with the Proposed Development.

The Strategy identifies that the implementation of PV Arrays will not contribute to an increase in hardstanding areas and that hardstanding is limited to the extents of the Onsite Substation and Solar Stations.

The implementation of planting within the Enhancement and Mitigation Areas are shown to provide an improvement in the interception and attenuation of

[31] Provided by Taylor Plant Drilling Limited.

surface water along existing flow routes within the Order limits relative to the existing scenario.

The surface water runoff associated with the Onsite Substation will be managed by a surface water drainage system designed to release surface water at a calculate greenfield runoff rate.

The implementation of the measures detailed in the Strategy will prevent a significant increase in surface water runoff and therefore prevent an increase in flood risk elsewhere.

4 NPPF SEQUENTIAL AND EXCEPTION TEST

4.1 Sequential Test

Paragraph 5.7.13 of NPS EN-1 states that preference should be given to locating projects within Flood Zone 1 and if there is no feasible and available sites within Flood Zone 1 then development can be located in Flood Zone 2. If there are no feasible and available sites in neither Flood Zone 1 or 2 then NSIP scale energy developments can be located within Flood Zone 3 subject to passing the Exception Test.

Paragraph 158 of the NPPF states that developments located within FZ 3 should apply a risk based sequential test in order to steer proposed development towards areas classed as having a lower probability of flooding. (i.e., in Flood Zone 1). Paragraphs 159 and 160 of the NPPF do, however, acknowledge that under certain circumstances it may not be possible to locate the development on land identified as having a lower risk of flooding and infrastructure can be located in Flood Zone 2 or 3 for certain infrastructure, subject to passing the Exception Test.

The Proposed Development is classified as Essential Infrastructure and is suitable within Flood Zone 2 should the Exception Test be passed.

The Onsite Substation is located within Flood Zone 1 and is therefore compliant with the Sequential Test.

The PV Arrays, ancillary infrastructure and the Compound is located outside of the 1 in 100-year (+20 %) event extent within Flood Zone 1 and minor areas of PV Arrays in Flood Zone 2, demonstrating a sequential design approach to remove PV Arrays from the extent of the Proposed Development within the floodplain.

The Order limits has been identified through an ongoing site search exercise undertaken by the Applicant with an Alternative Sites Assessment set out in ***Chapter 4: Alternatives and Design Development*** of the ES.

Key factors for consideration included:

- Solar irradiation levels;
- Proximity to an available grid connection;
- Proximity to local population;
- Topography;
- Field size / shading;

- Access to the site for construction;
- Archaeological interest;
- Agricultural land classification;
- Landscape designations;
- Nature conservation designations; and
- Commercial agreement with a landowner.

This process highlighted that there are no other potential sites within the proximity of the Order limits entirely within Flood Zone 1 which would be suitable for large scale solar development. Furthermore, it is found that there are no other substations within the area with nearby substations which have capacity for large scale renewables without the need for significant connection and upgrade works.

The Proposed Development will support the flexible operation of the national grid and decarbonisation of the electricity supply through the import of electricity to the existing Ryhall. As such the Proposed Development must be located within Flood Zone 2 to support the operation of the adjacent infrastructure.

Following consideration of the above factors the Order limits has been identified as having good potential for the Proposed Development with no reasonable alternatives which meat the criteria required for large-scale solar.

Paragraph 5.7.23 of NPS EN1 states that "*The sequential approach should be applied to the layout and design of the project. More vulnerable uses should be located on parts of the site at lower probability and residual risk of flooding*". This has been demonstrated by locating the Onsite Substation within Flood Zone 1 whilst the PV Arrays have been mostly located in Flood Zone 1 with minor areas located in Flood Zone 2.

For these reasons the Proposed Development meets the requirements set out in Table 3 of the Planning Practice Guidance and meets the requirements of the Sequential Test of NPS EN-1, NPPF and PPG.

4.2 Exception Test

Paragraph 5.7.16 of NPS EN-1 states that for the Exception Test to be passed it should be demonstrated that:

- The project provides wider sustainability benefits to the community that outweigh flood risk;
- The project reduces flood risk overall, where possible; and
- That there are no reasonable alternative sites on developable previously developed land subject to any exceptions set out in the technology-specific NPSs.

Table 2: Flood risk vulnerability and flood zone 'incompatibility' Guidance

Flood risk and coastal change[32] demonstrates that Essential Infrastructure in Flood Zone 2 does not need to apply the Exception Test. The two criteria set out in the Exception Test should be applied to developments are listed below for clarity and assessed for completeness:

[32] https://www.gov.uk/guidance/flood-risk-and-coastal-change#table2

- It must be demonstrated that the Development provides wider sustainability benefits to the community that outweigh flood risk, informed by a Strategic Flood Risk Assessment; and
- A site-specific flood risk assessment must demonstrate that 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.

The first Exception Test criterion of NPS EN-1 and NPPF is addressed in the following points as the Proposed Development:

- Has a primary function to export energy from renewable sources to the Ryhall substation to contribute to the decarbonisation of energy supply infrastructure; and
- IIs located partly within Flood Zone 2 in the most energy efficient location in terms of the limited distance for connection works required, which limits energy losses incurred in exporting to the grid and any need for upgrades related to connections. This also limits to footprint of any connection route, reducing environmental damage from excavations during its construction.

The second Exception Test criterion is addressed by this FRA as:

- The Proposed Development is located primarily within Flood Zone 1, with only a small footprint of the Solar PV Site located within the 1 in 1,000-year extents which will comprise PV Arrays which will be raised above flood levels for the 1:100 year event, plus climate change and not displace flood waters;
- The Proposed Development will incorporate planting and land management measures which will prevent any significant increase in surface water runoff;
- Hardstanding areas are to be served by surface water drainage infrastructure (SuDS) to prevent increases in surface water runoff as detailed in ***Appendix 11.6: Outline Surface Water Drainage Strategy***; and
- The Proposed Development is classed as Essential Infrastructure, as per Annex 3: Flood risk vulnerability classification: of the National Planning Policy Framework, which is appropriate in the Flood Zone 2, in terms of flood risk vulnerability.

As such, the Proposed Development passes the requirements of the Exception Test from both NPS EN-1 and the NPPF.

Regarding point three of the NPS EN-1 (previously developed land), the Alternative Sites Assessment, set out in ***Chapter 4: Alternatives and Design Development*** of the ES., considers the potential of previously developed land and concludes there is relatively little previously developed land located within a sufficient distance of the National Grid Ryhall Substation that an appropriate grid connection could be provided to. The previously developed land registers maintained by South Kesteven District Council and Rutland County Council show 22ha and 3.4ha respectively, which even together would be significantly below the area required to deliver a utility-scale solar farm.

As such, the Proposed Development therefore passes the third point of the Exception Test in the NPS EN-1.

5 CONCLUSION

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

The Order limits is partially located within FZ 2 and FZ 3.

In channel 1 in 100-year (plus 20 %) water levels for the West Glen River have been extrapolated utilising 1 m resolution LiDAR data to confirm a conservative 1 in 100-year plus 20 %) flood extent.

All aspects of the Proposed Development has been sequentially designed to be located outside the 1 in 100-year plus 20 %.

PV Arrays are to be set at 0.8 m above ground level and therefore will not be impacted during a 1 in 1,000-year pluvial event.

The use of vegetation under the PV Array drip line and within the Mitigation and Enhancement Area will limit the potential for significant increases in surface water runoff.

Appendix 11.6: Outline Surface Water Drainage Strategy of the ES outlines the surface water management measures to be implemented at the Proposed Development.

Table 2 shows that the residual risk of the Proposed Development flooding from all sources is Negligible.

Table 2: Risk of Development Flooding

Flooding Source	Potential Risk	Comment
Fluvial (River)	Negligible	The Proposed Development is defined as Essential Infrastructure. No areas of PV Arrays are located within of the 1 in 100-year (+20%) modelled extents. Only PV arrays, which are raised will be set approximately 0.8 m above ground level are located in FZ 2 via narrowing footings, highlighting a sequential design process will therefore remain operational without displacing floodwaters.
Pluvial (Surface Water)	Negligible	Areas with a pluvial depth 0.3 m or less will only have PV-arrays located within them. PV Arrays are located at a minimum height of 0.8 m and therefore will not be impacted.
Tidal	Negligible	There are no tidally influenced watercourses within the vicinity of the Order limits which is at an elevation range of 16 to 67 m AOD.
Groundwater	Negligible	BGS borehole records show clay-based strata to an approximate depth 23 m below ground level followed by 23m of limestone. Water was encountered between 12 – 24 m across the Order limits. It is unlikely that water would rise through the ground and inundate the Proposed Development, as passage through clay strata is impeded. The PV array racking system will be driven into the ground by circa 1 to 2.5 m and therefore is unlikely to impact, displace or develop surface pathways for groundwater.
Reservoirs	Negligible	The EA Flood Risk from Reservoirs Map shows that the Order limits is located in an area modelled to be at risk of flooding from reservoirs. The risk of flooding from reservoir is reduced through regular maintenance by the operating authority, with reservoirs in the UK having an extremely good safety record with no incidents resulting in the loss of life since 1925.
Drainage	Negligible	Surface water not contained with the A6121 drainage system will be intercepted by neighbouring woodland located between the Order limits and the highway. PV Arrays are located at a minimum height of 0.8 m and therefore will not be impacted if surface runoff from the highway were to reach the Proposed Development.

Artificial	Negligible	The EA Surface water flooding map shows any exceedance of the ponds within the vicinity would not impact any infrastructure associated with the Proposed Development.
Sewer	Negligible	It is not envisaged that the construction of the Proposed Development will increase the risk existing sewers flooding risk. It is proposed that construction compound area and staff welfare facilities during the operational phase will utilise local private drainage systems such as septic tanks which will be periodically emptied offsite by a licensed waste carrier.

ANNEX A – PROPOSED DEVELOPMENT LAYOUT

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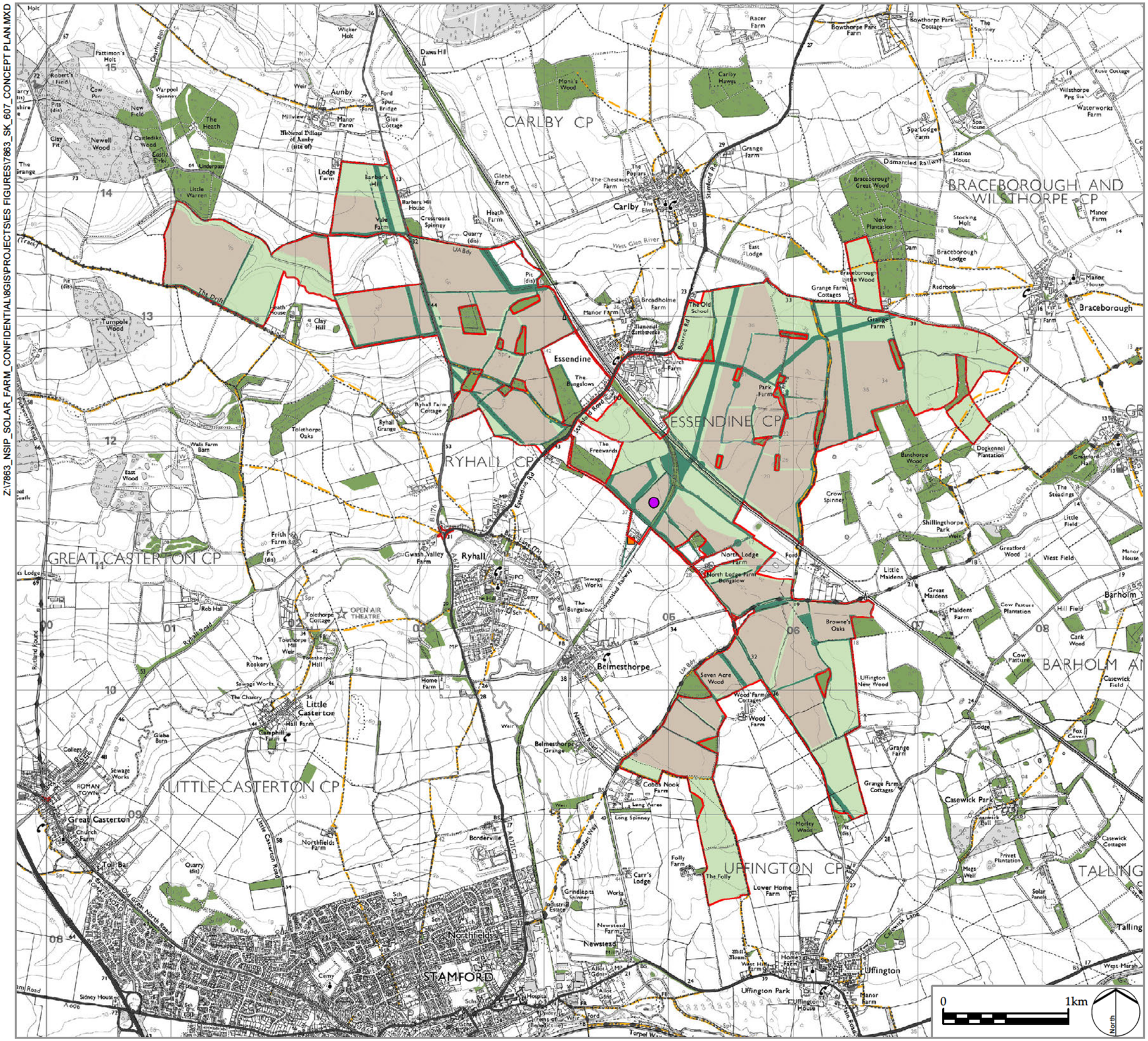

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Infrastructure Planning (Applications:
Prescribed Forms and Procedure) Regulations 2009
APFP Regulation: 5(2)(a)

PINS REFERENCE NUMBER
EN010127

LEGEND

Site Features

- Order limits
- National Grid Ryhall Substation
- Public Right of Way
- Woodland, hedgerows, trees, field boundaries and ditches

Concept Masterplan Proposals

- Solar PV Site
- Mitigation and Ehancement Areas
- Offsets to woodland, trees, hedgerows, ditches, utilities and Public Rights of Way
- Onsite Substation

REV.	DESCRIPTION	APP.	DATE
P0	DCO Submission	RP	06/11/22

Mallard Pass
Solar Farm

PROJECT TITLE
MALLARD PASS SOLAR FARM

DRAWING TITLE
Figure 4.3: Concept Masterplan

ISSUED BY	Oxford	T: 01865 887050	
DATE	Nov 2022	DRAWN	AG
SCALE @A3	1:30,000	CHECKED	RP
STATUS	Final	APPROVED	RP

DWG. NO. 7863_SK_607 REV: P0

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Sources: Ordnance Survey

ANNEX B – ORDER LIMITS LOCATION

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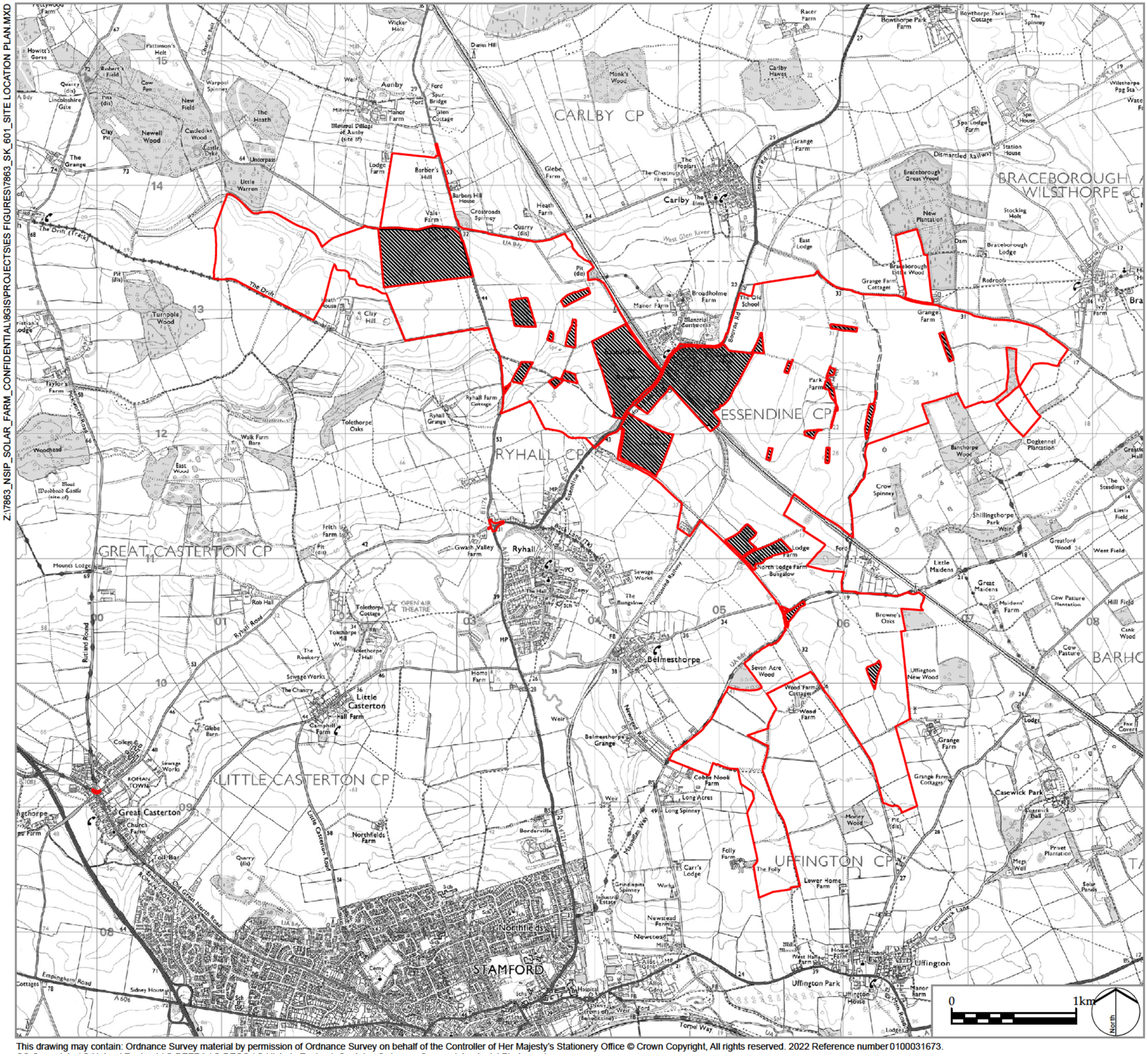

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Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009
APFP Regulation: 5(2)(a)

PINS REFERENCE NUMBER
EN010127

LEGEND

Order Limits

Areas outside the Order limits

REV.	DESCRIPTION	APP.	DATE
P0	DCO Submission	RP	06/11/22

Mallard Pass
Solar Farm

PROJECT TITLE
MALLARD PASS SOLAR FARM

DRAWING TITLE
Figure 1.1: Order limits

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ANNEX C – 100-YEAR PLUS 20 % FLUVIAL DEPTHS

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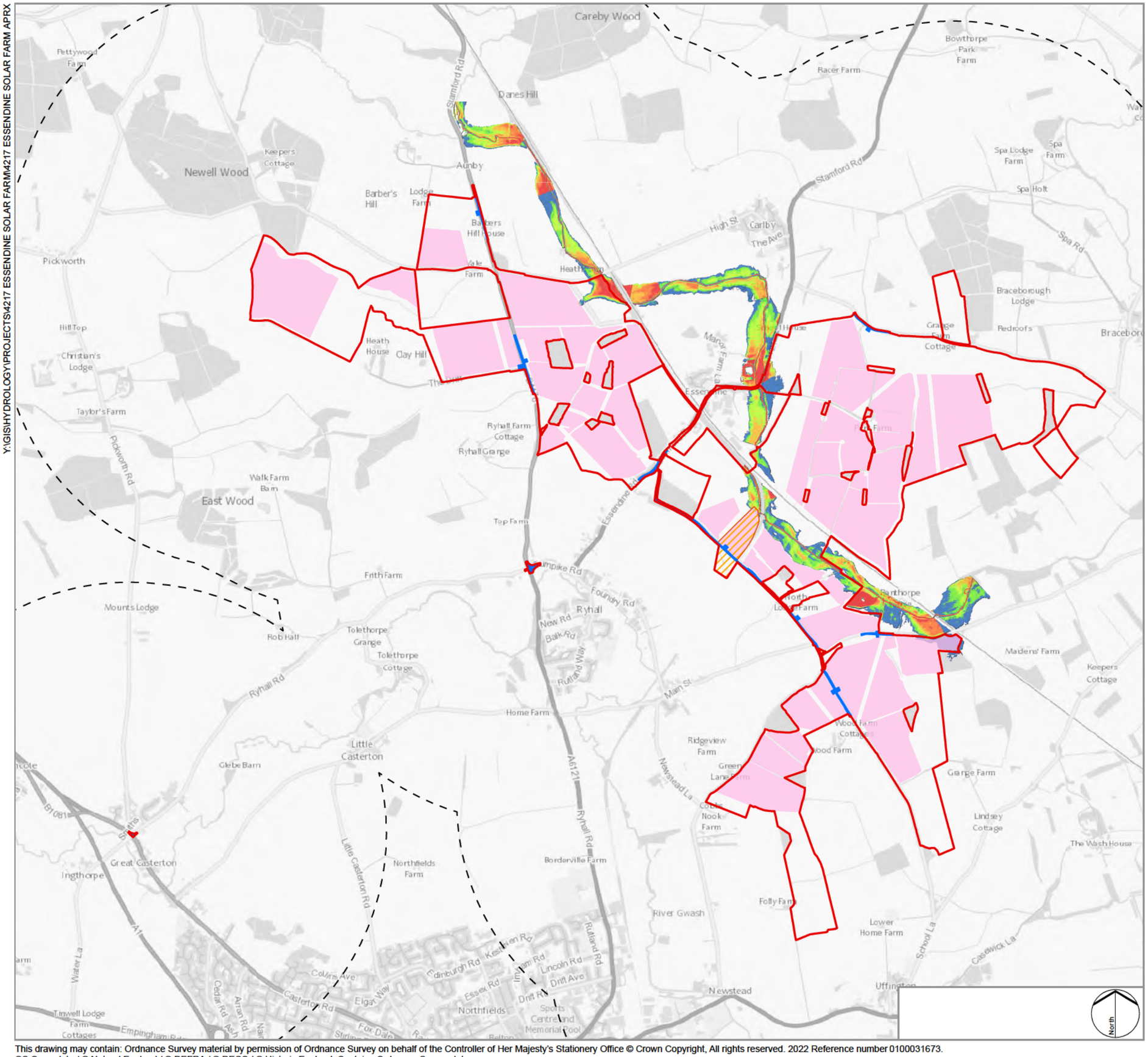

LEGEND

- Order Limits
- PWS Study Area (2 km)
- Solar PV Site
- Grid Connection Corridor
- Highways Works

West Glen 1:100-Year(+20%) Flood Depth (m)

- 0.2
- 0.4
- 0.6
- 0.8
- 1
- > 1

LDĀDESIGN

PROJECT TITLE

MALLARD PASS SOLAR FARM:
FLOOD RISK ASSESSMENT

DRAWING TITLE

100-Year plus 20% CC Fluvial Flood Depths

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DATE	18 November 2022	DRAWN	CH
SCALE @A3	1:30,000	CHECKED	LN
STATUS	Draft	APPROVED	SC

DWG. NO. Appendix C

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Sources: Ordnance Survey

ANNEX D – 100-YEAR PLUVIAL EVENT DEPTHS

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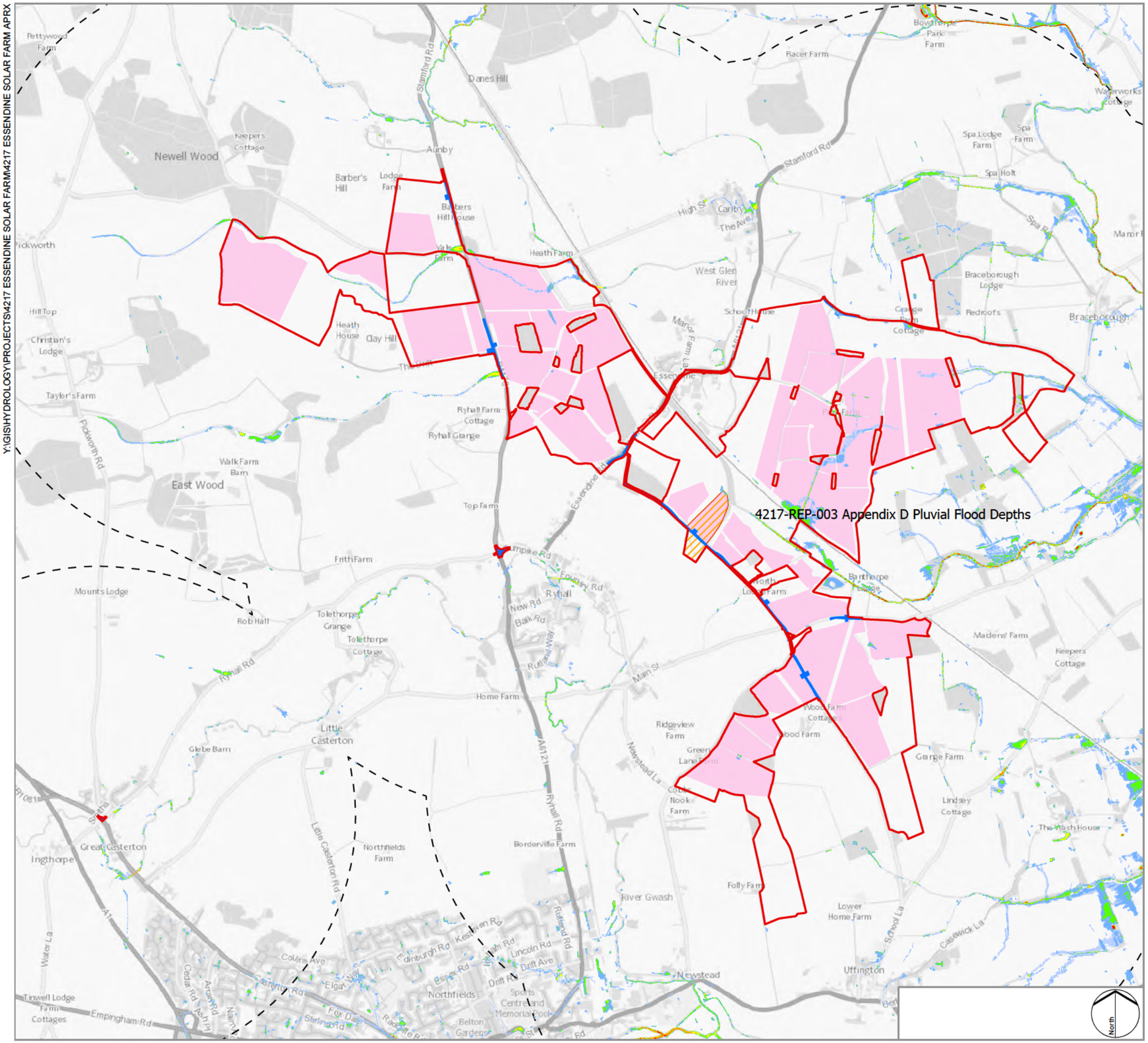

LEGEND

- Order Limits
- PWS Study Area (2 km)
- Solar PV Site
- Grid Connection Corridor
- Highways Works

100-Year Pluvial Flood Depths (m)

- 0.00 - 0.15
- 0.15 - 0.30
- 0.30 - 0.60
- 0.60 - 0.90
- 0.90 - 1.20
- > 1.20

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PROJECT TITLE

MALLARD PASS SOLAR FARM:
FLOOD RISK ASSESSMENT

DRAWING TITLE

100-Year Pluvial Flood Depths

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STATUS	Draft	APPROVED	SC

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ANNEX E – RESERVOIR FLOODING EXTENT MAP

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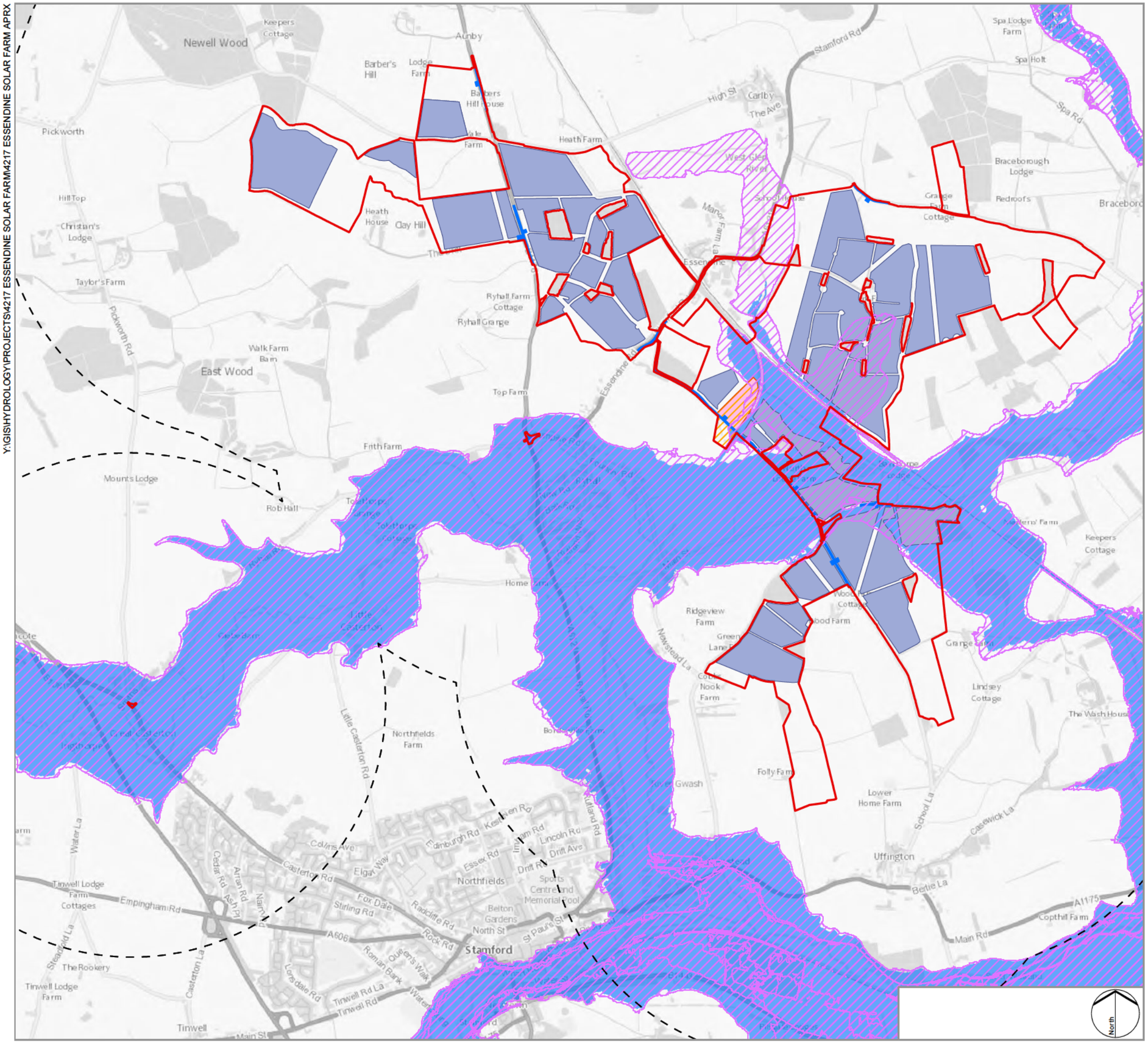

LEGEND

- Order Limits
- PWS Study Area (2 km)
- Solar PV Site
- Grid Connection Corridor
- Highways Works
- Reservoir flooding - Also flooding from rivers
- Reservoir flooding - River Levels are normal

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PROJECT TITLE

MALLARD PASS SOLAR FARM:
FLOOD RISK ASSESSMENT

DRAWING TITLE

Reservoir Flooding Extent

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ANNEX F – FLOOD ZONES

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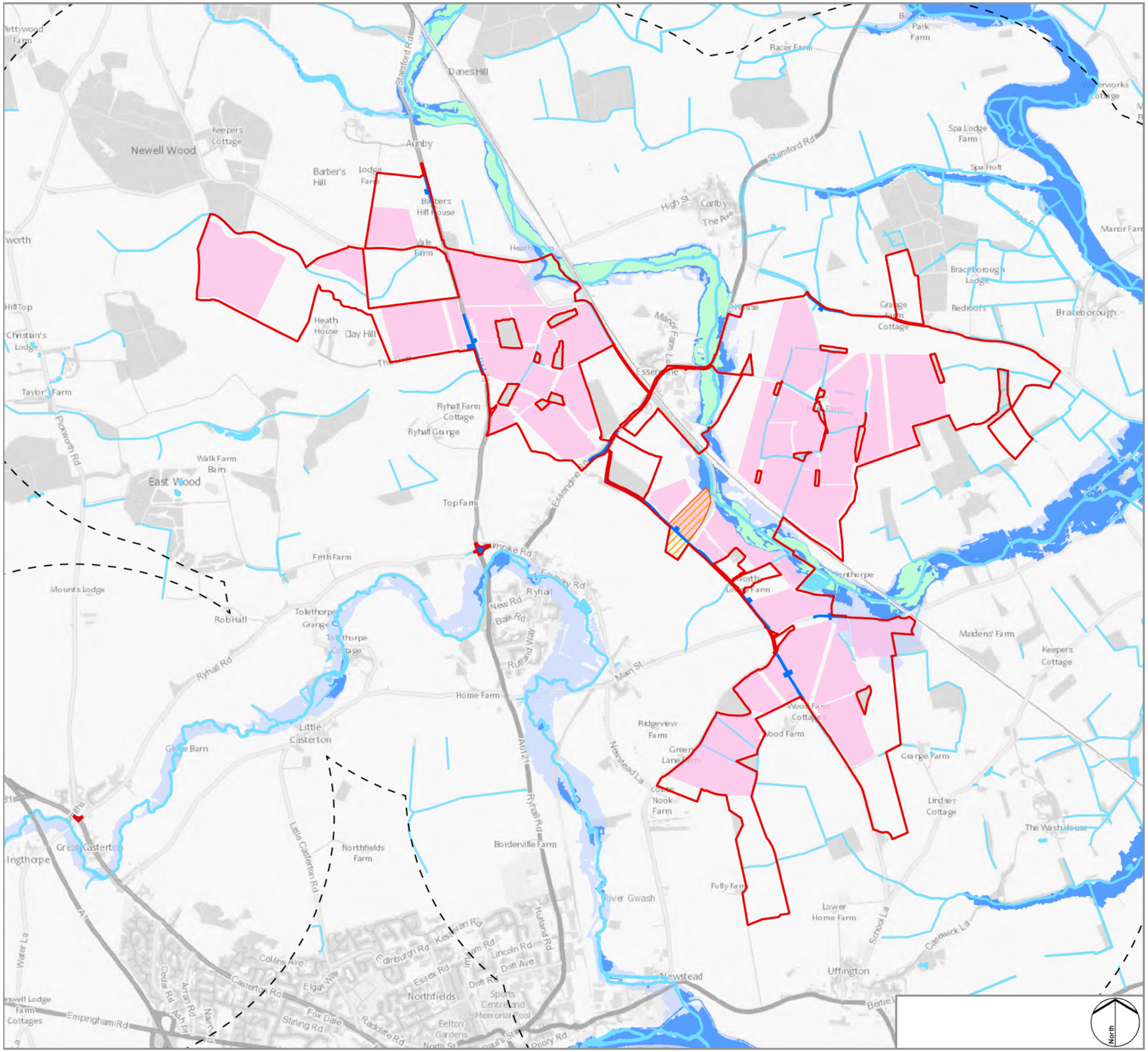

LEGEND

- Order Limits
- PWS Study Area (2 km)
- Solar PV Site
- Grid Connection Corridor
- Highways Works
- Watercourse
- Flood Zone 2
- Flood Zone 3a
- Flood Zone 3b

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PROJECT TITLE

MALLARD PASS SOLAR FARM: FLOOD RISK ASSESSMENT

DRAWING TITLE

Flood Risk Map

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SCALE @A3	1:30,000	CHECKED	LN
STATUS	Draft	APPROVED	SC

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