# BEACON FEN
## ENERGY PARK

Planning Inspectorate Reference: EN010151

Appendix 17.1 Ground Conditions Desk Study – Part 1
Document Reference: 6.3 ES Volume 2, 6.3.102a
April 2025

**The Planning Act 2008**
**The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 - Regulation 5(2)(a)**
**The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (SI 2017/572) – Regulation 14**

## Quality information

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# 1. INTRODUCTION

## Background and Planning Status

1.1.1 This Ground Conditions Desk Study has been prepared by Wardell Armstrong LLP (part of SLR) ('WA') on behalf of Beacon Fen Energy Park Ltd (the 'Applicant') in support of an application for a Development Consent Order (DCO) for Beacon Fen Energy Park (the 'Proposed Development'). This is a proposed ground-mounted solar photovoltaic (PV) electricity generation and battery energy storage system (BESS), together with associated grid connection infrastructure.

1.1.2 This report follows WA's **Appendix 1.1 Scoping Report (Document Ref: 6.3, ES Vol.2, 6.3.1**) and Preliminary Environmental Information Report (PEIR) (reference ST19595-REP-002, dated January 2024). This report supports the **Environmental Statement (Document Ref: 6.2)** and has been prepared in accordance with WA Standard Terms and Conditions and Limitations, as described in Appendix 1 and is an update of the equivalent report submitted with the PEIR in January 2024.

1.1.3 **Appendix 1.1 Scoping Report (Document Ref: 6.3, ES Vol.2, 6.3.1**), prepared in 2023, determined the following recommended approach for assessing potential risks / effects relating to ground conditions:

"*Based on the initial review of publicly available data and in consideration of the nature of the Proposed Development, there is considered to be a low risk to sensitive receptors during both the construction and* operational *phases of the Proposed Development. It would, therefore, be disproportionate and unnecessary to prepare a specific ground conditions chapter for inclusion within the Environmental Statement (ES). It is recognised, however, that there is a planning requirement to ensure that potential contamination and ground conditions risks have been fully considered and addressed (e.g. as required by the government's Land Contamination Risk Management Guidance and the relevant National Policy Statements for Energy). It is, therefore, intended to produce a standalone Phase 1 Ground Conditions Desk Study for inclusion within the ES. This will ensure that a proportionate level of information and assessment is provided*".

1.1.4 The Planning Inspectorate's (PINS) **Scoping Opinion (Document Ref: 6.3, ES Vol.2, 6.3.2 Appendix 1.2)** (*Scoping Opinion: Proposed Beacon Fen Energy Park*, 26 May 2023) stated that they agree with the approach of carrying out a desk study and that this should form justification for either confirming the suitability of scoping Ground Conditions out of the ES or, should it identify the possibility of significant effects, for the assessment of these to be scoped into the ES. The Scoping Opinion also included correspondence from the Environment Agency stating their agreement to scoping Ground Conditions out of the ES provided that a separate Phase 1 Ground Conditions Desk Study is submitted. Correspondence from North Kesteven District Council (NKDC) contained within the Scoping Opinion notes the presence of a groundwater Source Protection Zone (SPZ) at the Site, although it is noted that due to refinement of the Order Limits since Scoping this is no longer the case.

1.1.5 No comments were received on the first version of this report submitted with the PEIR from Statutory Consultation.

## Site Location

1.1.6 The Site is located near Sleaford, Lincolnshire. The Site comprises a land parcel named Beacon Fen Energy Park (BFEP) (centred at approximate National Grid Reference (NGR: TF 14687 48004) together with a Cable Route Corridor covering an area to the south and a Bespoke Access Corridor leading from the A17 in the west to the land parcel. These areas are referred to individually as the Solar Array Area, Cable Route Corridor and the Bespoke Access Corridor (for a bespoke site access road) or collectively as the Site and/or the Order Limits. The Site location is shown on WA Drawing ST19595-120 Site Location with 5km Buffer (within this report). The centre of the Site area is located at NGR: TF 17719 42741. The three areas as outlined above (Solar Array Area, Cable Route Corridor and Bespoke Access Corridor) are shown on Drawing ST19595-433 County Series Plan – 1888 (within this report) for clarification.

1.1.7 The Solar Array Area is located to the north of Heckington and adjacent to Ewerby Thorpe, is circa (c.) 529 hectares (ha) in area and generally comprises arable fields with hedgerows and drainage ditches and sparse tree cover. The Bespoke Access Corridor extends from the west of the Solar Array Area to the southwest towards the A17, east of Kirkby La Thorpe. The Cable Route Corridor is elongated in shape and covers an area south east of the Solar Array Area, extending from the south of the Solar Array Area to the National Grid Bicker Fen 400 kV Substation (hereafter Bicker Fen Substation). The total Site area including the Solar Array Area, Cable Route Corridor and Bespoke Access Corridor is c. 758 ha.

1.1.8 The Solar Array Area and Bespoke Access Corridor are located within the NKDC, with the Cable Route Corridor entering land within Boston Borough Council (BBC).

## Proposed Development

1.1.9 The Proposed Development comprises an above ground solar panel array and BESS infrastructure at the Solar Array Area, which will be connected to wider electricity infrastructure at Bicker Fen Substation by a new 400kV cable circuit to be installed within the Cable Route Corridor. At this stage, the location of the 400kV cable circuit within the Cable Route Corridor has not yet been finalised and will be confirmed as part of detailed design. The Bespoke Access Corridor will provide a transport connection to the Solar Array Area from the A17 to the west of the Site.

1.1.10 The solar panel infrastructure and engineering works within the Solar Array Area will include the following:

- Solar PV modules;
- PV solar mounting structures;
- Inverters;
- Transformers;
- High-voltage (HV) switchgear and control equipment;
- BESS;

- Electrical compounds;
- Temporary construction compounds;
- Onsite cabling kiosks;
- Storage facilities;
- Fencing, lighting and security;
- Drainage and utility connections; and,
- Access tracks, hardstanding and new or modified accesses.

1.1.11 The Proposed Development within the south of the Cable Route Corridor includes the upgrading and extending of the existing Bicker Fen Substation. At the time of writing, there is optionality within the design of the extension to Bicker Fen Substation. The two options under consideration are Air Insulated Switchgear (AIS) and Gas Insulated Switchgear (GIS). The area of land required for the substation extension under an AIS system is approximately 18,022m$^2$ (subject to National Grid's final design and reflective of the additional area assumed for the works necessary to deliver the Heckington Fen DCO generation bay). For the GIS solution, the maximum area of land for all the necessary elements of the GIS solution would be 75m x 75m.

1.1.12 The operational lifespan of the Proposed Development will be a maximum of 40 years, with a further 3 years for decommissioning. Construction of the Bespoke Access Corridor is anticipated to last between 6 and 12 months and 12 to 24 months for the Cable Route Corridor. Construction of the Solar Array Area will follow completion of the Bespoke Access Road and will last between 24 and 36 months. Therefore, the overall lifespan of the entire Proposed Development, including construction and decommissioning is anticipated to be approximately 45 years.

## Scope and Objectives

1.1.13 In line with the planning background described within Appendix 2, the overall purposes of this report are to:

- Provide a geo-environmental Phase 1 desk study in accordance with relevant planning policy and guidance; and
- Allow for conclusions to be made regarding the suitability of scoping the Ground Conditions topic out of the ES.

1.1.14 The general scope of work carried out in order to achieve these objectives comprises:

- A review of past and current uses of the Site and surrounding areas.
- A review of the geo-environmental setting of the Site, including geology, mining, hydrogeology and hydrology.
- The identification of potential contamination sources, pathways and receptors as part of a preliminary Conceptual Site Model (CSM).
- A preliminary geo-environmental risk assessment of any potentially viable source-pathway-receptor linkages identified.

1.1.15 This report has been prepared in general accordance with the principles of the Environment Agency's 'Land Contamination: Risk Management' (LCRM) guidance dated October 2020, updated July 2023. Further background to government guidance in assessing the risk of contamination at a site is provided in Appendix 2.

1.1.16 This report does not constitute or contain a valuation nor is it a full rigorous environmental audit.

## Data Sources

1.1.17 The history, environmental and geological setting of the Site and surrounding areas has been investigated by consultation with a range of publicly available information and purchased digital datasets, including:

- Historical mapping provided by Landmark Information Group in digital format, at 1:2,500 scale and 1:10,000 scale, dating from 1888 to 1995.
- Historical mapping available online from the National Library of Scotland.
- Google Earth satellite imagery from 2000 to present.
- British Geological Survey (BGS) Geohazards data ('GeoSure' data sets for soluble rocks, shrink swell clay, running sand, landslides, compressible ground, and collapsible ground).
- BGS bedrock and superficial geology mapping and aquifer data (1:50,000 scale).
- EA datasets available under Open Government Licence, comprising: groundwater and surface water abstractions, pollution incidents and discharge consents.
- UK Government open data sources (available under Open Government Licence), comprising: SPZ, authorised waste sites, historical landfill sites and nitrate vulnerable zones.
- Local planning documentation and maps regarding the locations of Local Geological Sites, including the Central Lincolnshire Local Plan StatMap Aurora Online Mapping.
- Radon risk designation data, available digitally from UK Radon.
- A data search reply from NKDC, confirming the absence of any sites formally determined as Contaminated Land under Part IIA of the Environmental Protection Act 1990, within their geographical boundaries.
- MAGIC Interactive Map (online: https://magic.defra.gov.uk/magicmap.aspx).

## Limitations

1.1.18 This report focusses primarily on geo-environmental issues. For information, some limited and basic general commentary is provided on geotechnical engineering constraints in Section 7. This is not intended to be comprehensive nor to constitute any formal geotechnical desk study nor to form any part of the formal geotechnical design process. Geotechnical desk studies and design reports should be undertaken as deemed necessary by the engineering designers of the Proposed Development.

1.1.19 This report does not provide any appraisal of the likely foundations solution for any structures at the Site. For the purpose of geo-environmental assessment, it is assumed that either shallow or deep foundations (e.g. piles) may be required.

1.1.20 This report does not consider Flood Risk or Water Resources matters that are covered within ES **Chapter 11: Water Resources (Document Ref: 6.2, ES Vol.1 6.2.11)** and the Flood Risk Assessment (FRA) **(Document Ref: 6.3, ES Vol.2 6.3.81)** produced to support the application.

1.1.21 Due to the size of the area covered, historical mapping has been reviewed in GIS format. For illustrative purposes, the 1:10,000 and 1:10,560 mapping is reproduced on ST19595-433 to ST19595-437. 1:2,500 scale mapping has been assessed, but this has not been reproduced on the drawings for brevity and covers some dates that are not shown on the included drawings. Extracts / data from the 1:2,500 data are available on request.

1.1.22 This report is supported by a walkover inspection carried out in the Solar Array Area. Corresponding walkover inspections have not been carried out specifically for the purpose of this report in the Cable Route Corridor or Bespoke Access Corridor, but cross-disciplinary working with other Wardell Armstrong teams (e.g. those involved in extensive archaeological works, including personnel with Asbestos Awareness training) has been used to ensure that the desk study information is verified and supplemented by site observations. Given the nature of the development (e.g. access roads, cable installation and substation extension) and agricultural nature of the land, this is considered a commensurate level of data collection to support the desk study.

# 2. SITE HISTORY AND CURRENT LAND USE

## Site History

### *Solar Array Area*

2.1.1 Based upon a review of historical mapping and satellite imagery dated between 1888 and present for the Solar Array Area and surrounding 250m, the Solar Array Area and surrounding areas have not undergone significant changes throughout this (137 year) timeframe. The historical maps for the Solar Array Area have been presented on WA Drawings ST19595-433 to ST19595-437 (within this report). The earliest mapping edition shows the Solar Array Area to predominantly comprise undeveloped land or agricultural fields divided into many field parcels bordered by hedgerows, drains or trees.

2.1.2 From the earliest mapping edition onwards, the Hodge Dike, a drainage channel, runs through the Solar Array Area from northeast to southwest, with a draining pump in the east. The Catchwater Drain, a drainage channel, runs along field boundaries through the centre of the Solar Array Area from the north-west and connects to the Hodge Dike in the centre of the Solar Array Area. The Twelve Drain is present, a drainage channel running northeast to southwest along field boundaries, in the north of the Solar Array Area. A small, unmarked structure is present in the far west of the Solar Array Area, from which an access track leads through the Solar Array Area from west to east. An area of woodland labelled Fox Covert is present in the north-west of the Solar Array Area. The Heckington Tunnel and Waithe Pumping Engines are present in the north-east corner of the Solar Array Area, adjacent to the Car Dyke, a straight drainage channel present as a continuation of the Hodge Dike towards the Head Dike in the southeast.

2.1.3 From the earliest mapping edition onwards, several farms are present immediately surrounding the Solar Array Area, including one that is surrounded by (but outside) the Solar Array Area boundary in the north-east of the Site. Asgarby Fen Farm is located immediately south of the Solar Array Area, with Cottager's Plot adjacent to the farm. The Car Dyke (Roman Canal) is present along the eastern Order Limits boundary, extending north and south of the Solar Array Area. The village of Ewerby Thorpe is present immediately west of the Site, with the town of Ewerby located further to the west. The village of Howell is present immediately southwest of the Solar Array Area, which includes a farm, a hall, a church and a rectory with a moat. Minor roads are present along the north, south and west boundaries of the Solar Array Area, with limited residential properties along their sides. Land beyond the roads and the Car Dyke is shown to comprise agricultural land in all directions surrounding the Solar Array Area. The River Slea is located c. 850m north of the Site, with a toll gate and bridge north-east of the Site where it meets the Car Dyke.

2.1.4 No significant changes to the Solar Array Area or surrounding areas (250m buffer) have been identified on any of the mapping through to present day, aside from minor changes to field boundaries and modernisations to farm structures. On 1:2,500 scale mapping, the Catchwater Drain is shown to be within a cutting.

### *Cable Route Corridor*

2.1.5 From the earliest available mapping (1888) onwards, the land is generally recorded to comprise agricultural land with small areas of woodland. The field parcels are generally bound by hedgerows, access tracks or drainage channels. Many farms are present across the Cable Route Corridor, but not with built development of any significant size. The Great Northern Railway line (Sleaford and Boston Branch) is present crossing through the centre of the Cable Route Corridor in an east to west orientation, then running parallel along the Order Limits boundary as it trends towards the east. This railway is shown to extend beyond the Cable Route Corridor boundary in both directions and is renamed on mapping from 1938 onwards as the London North Eastern Railway (Grantham, Sleaford and Boston). The Heckington Eau surface water body, a straight drainage channel, crosses through the north of the Cable Route Corridor, extending south-west towards Heckington and north-east to connect with the Head Dike. To the south of the railway line, the South Forty Foot Drain is present, a straight drainage channel orientated south to north-east through the Cable Route Corridor, before diverting east and running parallel to the railway line. Roads and tracks are present on mapping through to present day. The Hammond Brook, a narrow surface water feature and tributary of the Old Hammond Brook, is located c. 130 m south-east of the Cable Route Corridor.

2.1.6 A gravel pit is recorded on historical mapping (dated 1906 through to 1956) directly north of the Heckington Eau, encroaching slightly into the western boundary of the Cable Route Corridor at Howell Fen. Current aerial imagery and topographical data indicates this feature to have been infilled, and this feature is absent from mapping dated 1973 - 1977, suggesting it was infilled between 1956 and 1977, although a date for this is unknown.

2.1.7 The historical mapping shows the A17 as having been constructed by 1984, which is an expansion of a pre-existing road to the town of Heckington, and crosses the Cable Route Corridor on an east to west orientation. This follows the route of a previous local road, although the extent of the road is likely to be more significant in width crossing the Cable Route Corridor than the previous local route.

2.1.8 The Bicker Fen Substation appears to be present from c. 2005, onwards, in the far south of the Cable Route Corridor, although the exact date of construction of this structure is unknown. There are also various pylons and overhead lines connecting into this substation within the Cable Route Corridor. From c. 2019, onwards, wind turbines are present surrounding the south of the Cable Route Corridor (to the south of where the minor road, Bicker Drove, crosses the Cable Route Corridor), associated with Donnington Wind Farm.

2.1.9 With the exception of the identified gravel pit, the substation and wind farm developments in the south of the Cable Route Corridor and the construction of the A17 through the centre of the Cable Route Corridor, no areas of significant built development, changes in land use or likely sources of significant ground contamination potential were identified by the review of historical mapping.

### *Bespoke Access Corridor*

2.1.10 The proposed Bespoke Access Corridor connects the Solar Array Area, north of Howell, to the A17 towards the southwest, south of Kirkby la Thorpe. The earliest available mapping (dated 1888) shows the land within the Bespoke Access Corridor as comprising agricultural land with localised areas of woodland. Within the Bespoke Access Corridor, the field parcels are also generally bound by hedgerows, tracks or drainage channels. Several ponds are also recorded within the Bespoke Access Corridor on the earliest available mapping, some of which are absent from current aerial imagery so are assumed to have been backfilled. There are no other notable changes in land use from the earliest to latest available mapping across the Bespoke Access Corridor.

## Current Land Use

2.1.11 A site walkover was completed by a WA Engineer on 6th July 2023. The walkover route was planned to provide good spatial coverage across the Solar Array Area. No part of the Cable Route Corridor or Bespoke Access Corridor was covered within this walkover. The Solar Array Area falls under ownership of three landowners and permission was obtained from each to allow access on the date of the walkover.

2.1.12 The Solar Array Area was found to generally comprise agricultural land split into approximately 40 field parcels. These were generally segregated by drainage ditches or dirt, gravel or grass covered tracks. The Solar Array Area was observed to be relatively flat lying across its entirety, with little variation in elevation aside from the drainage ditches.

2.1.13 The perimeter of the Solar Array Area was lined with dense hedgerows and trees, with roads along the northern, western and southern site boundaries. The edges of the field parcels and drainage ditches were generally overgrown with weeds and vegetation, but the majority of the open field areas appeared to be maintained in good condition. Where clay was exposed at surface along the access tracks, desiccation cracks were present, considered to be a result of extended hot weather prior to the walkover survey.

2.1.14 The Solar Array Area is bisected through the centre by a culvert trending north-west to south-east, which links into the Car Dyke immediately east of Site, which (in turn) runs along the eastern boundary of the Site. Parallel and north of this feature, a large gravel track runs through the centre of the Solar Array Area, which is wide enough for vehicle and machinery to access the Site. This is blocked by a padlocked gate on the western Order Limits boundary. Adjacent to this track, within the centre/east of the Solar Array Area, is an area currently used by the landowners as miscellaneous storage. A review of the Safety Data Sheet for this product (available online) indicates that it is an ammonium nitrate fertiliser. The large fertiliser tank appeared to be in good condition, with no evidence of leaks or spills, and was cited on a concrete base. The stockpiles were observed to include many manmade constituents, including bricks, plastics, glass, tarpaulin, cement and ceramics. Flat sheets of rusty metal were also observed in this area. Photographs from the walkover are included in Appendix 3.

2.1.15 Several tracks lead south into the Solar Array Area from the northern Solar Array Area boundary, secured from public access by padlocked gates. Small wooded areas were recorded in the northern half of the Solar Array Area, adjacent to access tracks. No evidence of contamination was observed within these areas.

2.1.16 Gravel/dirt tracks also lead into the Solar Array Area from the south, some of which are blocked by padlocked gates and others open for access. Halfway along the southern boundary of the Solar Array Area, an access point was observed wide and level enough to be suitable for vehicular access. Adjacent to this, an area of cement hardstanding was observed with stockpiles including brick and cement, although no evidence of asbestos containing materials (ACM) was identified during this survey. No further evidence of possible contamination was observed within this area.

# 3. GEOLOGICAL AND HYDROGEOLOGICAL SETTING

## Geology

3.1.1 The assessment of the geology at the Site is based upon published geological mapping from the British Geological Survey (BGS). Geological mapping for the Order Limits is reproduced on WA Drawings ST19595-161 – Superficial Geology, ST19595-162 – Bedrock Geology and ST19595-163 – Artificial Geology (within this report).

3.1.2 A summary of the published geology of the Solar Array Area is provided in Table 3-1, below. A summary of the geological information relating to the Cable Route Corridor is provided below in Table 3-2 and that for the Bespoke Access Corridor is provided below in Table 3-3.

**Table 3-1 – Summary of Published Geology for the Solar Array Area**

| GEOLOGICAL FEATURE | DESCRIPTION |
|---|---|
| Made Ground | One area of Made Ground is recorded within the Solar Array Area boundary, located adjacent to an access track leading to the south of the Site and is recorded as an artificial deposit of undivided Made Ground. This appears to correlate with a rectangular (assumed manmade) water filled feature in this location and immediately adjacent land that is generally heavily vegetated. This feature was formed after 1994. No other Made Ground is recorded within the Solar Array Area, but might be present at limited thickness along roads/access tracks and surrounding existing properties. Made Ground deposits of significant thickness and extents are not expected within the Solar Array Area. |
| Superficial Deposits | The north and east of the Solar Array Area are recorded to be underlain by Tidal Flat Deposits, generally recorded as clay and silts. The centre, west and south of the Solar Array Area are recorded to be underlain by Mid-Pleistocene Till deposits (Diamicton). An area within the centre of the Solar Array Area is recorded to be underlain by Alluvium (Clay, Silt, Sand and Gravel) and a small area in the south of recorded as underlain by Glaciofluvial Ice Contact Sand and Gravel deposits. |
| Solid Strata | The majority of the Solar Array Area is recorded by the BGS 1:50,000 scale mapping to be underlain by solid strata of the Oxford Clay Formation, which is generally described as a silicate mudstone with sporadic beds of limestone nodules. The land in the far east of the Solar Array Area is recorded to be underlain by interbedded mudstone and siltstone of the West Walton Formation. |
| Geological Structure | A fault is recorded as running along the southern boundary of the Solar Array Area, trending northeast to southwest, extending into the Cable Route Corridor to the south, but does not enter the boundary of the Solar Array Area. The Solar Array Area is not located within an area of major geological folding with the beds generally dipping at very shallow angles to the east. |

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| Ground Stability Hazards | The spatial distribution of the ground stability hazards classifications is shown on Drawings ST19595-133 to ST19595-137 inclusive (within this report). The exception to this soluble rocks, which are not necessary to be shown on a drawing due to the uniformity of Class A (not prone to dissolution) across the Site. |

**Table 3-2 – Summary of Published Geology for the Cable Route Corridor**

| GEOLOGICAL FEATURE | DESCRIPTION |
|---|---|
| Made Ground | BGS 1:50,000 geological mapping does not record the presence of Made Ground within the Cable Route Corridor. However, the Cable Route Corridor crosses several roads, railway lines and access tracks where Made Ground is expected at variable thicknesses. It is considered unlikely that Made Ground would be present across the majority of the Cable Route Corridor in significant thicknesses as the land is predominantly agricultural land. |
| Superficial Deposits | The southern half of the Cable Route Corridor is recorded to be underlain entirely by clay and silt of Tidal Flat Deposits, which extend significantly beyond the Cable Route Corridor to the north, east and south. The northern half of the Cable Route Corridor is underlain by variable superficial deposits, the most extensive of which is recorded to be Mid-Pleistocene Till deposits. Localised areas in the north and centre are underlain by Sleaford Sand and Gravel, Glaciofluvial Sheet Deposits or Till deposits. |
| Solid Strata | Approximately half of the Cable Route Corridor (north-west and east) is recorded to be underlain by interbedded mudstone and siltstone of the West Walton Formation. The centre and south of the Cable Route Corridor is underlain by mudstone of the Oxford Clay Formation. |
| Geological Structure | A fault is recorded to cross the north of the Cable Route Corridor, extending east and west of the Cable Route Corridor. A second fault is present within the far north of the Cable Route Corridor, which extends to the east and west of the Site. |
| Ground Stability Hazards | The spatial distribution of the ground stability hazards classifications is shown on Drawings ST19595-133 to ST19595-137 inclusive (within this report). The exception to this soluble rocks, which are not necessary to be shown on a drawing due to the uniformity of Class A (not prone to dissolution) across the Site. |

**Table 3-3 – Summary of Published Geology for the Bespoke Access Corridor**

| GEOLOGICAL FEATURE | DESCRIPTION |
|---|---|
| Made Ground | BGS 1:50,000 geological mapping does not record the presence of Made Ground within the proposed Bespoke Access Corridor. However, the Bespoke Access Corridor crosses minor roads and access tracks where Made Ground is expected at limited thicknesses. It is considered unlikely that Made Ground would be present across the majority of the Bespoke Access Corridor in |

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|---|---|
| | significant thicknesses as the land is predominantly agricultural land. |
| Superficial Deposits | The eastern half and an area in the west of the Bespoke Access Corridor are recorded to be underlain entirely by Mid-Pleistocene Till deposits. A localised area in the west is recorded to be underlain by Glaciofluvial Sand and Gravel deposits and a smaller localised area further west is recorded to have no superficial deposits. The western end of the Bespoke Access Corridor is recorded to be underlain by Sleaford Sand and Gravel. |
| Solid Strata | The Bespoke Access Corridor is recorded to be underlain entirely by mudstone of the Oxford Clay Formation. |
| Geological Structure | A fault is recorded to cross the southwest of the Bespoke Access Corridor, extending northeast of the Bespoke Access Corridor and along the south of the Solar Array Area. |
| Ground Stability Hazards | The spatial distribution of the ground stability hazards classifications is shown on Drawings ST19595-133 to ST19595-137 inclusive (within this report). The exception to this soluble rocks, which are not necessary to be shown on a drawing due to the uniformity of Class A (not prone to dissolution) across the Site. |

## Hydrogeology

3.1.3 Hydrogeological information has been obtained from a review of:

- BGS Aquifer Designation data provided by Landmark Information Group.
- The MAGIC Interactive map.

### *Solar Array Area*

3.1.4 The Till superficial deposits in the centre, west and south of the Solar Array Area are designated as a Secondary Undifferentiated Aquifer, which is a designation that is applied where it is not possible to apply either a Secondary A or B definition because of the variable characteristics of the soil type. These usually only have a minor value and this designation is likely to be due to the largely variable characteristics of these deposits.

*3.1.5* The Alluvium and Glaciofluvial Deposits in the centre and south of the Solar Array Area are designated as a Secondary A Aquifer, which are described by the Environment Agency as permeable layers capable of supporting water supplies at a local (rather than strategic scale) and, in some cases, forming an important source of base flow to rivers. The Tidal Flat Deposits present in the north and east of the Solar Array Area are designated as Unproductive Strata.

### *Cable Route Corridor*

3.1.6 The southern half of the Cable Route Corridor is recorded to be underlain by Tidal Flat Deposits, designated as Unproductive Strata. The majority of the northern half of the Cable Route Corridor is recorded to be underlain by the Till deposits designated as a Secondary Undifferentiated Aquifer. The localised areas of Glaciofluvial Deposits or Sleaford Sand and Gravel in the northern half of the Cable Route Corridor are designated as Secondary A Aquifers.

3.1.7 The solid strata of the Oxford Clay Formation and West Walton Formation are designated as Unproductive Strata beneath both the Solar Array Area and Cable Route Corridor.

### *Bespoke Access Corridor*

3.1.8 The granular superficial deposits (Glaciofluvial Sand and Gravel and Sleaford Sand and Gravel) are designated as Secondary A Aquifers and the cohesive superficial deposits (Mid-Pleistocene Till) are designated as a Secondary Undifferentiated Aquifer. The bedrock strata (Oxford Clay Formation) recorded beneath the Bespoke Access Corridor are designated as Unproductive Strata.

### *Source Protection Zones*

3.1.9 The Solar Array Area, Cable Route Corridor, Bespoke Access Corridor and surrounding land are not located within a SPZ. The closest SPZ to the Solar Array Area is located c. 2.15km north-west, with the SPZ 1 inner catchment located c. 2.60km north-west of the Site.

### *Groundwater Flooding*

3.1.10 **Appendix 11.1 Flood Risk Assessment (FRA) (Document Ref: 6.3, ES Vol.2, 6.3.81)** and **Chapter 11 Water Resources (Document Ref: 6.2, ES Vol.1, 6.2.11)** within the **Environmental Statement (Document Ref: 6.2)** have been produced for this application and the risk of groundwater flooding is beyond the scope of this assessment and has not been discussed within this report.

### *Discharge Consents*

3.1.11 No discharge consents are recorded within the Solar Array Area, the Cable Route Corridor or the Bespoke Access Corridor. The discharge consents within 2km of the Order Limits boundary are shown on WA Drawing ST19595-132 Recorded Pollution Incidents, Water Abstractions and Discharges (within this report), with the closest located just outside the Solar Array Area boundary at Austhorpe Farm and associated with sewage discharge from a single domestic property. The discharge consents within proximity of the Cable Route Corridor relate to sewage works or farms.

### *Water Abstractions*

3.1.12 There are three recorded surface water abstractions located within the Solar Array Area and one recorded surface water abstraction located within the Cable Route Corridor. All of these permits relate to use for irrigation. There are no recorded surface water abstractions within the Bespoke Access Corridor.

3.1.13 In addition to the abstractions within the Order Limits described above, there are several surface water abstractions for irrigation located within a 2km buffer of either the Solar Array Area, the Cable Route Corridor or the Bespoke Access Corridor, as shown on WA Drawing ST19595-132 Recorded Pollution Incidents, Water Abstractions and Discharges (within this report). These abstractions appear to be from the extensive surface drainage network that is present within the Site and in the surrounding area. One of the abstractions, located immediately adjacent to the south of the Cable Route Corridor (within the centre at White House Farm), is also licensed for the transfer of water between sources.

3.1.14 There are no groundwater abstractions located within 250m of either the Solar Array Area, the Cable Route Corridor or the Bespoke Access Corridor. The closest groundwater abstraction is recorded to be c. 2.9km north-west of the Site at May Park Chicken Factory. The closest recorded potable water abstraction to the Site is a groundwater abstraction located c. 5.5km west of the Cable Route Corridor.

3.1.15 The locations of recorded surface water and groundwater abstractions at and within 2km of the Site are shown on Drawing ST19595-132 Recorded Pollution Incidents, Water Abstractions and Discharges (within this report).

### *Nitrate Vulnerable Zones*

3.1.16 The Site is located entirely within the 'Black Sluice Internal Drainage Board (IDB) draining to the South Forty Foot Drain' Nitrate Vulnerable Zone (NVZ), which extends far beyond the Site to the east, west and south. The land immediately north of the Solar Array Area is located within the 'Lower Witham' NVZ.

### *Hydrology*

3.1.17 Many surface water features are present within the Solar Array Area, Cable Route Corridor and Bespoke Access Corridor, predominantly small features along field boundaries. Larger surface drains that are present include the South Forty Foot Drain, which crosses the Cable Route Corridor, the Heckington Eau, which crosses the north of the Cable Route Corridor and the Car Dyke, which forms part of the eastern boundary of the Solar Array Area.

3.1.18 One reservoir, several small ponds and other surface water features are present within the Site.

# 4. MINING AND QUARRYING

4.1.1 Research of the mining and quarrying setting of the Site has been carried out based on an examination of the published geological and topographical information and the Mining Remediation Authority's Online Interactive Map Viewer. The Site does not fall within a known coalfield area and, as such, underground workings of coal and coal mining features are not expected.

4.1.2 A review of the available historical maps for the Solar Array Area, Cable Route Corridor and Bespoke Access Corridor did not identify any recorded areas of surface quarrying or pits within the Site or surrounding areas. The only exception to this is a gravel pit (dated between 1906 and 1956) located on the western boundary of the Cable Route Corridor and northeast of Heckington. This feature is shown on page 4 of Drawing ST19595-434 National Grid Plan – 1956 (within this report). A sand pit is also recorded on historical mapping northeast of Heckington but this feature is greater than 500 m from the Order Limits so has not been referenced further. No features associated with likely underground workings were evident on the historical maps, such as mine shafts or mining spoil heaps.

4.1.3 Therefore, the possibility that the ground conditions at the Site are affected by historical mining or quarrying is considered to be low.

# 5. ENVIRONMENTAL SETTING AND CONSULTATIONS

## Contaminated Land Register Entries and Notices

5.1.1 There are no known recorded contaminated land register entries or notices (i.e. sites formally designated as 'contaminated land' under Part 2A of the Environmental Protection Act) located within the Site or within 1km of the Order Limits. This has been confirmed in correspondence by an Environmental Health Officer of NKDC, dated 3rd July 2023, and by a review of relevant online information from BBC. This indicates that there are no such sites at all within the administrative boundaries of these three councils.

## Waste Management

5.1.2 There are no recorded historical landfills present within the Solar Array Area or the Cable Route Corridor. The closest recorded historical landfill to the Site is located c. 1.2km south-east of the Solar Array Area and c. 670m east of the Cable Route Corridor. This landfill is recorded to have accepted waste from 1964 and the license was surrendered in 1994. Accepted waste types included inert, industrial, household and special waste.

5.1.3 There are no active or permitted landfills recorded within the Solar Array Area or Cable Route Corridor. The closest permitted landfill is located c. 8.7km west of the Cable Route Corridor and is recorded to have been licensed from 1993 for Morris Construction Limited. This landfill accepts non-biodegradable wastes.

## Radon

5.1.4 Radon can be a hazard within built developments or within enclosed or confined spaces. The UK Health Protection Agency and BGS provide mapping of the number of homes in a given area above the 'Action Level' for radon (i.e. 200Bq/$m^3$), which is available online[1]. Although this data relates directly to measurements taken from homes or dwellings, it is also relevant to employers assessing risks for enclosed underground and ground floor workplaces.

5.1.5 The Site is located entirely within an area of the lowest radon potential, with less than 1% of homes recorded at or above the Action Level that would require protection measures. Land situated around 150m to the north-west of the Solar Array Area boundary is recorded to have between 1% and 3% of homes above the Action Level.

## Pollution Incidents

5.1.6 There are no recorded historical pollution incidents within the Solar Array Area or Bespoke Access Corridor, but one is recorded within the Cable Route Corridor and a further three are located beyond the Site but within close proximity to the Order Limits (all of which located within the south of this area). Details of these four incidents are provided in Table 5-1, below.

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1 [redacted]

**Table 5-1: Summary Information on Historical Pollution Incidents within the Order Limits**

| NOTIFCATION DATE | X, Y COORDINATE | WITHIN/OUTSIDE THE ORDER LIMITS | INCIDENT STATUS | AIR - INCIDENT CATEGORY | LAND - INCIDENT CATEGORY | WATER - INCIDENT CATEGORY | CAUSE OF INCIDENT | POLLUTANT |
|---|---|---|---|---|---|---|---|---|
| 10/03/2004 | 519815, 339199 | c. 25 m south | Closed | Category 4 (No Impact) | Category 1 (Major) | Category 4 (No Impact) | Fly-Tipping | Solvents |
| 27/06/2002 | 519999, 339090 | c. 40 m south | Closed | Category 4 (No Impact) | Category 4 (No Impact) | Category 2 (Significant) | Unauthorised Discharge or Disposal | Other Sewage Material |
| 16/08/2004 | 518675, 342111 | c. 90 m south | Closed | Category 4 (No Impact) | Category 4 (No Impact) | Category 3 (Minor) | Accidental Spillage | Gas and Fuel Oils |
| 03/01/2002 | 520348, 339435 | Within | Closed | Category 4 (No Impact) | Category 4 (No Impact) | Category 3 (Minor) | Other Inadequate Control or Containment | Other Agricultural Material or Waste |

5.1.7 A further two pollution incidents are recorded within 1km of the Order Limits. These incidents are located approximately 500m south of the Order Limits, within the area currently occupied by the Bicker Wind Farm, and 800m west of the Order Limits, west of the Bicker Wind Farm and southeast of Little Hale Fen. These incidents do not have a severity of greater than Category 3 (minor) in relation to either land or water. The location of all recorded pollution incidents is shown on Drawing ST19595-132 Recorded Pollution Incidents, Water Abstractions and Discharges (within this report).

## Asbestos

### *Desk Study & Walkover Information*

5.1.8 The Site generally comprises agricultural land and fields, with limited built development (both currently and historically). Several farms and residential properties are present, but these are isolated and there are no pockets of concentrated development of this type. The only change of use and built development across the Site (historically) is the minor encroachment of a small historical gravel pit (assumed to now be infilled) into the west of the Cable Route Corridor, the expansion of the major road (into the A17) in the north of the Cable Route Corridor, plus the construction of the Bicker Fen Substation (plus connecting power lines) and the Donnington Wind Farm in the far south of the Cable Route Corridor. There is some possibility of Asbestos Containing Materials (ACM) in the former gravel pit location (within the Cable Route Corridor at Howell Fen), depending on what material was historically used to fill this, although it is noted that this overlaps only very slightly into the Site. Likewise, historical agricultural use carries a generally low risk of introducing asbestos to the ground, although this risk is not zero due to the potential historical practices when sourcing material to form tracks, level ground etc. The recent developments (substation and wind farm) are not considered to present a significant risk of introducing asbestos to the soils at the Site, given that they were completed after 2000.

5.1.9 During the walkover survey that was undertaken in the Solar Array Area, no evidence of previous or current built development was identified. The walkover survey identified one area of surface Made Ground within the centre of the Solar Array Area, near to an above ground fertiliser storage tank where a stockpile of materials (including brick, cement and ceramics, etc.) was identified. No obvious evidence of asbestos was noted within this stockpile, but it should be noted that this statement is a general observation and does not represent a formal assessment by a qualified asbestos surveyor. Owing to the nature of the stockpile, the presence of asbestos could not be discounted without further information on its source and / or testing of the material.

5.1.10 In addition, limited Made Ground materials may be present along access tracks and roads. There is no reason to believe that, if present, any such Made Ground would contain traces or fragments of asbestos, but, likewise, this cannot be definitively discounted at this stage. At present, the likelihood is considered to be low.

5.1.11 Overall, the desk study and walkover information indicates that the risk of asbestos in the ground within the Cable Route Corridor and Bespoke Access Corridor, therefore, is considered to be low.

#### *Findings from Archaeological Surveys*

5.1.12 Archaeological trenching works carried out on 3 November 2023 encountered several fragments of fibrous material at approximate co-ordinates 513874, 347513 (in the west of the Solar Array Area). The trial pit was terminated and backfilled in accordance with the archaeological safety procedures. In addition, during the archaeological surveys, suspect material was also encountered at the surface at a field boundary in the west of the Solar Array Area, at approximate co-ordinates 513932, 347467.

5.1.13 A revisit to obtain samples for asbestos testing was undertaken on 8 December 2023, during which two samples were taken and sent to ALS Laboratories (UK) Limited for testing (one from each of the locations described above). This included re-excavating at the previous trial pit position to obtain a sample from the appropriate depth. The testing certificates are included within Appendix 4.

5.1.14 The fibrous material within the west of the Solar Array Area was determined to comprise non-asbestos fibres. Chrysotile (white) fibres were detected within the surface sample from the field boundary, with the material noted to comprise asbestos containing materials (ACM) typical of asbestos cement. This is considered to be an isolated / localised occurrence, given that it relates to the only observation of such suspect materials at surface to date, that there were no former structures in this location, and that the Site's previous use is not such that widespread asbestos would be expected.

### Unexploded Ordnance

5.1.15 The review of historical mapping across the Site has not indicated any previous military use within the Site or surrounding areas. For completeness, a third-party Detailed Unexploded Ordnance (UXO) Risk Assessment has been obtained, dated 6 December 2023 and provided in Appendix 5. This report summarises the probability of encountering and detonating any explosive ordnance during any intrusive works at the Site, and provides recommendations for mitigation measures where required.

5.1.16 The UXO report has summarised the overall risk rating from UXO as Low. Recommended mitigation measures for the Proposed Development include site-specific explosive ordnance safety and awareness briefings (a UXO toolbox talk) and site-specific safety instructions (SSSI) training courses for all personnel conducting intrusive works.

## Designated Sites

5.1.17 There are no recorded Sites Of Special Scientific Interest (SSSI), Special Areas Of Conservation (SAC), Special Protection Areas or Ramsar sites located within the Site or within 1km of either the Solar Array Area, the Cable Route Corridor or Bespoke Access Corridor.

5.1.18 There are no recorded Local Geological Sites at or within 1km of the Site.

# 6. CONCEPTUAL SITE MODEL

6.1.1 The UK legislative approach to the assessment of contaminated land is set out in Part 2A of the Environmental Protection Act (EPA) 1990. This defines contaminated land as land that is in such a condition that:

- Significant harm is being caused or there is a significant possibility of such harm being caused; or
- Significant pollution of Controlled Waters is being caused or there is a significant possibility of such pollution being caused.

6.1.2 Contaminated land assessment is incorporated into the UK planning regime through the National Planning Policy Framework (NPPF) (2025) and associated guidance, including the UK Government's Land Contamination Risk Management (last updated 2023) and Planning Practice Guidance (PPG).

6.1.3 Relevant policy for the Proposed Development includes the Department for Energy Security & Net Zero Overarching National Policy Statement for Energy (EN-1) and National Policy Statement for Renewable Energy Infrastructure (NE-3). Applicants are encouraged to consider development on suitable brownfield land as a preference for renewable energy infrastructure.

6.1.4 The planning regime is designed to provide an effective statutory framework for the assessment and remediation of contaminated land and is based on a number of principles, including the 'suitable for use' approach and the assessment of contamination by a risk-based approach.

6.1.5 The assessment of contamination risk is based on the 'contaminant-pathway-receptor' concept, referred to as a contaminant linkage. These terms are defined as follows:

- Contaminant – a contaminant or pollutant that is in, on or under the land and that has the potential to cause harm or pollution.
- Pathway – a route or means by which a receptor could be, or is, exposed to or affected by a contaminant.
- Receptor – in general terms, something that could be adversely affected by a contaminant, such as people, an ecological system, property, or a waterbody.

6.1.6 An important purpose of the desk study is to identify whether any potential contaminant linkages exist, together with a qualitative appraisal of their potential significance. All three components (i.e. contaminant source, pathway and receptor) must be present for there to be a viable contaminant linkage. This information is collated into a Preliminary Conceptual Site Model (PCSM), which summarises all of the potential contaminant linkages identified.

6.1.7 As part of the LCRM assessment methodology (detailed within Appendix 2), the components of the source pathway receptor linkage are identified below, prior to assessment within the PCSM in Table 6-1.

## Contaminants

6.1.8 The primary possible contaminants at the Site are considered to be:

- Potential herbicides and pesticides within the shallow soils from previous and current agricultural land use.
- Localised potential for contamination within the area of Made Ground and stockpiling adjacent to an above ground fertiliser storage tank within the Solar Array Area.
- Potential for contamination associated with the major railway line that runs through the Cable Route Corridor.
- Potential for unrecorded contamination associated with historical agricultural practices. Examples of contaminative practices can include burning (can generate ash residues enriched in contaminants), unrecorded infilling of low points / ponds, and the spreading of sewage sludge, although there is no specific record of any of these practices at the Site.
- Potential for accidental leaks and spills along road networks running across the Site and from farm vehicles and machinery.
- Potential for residual land contamination with solvents resulting from the Category 1 pollution incident listed in Table 5-1. However, it is noted that this incident took place a substantial time ago (2004) and is recorded by the Environment Agency to be ‘closed’, suggesting that remedial measures may have been undertaken to the satisfaction of the regulatory authorities at the time.
- Potential for water pollution from the Category 2 or Category 3 incidents recorded listed in Table 5-1, which relate to sewage, agricultural waste and gas and fuel oils. These incidents were all over 20 years ago and are recorded to be ‘closed’, so the likelihood of any significant residual contamination is low.
- Potential for contamination associated with the substation and wind farm developments in the south of the Cable Route Corridor. However, due to the nature and recency of these developments, the potential for them to have introduced significant soil or water contamination sources is considered to be low.
- Potential for contamination in the recorded artificial deposit of undivided Made Ground at the Solar Array Area. This appears to correlate with a rectangular (assumed manmade) water filled feature in this location and immediately adjacent land that is generally heavily vegetated. This feature was formed after 1994.
- Potential for an off-site source of ground gas, at the historical landfill approximately 670m east of the Site.
- Potential for contamination and ground gas associated with the former gravel pit within the north of the Cable Route Corridor, which encroaches into the Order Limits and is shown on historical mapping between 1906 and 1956.
- Potential for minor quantities of asbestos at / near the surface, similar to the isolated find identified during the archaeological investigations in 2023.

## Receptors

### *Human Health*

6.1.9 The potential human health receptors that may be affected are considered to be construction staff during the construction phase, maintenance staff during the operational phase and decommissioning staff during the decommissioning phase (worst case assumed to be a female adult)[2].

### *Controlled Waters*

6.1.10 The Site is underlain by various superficial Secondary aquifers. The solid strata beneath the Site are designated to be Unproductive Strata and, as such, are not considered to be a sensitive groundwater receptor. The Site is crossed by many small watercourses that run along field boundaries, and several larger drainage channels, that represent surface water receptors.

### *Structures*

6.1.11 There are permanent occupiable structures included within the Proposed Development, including the Onsite Substation within the Solar Array Area and the control building within the extension and upgrade to the Bicker Fen Substation. This structure is a possible receptor for ground gas accumulation. There is also potential for temporary occupied structures to be required for staff during the construction phase. Where concrete is used within the Solar Array Area for the permanent infrastructure (see **Chapter 2 Proposed Development (Document Ref: 6.2, ES Vol. 1, 6.2.2)**), any buried concrete, including deep foundations / piles, associated with these may be at risk from naturally occurring chemically aggressive ground conditions, noting that the Oxford Clay is a known sulphate and sulphide bearing rock.

### *Water Supply Pipes*

6.1.12 Should new potable water supply pipes be installed at the Site, these may (theoretically) be at risk from contaminant permeation should they be sited in ground that contains contaminants that can permeate certain water pipe materials. Examples of such contaminants are petroleum hydrocarbons and organic solvents.

## Pathways

6.1.13 In order for the potential contaminant sources discussed above to pose a contamination risk, a viable pathway to a receptor must exist. There are several potential pathways at the Site, which are discussed below.

### *Human Health*

6.1.14 Solar farm construction, maintenance and decommissioning staff may be exposed to contamination at the Site through accidental ingestion of contaminated soils or groundwater, dermal contact with the skin and inhalation of dust or gas/vapours. Workers and visitors on adjacent sites are also considered to be a receptor within this assessment.

### *Contaminant Leaching*

6.1.15 There is potential for contaminants to be present within the shallow soils at the Site, possibly within areas of isolated Made Ground deposits, adjacent to roads and the railway line, and surrounding the stockpile/storage area in the centre of the Solar Array Area. These contaminants may pose a risk to the shallow superficial aquifers at the Site through leaching. There is a high density of surface water features at the Site and within the surrounding area.

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[2] This assessment approach follows the methodology within Environment Agency guidance for Land Contamination Risk Management (LCRM) [Available online at: https://www.gov.uk/government/publications/land-contamination-risk-management-lcrm.

These have the potential to be negatively affected by contaminant leaching and direct runoff of contaminants.

### *Ground Gas Migration*

6.1.16 The potential ground gas sources at the Site appear to be limited to the infilled gravel pit, the potential for localised areas of Made Ground and potential natural organic matter within Alluvium. The primary pathway, therefore, would be likely to be direct vertical migration to any structures (e.g. temporary construction compounds) located directly on such deposits with a lower potential for horizontal migration e.g. through preferential pathways introduced by the cable conduits and bedding.

6.1.17 The likelihood / significance of lateral migration risk from these potential gas sources is expected to be low given their limited nature and considering the ground conditions (e.g. substantial areas of Till and Tidal Flat Deposits, which are commonly relatively clayey and have limited gas transmissivity). Similarly, the potential for the Site to be influenced by gas migration from off-site sources is considered to be low. Whilst there is a historical landfill around 670m east of the Cable Route Corridor and 1.2km south east of the Solar Array Area that may be a ground gas source, the intervening ground conditions are recorded to consist of Tidal Flat Deposits overlying mudstone and siltstone. These ground conditions typically have low gas transmissivity and, considering that the permanent manually accessible structures within the Site include the Bicker Fen Substation extension (which is over 7km from the landfill) and the Onsite Substation within the Solar Array Area (which is over 1.25km from the landfill), it is considered that there is not a possible contaminant-pathway-receptor linkage in relation to gas migration from this landfill.

## Preliminary Conceptual Site Model (PCSM)

6.1.18 The PCSM presented in Table 6-1, below, details an initial assessment of all potential contaminant linkages for the Site. The risk classifications in Table 6-1 are based on a qualitative appraisal of the information provided in this report, considering such factors as the sensitivity of the receptor, the potential severity of the consequences and the probability of contamination being present (e.g. based on the nature of the source).

6.1.19 It should be noted that risks to new below ground concrete are not included in Table 6-1 as this is primarily a routine engineering design issue and is discussed further in Section 7 of this report.

**Table 6-1: Tabulated Conceptual Site Model**

| POTENTIAL CONTAMINANT SOURCES | POTENTIAL PATHWAYS | POTENTIAL RECEPTORS | RISK CLASSIFICATION |
|---|---|---|---|
| **ONSITE SOURCES** | | | |
| 1) Potential herbicides and pesticides within the shallow soils from previous and current agricultural land use.<br>2) Potential for localised Made Ground around roads/railways and stockpiles noted during the site walkover survey, within the former gravel pit, in the area of undivided Made Ground recorded by the BGS, and from the construction and operation of the substation and wind farm.<br>3) Potential for unrecorded contamination associated with historical agricultural practices and from leaks / spills from agricultural machinery.<br>4) Potential for solvent contamination in the location of the historical Category 1 pollution incident.<br>5) Potential for contamination associated with recorded Category 2 and 3 pollution incidents.<br>6) Potential for localised / isolated occurrences of near surface asbestos.<br>The potential contaminants associated with each source type are:<br>1) Pesticides and herbicides.<br>2) Unknown, but common contaminants include metals, petroleum / diesel hydrocarbons (TPH), polycyclic aromatic hydrocarbons (PAH) and asbestos.<br>3) Unknown, but typical contaminants are as per point 2.<br>4) Organic solvents (unknown type).<br>5) Sewage and unknown agricultural waste.<br>6) Asbestos | Direct ingestion of soil and soil derived dust. Dermal contact of soil and soil derived dust. Inhalation of dust and vapours (outdoors and indoors, although indoor risk relates only to temporary construction accommodation). Direct contact and / or ingestion of surface water or groundwater contamination (not relevant to asbestos). | Human Health:<br>• Construction workers.<br>• Future site workers or visitors.<br>• Neighbouring site workers or visitors | **LOW -** The probability of contamination associated with agricultural land use (source types 1 and 3) is considered to be unlikely. In relation to source type 3, it is noted that no evidence of fuel storage, leaks or spillages were observed during the site walkover.<br>The probability of contamination associated with source type 2 is also unlikely, because the sources are not typically associated with notable contamination risks and because the area of undivided Made Ground appears largely to relate to a recent water feature. The possible exception to this is the backfilled former gravel pit. However, given that this only slightly (by around 5m) encroaches into the Site, and that it is in a location where cable installation would be by horizontal directional drilling (to cross beneath Heckington Eau) rather than trenching the risk of significant exposure to contamination (assuming standard Health & Safety compliance and use of appropriate PPE during directional drilling) is considered to be low.<br>The probability of contamination associated with source type 4 is unlikely, because the incident took place in 2004 and is recorded by the Environment Agency to be 'closed' (suggesting that satisfactory action was taken to address it).<br>The proposed land use is low sensitivity and the receptors would also benefit from suitable occupational health & safety controls (risk assessments, PPE, measures for dealing with unexpected contamination etc.) and environmental controls (dust management etc.) as is mandatory for construction projects. |
| Source types 1-5, as listed above. | Anthropogenic (man-made) pathways e.g. new foundations. Vertical and lateral migration in permeable strata. Surface water runoff. | Controlled Waters:<br>• Secondary A or Undifferentiated Aquifer (superficial deposits). | **LOW –** As above the probability of contamination sources is considered to be unlikely. The possible exception to this is the proposed trenchless methods, such as horizontal directional drilling (HDD) works that may intersect the backfilled former gravel pit close to Heckington Eau. |

| | | | |
|---|---|---|---|
| | | • Surface water including, but not limited to, Car Dyke, South Forty Foot Drain, Heckington Eau. | The groundwater sensitivity is relatively low given the nature and distribution of the aquifers. The recorded pollution incidents had minor or non-significant impacts on waters, although it is not recorded what receiving body this impact rating is based on. The surface water receptors are of higher sensitivity, provided that good environmental practice is followed during construction (e.g. leachate / run-off control, foundation works risk assessments for any piling activities etc.), construction activities would not be expected to present a significant contaminant mobilisation risk. The risk of mobilising contamination from the backfilled gravel pit during proposed trenchless methods (such as HDD works) for the cable crossing beneath Heckington Eau is considered low, because this can be dealt with through standard construction design and environmental compliance practices, e.g.:<br>• The gravel pit is on the periphery of the Site, so detailed design may mean that there is not a requirement for HDD to intersect the gravel pit (i.e. no ground disturbance).<br>• In the event that avoidance of the gravel pit was not the preferred design solution, it is expected that standard measures used to control environmental risks during HDD work (e.g. controls to prevent the loss of drilling fluid) would also be suitable to mitigate any contaminant mobilisation risk. This would be verified by ground investigations in advance of HDD works (reverting to a design avoidance solution in the unlikely event that severe contamination was present that could not be managed through standard controls). This process would be secured and implemented under to outline Construction Code of Practice. |
| Source types 1 to 4, as above. | Permeation of contaminants into water supply pipes. | Human Health:<br>• Consumption of drinking water from pipes affected by contaminant permeation. | **LOW -** The probability of a source of contaminants that present a pipe permeation risk is generally considered to be unlikely at the Site.<br>It is a mandatory design requirement for all new drinking water pipes to be designed having regard to the ground conditions, including consideration and assessment of ground contamination risks. Where this identifies potential risks, these can be avoided through standard design measures (e.g. use of barrier pipe). |
| Source types 2 and 3 above. Potential for localised, limited made ground deposits that may have a gas generation potential.<br>Additionally: 5) Potential for ground gas generation by natural superficial deposits with a high organic matter content (e.g. Alluvium, Tidal Flat Deposits). | Vertical ground gas migration into structures and / or lateral migration, resulting in explosion or asphyxiation. | Buildings and Human Health:<br>• Explosions and / or asphyxiation in buildings or other enclosed spaces. | **LOW -** Potential gas sources are limited in extent and at present are largely hypothetical / precautionary (i.e. rather than known / likely sources of substantial gas generation). The exception to this is the recorded gravel pit on the western boundary of the Cable Route Corridor, which was recorded on historical mapping and is assumed to have been backfilled with unknown materials. This feature is located within the north of the Cable Route Corridor and not in |

| | | | |
|---|---|---|---|
| | | | proximity to either the Onsite Substation within the Solar Array Area or the existing Bicker Fen substation, where enclosed spaces may allow for gas accumulation. It has been assumed that any temporary structures would be modular with adequate ventilation and therefore low risk from ground gas accumulation. There is also potential for gas generation by natural superficial deposits (e.g. Alluvium and Tidal Flat deposits) which underlie much of the Solar Array Area and Cable Route Corridor.<br>The only permanent occupiable structures within the development are the control building within the existing substation upgrade within the south of the Cable Route Corridor and the new Onsite Substation within the Solar Array Area. However, as discussed above, the potential for ground gas generation is low with no confirmed viable source. The temporary construction buildings are also typically of a form that minimises the risk of ground gas ingress e.g. temporary modular buildings. |
| **OFFSITE SOURCES** | | | |
| Potential contamination associated with adjacent agricultural activities and leaks/spills within adjacent roads, and possible Made Ground around roads and railways. | Direct ingestion soil derived dust blown onto Site. Dermal contact of soil derived dust blown on to Site. Inhalation of fugitive dust and vapours (outdoors). Inhalation of asphyxiating gases and volatile vapours (outdoors). | Human Health:<br>• Construction workers.<br>• Future site workers or visitors. | **VERY LOW**<br>Localised areas of potential contamination may occur e.g. in the location of the previous solvent spill. However, this is located c. 25 m south of the Cable Route Corridor so is not expected to be a viable source for the exposure pathways considered and it is also assumed that some level of clean up was enacted at the time to close the incident from a regulatory perspective. The incident was recorded as Category 4 (No Impact) in relation to water, so it is considered that there is a very low risk that contaminants from this incident have migrated onto the site through groundwater with potential to migrate onto Site and affect receptors via inhalation of vapours.<br>Whilst the potential for additional contamination cannot be discounted, it is considered within this assessment to be unlikely. The receptors at the Site would also benefit from suitable occupational health & safety controls (risk assessments, PPE, measures for dealing with unexpected contamination etc.). |
| | • Anthropogenic (man-made) pathways<br>• Vertical and lateral migration in permeable strata<br>• Surface water runoff | **Controlled Waters**<br>• Secondary A or Undifferentiated Aquifer (superficial deposits)<br>• Surface water including, but not limited to, Car Dyke, South Forty Foot Drain, Heckington Eau. | **LOW -** The Site is connected to a network of surface drains that may be affected by agricultural run-off / contaminants from off-Site sources, which in turn could then enter the Site. However, this can be considered a ubiquitous ‘background’ risk for an agricultural area and, in the absence of any specific recorded point contamination sources on adjacent land or potable surface water abstractions at the Site, the risk to surface water is classified as low.<br>Similarly, risks to the relatively low sensitivity shallow groundwater from off-site sources are classified as low. |

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# 7. PRELIMINARY GEOTECHNICAL CONSTRAINTS

7.1.1 A preliminary assessment of the potential geotechnical constraints is presented, below, on the basis of the available information. This section of the report should be read with regard to the limitations described in Section 1.

## Ground Conditions

7.1.2 The ground conditions at the Site are summarised within Tables 3-1 and 3-2, but are generally similar across the Solar Array Area, the Cable Route Corridor and Bespoke Access Corridor. There are recorded variable superficial deposits across the entire Site which are both cohesive and granular nature. The solid strata are recorded to comprise the Oxford Clay Formation or mudstones of the West Walton Formation.

## Topography

7.1.3 The Site as a whole appears to be relatively flat lying and comprises open agricultural fields with drainage ditches, roadways and hedgerows/treelines bordering field parcels.

## Foundations

7.1.4 The nature of the Proposed Development at the Site is such that foundations are only likely to be required in the Solar Array Area, associated with the BESS and Onsite Substation and for the control building within the substation extension and upgrade in the southeast of the Cable Route Corridor, although the design for this structure has not yet been confirmed. In line with the scope and limitations in Section 1, this report does not provide any appraisal of the likely suitable foundations for the structures at the Solar Array Area. The geo-environmental assessments provided in Section 6 are intended to be flexible to cover any foundations technique.

## Geohazards

7.1.5 The BGS Geohazards data sets indicate an elevated risk of compressible ground and shrink swell clays within the Solar Array Area, Cable Route Corridor and Bespoke Access Corridor. The potential for compressible deposits, shrink-swell clays, and the variable superficial deposits may present various geotechnical constraints, which should be considered by the geotechnical designer. Although not expected to be widespread, should Made Ground deposits be encountered, these are also likely to present a geotechnical constraint requiring consideration.

## Earthworks

7.1.6 Although the Site is relatively flat, it is understood that some form of earthworks may be required as part of the construction activities associated with the Proposed Development. Any earthworks will need to account for such issues as the likely variable composition of the shallow soils, localised risks of running sands, (very) high water table, the potential for high moisture content in earthworks material, and the potential for elevated sulphate / sulphide concentrations.

## Services

7.1.7 Due regard to the presence of existing services will be made during the design and construction of the Proposed Development. In particular, the south of the Site (i.e. within the Cable Route Corridor) contains various services and apparatus due to the presence of a substation and wind farm. Planning for the detailed design around existing services will be undertaken at the detailed design stage, as appropriate. The Principal Contractor will be responsible for ensuring any works adjacent to existing buried services during construction will be undertaken in accordance with best working practices, guidance and regulations, as described within **Appendix 2.4 Outline CEMP (Document Reference: 6.3 ES Volume 2, 6.3.7)**.

7.1.8 The Cable Route Corridor will connect the services from the Solar Array Area to the Bicker Fen Substation. The Cable Route will have to cross such features as roadways (Howell Fen Drove, Littleworth Drove, A17, Great Hale Drove, Carterplot Road, Timm's Drove, North Drove, Bicker Drove, Vicarage Drove, Doubletwelves Drove and unnamed access tracks), watercourses (Head Dike, Car Dyke, Great Hale Eau, South Forty Foot Drain, and small unnamed surface water features/drainage ditches) and the railway line along its path. Where services pass under roads and railways, etc., vertical drilling stand-offs (if trenchless techniques are used) or compaction (if trenching is used) should be designed to be suitably protective of both the existing and proposed infrastructure (e.g. in respect of ground settlement).

## Buried Structures

7.1.9 As discussed within Section 2 of this report, based on the review of the historical mapping at the Site and the lack of any historical built development, the risk of encountering significant buried structures is considered to be low.

## Excavations

7.1.10 Excavations will be required within the construction phase of the Proposed Development to allow for construction of foundations, to carry out earthworks and to install the cable route in the Cable Route Corridor. The shallow soils at the Site are likely to be variable in nature and, therefore, have the potential to comprise a mixture of cohesive and granular soils. It is considered possible that unsupported excavations may be prone to stability issues, including running sands where identified by the BGS geohazards data set.

## Controlled Waters

7.1.11 The hydrological setting of the Site is such that a significant number of surface water features are present both on and surrounding the Site. As the land is relatively flat-lying and close in elevation to these features, it is expected that groundwater is likely to be present at shallow depths beneath the Site. Any excavations, therefore, may be susceptible to flooding if left open for any length of time. Dewatering measures will be incorporated into the construction phase should they be required.

### Concrete Attack

7.1.12 Parts of the Site are recorded to be underlain by solid strata of the Oxford Clay Formation, which is a noted sulphate and sulphide bearing rock type. Additionally, there is the potential for elevated sulphate and sulphide concentrations in any Made Ground that may be present in the superficial deposits and in the other solid strata that are mapped to be present. Standard design procedures should be followed, including appropriate testing and risk assessment relative to the foundations and earthworks design to ensure that suitable chemical resistant concrete (and, if necessary, other associated protection measures) are incorporated into the design.

# 8. CONCLUSIONS AND RECOMMENDATIONS

8.1.1 This desk study report has summarised the available information and potential risks for the proposed development at the Site. The Site is considered to present an overall low risk from past land use, surrounding land use, ground instability and contamination.

8.1.2 Information obtained as part of the desk-based review indicates that the Site has been generally free from built development throughout its history. The Site has generally been used for agricultural purposes from the earliest available mapping, with the main previous land use being a historical gravel pit that marginally encroaches into the Cable Route Corridor (now backfilled), and recent substation and wind farm developments in the south. Roads / tracks cross the Site in several places and a railway line crosses through the centre of the Cable Route Corridor. The land surrounding the Site in all directions generally comprises similar land uses of agricultural and limited residential areas.

8.1.3 The information sources reviewed indicate the likely sources of potential contamination to be agricultural activities and the possibility of isolated areas of Made Ground, including within the historical gravel pit in the north of the Cable Route Corridor.

8.1.4 The PCSM indicates a low risk to receptors, considering the nature of the identified potential sources, the sensitivity of the receptors and the probability of a viable source-pathway-receptor linkage being present.

8.1.5 Significant contamination is not expected at the Site. Therefore, it is currently anticipated that any contamination risks at the Site would be adequately addressed by the adoption of best working practices in-line with standard construction environmental management and occupational health procedures to ensure that construction does not cause an unacceptable contamination risk and that any unexpected contamination encountered during construction is correctly addressed.

8.1.6 It is anticipated that a geotechnical ground investigation will be carried out for design purposes. It is recommended that this investigation incorporates contamination testing of the soils, informed by the findings of the desk study, to provide verification of the preliminary qualitative risk assessments in this desk study.

8.1.7 Overall, it is concluded that, in terms of potential contamination risks, the Site is likely to be suitable for the Proposed Development. No potential significant risks / effects have been identified that would require assessment through the preparation of an ES chapter. Provided that the following standard development procedures are carried out as part of the Proposed Development, it is considered that the identified low risks will be adequately addressed via:

- Environmental management (dust, leachate, surface water quality etc.) in accordance with **Appendix 2.4 Outline Construction Environmental Management Plan (OCEMP) (Document Ref: 6.3, ES Vol.2, 6.3.7)**;

- Occupational health & safety management in accordance with relevant legislation;
- Contamination testing to be carried out as a matter of completeness during geotechnical design investigations, informed by the findings of this desk study;
- Inspection of the ground at the location of the previous isolated asbestos find prior to any construction works in this area. This should be carried out by a suitably qualified asbestos professional to verify the absence of asbestos prior to works commencing in this location; and
- Maintenance of a watching brief across the Site for any further localised occurrences of asbestos containing material during any pre-construction or construction work that involves ground disturbance. This should be carried out in accordance with the OCEMP and, in the event that suspected asbestos is identified, the Control of Asbestos Regulations 2012.

8.1.8 There are potential geotechnical constraints at the Site, including those associated with the likelihood of variable shallow soils, high groundwater levels and sulphate / sulphides. These issues are common constraints and can be addressed through routine geotechnical design good practice.

# BFEP Appendices

# Appendix 1 Wardell Armstrong Standard Terms and Conditions and Limitations

## Appendix 1

## Standard Terms and Conditions and Limitations to Desk Study Reports

## STANDARD TERMS AND CONDITIONS AND LIMITATIONS TO REPORTS

1. This Report is provided for the stated purpose and for the sole use of the client in accordance with the Terms and Conditions of Appointment under which the services were performed. The Report is confidential to the client and no other warranty, expressed or implied, is made as to the professional advice included in the Report or any other services provided by Wardell Armstrong LLP. This Report may not be disclosed by the Client nor relied upon by any other party without the prior and express written agreement of Wardell Armstrong LLP.

2. This report has been prepared by Wardell Armstrong LLP with all reasonable skill, care and diligence, within the terms of the Contract with the Client. The report is confidential to the Client and Wardell Armstrong LLP accepts no responsibility of whatever nature to third parties to whom this report may be made known. No part of this document may be reproduced without the prior written approval of Wardell Armstrong LLP.

3. Should any third party wish to use or rely upon the contents of this report, written approval must be sought, and a charge may be levied accordingly.

4. The Executive Summary forms part of the overall report and should not be considered in isolation.

5. The report does not constitute or contain a valuation nor is it a full rigorous environmental audit. In this instance the report is prepared for the reasons outlined within the report only, inclusive of the intended use of the Site.

6. The findings outlined in the Report together with any opinions expressed and recommendations made are considered to be valid and appropriate at the time of preparation and for the specific purpose or purposes intended. Wardell Armstrong LLP will not be liable if any findings are used by third parties, without written agreement of the company, or if an interpretation is made and action taken without further consultation.

7. Whilst a walkover Site visit may have been carried out as part of the work this has been limited to observations only, in areas that were made available for inspection. Where any site observations have been carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results from any site observations made may vary and further confirmatory work should be made after the issuance of this Report. The walkover survey does not constitute an asbestos survey.

8. No physical investigations, sampling and testing work has been carried out as part of this work unless explicated stated.

9. The methodology adopted and the sources of information used by Wardell Armstrong LLP in providing the services are outlined in this Report. The work described in this Report is based on the conditions and information as stated at the date the Report was completed. The scope of this Report and the services are accordingly limited by these circumstances.

10. The conclusions and recommendations contained in this Report are based upon information provided by others including details supplied by the client and/or professional advisors on the assumption that all relevant information from whom it has been requested and/or supplied is accurate. The information has been accepted and used in good faith and unless otherwise stated, no attempt has been made to verify the information supplied. Should any of these factors or information change then the conclusions of the report may need to be amended.

11. It should be noted that any risks identified in a Preliminary Risk Assessment (Contamination and Geotechnical) are perceived risks based on the information reviewed. Actual risks can only be assessed following a physical investigation of the Site.

12. The report does not include any information pertinent to other disciplines, where specialists should be consulted.

13. Wardell Armstrong LLP disclaim any undertaking or obligation to advise any person of any change in any matter affecting the Report which may come or be brought to Wardell Armstrong LLP's attention after the date of the Report. Unless otherwise stated in this Report, the assessments made assume that the Site and facilities will continue to be used for their current purpose without significant changes.

# Appendix 2 Guidance on Contamination Assessment

# Appendix 2

# Guidance on Contamination Assessment

## CONTAMINATION

### Environmental Protection Act – Part IIA

Contaminated Land was defined for the first time under Part IIA of the Environmental Protection Act 1990. Part IIA was inserted into the 1990 Act by section 57 of the Environment Act 1995. The regime came into effect in England on 1 April 2000, Scotland on 12 July 2000 and Wales on 15 September 2001.

Contaminated Land is defined as "any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

(a) significant harm is being caused or there is a significant possibility of such harm being caused; or

(b) significant pollution of the water environment is being caused or there is a significant possibility of such pollution being caused."

Harm is described in the EPA 1990 as being *"harm to the health of living organisms or other interference with ecological systems of which they form part and, in the case of man, includes harm to his property".*

There are a number of important government policies and priorities underlying the Act. The first priority is to prevent the creation of new contamination by use of this Act and other controls such as Environmental Permitting (formerly regulated by Integrated Pollution Prevention and Control and Waste Management licensing). The second is to identify and remove unacceptable risks to human health and the environment. In addition there is a desire to bring Contaminated Land back into beneficial use whilst seeking to ensure that the cost burdens faced by individuals, companies and society as a whole are proportionate, manageable and economically sustainable.

Under Part IIA, Local Authorities are responsible for the inspection of Contaminated Land and for ensuring that remediation is undertaken where necessary. Local Authorities also maintain a Public Register detailing the regulatory actions that they have implemented. The Environment Agency has a complementary role and act as the enforcing Authority for designated special sites.

The policy objectives are underlain by the "suitable for use" approach to the remediation of Contaminated Land, which the Government considers is the most appropriate approach to achieving sustainable development. This approach recognises that the risks presented by any given level of contamination will vary greatly on a site by site basis.

In general, the responsibility for paying for remediation will, where feasible, follow the "polluter pays" principle. In the first instance, any person who caused or knowingly permitted the contaminating substance to be in, or under the Land will be the appropriate person(s) to undertake the remediation and meet its costs. If it is not possible to find such a person, responsibility will pass to the current owner or occupier of the Land.

**Planning Regime**

Land contamination, or the possibility of it, is a material consideration for the purposes of town and country planning. This means that the planning authority has to consider the potential implications of contamination both when it is developing structure or local plans and when it is considering individual applications for planning permission. Under the suitable for use approach, risks should be assessed and remediation requirements set, on the basis of both the current use and its proposed new use.

The planning policy varies by country, with the National Planning Policy Framework (NPPF) in England, the National Planning Framework (NPF) in Scotland, Planning Policy Wales, and the Strategy Planning Policy Statement in Northern Ireland. These planning policies outline government policies against which local plans are made for housing and other developments. There are also a number of local planning policies.

**Land Contamination Risk Management - LCRM**

*Guidance on Contaminated Land Risk Assessment*

In the UK, Contaminated Land is regulated by the planning and development control system and the contaminated land regime set out in Part IIA of the Environmental Protection Act (EPA) 1990.

When considering an application for development, the potential for the land to be contaminated is a material consideration, and the local planning authority should satisfy itself that any contamination is properly assessed and adequately remediated, based on a suitable for use approach. This is to ensure that the land is made suitable for its proposed new use.

The Environment Agency's (EA) Land Contamination Risk Management (LCRM) is the basis of contaminated land risk assessment in England, Wales, and Northern Ireland. It follows a three tier system of risk assessment (Preliminary Risk Assessment, Generic Quantitative Risk Assessment, and Detailed Quantitative Risk Assessment) prior to undertaking an options appraisal and remediation.

Guidance on the investigation of contamination is contained in British Standard 10175: 2011 (+A2-2017) "*Investigation of potentially contaminated sites - Code of Practice*". It involves an identification of risks due to the presence of contaminants, and an assessment of those risks based on the:

- possible sources of contamination;
- identification of who or what may be affected by the contaminants (the receptors);
- possible pathways by which contaminants may migrate to one or more of the receptors.

A conceptual site model (CSM) is a representation of the environmental processes that occur on and in the vicinity of the Site and its purpose is to identify the potential contamination linkages that exist on the Site. The assessment of the significance of these contamination linkages can then be carried out through the risk assessment process.

A CSM is a representation of the environmental processes that occur on and in the vicinity of the Site and its purpose is to identify the potential contamination linkages that exist on the site. The assessment of the significance of these contamination linkages can then be carried out through the risk assessment process.

Since the CSM underpins each stage of Contaminated Land management, BS10175: 2011 (+A2-2017) suggests that such a model should be developed for every Site. The CSM is an iterative process of all relevant and available information, including outlining any uncertainties that may be present. Accordingly, the results of the desk study research on the Site are used to identify the source- pathway-receptor relationships (contaminant linkages) that exist on the Site before and during redevelopment works. During the iterations brought about by obtaining more data (e.g. from site investigation), these identified contaminant linkages are refined and confirmed to enable mitigation (remediation).

In line with the guidance of BS21365:2020 “Soil quality – Conceptual Site Models for potentially contaminated sites” and LCRM, the CSM can be presented in different ways, such as: written description of the Site; tabular or matrix description; and/or drawing or diagrammatic illustration, where the complexity of the model should be consistent with the complexity of the Site.

**Environmental Risk Assessment Methodology**

In line with EA guidance, LCRM, plausible source, pathway and receptor linkages are identified through the CSM, considering all feasible changes (e.g. as a result of the development, or climate change). The information gathered in the CSM can be used to carry out a Qualitative Risk Assessment (QRA).

The LCRM outlines that for each tier of Risk Assessment the following steps must be taken:

1. Identify the hazard - establish contaminant sources.
2. Assess the hazard - use a source-pathway-receptor (S-P-R) linkage approach to find out if there is the potential for unacceptable risk.
3. Estimate the risk - predict what degree of harm or pollution might result and how likely it is to occur by using the tiered approach to risk assessment.
4. Evaluate the risk - decide whether a risk is unacceptable.

The LCRM states that the assessment must be based on the potential severity that the risk poses to the receptors against the likelihood of it happening. Subsequently, it is necessary to employ a risk assessment matrix. The CIRIA document *Contaminated Land Risk Assessment – a guide to good practice C552*, 2001 provides a good example of a suitable risk assessment matrices.

In the CIRIA methodology, the sensitivity assessment considers the contaminant-pathway-receptor in conjunction with the contamination linkage concept (described below). This information is then used to classify consequences and the probability of a contamination linkage occurring, affording the level of sensitivity of a given receptor to be established.

*Contamination Linkage Concept*

In forming a risk assessment for land contamination, there are three essential elements to be given consideration collectively known as a ‘contaminant linkage’:

- A contaminant/source – A substance that is in, on or under the land and has potential to cause harm or to cause pollution of controlled waters.
- A receptor – in general terms, something that could be adversely affected by a contaminant, these can include people, an ecological system, property or a water body; and
- A pathway – a route or means by which a receptor can be exposed to or affected by a contaminant.

Each of these elements can exist independently, but they create a risk where they are linked together, so that a particular contaminant affects a particular receptor through a particular pathway. This kind of linked combination of contaminant-pathway-receptor is described as a contaminant linkage.

*Sensitivity Assessment Criteria*

By considering the contaminant, pathways and receptors, an assessment of the environmental risk is made with reference to the degree of sensitivity of the receptor to a contaminant.

The qualitative sensitivity assessment is conducted by determining the severity of the potential consequences, taking into account the probability of risk and by considering the sensitivity of the receptor based on the categories below. It follows CIRIA documents C552 terminology and methodology as summarised:

| Potential Consequences | X | Probability of Risk | = | Risk Classification |
|---|---|---|---|---|
| (Table 1) | X | (Table 2) | = | (Table 3a) |

Table 1 presents the consequences to the receptor of the contaminant linkage being realised. It has four categories, with severe being the most serious and minor being the least serious consequences:

| Table 1 – Consequence of Risk Being Realised | | | |
|---|---|---|---|
| **Classification** | **Category** | **Definition** | **Examples (Not specific to this Site)** |
| **Severe**<br><br>short-term (acute) risks only | Humans | Short-term (acute) risk to human health likely to result in “significant harm” as defined by the Environment Protection Act 1990, Part 2A. | High concentrations of cyanide on the surface of an informal recreation area. |
| | Controlled Waters | Short-term risk of pollution (note: Water Resources Act 1991 contains no scope for considering significance of pollution) of sensitive water resource. | Major spillage of contaminants from site into controlled water. |
| | Property | Catastrophic damage to buildings/property. | Explosion causing building collapse (can also equate to a short-term human health risk if buildings are occupied. |
| | Ecological System | A short-term risk to a particular ecosystem, or organism forming part of such ecosystem. | |
| **Medium**<br><br>chronic (long term) risks; “significant harm” | Humans | Chronic damage to Human Health. | Concentrations of a contaminant from site exceed the generic, or site-specific assessment criteria |
| | Controlled Waters | Pollution of sensitive water resources (note: Water Resources Act contains no scope for considering significance of pollution). | Leaching of contaminants from a site into a major or minor aquifer. |
| | Ecological System | A significant change in a particular ecosystem. | Death of a species within a designated nature reserve. |

| Table 1 – Consequence of Risk Being Realised | | | |
|---|---|---|---|
| **Classification** | **Category** | **Definition** | **Examples (Not specific to this Site)** |
| **Mild**<br><br>chronic (long term) risks; fewer sensitive receptors | Controlled Waters | Pollution of non-sensitive water resources. | Pollution of non-classified groundwater |
| | Property | Significant damage to buildings, structures and services. Damage to sensitive buildings/structures/services | Damage to building rendering it unsafe to occupy (e.g., foundation damage resulting in instability) |
| | Ecological System | Significant damage to crops. Damage to the environment. | |
| **Minor**<br><br>chronic (long term) risks; mild | Financial / project | Harm, although not necessarily significant harm, which may result in a financial loss, or expenditure to resolve. | |
| | Humans | Non-permanent health effects to human health (easily prevented by means such as personal protective clothing, etc). | The presence of contaminants at such concentrations that protective equipment is required during site works. |
| | Property | Easily repairable effects of damage to buildings, structures and services | The loss of plants in a landscaping scheme. Discolouration of concrete. |

The likelihood of the pollution linkage being realised must take into account the presence of the source and position of the receptor as well as the pathway that connects them. Table 2 defines the likelihood of the pollution linkage occurring.

| TABLE 2: Probability of Risk Being Realised | |
|---|---|
| **Classification** | **Definition** |
| **High Likelihood** | There is a contaminant linkage and an event that either appears very likely in the short term and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution. |
| **Likely** | There is a contaminant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term. |
| **Low Likelihood** | There is a contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term. |
| **Unlikely** | There is a contaminant linkage, but circumstances are such that it is improbable that an event would occur even in the very long term. |

The potential consequences and the probability of the risk occurring are combined to form the classification of sensitivity matrix, as presented in Table 3a below. It provides a sensitivity category for potential receptors if a pollution linkage exists, allowing the level of sensitivity of a receptor in a particular circumstance can be determined.

| TABLE 3a: Risk Classification Matrix |
|---|

| TABLE 3a: Risk Classification Matrix | | | | | |
|---|---|---|---|---|---|
| | | Consequence | | | |
| | | Severe | Medium | Mild | Minor |
| Probability | High Likelihood | Very High | High | Moderate | Moderate/Low |
| | Likely | High | Moderate | Moderate/Low | Low |
| | Low Likelihood | Moderate | Moderate/Low | Low | Very Low |
| | Unlikely | Moderate/Low | Low | Very Low | Very Low |

| TABLE 3b: Risk Classification Definitions | |
|---|---|
| **Very High** | There is a high probability that severe harm could arise to a designated receptor from an identified hazard, OR there is evidence that severe harm to a designated receptor is currently happening. This risk, if realised, is likely to result in a substantial liability. Urgent investigation (if not undertaken already) and remediation are likely to be required. |
| **High** | Harm is likely to arise to a designated receptor from an identified hazard. Realisation of the risk is likely to present a substantial liability. Urgent investigation (if not undertaken already) is required and remedial works may be necessary in the short term and are likely over the longer term. |
| **Moderate** | It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that such harm would be severe, or if any harm were to occur it is more likely that the harm would be relatively mild. Investigation (if not already undertaken) is normally required to clarify the risk and to determine the potential liability. Some remedial works may be required in the longer term. |
| **Moderate / Low** | A notable balance between moderate and low categorisation. The moderate/low interface. |
| **Low** | It is possible that harm could arise to a designated receptor from an identified hazard, but it is likely that this harm, if realised, would at worst normally be mild. |
| **Very Low** | There is a low possibility that harm could arise to a receptor. In the event of such harm being realised it is not likely to be severe. |

Under each of the contaminant linkage categories, the identified environmental risks have been assessed with regard to a wide range of topics including (where appropriate):

- the 'source-pathway-receptor' concept;
- the behaviour of potential contaminants within the environment;
- environmental processes;
- industrial operations and best practice;
- current environmental legislation;
- the views and practices of the environmental regulators;
- the likelihood of environmental notices, orders or other enforcement action;
- any requirements to remove waste, contaminated or hazardous materials;
- the health and safety of occupiers or neighbours;
- any redevelopment plans for the site; and
- effects on the fabric of buildings caused by contamination.

# Appendix 3 Walkover Photographs

**Appendix 3: Site Walkover Photographs 6 July 2023**

Figure 1. View of footpath showing overgrown drainage ditch and wooded area.

Figure 2. Desiccation cracks within footpaths.

Figure 3. View across field parcel showing the nature of current crops.

Figure 4. View along access track through the centre of the Solar Array Area running east to west.


Figure 5. View across field parcel showing nature of vegetation/crops present.


Figure 6. View across a recently ploughed field, showing the flat and homogenous landscape.

Figure 9. Flint gravel and fossils identified within the topsoil along a footpath.

Figure 8. View looking across field parcels showing footpath and height of trees in wooded areas.

Figure 9. View across the centre of the Site, showing the nature of crops and wooded areas.

Figure 10. Showing a gated access point into the north of the Site suitable for vehicles.

Figure 11. View across the Site looking southeast showing overgrown vegetation and open land.

Figure 12. View looking east along the access track in the centre of the Solar Array Area, showing the storage tank.


Figure 13. Chemical labels on the above ground storage tank in the centre of the Solar Array Area.

Figure 14. Gravel stockpile in the south of the Solar Array Area.

Figure 15. Waste and rubble stockpile in the centre of the Solar Array Area.

Figure 16. Scrap metal stored in the centre of the Solar Array Area.

Figure 17. View from the access track looking across the Site.

Figure 18. Area of hardstanding in the south of the Solar Array Area.

Figure 19. Stockpile in the south of the Solar Array Area on the hardstanding in Figure 18.

Figure 20. View across a grass covered access track showing tall crops and vegetation.

Figure 21. View across converging access tracks within the north of the Solar Array Area, looking south.

Figure 22. View looking out over field parcel in the centre of the Solar Array Area showing height of vegetation.

# Appendix 4 Laboratory Geochemical Testing Certificates

Unit 7-8 Hawarden Business Park
Manor Road (off Manor Lane)
Hawarden
Deeside
CH5 3US
Tel: (01244) [redacted]
email: [redacted]
Website: [redacted]

Wardell Armstrong LLP
Sir Henry Doulton House
Forge Lane
Etruria
Stoke on Trent
Staffordshire
ST1 5BD

**Attention:** Sam Jones

# CERTIFICATE OF ANALYSIS

| | |
|---|---|
| **Date of report Generation:** | 15 December 2023 |
| **Customer:** | Wardell Armstrong LLP |
| **Sample Delivery Group (SDG):** | 231209-65 |
| **Your Reference:** | ST20560 |
| **Location:** | Beacon Fen |
| **Report No:** | 714661 |
| **Order Number:** | |

We received 2 samples on Saturday December 09, 2023 and 2 of these samples were scheduled for analysis which was completed on Friday December 15, 2023. Accredited laboratory tests are defined within the report, but opinions, interpretations and on-site data expressed herein are outside the scope of ISO 17025 accreditation.

Should this report require incorporation into client reports, it must be used in its entirety and not simply with the data sections alone.

Chemical testing (unless subcontracted) performed at ALS Laboratories (UK) Limited Hawarden.

All sample data is provided by the customer. The reported results relate to the sample supplied, and on the basis that this data is correct.
Incorrect sampling dates and/or sample information will affect the validity of results.
The customer is not permitted to reproduce this report except in full without the approval of the laboratory.

Approved By:

[redacted]

Operations Manager

1291

# Received Sample Overview

| Lab Sample No(s) | Customer Sample Ref. | AGS Ref. | Depth (m) | Sampled Date |
|---|---|---|---|---|
| 29078349 | N18-171 | | 0.50 - 1.00 | 08/12/2023 |
| 29078352 | N19-boundary | | 0.00 - 0.00 | 08/12/2023 |

**Only received samples which have had analysis scheduled will be shown on the following pages.**

# CERTIFICATE OF ANALYSIS

**SDG:** 231209-65 **Report Number:** 714661 **Superseded Report:**
**Client Ref.:** ST20560 **Location:** Beacon Fen

**Results Legend**

X Test

N No Determination Possible

Sample Types -
S - Soil/Solid
UNS - Unspecified Solid
GW - Ground Water
SW - Surface Water
LE - Land Leachate
PL - Prepared Leachate
PR - Process Water
SA - Saline Water
TE - Trade Effluent
TS - Treated Sewage
US - Untreated Sewage
RE - Recreational Water
DW - Drinking Water Non-regulatory
UNL - Unspecified Liquid
SL - Sludge
G - Gas
OTH - Other

| | | | | |
|---|---|---|---|---|
| Lab Sample No(s) | | | 29078349 | 29078352 |
| Customer Sample Reference | | | N18-171 | N19-boundary |
| AGS Reference | | | | |
| Depth (m) | | | 0.50 - 1.00 | 0.00 - 0.00 |
| Container | | | 1kg TUB with Handle (ALE260) | 1kg TUB with Handle (ALE260) |
| Sample Type | | | S | S |
| Asbestos Identification | All | NDPs: 0 Tests: 2 | X | X |

16:15:53 15/12/2023

# Asbestos Identification - Bulk (Overview)

Customer Sample Ref.: N18-171 - 0.50 - 1.00 - SOLID - 08/12/2023 00:00:00 09/12/2023 07:00:00 - 231209-65 - 29078349 - TM048

| | | | | | |
|---|---|---|---|---|---|
| Chrysotile White : | Not Detected | (#) | Asbestos Tremolite : | Not Detected | (#) |
| Amosite Brown : | Not Detected | (#) | Asbestos Actinolite : | Not Detected | (#) |
| Crocidolite Blue : | Not Detected | (#) | Trace Asbestos : | Not Detected | |
| Asbestos Anthrophyllite : | Not Detected | (#) | Non-Asbestos Fibre : | Detected | |

Customer Sample Ref.: N19-boundary - 0.00 - 0.00 - SOLID - 08/12/2023 00:00:00 09/12/2023 07:00:00 - 231209-65 - 29078352 - TM048

| | | | | | |
|---|---|---|---|---|---|
| Chrysotile White : | Detected | (#) | Asbestos Tremolite : | Not Detected | (#) |
| Amosite Brown : | Not Detected | (#) | Asbestos Actinolite : | Not Detected | (#) |
| Crocidolite Blue : | Not Detected | (#) | Trace Asbestos : | Not Detected | |
| Asbestos Anthrophyllite : | Not Detected | (#) | Non-Asbestos Fibre : | Not Detected | |

# Asbestos Identification - Bulk

**Results Legend**

| | |
|---|---|
| # | ISO17025 accredited. |
| M | *m*CERTS accredited. |
| * | Subcontracted test. |
| (F) | Trigger breach confirmed |
| 1-5&♦§@ | Sample deviation (see appendix) |

| | | Date of Analysis | Comments | Analyst Name | Asbestos Detected | Homogenous | Non-asbestos fibre |
|---|---|---|---|---|---|---|---|
| Cust. Sample Ref.<br>Depth (m)<br>Sample Type<br>Date Sampled<br>Date Receieved<br>SDG<br>Original Sample<br>Method Number | N18-171<br>0.50 - 1.00<br>SOLID<br>08/12/2023 00:00:00<br>09/12/2023 07:00:00<br>231209-65<br>29078349<br>TM048 | 15/12/2023 | - | Odhran McLernon | Asbestos Not Detected (#) | Yes | Detected |
| Cust. Sample Ref.<br>Depth (m)<br>Sample Type<br>Date Sampled<br>Date Receieved<br>SDG<br>Original Sample<br>Method Number | N19-boundary<br>0.00 - 0.00<br>SOLID<br>08/12/2023 00:00:00<br>09/12/2023 07:00:00<br>231209-65<br>29078352<br>TM048 | 15/12/2023 | ACM typical of asbestos cement | Odhran McLernon | Chrysotile (#) | Yes | Detected |

# Table of Results - Appendix

| Method No | Description |
|---|---|
| TM048 | Identification of Asbestos in Bulk Material |

NA = not applicable.

Chemical testing (unless subcontracted) performed at ALS Laboratories (UK) Limited Hawarden (Method codes TM).

# Test Completion Dates

| | | |
|---|---|---|
| Lab Sample No(s) | 29078349 | 29078352 |
| Customer Sample Ref. | N18-171 | N19-boundary |
| AGS Ref. | | |
| Depth | 0.50 - 1.00 | 0.00 - 0.00 |
| Type | Soil/Solid (S) | Soil/Solid (S) |
| Asbestos Identification | 15-Dec-2023 | 15-Dec-2023 |

# Appendix General

1. Results are expressed on a dry weight basis (dried at 35ºC) for all soil analyses except for the following: NRA and CEN Leach tests, flash point LOI, pH, ammonium as NH4 by the BRE method, VOC TICs and SVOC TICs.

2. If sufficient sample is received a sub sample will be retained free of charge for 15 days after analysis is completed (e-mailed) for all sample types unless the sample is destroyed on testing. The prepared soil sub sample that is analysed for asbestos will be retained for a period of 6 months after the analysis date. All bulk samples will be retained for a period of 6 months after the analysis date. All samples received and not scheduled will be disposed of 15 days after the date of receipt unless we are instructed to the contrary. Once the initial period has expired, a storage charge will be applied for each month or part thereof until the client cancels the request for sample storage. ALS reserve the right to charge for samples received and stored but not analysed.

3. With respect to turnaround, we will always endeavour to meet client requirements wherever possible, but turnaround times cannot be absolutely guaranteed due to so many variables beyond our control.

4. We take responsibility for any test performed by sub-contractors (marked with an asterisk). We endeavour to use UKAS/MCERTS Accredited Laboratories, who either complete a quality questionnaire or are audited by ourselves. For some determinands there are no UKAS/MCERTS Accredited Laboratories, in this instance a laboratory with a known track record will be utilised.

5. If no separate volatile sample is supplied by the client, or if a headspace or sediment is present in the volatile sample, the integrity of the data may be compromised. This will be flagged up as an invalid VOC on the test schedule and the result marked as deviating on the test certificate.

6. NDP - No determination possible due to insufficient/unsuitable sample.

7. Results relate only to the items tested.

8. LoDs (Limit of Detection) for wet tests reported on a dry weight basis are not corrected for moisture content.

9. **Surrogate recoveries** - Surrogates are added to your sample to monitor recovery of the test requested. A % recovery is reported, results are not corrected for the recovery measured. Typical recoveries for organics tests are 70-130%. Recoveries in soils are affected by organic rich or clay rich matrices. Waters can be affected by remediation fluids or high amounts of sediment. Test results are only ever reported if all of the associated quality checks pass; it is assumed that all recoveries outside of the values above are due to matrix affect.

10. Stones/debris are not routinely removed. We always endeavour to take a representative sub sample from the received sample.

11. In certain circumstances the method detection limit may be elevated due to the sample being outside the calibration range. Other factors that may contribute to this include possible interferences. In both cases the sample would be diluted which would cause the method detection limit to be raised.

12. For dried and crushed preparations of soils volatile loss may occur e.g volatile mercury

13. For leachate preparations other than Zero Headspace Extraction (ZHE) volatile loss may occur.

14. For the BSEN 12457-3 two batch process to allow the cumulative release to be calculated, the volume of the leachate produced is measured and filtered for all tests. We therefore cannot carry out any unfiltered analysis. The tests affected include volatiles GCFID/GCMS and all subcontracted analysis.

15. Analysis and identification of specific compounds using GCFID is by retention time only, and we routinely calibrate and quantify for benzene, toluene, ethylbenzenes and xylenes (BTEX). For total volatiles in the C5-C12 range, the total area of the chromatogram is integrated and expressed as ug/kg or ug/l. Although this analysis is commonly used for the quantification of gasoline range organics (GRO), the system will also detect other compounds such as chlorinated solvents, and this may lead to a falsely high result with respect to hydrocarbons only. It is not possible to specifically identify these non-hydrocarbons, as standards are not routinely run for any other compounds, and for more definitive identification, volatiles by GCMS should be utilised.

16. We are accredited to MCERTS for sand, clay and loam/topsoil, or any of these materials - whether these are derived from naturally occurring soil profiles, or from fill/made ground, as long as these materials constitute the major part of the sample. Other coarse granular material such as concrete, gravel and brick are not accredited if they comprise the major part of the sample.

17 Data retention. All records, communications and reports pertaining to the analysis are archived for seven years from the date of issue of the final report.

18. **Tentatively Identified Compounds (TICs)** are non-target peaks in VOC and SVOC analysis. All non-target peaks detected with a concentration above the LoD are subjected to a mass spectral library search. Non-target peaks with a library search confidence of >75% are reported based on the best mass spectral library match. When a non-target peak with a library search confidence of <75% is detected it is reported as “mixed hydrocarbons”. Non-target compounds identified from the scan data are semi-quantified relative to one of the deuterated internal standards, under the same chromatographic conditions as the target compounds. This result is reported as a semi-quantitative value and reported as Tentatively Identified Compounds (TICs). TICs are outside the scope of UKAS accreditation and are not moisture corrected.

19. **Sample Deviations**

If a sample is classed as deviated then the associated results may be compromised.

| | |
|---|---|
| 1 | **Container with Headspace provided for volatiles analysis** |
| 2 | **Incorrect container received** |
| 3 | **Deviation from method** |
| 4 | **Matrix interference** |
| ♦ | **Sample holding time exceeded in laboratory** |
| @ | **Sample holding time exceeded due to late arrival of instructions or samples** |
| § | **Sampled on date not provided** |

20. **Asbestos**

When requested, the individual sub sample scheduled will be analysed in house for the presence of asbestos fibres and asbestos containing material by our documented in house method TM048 based on HSG 248 (2021), which is accredited to ISO17025. If a specific asbestos fibre type is not found this will be reported as “Not detected”. If no asbestos fibre types are found all will be reported as “Not detected” and the sub sample analysed deemed to be clear of asbestos. If an asbestos fibre type is found it will be reported as detected (for each fibre type found). Testing can be carried out on asbestos positive samples, but, due to Health and Safety considerations, may be replaced by alternative tests or reported as No Determination Possible (NDP). The quantity of asbestos present is not determined unless specifically requested.

**Identification of Asbestos in Bulk Materials & Soils**

The results for identification of asbestos in bulk materials and soils are obtained from supplied bulk materials andd soils which have been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining, based on HSG 248 (2021).

The results for identification of asbestos in soils are obtained from a homogenised sub sample which has been examined to determine the presence of asbestos fibres using ALS (Hawarden) in-house method of transmitted/polarised light microscopy and central stop dispersion staining.

| Asbestos Type | Common Name |
|---|---|
| Chrysotile | White Asbestos |
| Amosite | Brown Asbestos |
| Crocidolite | Blue Asbestos |
| Fibrous Actinolite | - |
| Fibrous Anthophyllite | - |
| Fibrous Tremolite | - |

**Visual Estimation Of Fibre Content**

Estimation of fibre content is not permitted as part of our UKAS accredited test other than: - Trace - Where only one or two asbestos fibres were identified.

**Respirable Fibres**

Respirable fibres are defined as fibres of <3 µm diameter, longer than 5 µm and with aspect ratios of at least 3:1 that can be inhaled into the lower regions of the lung and are generally acknowledged to be most important predictor of hazard and risk for cancers of the lung.

**Further guidance on typical asbestos fibre content of manufactured products can be found in HSG 264.**

**The identification of asbestos containing materials and soils falls within our schedule of tests for which we hold UKAS accreditation, however opinions, interpretations and all other information contained in the report are outside the scope of UKAS accreditation.**

# Appendix 5 Igne Detailed Unexploded Ordnance Risk Assessment

# Detailed Unexploded Ordnance Risk Assessment

LCS117 Beacon Fen

9974 RA





Unit 3, The Courtyard Campus Way, Gillingham Business Park, Gillingham, Kent, ME8 0NZ

This Report has been produced in compliance with the Construction Industry Research and Information Association guidelines for the preparation of Detailed Unexploded Ordnance Risk Assessments in the management of UXO risks in the construction industry. This report has been compiled using all due diligence and expertise and having made all proper but reasonable enquiries within given time limitations. However, in accepting and implementing the recommendations contained in this report, the client does so strictly at his own risk.

## Distribution

| Version | Format | Recipient | Author | Review | Authorisation | Date |
|---|---|---|---|---|---|---|
| 1.0 | PDF Copy | Low Carbon | OA | CK | NB | 06/12/23 |

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## Report Summary

| Project Site Information | | | | | |
|---|---|---|---|---|---|
| **Project site address** | Ewerby Fen, Ewerby and Evedon, North Kesteven, Lincolnshire, NG34 9PU | | | | |
| **NGR Centre Point** | TF 14684 47722 (Northern Section)<br>TF 18243 42685 (Centre Section)<br>TF 19709 38563 (Southern Section) | | | | |
| **Scope of proposed works** | Proposed works are expected to include the construction of a solar farm site. The proposed depths of the works are expected to be approximately 3-5m bgl. | | | | |
| **Overall Risk Rating** | **Low** | | | | |
| **Summary of Risk Ratings** | | | | | |
| **Hazard** | **Average Depth of Hazard** | **pE** | **cD** | **Risk Analysis (pE x cD)** | **Risk Rating** |
| HE | <12m bgl[1] | 1 | 5 | 5 | Low |
| IB | <1m bgl | 1 | 4 | 4 | Low |
| AA | <5m bgl | 1 | 3 | 3 | Low |
| LSA | <2m bgl | 1 | 4 | 4 | Low |
| SAA | <1m bgl | 1 | 2 | 2 | Low |
| Practice | <1m bgl | 2 | 2 | 4 | Low |
| **Recommended Mitigation Measures** | | | | | |
| **Proposed Works** | **Risk Mitigation Recommendation** | | | | |
| All | • Site Specific Explosive Ordnance Safety and Awareness Briefings (UXO Toolbox Briefing) to all personnel conducting intrusive works<br>• Site Specific Safety Instructions (SSSI) Training Course | | | | |

In accordance with CIRIA guidelines this assessment has carried out research, analysed the evidence and considered the likelihood that the site has been contaminated with unexploded ordnance; that such items remained on site; the risk that they could be encountered during any intrusive works and the consequences that could result. Appropriate risk mitigation measures have been proposed.

[1] See Section 7.6. A site-specific maximum bomb penetration depth is assumed between 10-12m below WWII ground level.

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## Figures



## Appendices

## Glossary of Terms

| | |
|---|---|
| AAA | Anti-Aircraft Artillery |
| ALARP | As Low As Reasonably Practicable |
| AP | Anti-Personnel |
| ARP | Air-raid Precautions |
| BDO | Bomb Disposal Officer |
| BPD | Bomb Penetration Depth |
| EOD | Explosive Ordnance Disposal (current term for “bomb” disposal) |
| HAA | Heavy Anti-Aircraft |
| HE | High Explosive |
| HG | Home Guard |
| IB | Incendiary Bomb |
| LAA | Light Anti-Aircraft |
| LM | Land Mine |
| LSA | Land Service Ammunition (includes grenades, mortars, etc.) |
| Luftwaffe | German Air Force |
| m bgl | Metres Below Ground Level |
| MoD | Ministry of Defence |
| NGR | National Grid Reference |
| OB | Oil Bomb |
| PM | Parachute Mine |
| RAF | Royal Air Force |
| SI | Site Investigation |
| SAA | Small Arms Ammunition (small calibre cartridges used in rifles & machine guns) |
| UXB | Unexploded Bomb |
| UXO | Unexploded Ordnance |
| V-1 | “Doodlebug” the first cruise type missile, used against London from June 1944. Also known as ‘Flying Bomb’ |
| V-2 | The first ballistic missile, used against London from September 1944 |
| WWI | First World War (1914 -1918) |
| WWII | Second World War (1939 – 1945) |

# Detailed Unexploded Ordnance Risk Assessment

**In respect of**

## LCS117 Beacon Fen

## 1. Introduction

Low Carbon ("The client") has commissioned Igne to conduct a Detailed Unexploded Ordnance Risk Assessment of LCS117 Beacon Fen ("the site").

Unexploded Ordnance (UXO) poses significant risks to UK construction projects due to past conflicts and military activity. Buried unexploded air-dropped bombs and anti-aircraft projectiles, with an estimated failure rate of 10%, can be found at various depths depending on their characteristics and the ground conditions. Furthermore, it is estimated that over 20% of the UK land mass has been utilised by the military.

Despite efforts to locate and render safe UXO, ongoing discoveries during construction-related ground works continue to occur.

Increased risk awareness and proactive safety measures have reduced the risk to personnel. However, even the discovery of a suspected device can disrupt production and lead to delays and expenses. Site-specific risk understanding and appropriate mitigation measures can help address these risks effectively.

## 2. Construction Industry Duties and Responsibilities

### 2.1 The UK Regulatory Environment

The construction industry is not legally required to control and mitigate UXO risk. However, CIRIA (C681): Unexploded Ordnance (UXO) A Guide for the Construction Industry provides guidelines for good practice and information on managing UXO risk. These guidelines include a process for risk assessment and implementation of site-specific mitigation strategies. While these is no specific legislation for UXO risk, health and safety regulations address the responsibility of the construction industry to protect workers engaged in ground-intrusive operations from foreseeable UXO risks.

### 2.2 The Health and Safety at Work Act, 1974

The Act places a duty of care on an employer to put in place safe systems of work to address, as far as is reasonably practicable, all risks (to employees and the general public) that are reasonably foreseeable.

### 2.3 Construction (Design and Management) Regulations 2015

CDM 2015 ensures that health and safety within the construction industry is continually improved:

- Works are sensibly planned and managed.
- Competent staff are engaged in the works.

- Risks are identified and managed.
- All parties cooperate and coordinate activities.
- Communication flows to those who require it.
- Workers are consulted and engaged about risks and how they are being managed.

In line with CDM 2015 legislation, Igne are able to assist parties in their discharge of CDM duties as follows:

- Assist Principal Designers with pre-construction information and risk assessments.
- Assist the Designer with the Designer's Risk Assessment.
- Issue UXO risks as have been identified and manage risks accordingly.
- Assist the Principal Contractor with the construction phase information, in particular risk assessments and mitigation strategies.
- Plan, manage and monitor survey and clearance works under Igne's control.

### 2.4 Other Legislation

Other relevant legislation includes the "Management of Health and Safety at Work Regulations 1999" and "The Corporate Manslaughter and Corporate Homicide Act 2007".

## 3. The Role of the Authorities and Commercial Contractors

### 3.1 The Authorities

The Police coordinate emergency services in ordnance-related incidents on construction sites. They assess the risk and may establish a safety cordon, evacuate the area, and contact the military authorities (JSEODOC – Joint Services Explosive Ordnance Disposal Operations Centre) for investigation or disposal. If no EOD specialist is present, the Police impose precautions and away JSEODOC advice.

The response time from JSEODOC depends on the assessed risk and resource availability. They may remove or dispose of the ordnance on site if deemed necessary, potentially requiring additional cordons and evacuations. In routine cases, JSEODOC may not treat each occurrence as an emergency and may advise the construction company to engage a commercial contractor for managing the situation and reducing pressure on JSEOD disposal teams.

### 3.2 Commercial Contractors

In addition to pre-construction site surveys and follow-on clearance work, a commercial contractor is able to provide a reactive service on construction sites. The presence of a qualified EOD Engineer with ordnance recognition skills will avoid unnecessary callouts to the authorities and the contractor will be able to arrange for the removal and disposal of low-risk ordnance. If high risk ordnance is discovered actions will be co-ordinated with the authorities with the objective of causing the minimum possible disruption to site operations whilst putting immediate, safe and appropriate measures in place.

# 4. This Report

## 4.1 Aims and Objectives

The aim of this report is to examine the probability of encountering and detonating any explosive ordnance during any intrusive works at the site. Risk mitigation measures will be recommended in line with the CIRIA C681 guidelines, to reduce the risk of detonating UXO, and the subsequent risk of harm / damage during the envisaged works to as low as reasonably practicable (ALARP).

This report is a live document and should be updated if any new information comes to light after issue.

## 4.2 Risk Assessment Methodology

The following issues will be addressed in the report:

- The probability that the site was contaminated with unexploded ordnance.
- The probability that unexploded ordnance remains on site.
- The probability that ordnance may be encountered during any intrusive works.
- The probability that ordnance may be detonated.
- The consequences of detonating or encountering ordnance.

Risk mitigation measures, appropriate to the assessed level of risk and site conditions, will be recommended.

## 4.3 Approach

In preparing this Unexploded Ordnance Risk assessment, Igne has considered general and, as far as possible, site-specific factors including:

- Evidence of German bombing and delivery of UXBs.
- Site history, occupancy and conditions during WWII.
- The legacy of Allied military activity.
- Details of any known EOD clearance activity.
- The extent of any post war redevelopment.
- Scope of the current proposed works.

## 4.4 Sources of Information

Igne has carried out detailed historical research for this Unexploded Ordnance Risk Assessment including accessing military records and archived material held in the public domain and in the MoD.

Material from a range of sources has been consulted, including but not limited to:

- The National Archives.
- National Library of Scotland (NLS).
- Relevant information supplied by the client.
- Igne's extensive archives built up over many years of research and hands-on Explosive Ordnance Disposal activities in the UK.
- Open sources such as published books, local historical records and the internet.

## 4.5 Reliability of Historical Records

### 4.5.1 General Considerations

This report is based upon research of historical evidence. Whilst every effort has been made to locate all relevant material Igne cannot be held responsible for any changes to the assessed level of risk or risk mitigation measures based on documentation or other information that may come to light at a later date.

The accuracy and comprehensiveness of wartime records is frequently difficult or impossible to verify. As a result, conclusions as to the exact location, quantity and nature of the ordnance risk can never be definitive but must be based on the accumulation and careful analysis of all accessible evidence. Igne cannot be held responsible for inaccuracies or gaps in the available historical information.

### 4.5.2 Bombing Records

During WWII, considerable efforts were expended in recording enemy air raids. Air Raid Precautions (ARP) wardens were responsible for making records of bomb strikes either through direct observation or by post-raid surveys. However, their immediate priority was to deal with casualties and limit damage, so it is to be expected that records are often incomplete and sometimes contradictory. Record keeping in the early days of bombing was not comprehensive and details of bombing in the early part of the war were sometimes destroyed in subsequent attacks. Some reports may cover a single attack, others a period of months or the entire war.

Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are not always reliable; records of attacks on military or strategic targets were often maintained separately from the general records and have not always survived.

# 5. The Site and Scope of Proposed Works

Details for the site and the proposed works are presented in the following table.

| | | |
|---|---|---|
| **Site Address** | Ewerby Fen, Ewerby and Evedon, North Kesteven, Lincolnshire, NG34 9PU | |
| **OS National Grid Reference** | TF 14684 47722 (Northern Section)<br>TF 18243 42685 (Centre Section)<br>TF 19709 38563 (Southern Section) | |
| **Site Description** | The site encompasses a route from the south of Drayton to Howell, across largely agricultural open-ground with some small structures interspersed throughout, as well as multiple drainage systems and a railway line. The southern section is occupied by a substation and its associated features. | |
| **Proposed Works** | Proposed works are expected to include the construction of a solar farm site. The proposed depths of the works are expected to be approximately 3-5m bgl. | |
| **References** | Site Location Maps | Figure 1.0 |
| | Recent Aerial Photograph | Figure 2.0 |

# 6. WWII Site Conditions

Available mapping and photography were sought for the site, in order to assess site conditions pre, during and post-wartime.

## 6.1 Pre and Post-WWII OS Mapping

The following historic OS mapping for the site was obtained and reviewed.

| | Date | Observations | Reference | Source |
|---|---|---|---|---|
| **Pre-WWII** | 1888-1913 | • The site encompasses rural agricultural fields. A small number of developments are present on the site, likely agricultural ancillary buildings. | Open Source.[2] | National Library of Scotland |
| **Post-WWII** | 1949-72 | • The site conditions mirror those presented in the current day- open-agricultural land, interspersed by drains.<br>• No clear signs of clearance or redevelopment indicative of bomb damage are evident across the site.<br>• However, due to the small scale of the mapping, an accurate assessment is difficult to make at this time. | Open source.[3] | |

## 6.2 WWII-era RAF Aerial Photography

No following WWII-era aerial photography could be obtained within the timeframe of this report.

2 [redacted]

3 [redacted]

# 7. The Threat from Aerial Bombing

## 7.1 General Bombing History of Lincolnshire

### 7.1.1 First World War

During WWI, Leicestershire, Nottinghamshire, and Lincolnshire were targeted and bombed by Zeppelin Airships. However as British defensive measures became more effective the German military were forced to cease these attacks before switching to daylight raids by fixed wing aircraft in June 1917.

A WWI bomb census map (not annexed) indicates that HE bombs were dropped in the East Midlands area. However, due to the poor scale of the map the exact locations of bombing in relation to the site cannot be accurately assessed.

WWI bombs were generally smaller than those used in WWII and were dropped from a lower altitude, resulting in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons, there is a limited risk that UXBs passed undiscovered. When combined with the relative infrequency of attacks and an overall low bombing density the risk from WWI UXBs is considered low and will not be further addressed in this report.

### 7.1.2 Second World War

At the start of WWII, the Luftwaffe planned to destroy key military installations, including RAF airfields and Royal Navy bases, during a series of daylight bombing raids. After the Battle of Britain these tactics were modified to include both economic and industrial sites. Targets included dock facilities, railway infrastructure, power stations, weapon manufacturing plants and gas works. As a result of aircraft losses, daylight raids were reduced in favour of attacking targets under the cover of darkness.

As the war progressed, the strategy changed to one of attempting to destroy the morale of the civilian population by the “carpet bombing” of major towns and cities. By May 1941, concentrated attacks ceased as the Luftwaffe was diverted east to prepare for ‘Operation Barbarossa’, the invasion of the Soviet Union.

During 1940 and the first half of 1941, the county of Lincolnshire was bombed on average between 13 and 15 days out of each month. This included the town of Folkingham, which suffered a number of minor raids. This bombing campaign largely came to an end in May 1941 as the Luftwaffe was diverted east to prepare for ‘Operation Barbarossa’ (the invasion of the Soviet Union).

After this period, small scale ‘nuisance’ raids would continue in the county throughout the next few years. Consequently, the site will have been vulnerable to ‘Tip and Run’ bombing incidents. These occurred when an enemy aircraft, under heavy AA fire or fighter interception would prematurely and indiscriminately jettison its bomb load in order to evade these defences, before returning to base. These apparently random bombing incidents also occurred when Luftwaffe pilots became disorientated over enemy territory and would instead jettison their bomb load on the most viable target nearby, such as railway lines.

January of 1942 was the first month since the beginning of The Battle of Britain, where no bombs were dropped on Lincolnshire, however minor attacks carried on through this year and into 1943 and 1944. By this time, the Luftwaffe was a lot weaker in northern France and consequently bombing raids over Lincolnshire were virtually non-existent.

Note, Lincolnshire was predominantly agricultural in nature and was thought of as an ideal area for bombing practice, to the point where it became known as ‘Bomber County’. At its peak there were over 50 British and American operational airfields in the county, with the majority of them sending bombers over occupied Europe.

## 7.2 Generic Types of WWII German Air-delivered Ordnance

The nature and characteristics of the ordnance used by the Luftwaffe allows an informed assessment of the hazards posed by any unexploded items that may remain today.

| | |
|---|---|
| **HE Bombs** | In terms of weight of ordnance dropped, HE bombs were the most frequent weapon deployed. Most bombs were 50kg, 250kg or 500kg (overall weight, about half of which was the high explosive) though large bombs of up to 2,000kg were also used. HE bombs had the weight, velocity and shape to easily penetrate the ground intact if they failed to explode. Post-raid surveys would not always have spotted the entry hole or other indications that a bomb penetrated the ground and failed to explode, and contemporary ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded 50kg bomb. Unexploded HE bombs therefore present the greatest risk to present–day intrusive works. |
| **Blast Bombs / Parachute Mines** | Blast bombs generally had a slow rate of descent and were extremely unlikely to have penetrated the ground. Non-retarded mines would have shattered on most ground types if they had failed to explode. There have been extreme cases when these items have been found unexploded, but this was where the ground was either very soft or where standing water had reduced the impact. Igne does not consider there to be a significant risk from this type of munition on land. |
| **Large incendiary bombs** | This type of bomb ranged in size from 36kg to 255kg and had a number of inflammable fill materials (including oil and white phosphorus), and a small explosive charge. They were designed to explode and burn close to the surface, but their shape and weight meant that they did have penetration capability. If they penetrated the ground, complete combustion did not always occur, and, in such cases, they remain a risk to intrusive works. |
| **1kg Incendiary Bombs (IB)** | These bombs, which were jettisoned from air-dropped containers, were just over 30cm in size and therefore highly likely to go unnoticed. They had the potential to penetrate soft ground and left a very small entry hole. Furthermore, if bombs did not initiate and fell in water or dense vegetation or became mixed with rubble in bomb damaged areas, they could have remained hidden to this day. Some variants had explosive heads, and these present a risk of detonation during intrusive works, particularly due to their shape, which leads them to often be misidentified. |
| **Anti-personnel (AP) Bomblets** | AP bombs had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble. |
| **Specialist Bombs (smoke, flare, etc)** | These types do not contain high explosive and therefore a detonation consequence is unlikely. They were not designed to penetrate the ground. |
| **Examples of the most commonly deployed German bombs are presented at Appendix 1.** | |

## 7.3 Second World War Bombing Statistics

The following table summarises the quantity of German bombs (excluding 1kg incendiaries and anti-personnel bombs) falling on the Rural District of East Kesteven between 1940 and 1945.

| Record of Ordnance Dropped on the Rural District of East Kesteven | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Area Acreage | HE bombs (all) | Para-chute Mines | Oil Bombs | Phos. Bombs | Fire Pots | V1 | V2 | Total | Items per 1000 acres |
| 123,406 | 296 | 2 | 2 | - | - | - | - | 300 | **2.4** |

*Source: Home Office Statistics*

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record.

Although the incendiaries are not particularly significant in the risk they pose, they nevertheless are items of ordnance that were designed to cause damage and inflict injury and should not be overlooked in assessing the general risk to personnel and equipment. The anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous.

## 7.4 Site Specific WWII Bombing Records

### 7.4.1 Original ARP Bombing Incident Records

Throughout WWII, records of bombing incidents were kept by the ARP and Civil Defence Office. These records were kept in the form of typed or hand-written notes and/or presented on bomb plot maps. Some other organisations, such as port authorities and railways, maintained separate records. None covering the site could be found within the timeframe of this report.

### 7.4.2 Home Office Intelligence Reports

The Home Office Intelligence reports document enemy action on British domestic soil and were prepared twice a day for the Home Security War Room. The summaries were prepared by intelligence staff, who compiled reports received from the twelve civil defence regions.

However, available records only document time and general location of attack and numbers of casualties. The intelligence officials generally only recorded locations on municipal level (town, village, or city), rarely providing specific addresses.

| Date | Location | Details |
|---|---|---|
| 30 – 31/03/1941 | Swineshead | Night raid – 0 casualties recorded. |
| 07 – 08/08/1941 | Swineshead | Night raid – 0 casualties recorded. |
| 03/08/1942 | Helpringham | Day raid – 11 casualties were recorded. |

### 7.4.3 Secondary Source / Anecdotal Evidence

Anecdotal evidence of local bombing incidents was sought from publications and web resources. No references to incidents on site or in the surrounding area were found.

### 7.4.4 Bombing Decoy Sites

In July 1940, a national decoy authority led by Colonel John Fisher Turner was established. Urban lighting decoys, known as “Civil” sites, were set up following earlier experiments in Glasgow and Sheffield. These sites, designated as “QL” for urban lighting simulation and “QF” for dummy fires, used electrical and pyrotechnical apparatus to imitate various sources of light and flare. Additional sites simulated small fired caused by incendiary bombs, including special “SF” sites known as “Starfish” sites that attracted enemy bombers away from populated areas and defence installations. Decoy sites were quite successful, with airfield decoys receiving 359 attacks compared to 358 attacks on real airfields by the end of 1941.

| | |
|---|---|
| **A bombing decoy site was established in close proximity to the site** | ✗ |
| **Distance from site** | 3km north-west |

### 7.4.5 Abandoned Bombs

After an air raid, a survey would be conducted to search for bomb entry holes. If evidence was found, Bomb Disposal Officer teams would be called to locate and dispose of the bomb. However, sometimes UXBs were discovered but could not be accessed or rendered safe due to various reasons. These incidents could be recorded as Abandoned Bombs. Due to inaccurate records and the nature of these abandoned bombs, their locations are not definitive, and the lists may not be exhaustive. The MoD would only take action to make the devices safe if they were deemed unstable. It should be noted that aside from officially abandoned bombs, there may be unrecorded UXBs.

| | |
|---|---|
| **Igne holds records of officially registered abandoned bombs at or near the site** | ✓ |
| **Additional Comments** | A 50/250kg HE bomb was recorded as abandoned in a field in Bicker Bar, approximately 1.1km to the south of the site. |

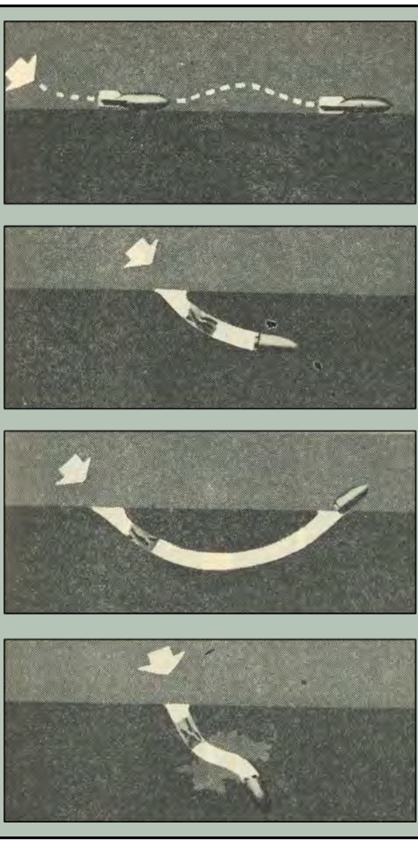
## 7.5 UXB Ground Penetration

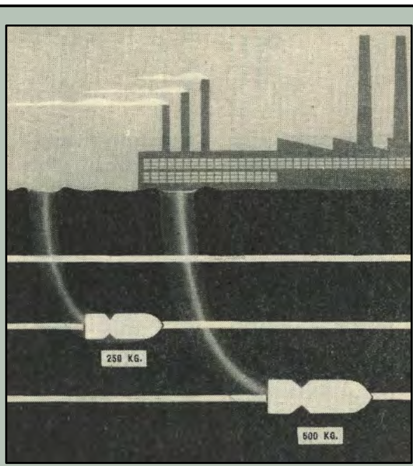
### 7.5.1 General Considerations

The depth bombs penetrate the ground depends on factors such as their mass, shape, velocity, angle of impact, and the characteristics of the ground cover. Softer ground allows for greater penetration, with peat, alluvium and soft clays being easier to penetrate compared to gravel and sand. Bedrock or large boulders can bring bombs to a stop or cause deflection.

### 7.5.2 The “J” Curve Effect

When an air-dropped bomb is released from a normal bombing altitude (approximately 5,000m), it can reach a terminal velocity of 350-400 ms-1. The bomb enters the earth at an angle or approximately 15° from the perpendicular, making its exact path hard to trace. As the bomb travels through the ground, it undergoes an upward curve due to energy transfer. The slower nose of the bomb experiences more drag/friction compared to the faster-moving rear. This causes the bomb's location to be offset from the entry hole. The offset is generally one-third of the penetration depth but can reach up to 15m (50') depending on ground conditions and the bomb's angle of impact. The J-Curve effect illustrated below demonstrates not UXBs can come to rest beneath undamaged buildings in homogeneous ground.






A UXB can come to rest beneath undamaged buildings due to the J-Curve effect if it lands in nearby soft ground.

Image source: *Field Manual for Unexploded Bombs: Organisation and Operation For Disposal, United States War Department 1943*

**Left: Path of UXB in soft ground:**

1. Ricochet resulting from low level attack: UXB stays perpendicular to ground and rests at surface.
2. Buried UXB with J-Curve: Bomb curves horizontally and rests perpendicular to surface.
3. UXB returning to surface due to J-Curve: Bomb points towards surface but may remain partially or completely below ground level.

### 7.5.3 Second World War Bomb Penetration Studies

During WWII, the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by Bomb Disposal, mostly in the London area. They then came to conclusions as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

The table below presents the maximum and average penetration depths observed during this survey. Note, the table includes the most commonly dropped HE bomb sizes, from 50kg to 1000kg.

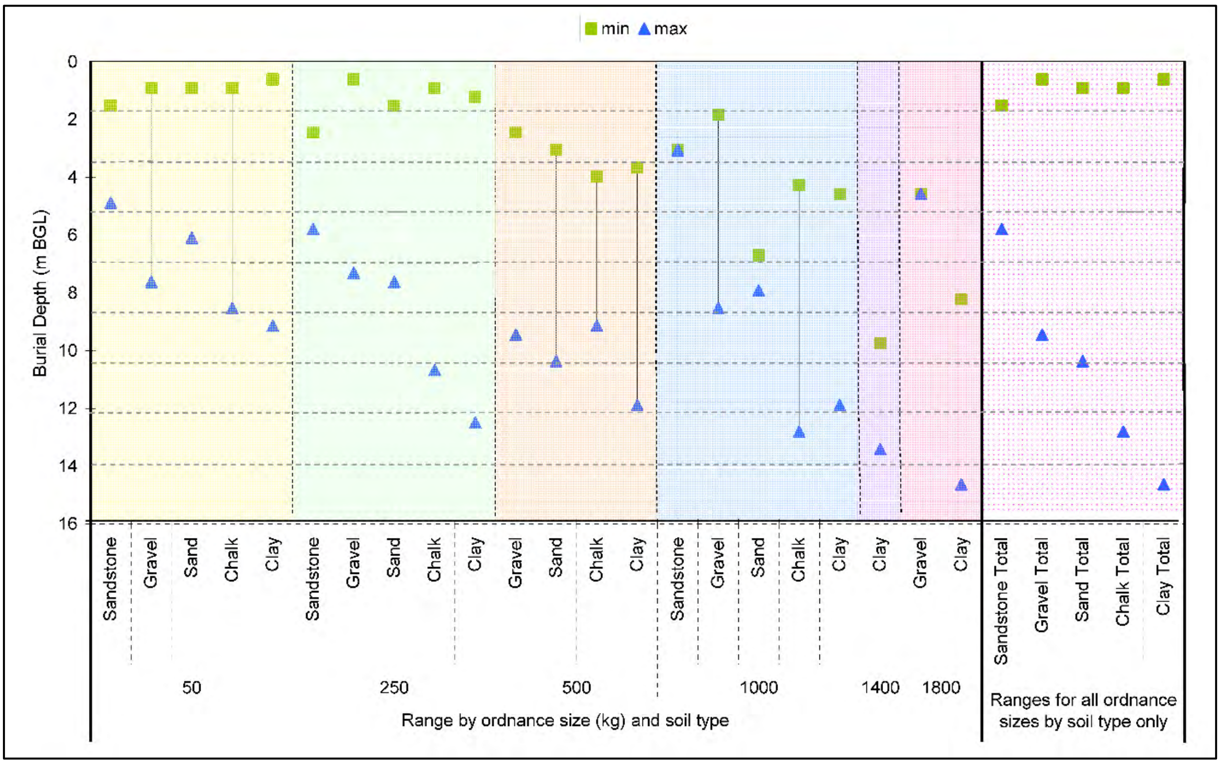
| | | Bomb penetration depth | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Av. | Max. | Av. | Max. | Av. | Max. | Av. |
| HE bomb size | | 50kg | | 250kg | | 500kg | | 1000kg | |
| Ground Type | Sandstone | 6.1m | 2.7m | 10.4m | 4.6m | 13.1m | 5.8m | 16.5m | 7.3m |
| | Gravel | 7.8m | 2.8m | 13.7m | 4.8m | 17.3m | 6.0m | 21.9m | 7.6m |
| | Sand | 7.8m | 2.8m | 13.7m | 4.8m | 17.3m | 6.0m | 21.9m | 7.6m |
| | Chalk | 7.7m | 3.5m | 13.1m | 6.0m | 16.4m | 7.6m | 20.7m | 9.6m |
| | Clay | 9.1m | 4.0m | 15.8m | 6.8m | 19.8m | 8.7m | 24.9m | 10.9m |

Note, theoretical calculations suggested that significantly greater penetration depths were probable.

### 7.5.4 CIRIA Bomb Penetration Depth Specifications

As stated within C681, the ground conditions at any individual site are likely to be highly variable and this results in a large range of burial depths for each different size bomb.

The chart to below shows the observed variation in burial depths of various sizes of air-delivered UXO for different ground conditions.



#### 7.5.5 Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site, the following parameters would be used:

<table>
<tr><th>Parameter</th><th colspan="3">Details</th></tr>
<tr><td rowspan="6">Geology</td><td rowspan="4">British Geological Survey Borehole</td><td>Borehole Reference</td><td>TF14NW3</td></tr>
<tr><td>Location</td><td>Northern extent, near Howell.</td></tr>
<tr><td>Date</td><td>Unknown.</td></tr>
<tr><td>Recorded Shallow Geology</td><td>• 72.4m – CLAY.</td></tr>
<tr><td rowspan="2">British Geological Survey Mapping</td><td>Superficial Deposits</td><td>Detailed mapping of the geology can be found in Figure 3.<br>• Tidal Flat Deposits – Clay and Silt.<br>• Sand and Gravel (unknown) – Sand and Gravel.<br>• Till, Mid Pleistocene – Diamicton.<br>• Alluvium – Clay, Silt, Sand, and Gravel.<br>• Sleaford Sand and Gravel – Sand and Gravel.<br>• Glaciofluvial Ice Contact Deposits – Sand and Gravel.</td></tr>
<tr><td>Bedrock</td><td>• Oxford Clay Formation – Mudstone.<br>• West Walton Formation – Mudstone and Siltstone.</td></tr>
<tr><td>Impact Angle and Velocity</td><td colspan="3">80-90° from horizontal and 267 metres per second</td></tr>
<tr><td>Bomb Mass and Configuration</td><td colspan="3">The 500kg SC (General Purpose) HE bomb, without retarder units or armour piercing nose. This was the largest of the common bombs used against Britain.</td></tr>
</table>

#### 7.5.6 Deductions

Based on WWII-era studies, a 500kg bomb could have penetrated up to approximately 19.8m below ground level (bgl), with an average depth of around 8.7m bgl. However, considering the varied strata and limited data, it is estimated that the bomb's maximum bomb penetration depth (BPD) during that era was likely between 10-12m bgl, as per CIRIA guidelines.

The current ground level should be evaluated to determine its impact on the BPD. If the UXB is larger, the BPD could potentially be greater, although only 4% of German bombs used in WWII over Britian were of that size.

UXBs can be found at any depth between just below WWII ground level and the maximum BPD. It should be noted that ground conditions can vary significantly on site, and these guidelines may change once on-site conditions are assessed prior to any necessary mitigation works.

## 7.6 Likelihood of Post-Raid UXO Detection

Utilising the available historical bombing records as reviewed in Section 7.4, it is possible to make an assessment of the likelihood that evidence of UXO would have been noted on a site during the war and the incident dealt with or recorded at the time. Factors such as bombing density, frequency of access, ground cover, damage and failure rate have been taken into consideration.

| Factor | General Considerations | Site Specific Considerations |
|---|---|---|
| **Density of bombing** | Bombing density impacts the likelihood of UXBs remaining in an area. A high density of bombs increases the chance of record-keeping errors, due to overwhelmed civil defence and emergency response personnel. It also raises the total number of actual UXBs in a given area. The type and location of recorded bomb strikes are significant factors. If a stick of bombs is plotted in line with or straddling a side, it suggests the possibility of an unrecorded UXB from the same stick hitting that site. | • Low bombing density.<br>• Bombs recorded to have landed at surrounding towns in the wider area.<br>• Abandoned bomb recorded in Bicker, approximately 1.1km to the south of the site. |
| **Bomb damage** | In Blitzed cities and towns across Britain, bomb sites were often left uncleared until after the war. Mid-war repairs were focused on vital facilities, while buildings with upper floor damage had their ground floor damage reported and dealt with at the time. HE bomb strikes on open ground created visible craters and soil disturbance. Subsequent UXB strikes in disturbed ground would go unnoticed without identifiable entry holes. The German V1 and V2 campaigns caused widespread devastation in London and south-east England. However, damage from these weapons does not necessarily indicate increased risk of Luftwaffe freefall UXB contamination, as they were used after significant Luftwaffe air raids. Damage from earlier Luftwaffe raids may have been erased by subsequent V weapon strikes. | • Due to a lack of aerial photography, an accurate assessment of the ground conditions and therefore the extent of any possible bomb damage cannot be made. |
| **Ground conditions** | The entry hole of a 50kg UXB (common German HE bomb) could be as small as 20cm in diameter. Records confirm that even small 1kg German incendiary bombs could penetrate soil, leaving tiny entry holes (5cm) or burying completely. During WWII, the quantity and type of ground cover affected the visibility of buried UXBs. Dense vegetation, soft ground, rubble, railway ballast or stockpiled material could obscure evidence. UXB strikes in waterlogged areas or open water would be hidden beneath the waterline. Tidal mudflats or river banks would temporarily cover entry holes with water and sediment. Elevated risk ground cover could cause UXBs to end up beneath neighbouring undamaged buildings or hardstanding due to the “J Curve” Effect. UXB strikes on intact or superficially damaged buildings and hardstanding would cause significant damage or leave easily identifiable entry holes. Well-maintained lawns or gardens are less likely to overlook an HE UXB entry hole, with such incidents reported and the UXB removed. | • Likely comprised open agricultural ground.<br>• Some farm related structures and other ancillary buildings may have been present on site.<br>• Various drains / drainage systems located on site are likely to have covered the ground. |

| Factor | General Considerations | Site Specific Considerations |
|---|---|---|
| **Frequency of access** | A UXB strike in a site with infrequent human access would have a lower chance of being observed, reported and recorded compared to a developed site with regular access. Strikes during nighttime raids are also more likely to go unnoticed compared to daytime attacks when German aircraft could be detected more easily. In frequently bombed cities / towns, ARP Wardens searched for UXBs in recently bombed residential areas and schools. Important facilities had dedicated ARP teams or Fire Watchers responsible for observing air raids and reporting UXB strikes. However, anecdotal evidence suggests that Fire Watchers were not always present, so their activities cannot be assumed without specific evidence. Less important buildings damaged by bombs would be abandoned until the German bombing campaign ceased, reducing access to those sites. Schools closed due to evacuations were often used as First Aid posts and reception centres, increasing access to those locations. | • The site is likely to have seen seasonal access, while some peripheral areas such as the drains likely saw less access. |
| **German air-delivered ordnance failure rate** | Empirical evidence suggests that approximately 10% of German HE bombs dropped during WWII failed to explode as intended. This estimate, based on recovered UXB statistics, likely underestimates the true number as unrecorded UXBs were not accounted for at the time.<br>The reasons for failures include:<br>• Fuze or gaine malfunction due to manufacturing fault, sabotage (by forced labour) or faulty installation.<br>• Clockwork mechanism failure in delayed action bombs.<br>• Failure of the bomber aircraft to arm the bombs (charge the electrical condensers which supplied the energy to initiate the detonation sequence) due to human error or equipment defect.<br>• Jettison of the bomb before it was armed or from a very low altitude. Most likely if the bomber was under attack or crashing.<br>According to War Office statistics, an average of 84 malfunctioning bombs were dropped on civilian targets in Britain per day from 21/09/1940 to 05/07/1941. About 1 in 12 of these bombs, likely those with time delay fuzes, exploded after landing, while the rest unintentionally failed to detonate.<br>From 1940 to 1945 bomb disposal teams dealt with a total of 50,000 explosive items of 50kg and over (German bombs), 7,000 AAA shells and 300,000 beach mines. These operations resulted in the deaths of 394 officers and men. However, UXO is still regularly encountered across the UK.<br>Note, due to manufacturing fault or failure of the bomber crew to correctly arm their munitions, whole bomb loads often failed to detonate. Therefore, the presence of | • No evidence has been found to suggest the ordnance failure rate in this area was higher than 10%. |

| Factor | General Considerations | Site Specific Considerations |
|---|---|---|
| | reported UXBs increases the likelihood of an additional unrecorded UXB in the vicinity. | |

# 8. The Threat from Allied Military Ordnance

The following potential historical and modern sources of UXO contamination on site or in the surrounding area have been considered:

- Army, Navy & RAF bases & installations
- Military training areas & weapons ranges
- Ordnance / explosives factories & storage depots
- Sites requisitioned for military use
- Sites used or occupied by the Home Guard
- Military fortifications & coastal defences
- Locations of Army Explosive Ordnance Clearance (EOC) tasks
- WWII heavy and light anti-aircraft batteries
- WWII pipe-mined locations and beach minefields

The risk of contamination from Allied UXO on site is discussed below.

## 8.1 Land Service and Small Arms Ammunition (LSA/SAA)

It is estimated that around 20% of the UK's landmass has been used by the military at some point. As such, a large proportion of sites can remain at risk from military related UXO, through training, testing, storage, disposal or manufacture.

### 8.1.1 Defensive Fortifications

After the defeat at Dunkirk in May 1940, Britain rushed to establish defences against the imminent invasion. Coastlines and inland areas were fortified with anti-tank obstacles, ditches, pillboxes and gun emplacements. The goals of these defences were to prevent enemy landings at sea or by aircraft, protect ports and harbours, stop armoured columns from advancing, and safeguard vulnerable locations. Stop lines were created to halt German armoured units, with anti-tank obstacles and pillboxes strategically positioned. The defences were manned by Home Guard and military personnel.

### 8.1.2 Home Guard Activity

The Home Guard (HG) was a British Army defence organisation active from 1940-44. Comprising 1.5 million local volunteers ineligible for military service, it served as a secondary defence force against enemy invasion. The HG protected coastal areas, important facilities and urban centres. Official records were scarce, making present-day evidence mostly anecdotal. HG personnel conducted training, including weapons training, in rural areas near towns and cities. Present-day discoveries of

HG-related ordnance indicate a culture of lax discipline regarding live ammunition. HG members purposefully buried caches of weapons and ammunition in strategic locations for future use, some of which were forgotten and have been found as UXO in recent years. The table below provides several examples: [4]

| Home Guard UXO Finds: | |
|---|---|
|  | Live unexploded WWII grenade found in a residential garden, Devon – March 2023 |
|  | A cache of phosphorous grenades found buried underneath a school during construction works in Swindon – November 2022 |
|  | Unexploded Spigot Mortar Round, used by the Home Guard in WWII, found and disposed of in Hayle, Cornwall – January 2021 |
|  | 24 x WWII grenades found buried in a field in Sibton, Suffolk – May 2019 |
|  | A cache of 80 phosphorous grenades buried by the Home Guard found in Eastbourne – September 2015 |
|  | Home Guard Phosphorous Grenades found buried beneath a bridge in Herne Bay – July 2015 |

[4] Various News Sources

### 8.1.3 Generic Types of WWII British / Allied UXO (LSA/SAA)

The nature and characteristics of the ordnance used by the military allows an informed assessment of the hazards posed by any unexploded items that may remain today.

<table>
<tr><th>Hazard Type</th><th colspan="3">Description</th></tr>
<tr><td rowspan="3">Land Service Ammunition</td><td rowspan="2">The term Land Service Ammunition covers all items of ordnance that are propelled, placed or thrown during land warfare. They may be filled or charged with explosives, smoke, incendiary or pyrotechnics. They can be broken into five main groups:<br>1. Mortars<br>2. Grenades<br>3. Projectiles<br>4. Rockets<br>5. Landmines</td><td>Mortars</td><td>A mortar bomb is a fin-stabilised munition with a nose fuze and its own propelling charge. Additional propellant can be added to increase range. They come in HE or Carrier types and are typically tear-dropped in shape (though older variants may have parallel sides) with a finned ‘spigot tube’ at the rear housing the propellant.<br>Detonation of a mortar relies on the striker hitting a detonator, which may already be in contact, requiring only slight pressure for initiation. Discarded augmenting charges are commonly found near mortar firing areas/bases.</td></tr>
<tr><td>Grenades</td><td>A grenade is a short-range weapon that can be thrown by hand, fired from a rifle, or launched from a specialised grenade launcher. There are two categories: HE and carrier (typically smoke). Like mortars, a grenade’s striker may either be in close contact with the detonator or held by a tensioned spring, so shock can cause it to function. Grenades have an explosive range of 15-20m. Older variants often have a classic “pineapple” shape, while modern grenades are usually smooth-sided.</td></tr>
<tr><td colspan="3">Unexploded or partially unexploded Mortars and Grenades are among the most common items of UXO encountered in the UK. They are commonly encountered in areas used by the military for training and are often found discarded on or near historic military bases.</td></tr>
<tr><td>Small Arms Ammunition</td><td colspan="3">The most likely type of ordnance to be encountered on site are items of SAA (bullets), especially .303” ammunition which was the standard British and Commonwealth military cartridge from 1889 until the 1950s.<br>However even if an item such as this functioned, the explosion would not be contained within a barrel and detonation would only result in local overpressure and very minor fragmentation from the cartridge case.<br>Some LAA guns and RAF fighter cannons in use with British forces during WWII utilised the 20mm round. These bullets had a small fuse and a ~4gram HE or incendiary charge. Although small, this fill quantity still has the potential to cause serious injury.</td></tr>
<tr><td colspan="4">Examples of the most commonly used British / Allied ordnance types are presented in Appendix 2.</td></tr>
</table>

#### 8.1.4 Site Specific Threat from LSA / SAA

The following table discusses site-specific potential UXO contamination from military activity.

| Potential Source | Details |
|---|---|
| **Defensive features within the vicinity** | • Auxiliary Operational Base located near Swineshead Bridge, 500m east of the site.<br>• Nissen Hut recorded in Heckington approx. 1.9km south-west. (Not confirmed as military). |
| **Home Guard / Military Activity on site** | • The 1st Kesteven (East) Battalion was the closest Home Guard Battalion to the site, but its likely various companies defended the towns within proximity.<br>• Experience has shown that the 'housekeeping' of WWII soldiers/HG personnel was often carried out to a poor standard with HG personnel known to have purposefully buried caches of ammunition and weapons in tactical positions, to be exhumed and used in case of invasion.<br>• The site was occupied by open countryside, typical of that used for HG training exercises. However, no evidence has been found to suggest that any such activity took place within the study area. |
| **Practice bombing** | • Lincolnshire was notorious for practice bombing, especially over agricultural ground. However, a confirmed bombing range has not been identified on or around the site.<br>• The nose cone of a possible practice bomb was discovered in Bicker approximately 1.1km to the south of the site (See Section 9.2.2).<br>• Although it is considered unlikely that practice bombing took place on site, it cannot be entirely discounted that a missed target, overspill or mistakenly dropped practice bomb could have landed in the vicinity. |

### 8.2 Anti-Aircraft Gun Batteries

At the war's outset, two types of AAA guns were used: Heavy Anti-Aircraft (HAA) and Light Anti-Aircraft (LAA). LAA batteries targeted fast, low-flying aircraft near airfields and strategic sites. These mobile batteries, equipped with four guns each, could rapidly fire multiple rounds. Unexploded AAA shells from WWII are still occasionally found today.

Initially, the maximum firing height was about 11,000m. However, improved versions of the 3.7" gun and larger 5.25" weapons with higher firing ceilings (over 18,000m) were introduced from 1942.

The 3.7" AA gun was said to have a maximum firing range of around 5.6km when fired horizontally or 12km when fired at an angle. The 5.25" AA gun had a potential maximum firing range of 14.2km, with naval versions capable of reaching up to 22km. Other types, like the 4.5" AA gun and the Bofors 40mm, had a maximum range of approximately 12.5km.

When Switzerland stopped supplying clockwork fuses, Britain had to produce its own. Due to a lack of engineering expertise, many AA shells prematurely detonated, causing casualties or becoming UXBs. In January 1944, more people in London were killed by HAA shells than by German bombs.

Unexploded AA shells are frequently found across the UK. The table below provides several examples:[5]

| Anti-Aircraft Artillery UXO Finds: | |
|---|---|
|  | AA shell found in a canal, Ashton-under-Lyne, June 2022. |
|  | AA shell found in the River Great Ouse, Bedford town centre, July 2021. |
|  | Several AA shells found during construction in Somersham, November 2017. |
|  | AA shell found in a residential garden, Potters Bar, October 2015. |
|  | AA shell found on a construction site, Waltham Abbey, May 2015. |

[5] Various News Sources

### 8.2.1 Generic Types of WWII British / Allied Unexploded Ordnance (Artillery)

The nature and characteristics of the ordnance used by the military allows an informed assessment of the hazards posed by any unexploded items that may remain today.

<table>
<tr><th>Hazard Type</th><th colspan="5">Description</th></tr>
<tr><td rowspan="5">Anti-Aircraft Shells</td><td colspan="5">At the start of WWII, two types of AAA guns were used: HAA with large calibre weapons like the 3.7” QF gun, and LAA with smaller calibre weapons like the 40mm Bofors gun. The Bofors gun could fire up to 120 shells per minute. Due to AAA shortages, older WWI guns were also deployed. These shells, often mistaken for German bombs, can be identified by the copper driving band. Unexploded larger projectiles are found close to ground level and pose a significant risk due to their HE fill and fragmentation. Smaller 40mm projectiles resemble SAA and present a lower risk. Details of the most commonly deployed WWII AAA projectiles are shown below:</td></tr>
<tr><td>Gun type</td><td>Calibre</td><td>Shell Dimensions</td><td>Shell Weight</td><td>HE Fill Weight</td></tr>
<tr><td>3.7 Inch</td><td>94mm</td><td>94mm x 438mm</td><td>12.7kg</td><td>1.1kg</td></tr>
<tr><td>4.5 Inch</td><td>114mm</td><td>114mm x 578mm</td><td>24.7kg</td><td>1.7kg</td></tr>
<tr><td>40mm</td><td>40mm</td><td>40mm x 311mm</td><td>0.84kg</td><td>70g</td></tr>
<tr><td colspan="6">Examples of the most commonly used British / Allied ordnance types are presented in Appendix 2.</td></tr>
</table>

## 8.3 Site-Specific Threat from Anti-Aircraft Artillery

The following table discusses site-specific potential UXO contamination from anti-aircraft artillery.

| Potential Source | Details |
|---|---|
| **Threat to the site from unexploded AA shells** | • No HAA batteries were located within 5km of the site.<br>• Whilst no recorded HAA batteries were present in the surrounding area during WWII. It is considered likely that additional emplacements would have been present within range of the site.<br>• During the war, the site was mostly occupied by soft open ground. In such ground conditions, it is conceivable that an unexploded AA shell or a rocket strike that landed in the ground would have gone unnoticed.<br>• However, due to the overall low bombing density in the surrounding area, the volume of AA fire over the site is unlikely to have been greatly elevated. As such, the possibility of an unexploded AA shell landing on site is considered to be relatively low. |

## 9. Overview of UXO Risk Assessment Methodology

Taking into account the quality and nature of the historical evidence, the assessment of the overall risk to any intrusive works from UXO must evaluate the following factors:

**The probability that the site was contaminated with UXO**

↓

**The probability that UXO remains on site**

↓

**The probability that UXO could be encountered during site works**

↓

**The probability that UXO could be detonated during site works**

↓

**The potential consquence of UXO detonation**

Each of these steps will be evaluated in the following sections in order to conclude the total risk from UXO to the proposed works to be undertaken within the project site.

## 9.1 The Probability of UXO Contamination on Site

### 9.1.1 Contamination Factors

The table below presents generalised factors used to determine the probability that the site was contaminated with unexploded ordnance. Note that additional site-specific information can adjust UXO risk beyond these criteria:

| | Probability of Contamination Definitions | |
|---|---|---|
| | **German Air-Delivered Ordnance / Allied Anti-Aircraft Shells** | **British / Allied Land Service or Small Arms Ammunition** |
| **Probable** | • High local bombing density or evidence of bombing /bomb damage on or adjacent to the site. Confirmed finds of WWII UXB.<br>• Ground conditions that would have immediately and completely obscured the existence of UXB.<br>• Site may be completely obscured from view or subject to very infrequent access. | • Evidence of weapons testing or disposal on or adjacent to the site.<br>• Evidence of UXO finds on or in the vicinity of the site. |
| **Possible** | • Moderate to High local bombing density or evidence of bombing / bomb damage on or close to the site.<br>• Ground conditions that allow for bomb penetration.<br>• Site located in an area that was infrequently observed or accessed, with a low likelihood that a UXB strike would have been noticed. | • Clear evidence of military training activity on site involving live ammunition / munitions.<br>• Military sites which have not undergone clearance operations or redevelopment since use.<br>• Evidence of weapons storage on site.<br>• Open or unmaintained ground that may have been used for disposal or caching of munitions. |
| **Unlikely** | • No evidence of bombing / bomb damage on site coupled with low local bombing density.<br>• Ground conditions that would prevent UXB penetration or lead to easily identifiable entry holes.<br>• Site was occupied and accessed fully throughout the bombing campaign. | • No evidence of Allied military activity on or near the site.<br>• Or<br>• Military sites which have been cleared / redeveloped since their use<br>• Or<br>• Military-owned sites which have not been used for training with live munitions.<br>• Developed areas that are unlikely to have been used for military exercises. |

The following sections assess the probability of contamination from German UXO and British / Allied UXO, based on the evidence discussed in the previous sections.

### 9.1.2 The Probability of Contamination from German UXO

The following table discusses the overall probability of contamination from German UXO, based on the evidence discussed in Section 7.

| Overview of the Potential Sources of German Air-Delivered UXO | | Overall Probability of Contamination |
|---|---|---|
| **Bombing density** | • Low bombing density.<br>• Home Office Statistics indicate bombing in the wider areas surrounding the site.<br>• An abandoned bomb was recorded in Bicker approx. 1.1km to the south of the site. | **Unlikely** |
| **Bomb Damage** | • Due to a lack of aerial photography, an accurate assessment of the ground conditions and therefore the extent of any potential bomb damage cannot be made. | |
| **Ground Conditions** | • Soft open agricultural ground.<br>• Farmhouses and other ancillary structures.<br>• Drains present throughout. | |
| **Frequency of Access** | • Seasonal access to agricultural land. | |
| **J-Curve Effect** | • Had any UXB landed within the soft ground on site, it could have come to rest beneath the adjacent unconsolidated ground. | |
| **Other considerations** | • n/a | |

### 9.1.3 The Probability of Contamination from British / Allied UXO

The following table discusses the overall probability of contamination from British / Allied UXO, based on the evidence discussed in Section 8.

| Overview of the Potential Sources of British / Allied UXO | | Overall Probability of Contamination |
|---|---|---|
| **Land Service Ammunition / Small Arms Ammunition** | • No evidence has been found to suggest that the site formerly had any British / Allied military occupation or usage that could have led to contamination with items of Land Service or Small Service Ammunition. | **Unlikely** |
| **Practice Bombing** | • Lincolnshire was notorious for practice bombing, especially over agricultural ground, however, a bombing range has not been identified on or around the site.<br>• The nose cone of a possible practice bomb was discovered in Bicker approximately 1.1km to the south of the site (See Section 9.2.2).<br>• Although it is considered unlikely that practice bombing took place on site, it cannot be entirely discounted that a missed target, overspill or mistakenly dropped practice bomb could have landed in the vicinity. | **Unlikely** |
| **Anti-Aircraft Projectiles** | • No HAA batteries were situated within a 5km radius of the site during WWII.<br>• Due to the overall low bombing density in the surrounding area, the volume of AA fire over the site is unlikely to have been high. As such, the possibility of an unexploded AA shell landing on site is considered to be relatively low. | **Unlikely** |

## 9.2 The Probability that UXO Remains on Site

### 9.2.1 General

The extent to which any ordnance clearance activities have taken place on site or extensive ground works have occurred is relevant, since they may indicate previous ordnance contamination but also may have reduced the risk that ordnance remains undiscovered

### 9.2.2 EOD Bomb Disposal, Clearance Tasks and UXO Finds

Post-WWII UXO finds are vital, as they can tell us locations where UXO was dropped or buried, the types of munitions used and the numbers that went unnoticed for years after the war ended.

Igne holds a number of official records of explosive ordnance disposal operations during and following WWII, obtained from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD), British Army.

Igne have also sought news articles, publications, anecdotal records and local Igne projects to determine post-WWII UXO encounters on or near to the site.

| UXO found | Details |
|---|---|
| WWII Shell | 8th October 2010 - A WWII shell was discovered on a building site in Bicker, believed to be nose cone of a plane-mounted bomb. It was discovered approximately 1km to the south of the site.[6] Due to the nature of the shell, it is likely a practice bomb. |

### 9.2.3 Post War Redevelopment

The nature of post-WWII ground works, redevelopment and construction has been considered. Significant structural redevelopment on site can, in some cases, provide a level of mitigation, particularly from shallow buried items. However, if a site has not undergone any extent of redevelopment, the likelihood of UXO remaining within its boundaries can remain.

| Redevelopment Details |
|---|
| Majority of the site would have likely remained undeveloped, a substation was developed in the southern extent around 2007, no other holistic development is apparent. |

### 9.2.4 Site-Specific Analysis

The following table discusses the likelihood that UXO could remain on site, following any post-WWII activity.

| | |
|---|---|
| **Mitigating factors during post-WWII period** | Some areas have been developed since WWII, it is likely the substation and its associated environs would have required a level of deeper intrusive works.<br>The site has remained largely undeveloped since the end of WWII. |
| **Further comments** | The threat of UXO contaminating the site has been assessed as minimal and therefore the likelihood of UXO remaining on site is also minimal. |

6 [redacted]

## 9.3 The Probability that UXO may be Encountered during the Works

UXO may be encountered during constructions works, particularly piling, drilling or bulk excavations. The risk depends on the extent of the works, such as the number of boreholes / piles, and excavation volume. Shallow excavations near the original WWII ground level may also pose a risk. If the works are within post-WWII fill material, the risk of encountering WWII UXBs is lower. However, the risk significantly increases if the works are below the WWII ground level. The probability of encounter can be determined using the table below.

| Probability of Encounter | |
|---|---|
| 1 | Rare |
| 2 | Unlikely |
| 3 | Possible |
| 4 | Probable |
| 5 | Highly Probable |

## 9.4 The Probability that UXO may be Detonated

Items of ordnance do not become inert or lose their effectiveness with age. Time can indeed cause items to become more sensitive and less stable. This applies equally to items submerged in water or embedded in silts, clays or similar materials. The greatest risk occurs when an item of ordnance is struck or interfered with. This is likely to occur when mechanical equipment is used or when unqualified personnel pick up munitions.

### 9.4.1 Detonation of Unexploded Bombs

In the case of unexploded German bombs discovered within the construction site environment, there are a number of potential initiation mechanisms:

| | |
|---|---|
| **Direct Impact onto the main body of the bomb** | Unless the fuze or fuze pocket is struck, there needs to be a significant impact to initiate a buried HE bomb. |
| **Re-starting the clock timer in the fuze** | Only a small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion has taken place within the fuze since the end of WWII that would prevent clockwork mechanisms from functioning, nevertheless it was reported that the fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did recommence. |
| **Induction of a static charge, causing a current in an electric fuze** | The majority of German WWII bombs employed electric fuzes. It is probable that significant corrosion has taken place within the fuze mechanism since the end of WWII such that the fuze circuit could not be activated. |
| **Friction impact initiating the (shock-sensitive) fuze explosive** | This is the most likely scenario resulting in the bomb detonating. |

### 9.4.2 Activities that may Result in the Detonation of UXO

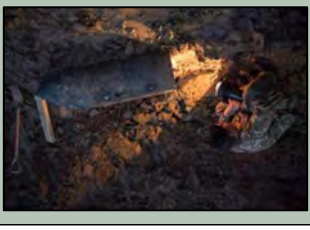
Unexploded bombs do not spontaneously explode. All high explosive requires significant energy to create the conditions for detonation to occur. The risk that UXO could be initiated if encountered will depend on its condition, how it is found and the energy with which it is struck. However certain activities pose a greater risk than others.

| | |
|---|---|
| **Percussive piling or deep mechanical excavations** | The most violent activity on most construction sites is percussive piling or deep mechanical excavations. If an item is struck with a significant enough impact, be it direct or through friction/vibration, it risks detonation. |
| **Shallow excavation** | Soil levelling and shallow excavation such as trial pits can pose a similar risk to deeper excavations, since UXO can be found at any depth between ground level and the maximum bomb penetration depth. In addition to risk of initiation by violent impact or vibration, detonation can also occur if discovered items are mishandled by unqualified personnel. This is particularly common when onsite personnel are not trained in the recognition of ordnance. |
| **Non-intrusive works** | In the case of non-intrusive planned works, little risk is posed by items of UXO that are buried beneath the ground. However, risk can arise from unburied munitions, particularly items of ordnance discarded in periphery areas of military sites. These items are frequently discovered by onsite personnel and remain live and liable to activate if mishandled. |

### 9.4.3 The Consequences of Encountering or Detonating UXO

An inadvertent detonation of UXO during construction operations would have catastrophic consequences, including a serious risk to life, damage to equipment and a complete site shutdown for subsequent investigations. Appropriate mitigation measures can significantly reduce the risk of initiating ordnance, but the most significant consequence of ordnance discovery is economic, especially in high-profile locations that may require a public evacuation. The unsuspected discovery of ordnance can lead to site closure for a period ranging from a few hours to a week, resulting in substantial lost time costs. Additionally, involving authorities for handling suspected ordnance may further disrupt production, as the police would typically isolate the area while waiting for military assistance, even if it proves unnecessary.

The following table details several recent UK-based UXO incidents:

| Recent UK-Based UXO Incidents | |
|---|---|
|  | February 2021-March 2023 – A WWII-era German 1000kg HE UXB was discovered in Exeter, Devon, February 2021. Consequences to the project included:<br>• Halt to construction works while 400m cordon was implemented.<br>• Approximately 2600 properties in the vicinity were evacuated for 2 days.<br>• Structural damage within blast radius during in-situ disposal.<br>• Insurance claim was declined by insurers (March 2023). |
|  | February 2023 – A WWII UXB unexpectedly exploded at the site of a construction project in Great Yarmouth, Norfolk. Consequences to the project included:<br>• Resulted in a 4-day major incident.<br>• Minor damage to the road, and damage to the river wall. |
|  | February 2018 – WWII UXB found in King George V dock, London. Consequences to the project included:<br>• 214m exclusion zone implemented.<br>• Closure of London City Airport with all flights cancelled. |
|  | March 2017 – Construction workers found a WWII UXB in Brondesbury Park, London. Consequences to the project included:<br>• Evacuation or residents and 2 schools.<br>• Halt to construction and delays to project. |

# 10. UXO Risk Analysis and Risk Rating

## 10.1 Risk Analysis Methodology

In order to identify appropriate risk ratings and recommended risk mitigation measures, a semi-quantitative assessment has been undertaken, using all available information discussed in this report.

This risk assessment is designed to determine the level of risk associated with the planned works / actions on site. Igne will identify the hazards and investigate the potential receptor that could be affected. The pathway to the hazard will determine the risk on site. This relationship is usually described as Source – Pathway – Receptor.

**Source (or Hazard):** Based on the information discussed throughout the report, the most likely potential sources of hazard include:

- HE bombs
- Incendiary bombs
- AA Projectiles
- Land Service Ammunition
- Small Arms Ammunition

**Pathway**: this is defined as the route in which a hazard could reach the receptor. This will usually include any intrusive ground works.

**Receptors:** Taking into account the proposed project details, potential receptors could include:

- Personnel (people, workers, engineers, public)
- Equipment & infrastructure
- Environment
- Reputation

An evaluation of the risk rating on site will be determined by several factors; the probability of UXO to remain on site, the probability that it could be encountered / initiated during the proposed works, and the consequences of an accidental detonation. A total risk rating for the site will be determined by considering these factors.

The final risk rating is based upon:

## Probability of Encounter (pE) x Consequence of Detonation (cD)

using the definitions below:

| Probability of Encounter (pE) | | Consequence of Detonation (cD) | |
|---|---|---|---|
| 1 | Rare | 1 | Insignificant or Very Low |
| 2 | Unlikely | 2 | Minor or Low |
| 3 | Possible | 3 | Moderate or Medium |
| 4 | Probable | 4 | Major or High |
| 5 | Highly Probable | 5 | Catastrophic or Very High |

| Conse-quence Level | Potential Consequences | | | | |
|---|---|---|---|---|---|
| | Personnel | Assets and Equipment | | Environment | Reputation |
| | | Plant & Equipment | Infrastructure | | |
| 1 | Minor injury, first aid required | No noticeable impact | No noticeable impact | Minor disturbance | No noticeable impact |
| 2 | Injury with time lost (<3 days) | Slight superficial damage | Slight superficial damage | Significant disturbance | Minor impact |
| 3 | Serious injury, hospital treatment required | Minor component repair or replacement required | Non-structural repairs required | Moderate damage to habitats | Moderate impact |
| 4 | Localised fatalities | Significant component repair or placement required | Structural repairs required | Moderate damage to habitats with minor long-term impact | Major impact |
| 5 | Fatalities over a substantial area | Irreparable damage or loss of unit | Localised structural destruction, collapse or failure | Localised destruction of habitats with moderate long-term impact | Significant Impact |

## 10.2 Risk Matrix

Using the classifications presented in section 10.1, the risk matrix below will be utilized to determine the final risk rating for the site.

| | | Consequence of Detonation (cD) | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| Probability of Encounter (pE) | **1** | 1 | 2 | 3 | 4 | 5 |
| | **2** | 2 | 4 | 6 | 8 | 10 |
| | **3** | 3 | 6 | 9 | 12 | 15 |
| | **4** | 4 | 8 | 12 | 16 | 20 |
| | **5** | 5 | 10 | 15 | 20 | 25 |

| Risk Ratings Definitions | |
|---|---|
| High (16-25) | Significant or unacceptable risk. Action required to mitigate the risk before works commence to prevent a significant incident. |
| Medium (6-15) | Tolerable level of risk if controls lower the risk to ALARP. Workers should proceed with extra caution. Increased monitoring and evaluation required. |
| Low (1-5) | Acceptable risk. Minimum proactive risk mitigation measures are recommended on site prior to further site works. |

## 10.3 Final Risk Rating & Recommended Risk Mitigation Measures

### 10.3.1 Risk Rating

The following table discusses the risk rating across the entire site:

| Hazard | Average Depth of Hazard | pE | cD | Risk Analysis (pE x cD) | Risk Rating |
|---|---|---|---|---|---|
| HE bombs | <12m bgl | 1 | 5 | 5 | Low |
| IB | <1m bgl | 1 | 4 | 4 | Low |
| AA | <5m bgl | 1 | 3 | 3 | Low |
| LSA | <2m bgl | 1 | 4 | 4 | Low |
| SAA | <1m bgl | 1 | 2 | 2 | Low |
| Practice Bomb | <1m bgl | 2 | 2 | 4 | Low |

### 10.3.2 Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended in order to lower the overall risk during the proposed works to ALARP. Additional information regarding these methods can be found in Section 10.4. In the event of significant additions or alterations to the proposed scope of works, please refer to Section 10.4 for a comprehensive list of risk mitigation details. Furthermore, in the event of any such changes to the proposed works on site, Igne should be contacted to ensure correct mitigation methods are applied based on specific scope of works.

| Pathway | Risk Rating | Recommended Risk Mitigation Measure(s) |
|---|---|---|
| All | Low | • Site Specific Explosive Ordnance Safety and Awareness Briefings (UXO Toolbox Briefing) to all personnel conducting intrusive works<br>• Site Specific Safety Instructions (SSSI) Training Course |

## 10.4 Risk Mitigation Overview

An overview of Risk Mitigation Measures is presented below.

| Site-Specific Proposed Works | Risk Mitigation Measures | Further Detail |
|---|---|---|
| All | Site Specific Explosive Ordnance Safety and Awareness Briefings (UXO Toolbox Briefing) to all personnel conducting intrusive works | These briefings are intended to make site operatives aware of the nature of explosive ordnance that may be encountered on their project site.<br>• Delivered by a specialist Explosive Ordnance Disposal Engineer.<br>• Provides information on the site-specific explosive ordnance risk.<br>• Basic ordnance identification.<br>• What to do in the event of an encounter with a suspicious object.<br>• Provide UXO response procedures. |
| All | Site Specific Safety Instructions (SSSI) Training Course | For longer term projects that require Explosive Ordnance Safety and Awareness Briefings as part of the Explosive Ordnance Risk Mitigation measures for the project, SSSIs can be provided to allow nominated site representatives to deliver these briefings after initial training.<br>• 2/3-hour presentation and training course.<br>• Delivered by a fully qualified senior EOD Engineer.<br>• Suitable for Project Site Manager HSE representative and supervisors.<br>• Includes briefing pack.<br>This provides a cost-effective solution to ensure that the Explosive Ordnance Safety and Awareness Briefings can be delivered effectively and efficiently to the required standard. |
| Open excavation<br>Shallow intrusive works | Explosive Ordnance Disposal (EOD) Engineer On-Site Support (Watching Brief) | In areas where the risk posed by the potential presence of explosive ordnance is low or where the conditions are not suitable for pro-active survey, EOD On-Site Support can provide a reactive response to any suspicious object that may be encountered during open excavation works.<br>The presence of the EOD Engineer (sometimes referred to as 'high risk dig wardens') on-site in support of shallow intrusive work allows for a direct monitoring of works using visual recognition and instrumentation and provides an immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by ground workers.<br>Igne EOD personnel on-site also have the additional benefit of providing Explosive Ordnance Safety and Awareness briefings (UXO TBB) to any staff that have not received them earlier and can advise staff of the need to modify working practices to take account of the ordnance threat. The EOD Engineer will also aid potential incident management which would involve liaison with the local |

| Site-Specific Proposed Works | Risk Mitigation Measures | Further Detail |
|---|---|---|
| | | authorities and police should ordnance that presents an explosive hazard be identified.<br>• Specialist Explosive Ordnance Disposal Engineer.<br>• Maintains a watching brief over all excavations.<br>• Provides safety and awareness briefings to construction personnel as required.<br>• Provides immediate identification of any suspicious item that is encountered.<br>• Identifies whether any UXO item is live or inert.<br>• Provides liaison assistance with the relevant authorities when dealing with any live UXO.<br>Avoids on site delays which can be caused by the incorrect identification of a suspect item being potential UXO. |
| Boreholes | Support to Borehole Drilling | For cost effective risk mitigation for site investigation work, the site operative can conduct intrusive surveys for borehole and window sample locations working in conjunction with the site investigation team. The On-Site Support will also provide a reactive response to any suspicious object that may be encountered during open excavation works.<br>• Works in conjunction with the drilling team to survey all borehole and window sample locations in real-time using a staged drilling and magnetometer survey procedure.<br>• Avoids on site delays which can be caused by the incorrect identification of a suspect item being potential UXO.<br>*Technical Information*<br>1. In optimum ground conditions each survey using the borehole technique will have a 1 metre look ahead capability.<br>2. Any steel casing used for borehole surveys will need to be retracted by 3 metres to allow the magnetometer survey to be conducted.<br>Non-ferrous pipe will be required to support the borehole during the survey minimum diameter 60mm (to be supplied by the client). |
| Shallow intrusive works (max. 2m bgl) | Search & Clear | Where a non-intrusive magnetometer survey is not possible (e.g. wooded areas) Igne can deploy a two-man Explosive Ordnance Disposal Engineer team using handheld magnetometer equipment who will proactively survey either in search lanes or boxes, investigating each reading with the support of an operated excavator. The survey is suited to detecting suspicious ferro-magnetic buried objects that may be munitions and/or explosive ordnance related.<br>All Igne personnel involved with the Search and Clearance Works will be former military personnel who have gained formal NATO Military Explosive Ordnance Disposal Qualifications, having completed training at the Defence Explosive Ordnance Disposal |

| Site-Specific Proposed Works | Risk Mitigation Measures | Further Detail |
|---|---|---|
| | | School (DEODS) Chattenden, Kent or similar establishment throughout their military service.<br>The client will be responsible for:<br>• Demarcating the areas to be searched.<br>• Providing services clearance and permit to dig.<br>• Providing operated excavator to access deeper targets if required (Igne can provide this service at additional cost).<br>• Providing coordinates of positions where debris have been identified (if information required in report).<br>• Providing storage for recovered debris.<br>Output will depend upon terrain and contamination (number of readings to be investigated). |
| Shallow intrusive works (max. 2m bgl) | Non-Intrusive Magnetometer Survey and Target Investigation (greenfield land only) | *Non-Intrusive Survey*<br><br>This survey type is designed for use on magnetically 'clean' land commonly referred to as 'greenfield'. Brownfield land is often described as that which has had previous industrial or commercial use. In this context it specifically encompasses sites with are underlain by 'made ground' which may contain metallic contamination. Non-intrusive magnetometry or electromagnetic equipment which is used in the search for buried UXO relies upon the detection of small changes between clear ground and that containing UXO.<br><br>The technique operates very successfully in environments where there is minimal ground contamination from other sources such as fired bricks, reinforced concrete, discarded scrap metal and buried services. There are also man-made ambient effects on magnetic and electromagnetic non-intrusive survey systems which include moving plant vehicles, power cables, electric trains etc.<br><br>Non-Intrusive survey is carried out using either total-field or gradiometer magnetometry, dependent upon site conditions. Data is recorded and then interpreted using advanced AGSPRoc software in order to map magnetic fields and model discrete magnetic anomalies (variations in the Earth's magnetic field caused by ferro-magnetic objects electrical fields or geology). The location of such anomalies is determined, and mathematical modelling used to estimate their mass and depth. The survey will also locate any buried services with a magnetic signature and indicate any areas of gross magnetic "contamination" which may indicate the |

| Site-Specific Proposed Works | Risk Mitigation Measures | Further Detail |
|---|---|---|
| | | presence of unknown obstructions. Additionally, the survey can provide information on archaeological features.<br><br>The system can detect the magnetic field from a 50kg WWII air-dropped bomb at a depth of 4m and smaller items such as Land Service Ammunition to depths of up to 1.5m in ground with a low ambient magnetic field. In the case of soft geology, it should be noted that a 50kg high explosive bomb may be buried greater than 4 metres below ground level and therefore may not be detected by the survey. In this instance intrusive surveys may be required.<br><br>The non-intrusive survey system will be deployed utilising the pedestrian survey frame. The output for the pedestrian frame is estimated at up to 2Ha per day.<br><br>*Technical information:*<br>• Client to clearly demarcate area to be surveyed prior to start and highlight any known services/underground obstructions.<br>• Ground must be level, free of obstacles / obstructions and clear of undergrowth. Height of any crops should be no more than 400mm and where crops are present Igne would require written approval from the landowner or client to walk over the site area.<br>• When working adjacent to existing infrastructure the survey may be ineffective due to the ferro magnetic interference caused by passing vehicles and the presence of underground buried services. A site visit may be recommended prior to commencement.<br>• Note: the survey will be ineffective on Brownfield sites due to the magnetic nature of building rubble, which typically masks the weaker magnetic signatures of buried objects. If parts of the site are contaminated, then alternative risk mitigation measures may need to be considered.<br><br>*Target Investigation*<br>If a buried anomaly is detected that cannot be discounted as a potential UXO / UXB then the object will need to be investigated to positively identify the item.<br>The process will include;<br>• Specialist two-man Explosive Ordnance Disposal Team.<br>• Combination of manual and mechanical excavation techniques.<br>• Excavator shafting, shoring and dewatering equipment can be provided by Igne if required.<br>• Excavation techniques will be defined and agreed prior to the commence.<br>A factual report with clearance certificate will be issued on completion of the investigation. |

| Site-Specific Proposed Works | Risk Mitigation Measures | Further Detail |
|---|---|---|
| Piling | Intrusive Magnetometer Survey of all pile locations down to the maximum bomb penetration depth | Igne can deploy a range of intrusive magnetometry techniques to clear ahead of all the pile locations. The appropriate technique is governed by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed. A site meeting would be required between Igne and the client to determine the methodology suitable for this site. Target investigation or avoidance will be recommended as appropriate. |

## Bibliography

The key sources consulted during this assessment are listed below;

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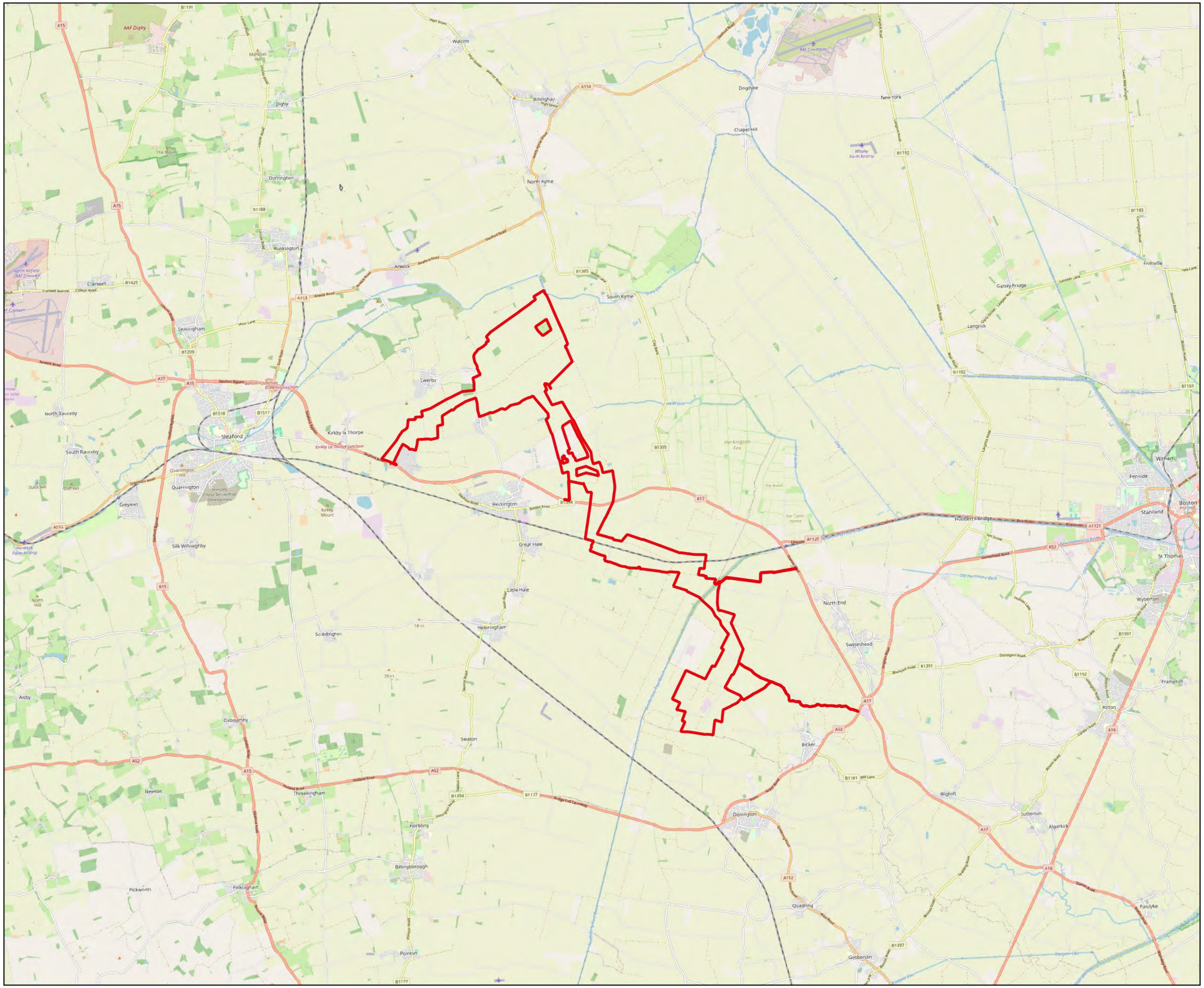
10. Whiting, C., *Britain Under Fire: The Bombing of Britain's* Cities 1940-1945, (Pen & Sword Books Ltd. 1999).

# Figures



0 5 10 km

# Figure 1.0

Site Location Maps

Key

Site Boundary

N
W E
S

Source:
OpenStreetMap

Document Reference: 9974


# Figure 2.0

Recent Aerial Photograph

Key

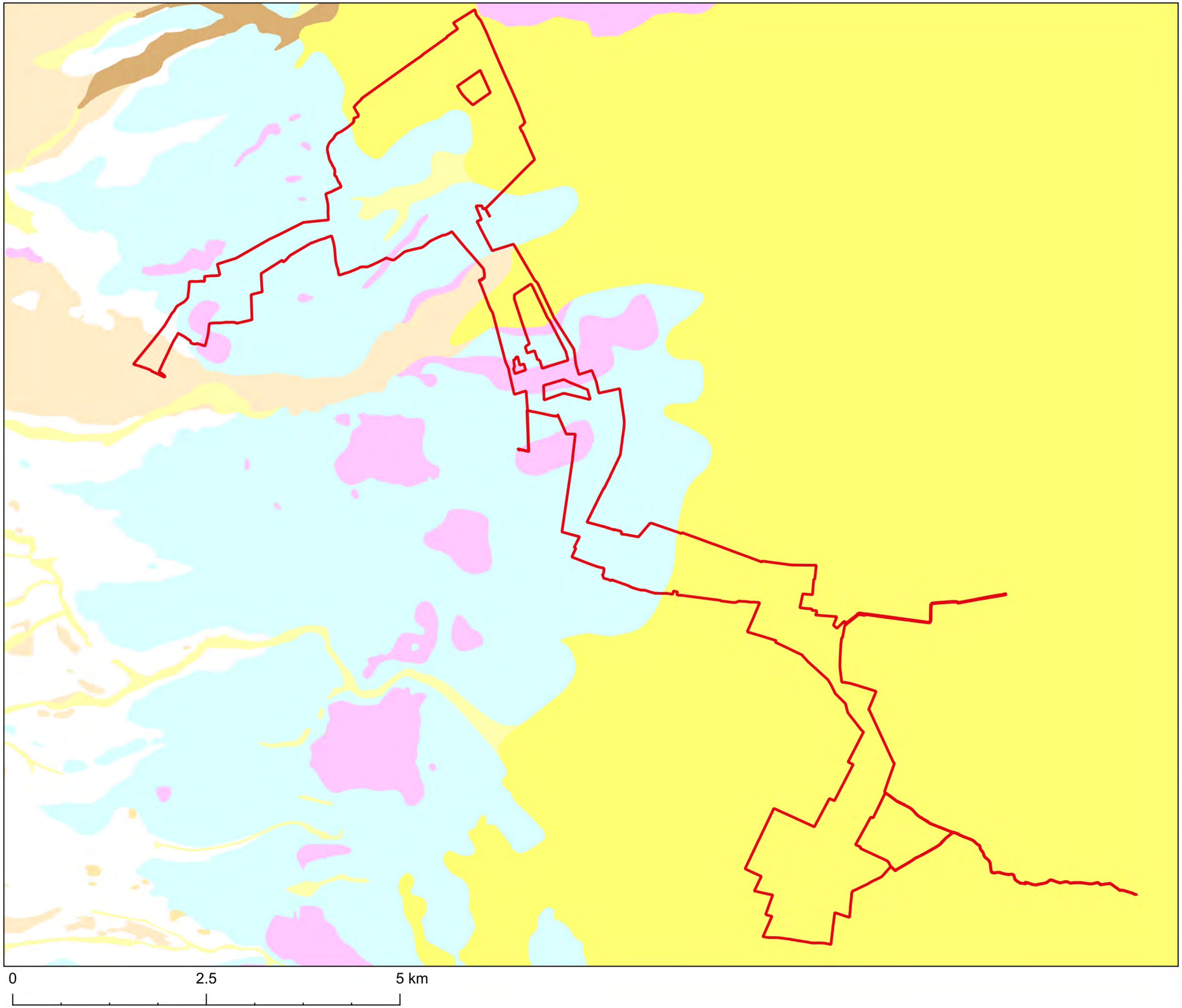
Site Boundary

Notes:

Source:
Google Earth Mapping Services

Document Reference: 9974

igne




# Figure 3.1

Superficial Deposits

Key

Site Boundary
Sleaford Sand and Gravel
Glacdiofluvial Ice Contact Deposits
Alluvium
Tidal Flat Deposits
Till

N
W
E
S

Notes:

Source:
British Geological Survey

Document Reference: 9974

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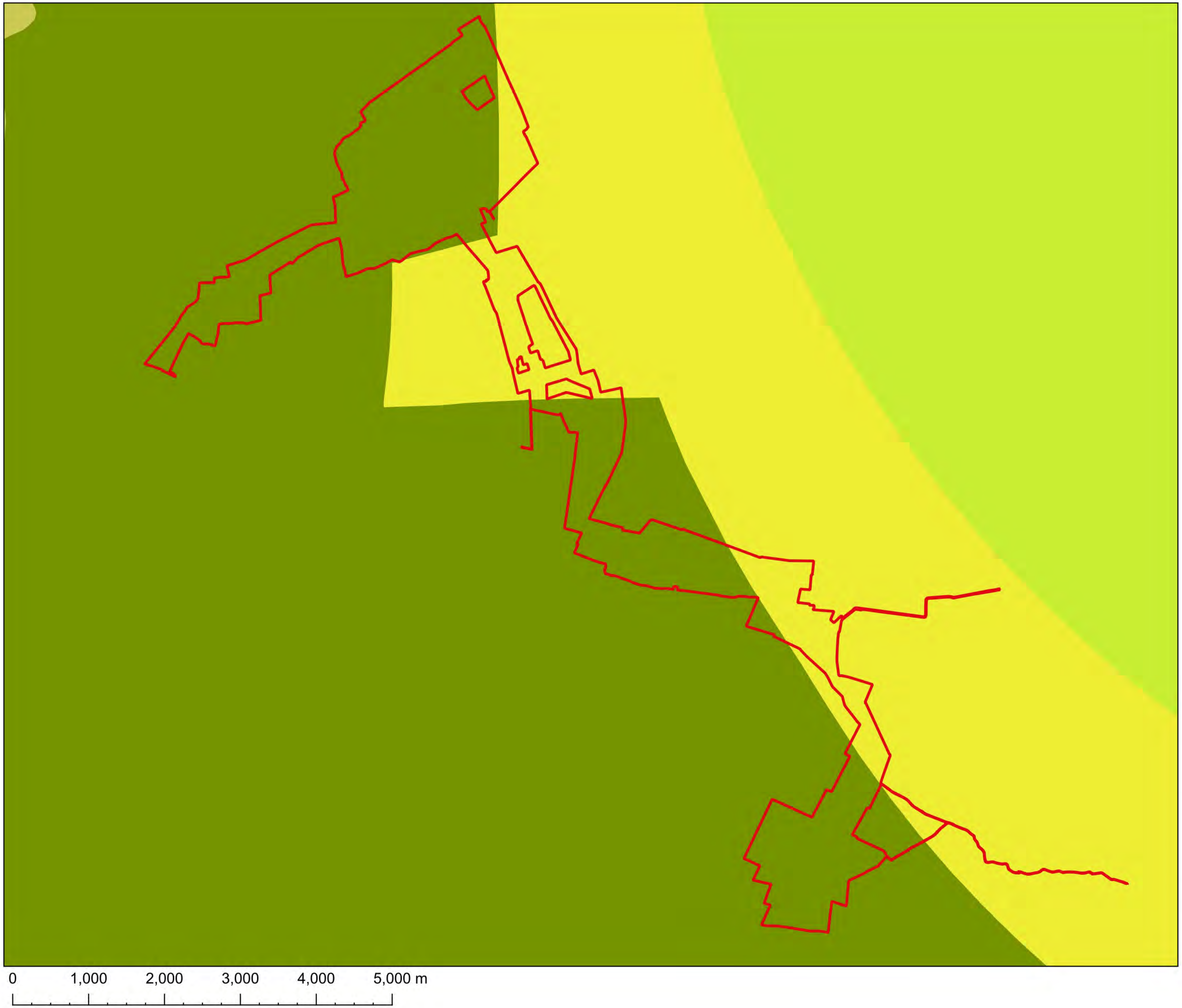



# Figure 3.2

## Bedrock Geology

Key

Site Boundary
Oxford Clay Formation
West Walton Formation

N
W
E
S

Notes:

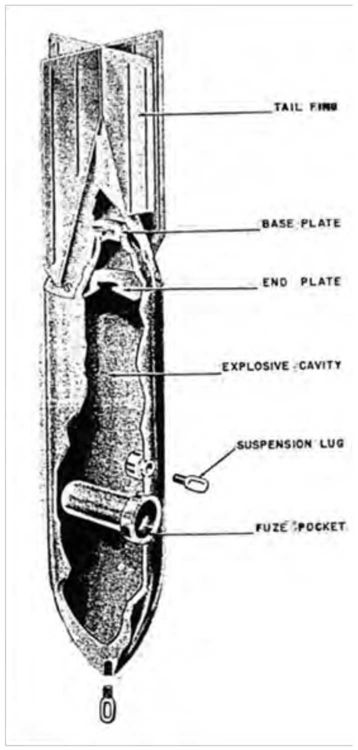
Source:
British Geological Survey

Document Reference: 9974

igne

# Appendices

# Sprengbombe Cylindrisch 50 (SC50)




### SC50 found on site

In May 2015, an SC50 was found at a building site on Empire Way, Wembley, London. (*Image source: The Guardian*)

**Bomb weight**: 40-54kg

**Fuze Type**: Impact fuze / electro-mechanical time delay fuze

**Bomb Dimensions**: 1090 x 280mm

**Body Diameter**: 200mm

**Use**: Used against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to 3-storeys.

**Remarks**: The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.

# Appendix 1.1

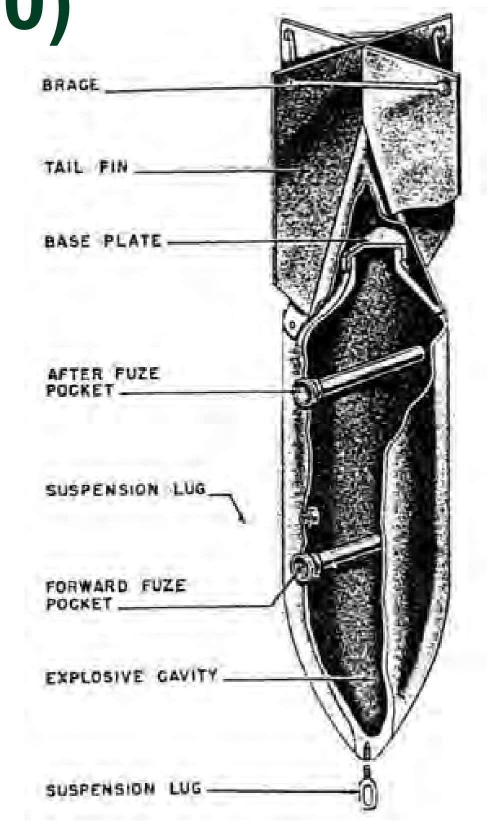
Generic Types of German Air-Dropped Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# Sprengbombe Cylindrisch 250 (SC250)

**Bomb weight**: 245-256k
**Explosive Weight:** 125-130kg
**Fuze Type**: Electrical impact / mechanical time delay fuze
**Bomb Dimensions**: 1640x512mm
**Body Diameter**: 368mm
**Use**: Used against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations




**SC250 found on site**
In 2000, Igne discovered an SC250 whilst supervising construction work at Hawkinge, Kent.

**SC250 found on site**
In 2015, a 250kg HE bomb was found on a construction site in Bermondsey, London.

# Appendix 1.2

Generic Types of German Air-Dropped Ordnance

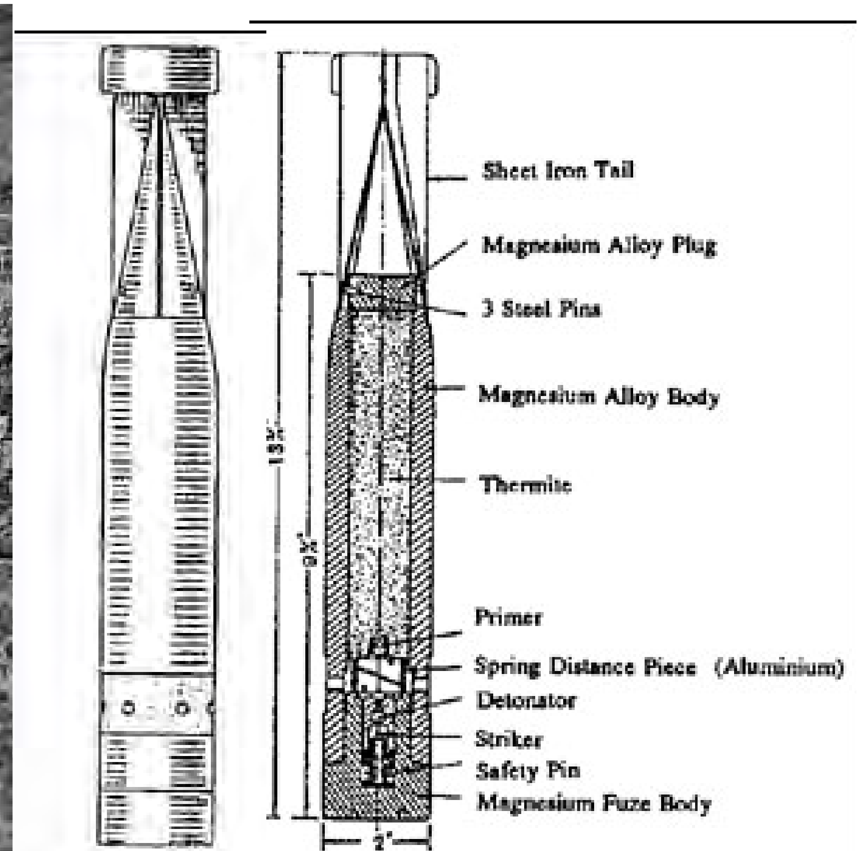
Additional Notes:

The images show SC250 bombs facing upwards in the ground, illustrating the J-Curve Effect.

Sources:
Various news sources
Open source images

igne

# 1kg Incendiary Bomb (IB)




**Bomb weight**: 1.0 & 1.3kg
Filling: 680g Thermite
**Fuze Type**: Impact fuze
**Body Dimensions**: 350 x 50mm
**Body Diameter**: 50mm
**Use**: As incendiary – dropped in clusters against towns and industrial complexes
**Remarks**: Jettisoned from air-dropped containers. Magnesium alloy case. Sometimes filled with high explosive charge.

Left: ordinary scaffold pipe

Centre: 1kg incendiary bomb

Right: incendiary bomb found on site in UK

# Appendix 1.3

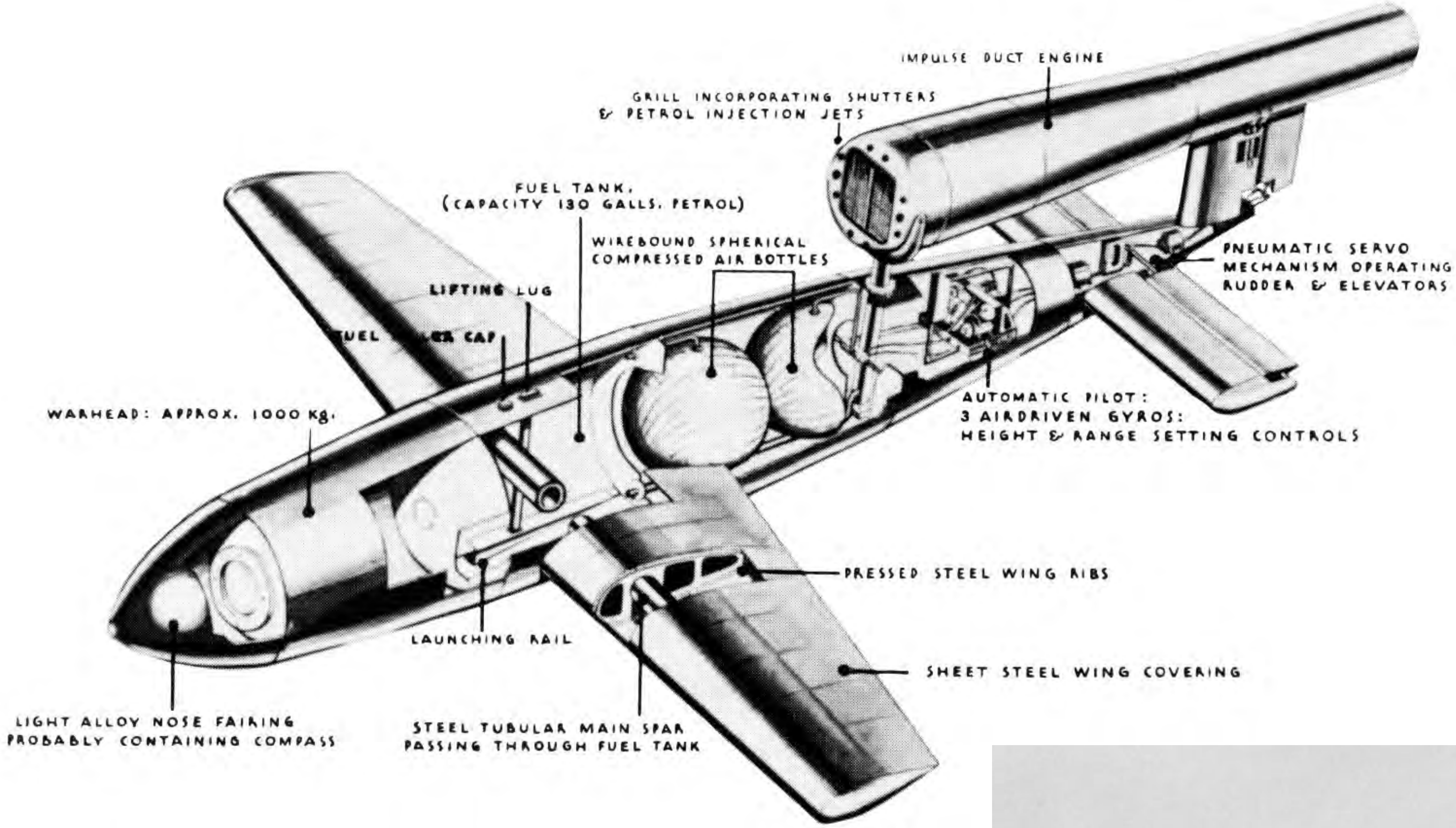
Generic Types of German Air-Dropped Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

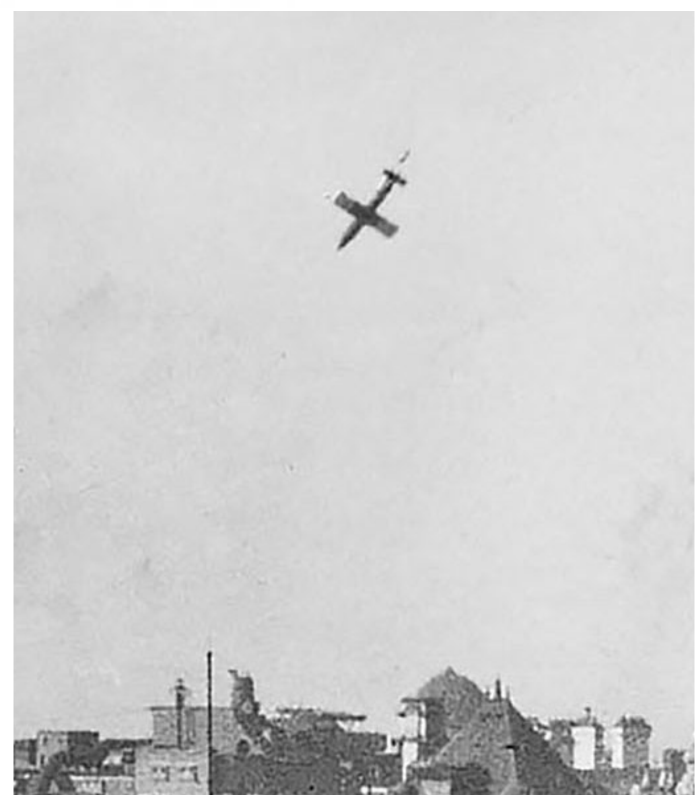
igne

# Vergeltungswaffe 1 (V1) “Fly” Bomb




**Missile Weight**: 2,150kg

**Fuze Type**: Electric Impact Fuze
**Missile Length**: 8.32m
**Width**: 5.37m
**Range**: 250km
**Use**: Pulsejet-powered guided cruise missile, designed to attack Allied cities.
**Remarks**: Armed with an 850kg warhead, around 10,000 V-1 flying bombs were fired at England, causing significant damage and killing approximately 6,000 people . There is a negligible risk from unexploded V-1s today, since the remains would have left incontrovertible evidence of the impact.



A V-1 ‘Fly’ Bomb, captured over London, seconds before impacting

# Appendix 1.4

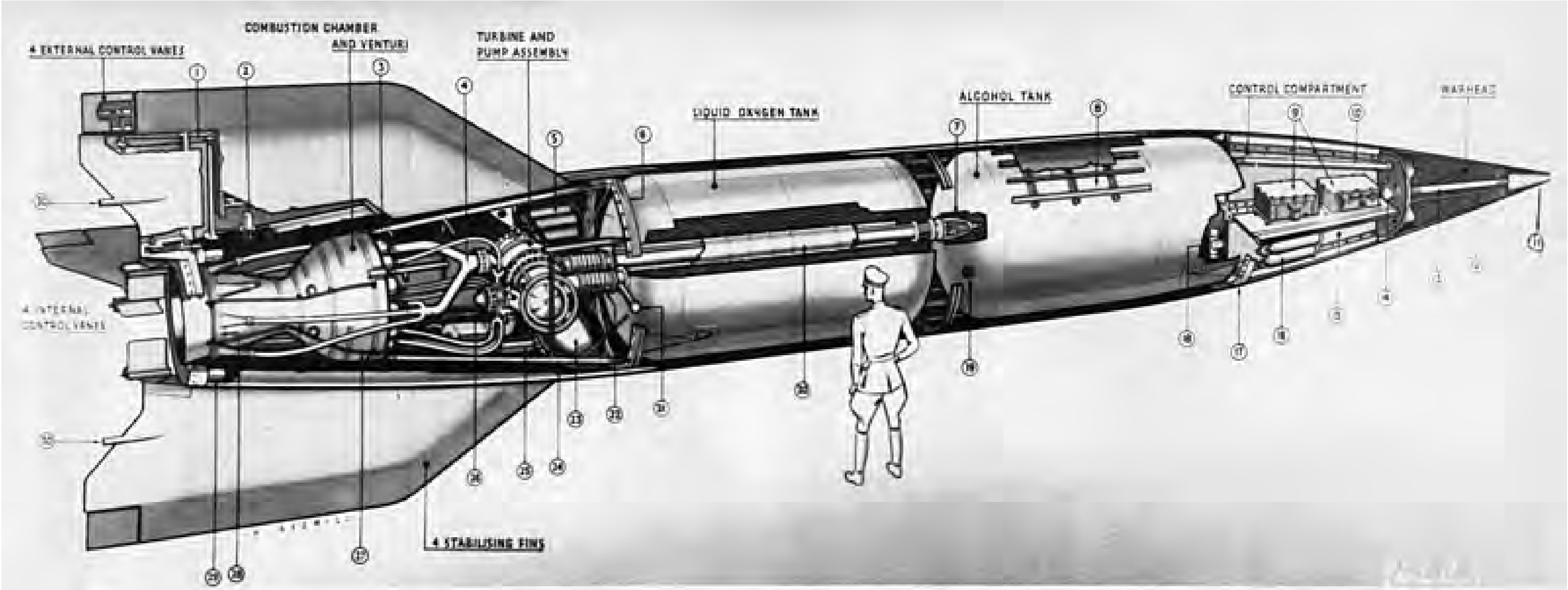
Generic Types of German Air-Dropped Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# Vergeltungswaffe 2 (V2) Rocket

**Rocket Weight**: 12,500kg
**Fuze Type**: Electric Impact Fuze
**Rocket Length**: 14m
**Body Diameter**: 1.65m
**Range**: 320km
**Use**: Long-range ballistic missile, designed to attack Allied cities.
**Remarks**: Armed with a 975kg warhead and travelling at three times the speed of sound, the V-2 could cause widespread destruction. There is a negligible risk from unexploded V-2s today, since the remains would have left incontrovertible evidence of the impact.




1 CHAIN DRIVE TO EXTERNAL CONTROL VALVE
2 ELECTRIC MOTOR
3 BURNER CUPS
4 ALCHOL SUPPLY FROM PUMP
5 AIR BOTTLES
6 REAR JOINT RING AND STRONG POINT FOR TRANSPORT
7 SERVO-OPERATED ALCOHOL OUTLET VALVE
8 ROCKET SHELL
9 RADIO EQUIPMENT
10 PIPE LEADING FROM ALCOHOL TANK TO WARHEAD
11 NOSE PROBABLY FITTED WITH NOSE SWITCH, OR OTHER DEVICE FOR OPERATING WARHEAD FUZE
12 CONDUIT CARRYING WIRES TO NOSE OF WARHEAD
13 CENTRAL EXPLODER TUBE
14 ELECTRIC FUZE FOR WARHEAD
15 PLYWOOD FRAME
16 NITROGEN BOTTLES
17 FRONT JOINT RING AND STRONG POINT FOR TRANSPORT
18 PITCH AND AZIMUTH GYROS
19 ALOCHOL FILLING POINT
20 DOUBLE WALLED ALCOHOL DELIVERY PIPE TO PUMP
21 OXYGEN FILLING POINT
22 CONCERTINA CONNECTIONS
23 HYDROGEN PEROXIDE TANK
24 TUBULAR FRAME HOLDING TURBINE AND PUMP ASSEMBLY
25 PERMANGANATE TANK (GAS GENERATOR UNIT BEHIND THIS TANK)
26 OXYGEN DISTRIBUTOR FROM PUMP
27 ALCOHOL PIPES FOR SUBSIDIARY COOLING
28 ALCOHOL INLET TO DOUBLE WALL
29 ELECTRO-HYDRAULIC SERVO MOTORS
30 AERIAL LEADS

# Appendix 1.5

Generic Types of German Air-Dropped Ordnance

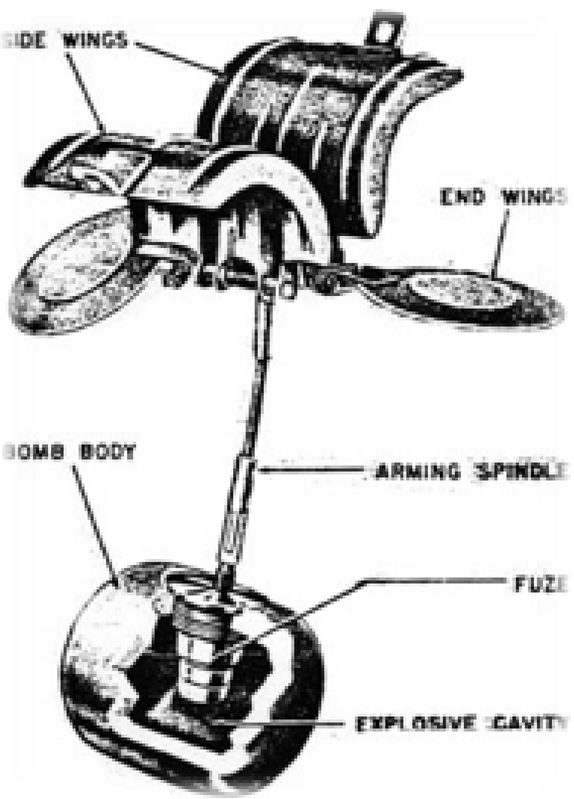
Additional Notes:

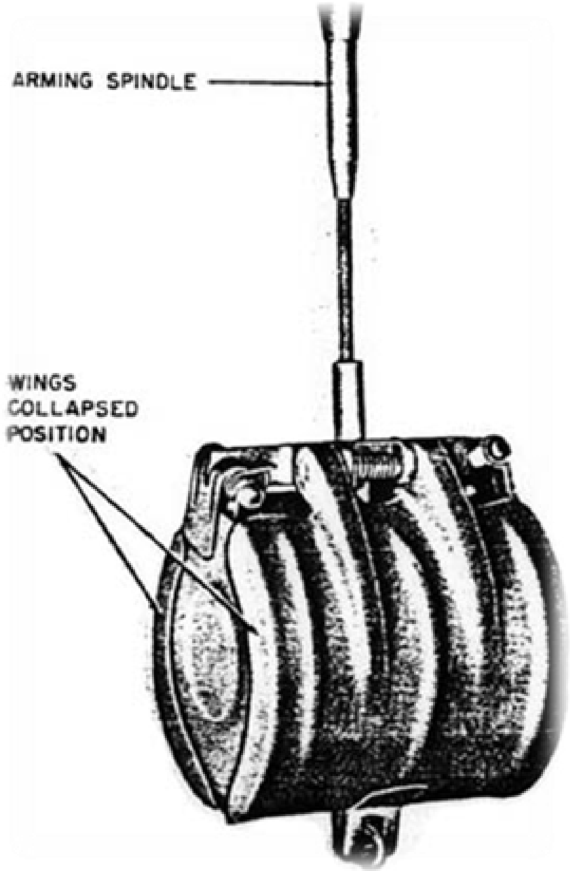
Sources:
Various news sources
Open source images

# SD-2 & SD-2 B "Butterfly Bomb"

**Bomb Weight**: 2.0kg
**Explosive Weight**: 0.225kg
**Explosive Filling**: 225g of TNT
**Fuze Type**: Mechanical (41) clockwork fuze only in SD-2
**Bomb Dimensions**: 200x76mm with cable attachment but without brake airscrews
**Bomb Diameter**: 76mm
**Use**: Against living targets and with Störzünder (deterrent fuze) as mine
**Remarks**: Jettisoned from air-dropped containers. Generally lethal to anyone within a radius of 25m and could injure people as far away as 150m.





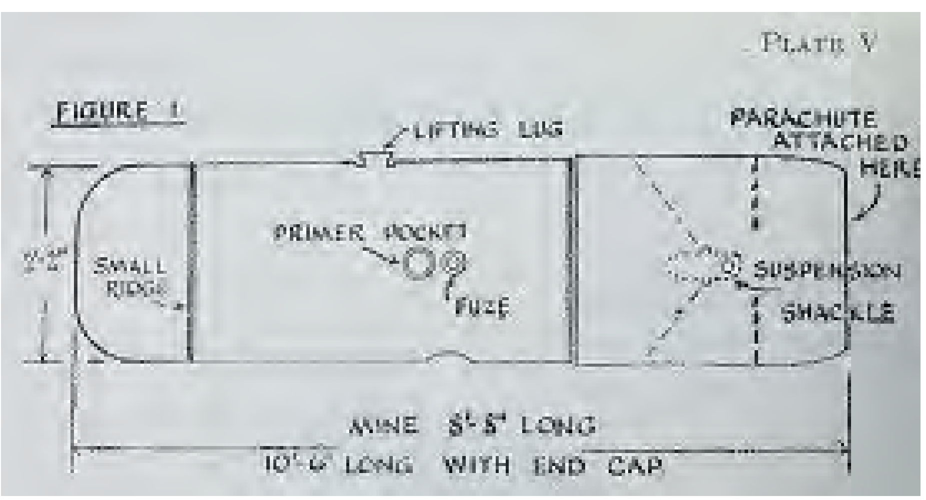

# Appendix 1.6

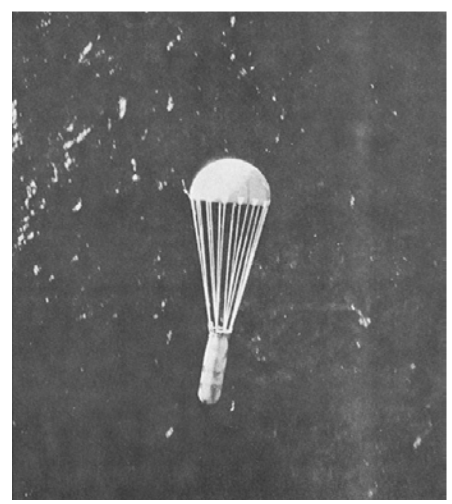
Generic Types of German Air-Dropped Ordnance

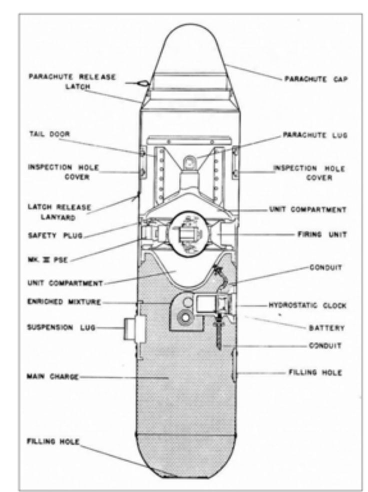
Additional Notes:

Sources:
Various news sources
Open source images

# Luftmine A/B “Parachute Mine”






**Bomb Weight**: A- 500kg, B – 1000kg
**Fuze Type**: Mechanical clockwork fuze
**Bomb Dimensions**: A – 1768mm, B – 2682mm
**Use**: Capable of creating severe blast damage in built-up areas
**Remarks**: Parachute mines were standard German sea mines fitted with a suitable detonator. They were widely used against British cities.

# Appendix 1.7

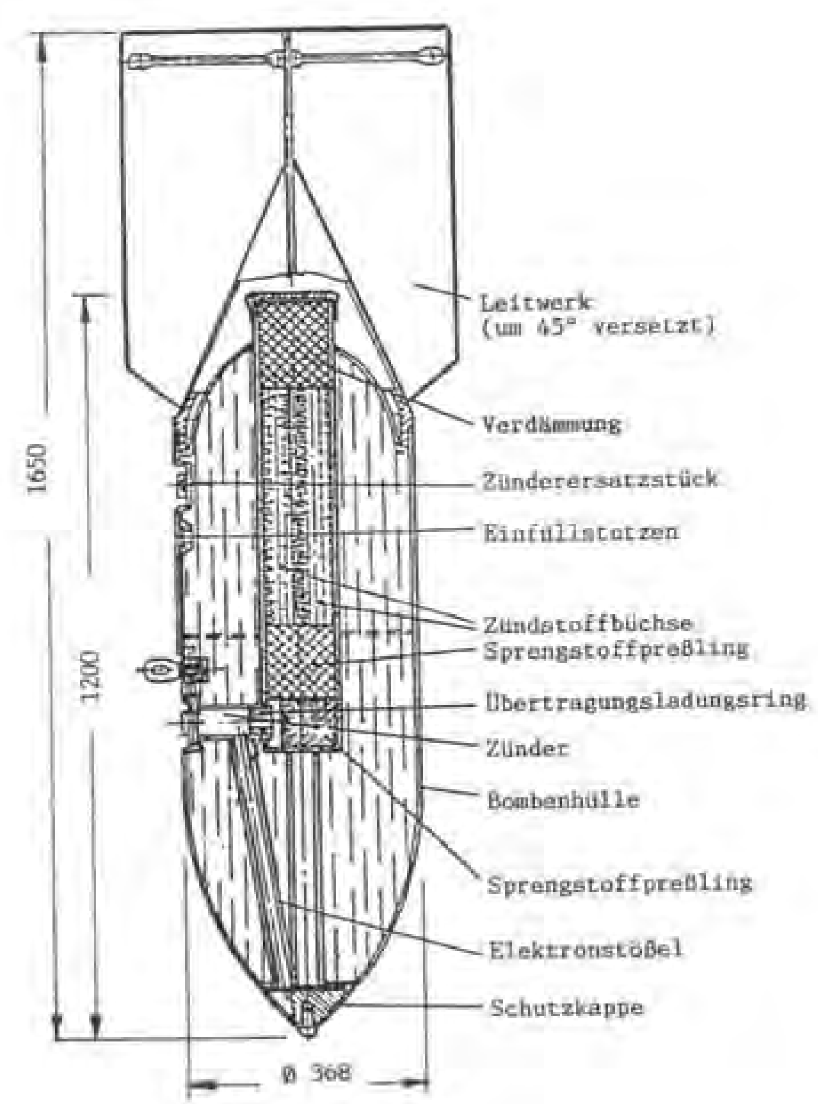
Generic Types of German Air-Dropped Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# Flam C-250 "Oil Bomb"

**Bomb Weight**: 125kg
**Explosive Weight**: 1kg
**Flammable Weight:** 74kg
**Filling:** Mixture of 30% petrol and 70% crude oil
**Fuze Type:** Super-fast electrical impact fuze
**Bomb Dimensions:** 1650 x 512.2mm
**Body Diameter:** 368mm
**Use:** Often used for surprise attacks on living targets, against troop barracks and industrial installations
**Remarks:** Thin casing – not designed for ground penetration



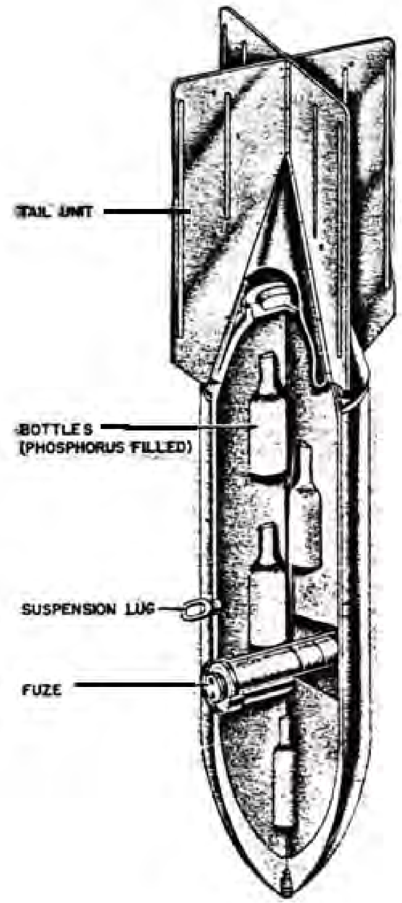

# Appendix 1.8

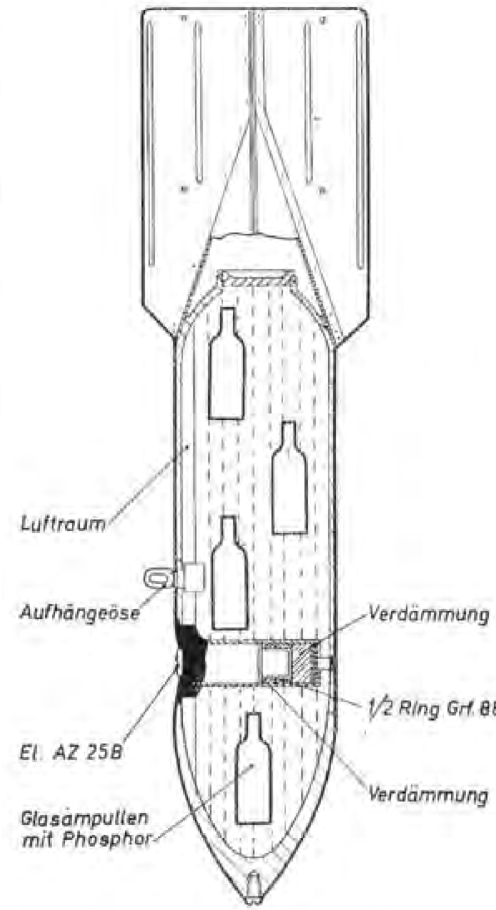
Generic Types of German Air-Dropped Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# C-50 A Phosphorous Bomb




**Bomb Weight**: c.41kg
**Explosive Weight**: 0.03kg
**Incendiary Filling**: 12kg liquid filling with phosphor igniters in glass phials
**Fuze Type**: Electrical impact fuze
**Bomb Dimensions**: 1100 x 2800mm
**Body Diameter**: 200mm
**Use**: Against all targets where an incendiary effect is to be expected
**Remarks**: Early fill was a phosphorus / carbon disulphide incendiary mixture

## Appendix 1.9

Generic Types of German Air-Dropped Ordnance

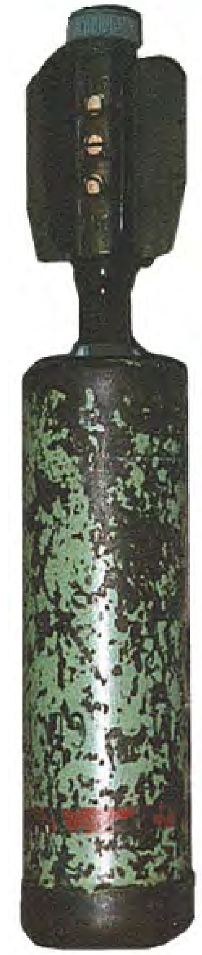
Additional Notes:

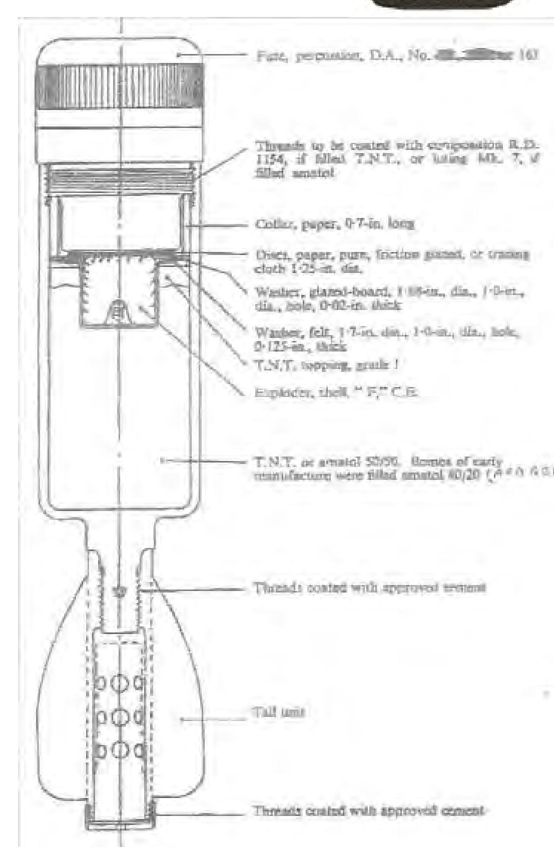
Sources:
Various news sources
Open source images

igne

# Typical 2” High Explosive Mortar

**Bomb weight**: 1.02kg
**Fuze Type**: High Explosive
**Bomb Dimensions**: 51 x 290mm **Filling**: 200g RDX/TNT
**Remarks**: Fitted with an impact fuze which detonates the fuze booster charge (exploder) and, in turn, the high explosive charge. The main charge shatters the mortar bomb body, producing near optimum fragmentation and blast effect at the target.






# Appendix 2.1

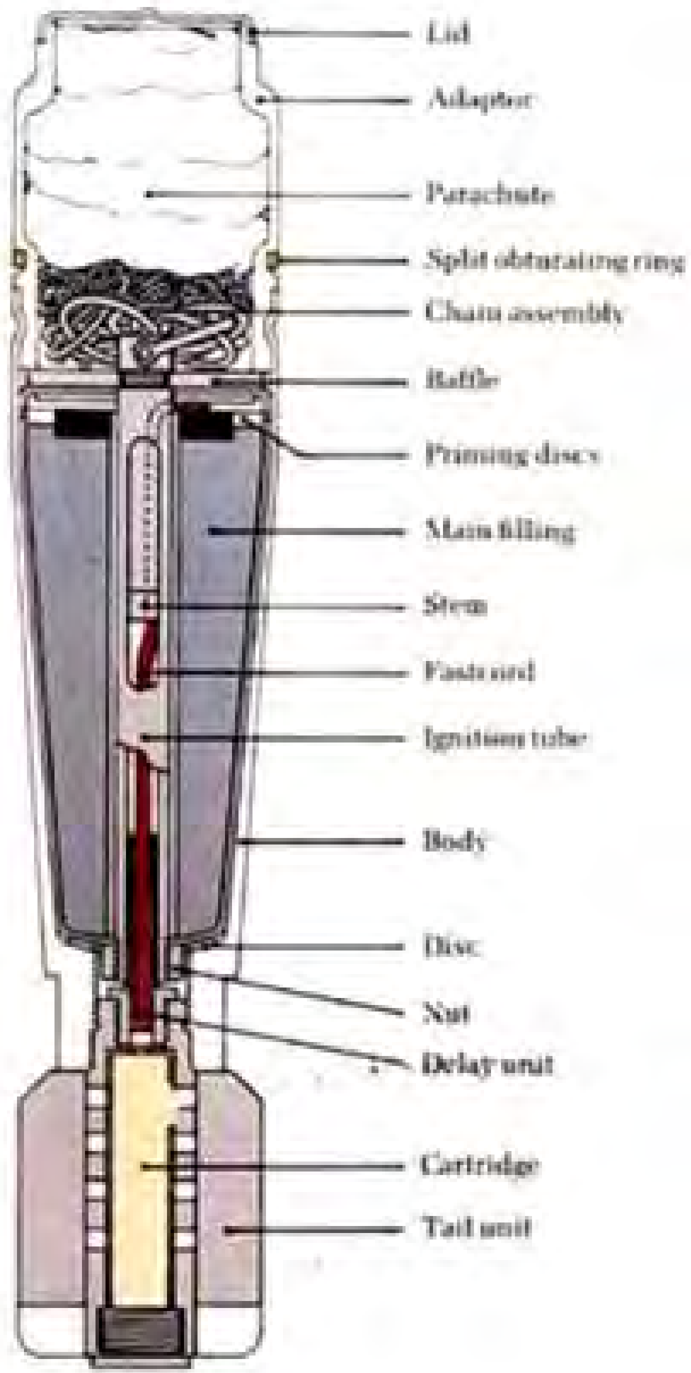
Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# Typical 2” Illuminating Mortar

**Fuze Type**: Illuminating
**Bomb Dimensions**: 51 x 290mm
**Filling**: Various
**Remarks**: The expulsion charge ignites and ejects the candle assembly. A spring ejects the parachute from the tail cone. The parachute opens, slowing the descent of the burning candle which illuminates the target.





# Appendix 2.2

Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# Typical 3” Smoke Mortar

**Fuze Type**: Smoke
**Bomb Dimensions**: c.490 x 76mm
**Filling**: Typically, white phosphorus
**Remarks**: On impact, the fuze functions and initiates the bursting charge. The bursting charge ruptures the mortar bomb body and disperses the white phosphorous filler. The white phosphorous produces smoke upon exposure to the air.

## Appendix 2.3

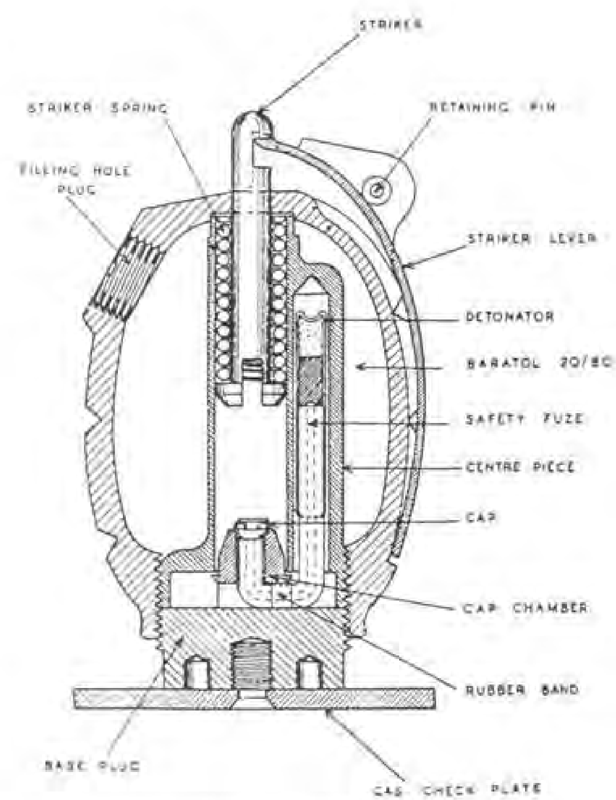
Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

igne

# No. 36 “Mills” Grenade




Grenade, .303 inch rifle, No. 36M, Mark I.

**Weight**: 0.7kg filled
**Type**: Hand or discharger, fragmentation
**Dimensions**: 95 x 61mm
**Filling**: Alumatol, Amatol 2 or TNT
**Remarks**: 4 second hand-throwing fuze with approximate range of 30m. First introduced May 1918.

# Appendix 2.4

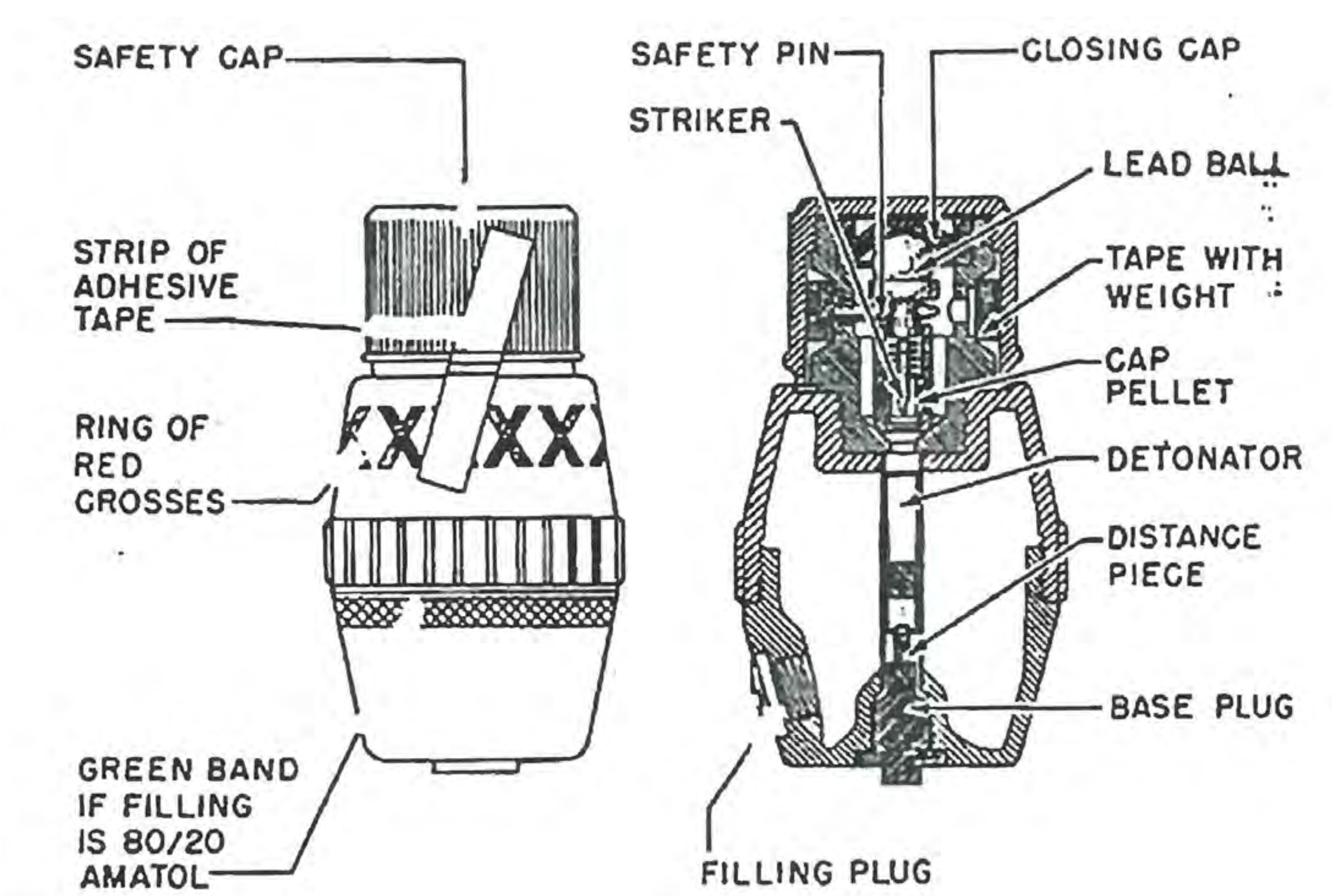
Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# No. 69 Grenade

**Weight**: 038kg filled
**Type**: Percussion / Blast
**Date Introduced**: December 1940
**Remarks**: Black Bakelite body. Blast rather than fragmentation type. After unscrewing the safety cap, a tape is held when throwing the grenade releasing the safety bolt in the throwing motion. Detection is problematic due to its very low metal content.



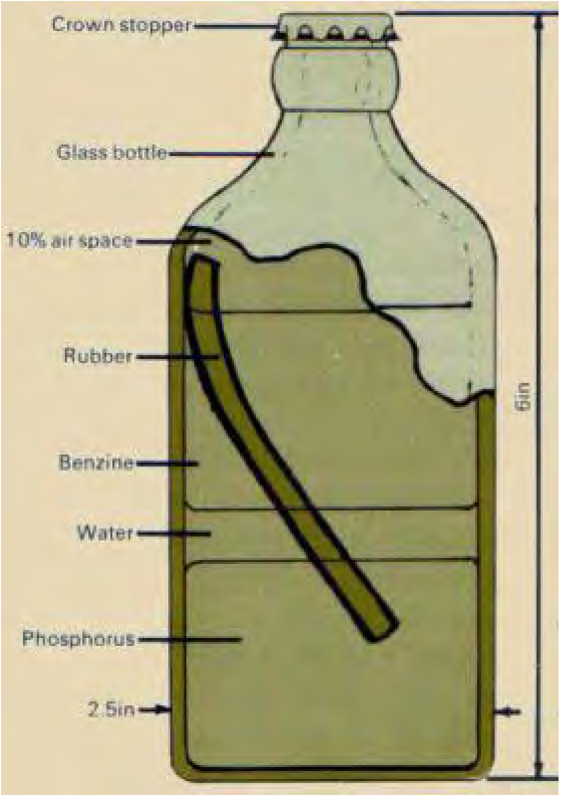

# Appendix 2.5

Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# Self-Igniting Phosphorous (SIP) Grenade




Sometimes called the "A&W (Albright & Wilson)" grenade.

The grenade comprised a glass bottle with a total volume of approximately 1 pint. It was filled with white phosphorous, benzene, a piece of rubber and water. Over time, the rubber dissolved to create a sticky fluid which would self-ignite when the bottle broke.

Fired by hand or Northover Projector.

# Appendix 2.6

Generic Types of British / Allied Land Service Ammunition

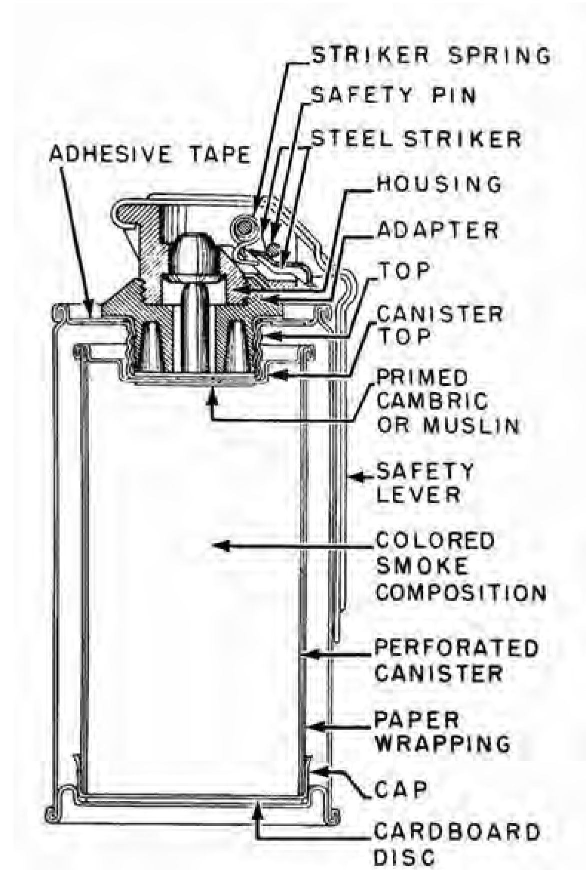
Additional Notes:

Sources:
Various news sources
Open source images

igne

# Typical Smoke Grenade

**Dimensions**: Approx. 65 x 115mm
**Type**: Smoke
**Date Introduced**: Current MoD issue
**Remarks**: Smoke grenades are used as ground-to-ground or ground-to-air signalling devices, target or landing zone marking devices, and screening devices for unit movement.





# Appendix 2.7

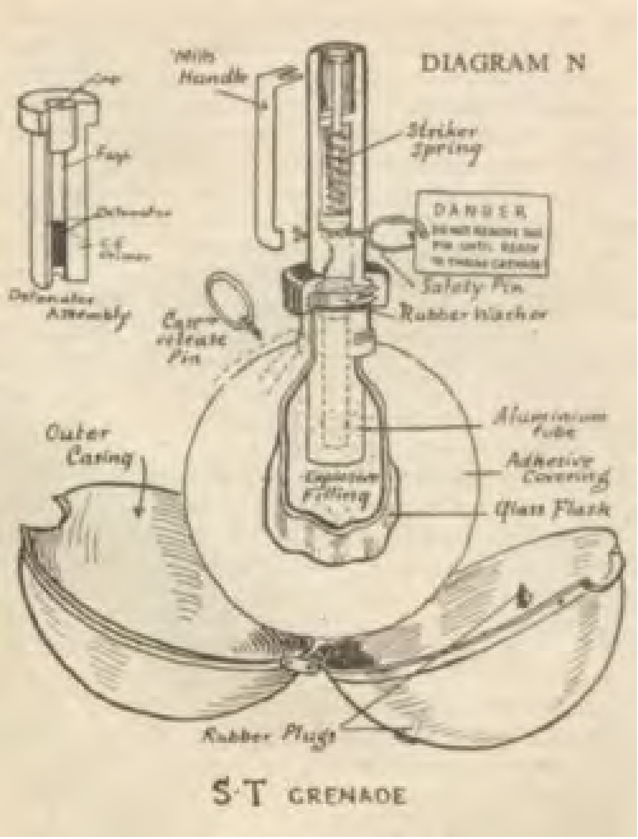
Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# No. 74 Grenade ("Sticky Bomb")

Designed as an anti-tank grenade and used by the Home Guard. The grenade consisted of a glass ball on the end of a Bakelite (plastic) handle. Inside the glass ball was an explosive filling whilst on the outside was a very sticky adhesive covering. Until used, this adhesive covering was encased in a metal outer casing.




## Appendix 2.8

Generic Types of British / Allied Land Service Ammunition

Additional Notes:

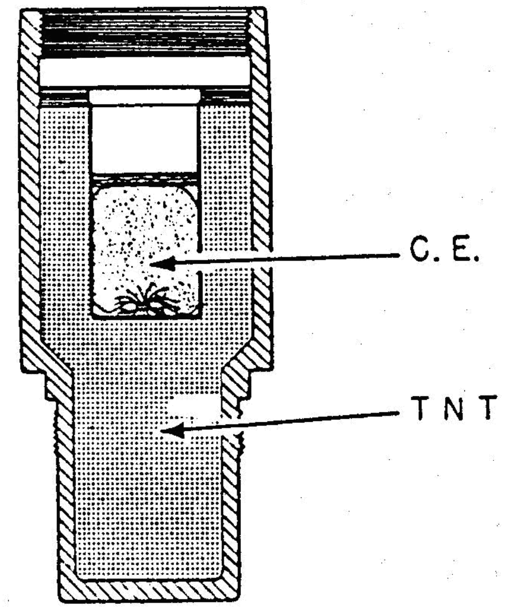
Sources:
Various news sources
Open source images

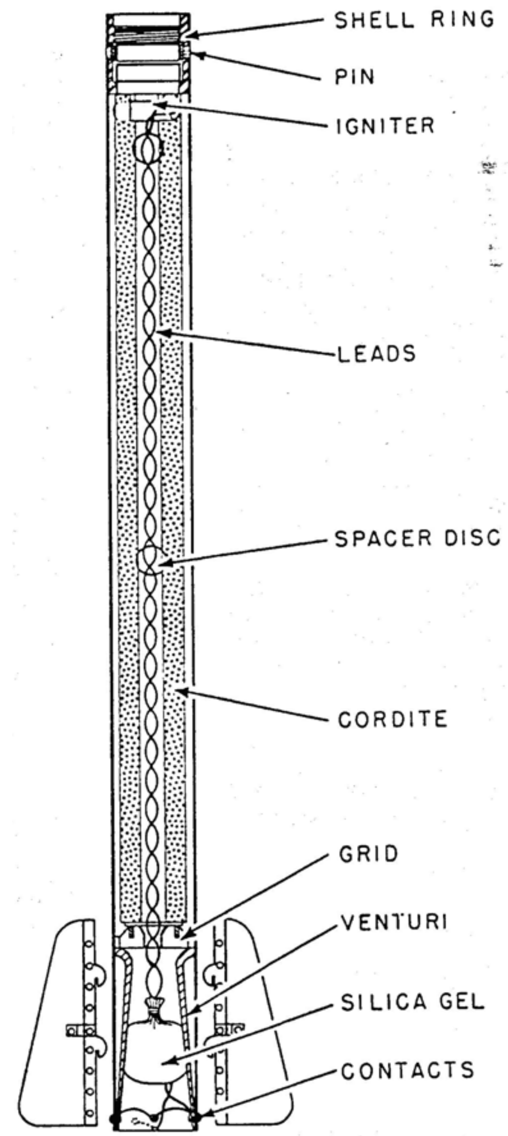
igne

# Rockets / Un-rotating Projectiles

**Weight**: 24.5kg
**Bomb Dimensions**: 94 x 360mm
**Carriage**: Typically, white phosphorus
**Rate of Fire**: 10-20 rounds per minute
**Ceiling**: 9,000-18,000m
**Muzzle Velocity**: 72m/s
**Remarks**: 4.5” projectiles were also commonly utilized.

Home Guard soldiers load an anti-aircraft rocket at a 'Z' Battery




# Appendix 2.9

Generic Types of British / Allied Anti-Aircraft Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# High Explosive Projectile: Fragmentation & Blast

**Features**:

a) Long, pointed ogival nose and streamlined body.

b) Square or tapered base. Boat tailed/streamlined.

c) One-piece body construction.

d) Base plate screwed or welded to the base, occasionally of one piece construction.

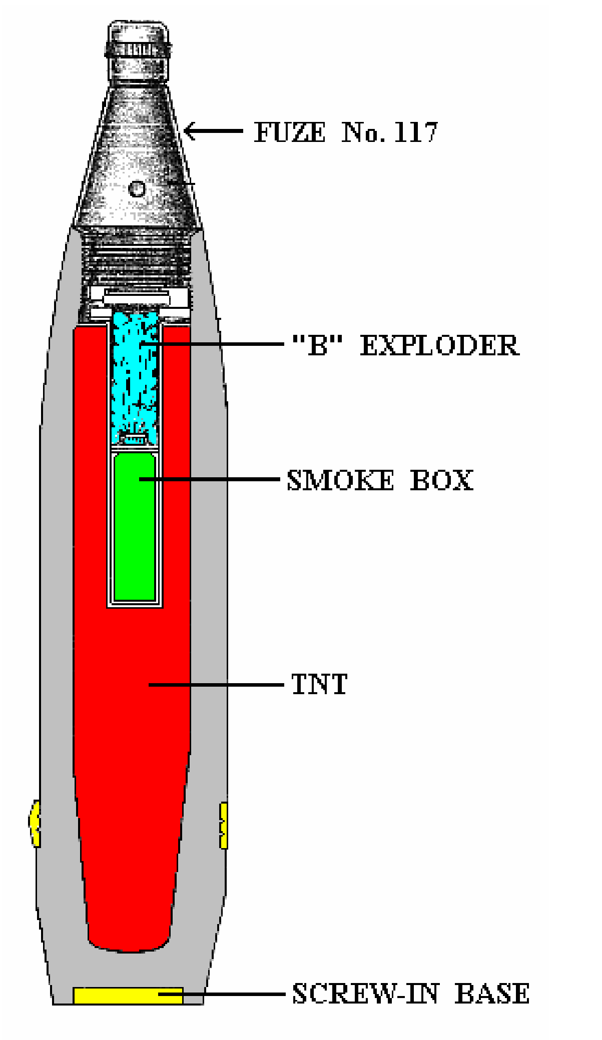
e) Copper driving band near the base of the projectile.

f) Body construction normally thin.

g) Low charge to weight ratio.

h) Fuzed with point-initiating and/or base-detonating fuze.

i) If no driving band is present, it may use two bourrelets.




4in HE Projectile

2in HE Projectile

# Appendix 2.10

Generic Types of British / Allied Land Service Ammunition

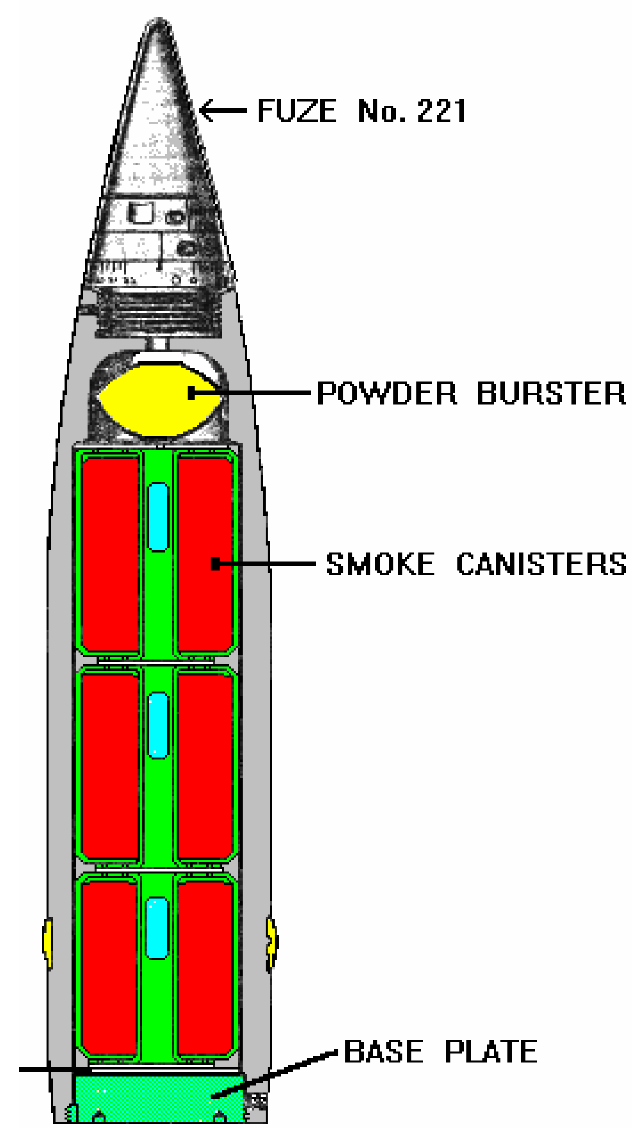
Additional Notes:

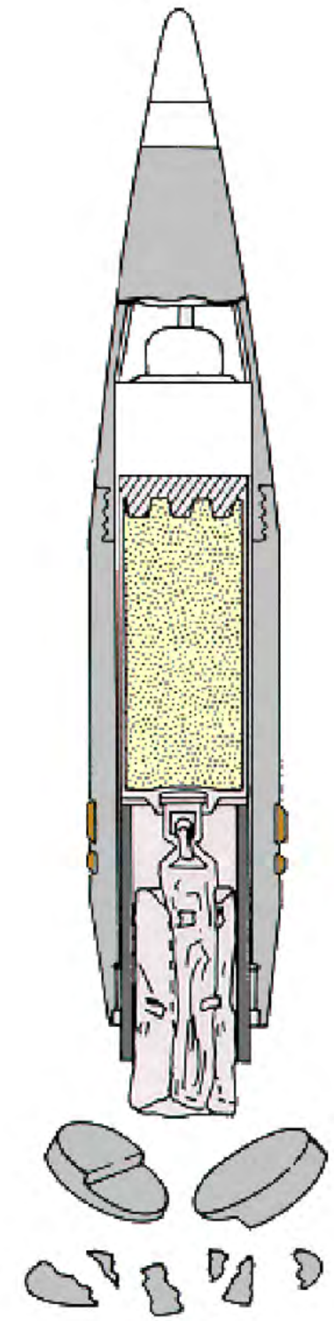
Sources:
Various news sources
Open source images

# Carrier Projectiles: Base Ejection

**Features**:

a) Ogival streamlined nose.
b) Nose/Time fuzed.
c) Parallel sides (on older items).
d) Square or tapered base.
e) One or two-piece body construction.
f) Base plate held in place by weakened PVC ring or shear pins.
g) Copper driving band may be fitted.
h) Base plate ejected if the munition has functioned.
i) Contains a small low explosive burster/expulsion charge.



# Appendix 2.11

Generic Types of British / Allied Land Service Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# Shot Projectiles

**Features**:

a) Driving bands (early designs) or obturators (current designs).

b) Tracer pockets common.

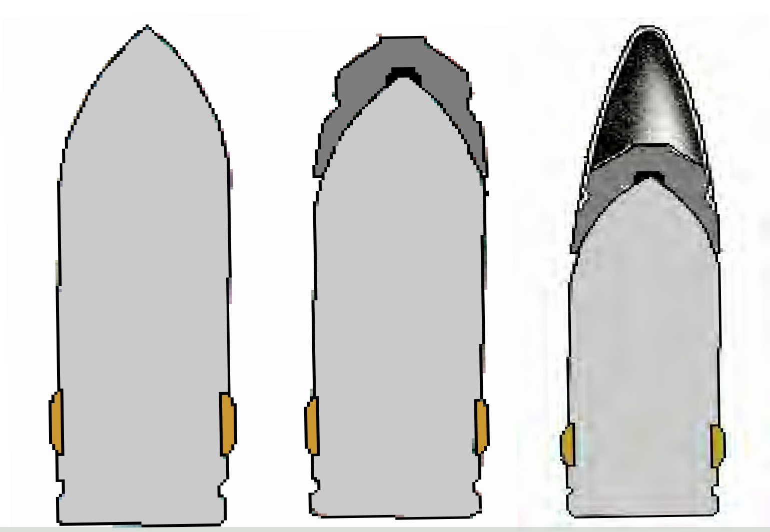
c) Ballistic caps and piercing caps (current designs).

d) Early shot projectiles were made of hard high grade steel. Current designs use tungsten carbide or Depleted Uranium (DU) cores or penetrators.

e) Most current shot projectiles now use discarding sabots, either of the post or petal type

f) Proof shot projectiles have flat heads and are used to test guns.

g) No fuzes are present.

Shot AP Capped AP Capped BC

4in Solid Shot

# Appendix 2.12

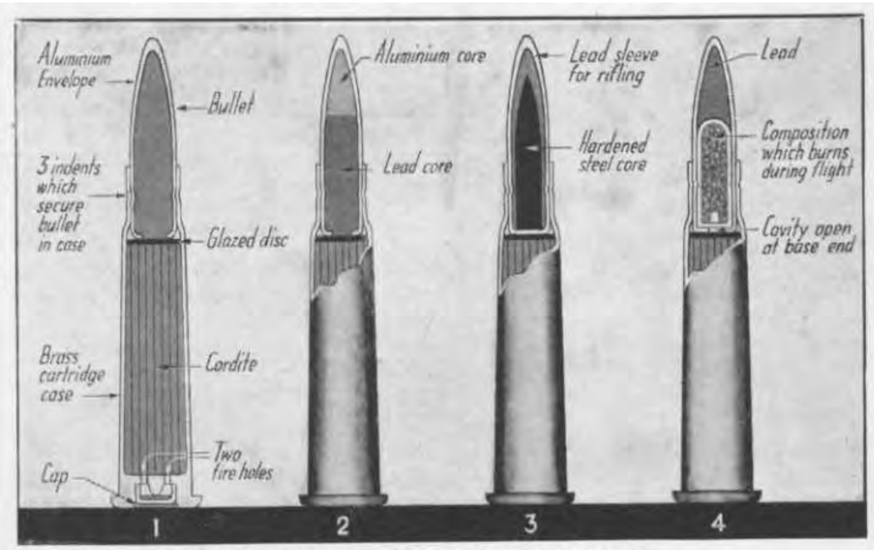
Generic Types of British / Allied Land Service Ammunition

Additional Notes:

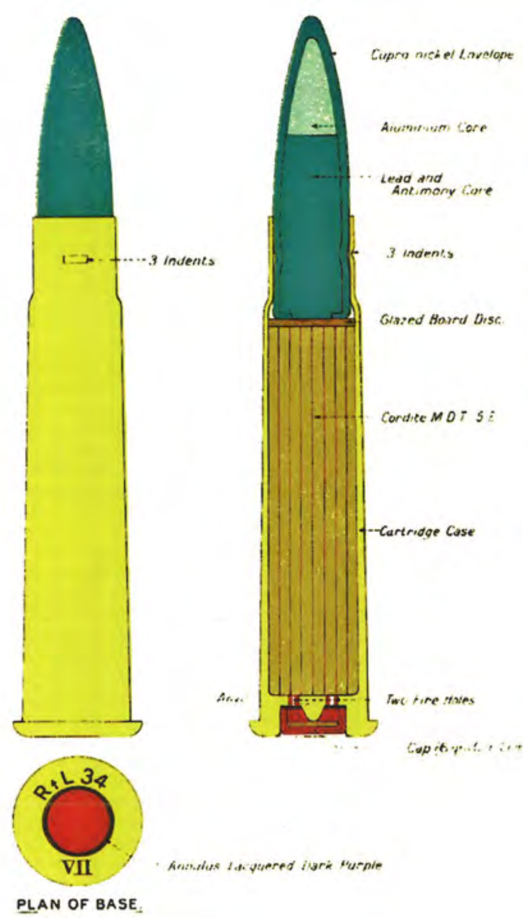
Sources:
Various news sources
Open source images

igne

# .303” Ammunition




TYPES OF SMALL ARMS AMMUNITION
**Fig. 1.** *Four types of ammunition used by modern infantry. 1 and 2 are ball cartridges, 3 is an armour-piercing bullet, and 4 a tracer bullet which burns and makes its flight visible.*




**Type:** Rifle / machine gun round
**Markings**: Regular round – none. Tracer round – red primer
**Bullet Weight**: 150 – 180g
**Dimensions**: Total cartridge / projectile length – 182mm
**Filling**: Regular round – none. Tracer round – small incendiary fill
**Threat**: Explosive cordite within unspent cartridge
**Deployment**: Royal Navy, RAF and British Army Light Anti-Aircraft guns, machine guns and rifles. Standard British and Commonwealth military cartridge from 1889 until the end of the 1950s.
**Remarks**: Cartridges are belted or supplied loose in cartons

# Appendix 2.13

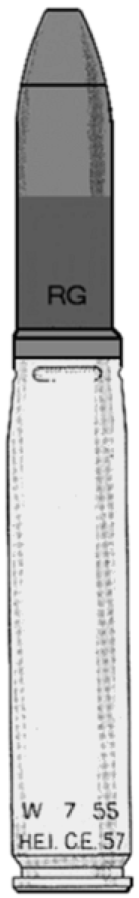
Generic Types of British / Allied Small Arms Ammunition

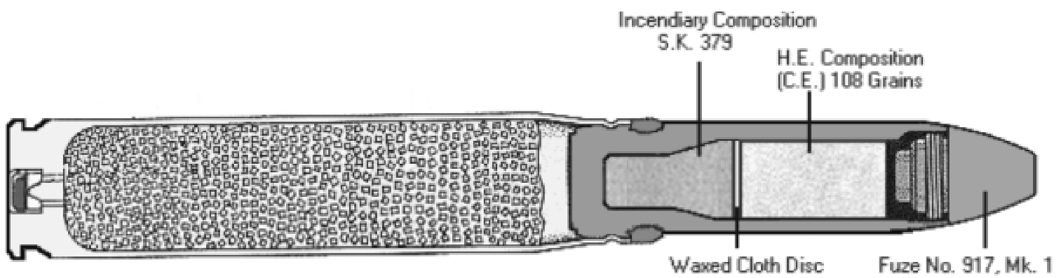
Additional Notes:

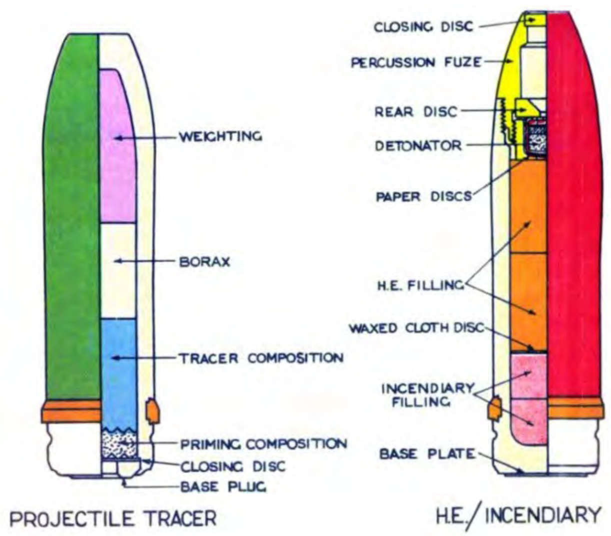
Sources:
Various news sources
Open source images

igne

# 200mm Hispano HEI Ammunition




| COLOUR IDENTIFICATION | | |
|---|---|---|
| BRITISH | | |
| NATURE OF SHELL | H.E. FILLING | COLOUR |
| H.E. TRACER | T.N.T. | |
| H.E | T.N.T. | |
| PROJ. PRACTICE | | |
| PROJ. TRACER | | |
| H.E. INCENDIARY | T.N.T. | |
| H.E. INCENDIARY TRACER | T.N.T. | |

**Type**: Live cannon round
**Markings**: Upper half of projectile painted “buff” colour, lower half is red
**Cartridge Weight**: 256g
**Dimensions**: Total cartridge / projectile length – 182mm
**Fuze**: Contact fuze – No. 253, No. 254 or No. 917
**Filling**: 108 grains of contact explosive & 68 grains of SR. 379 incendiary composition
**Threat**: Explosives within unspent cartridge as well as the projectile
**Deployment**: Royal Navy, RAF and British Army Light Anti-Aircraft guns, and RAF aircraft cannons.
**Remarks**: Cartridges are belted or supplied loose in cartons.

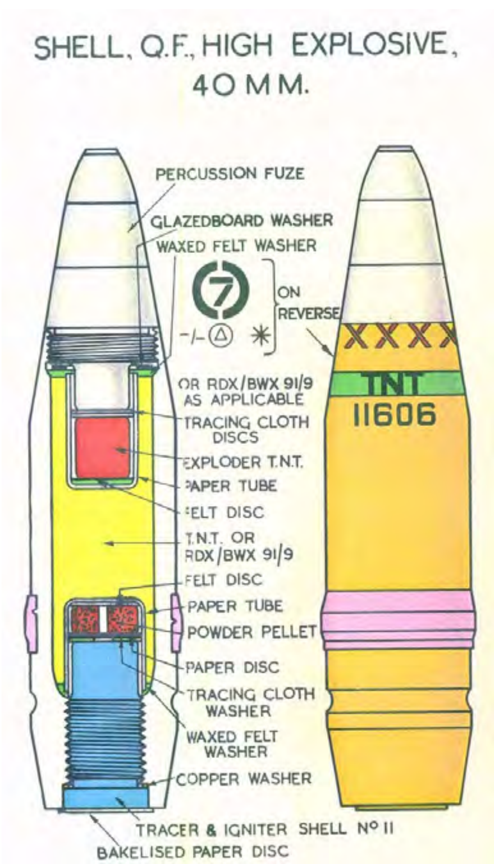
Appendix 2.14

Generic Types of British / Allied Small Arms Ammunition

Additional Notes:

Sources:
Various news sources
Open source images

# 40mm Bofors Gun Projectile




**Weight**: 0.86kg
**Bomb Dimensions**: 40mm x 310mm
**Rate of Fire**: 120 rounds per min
**Ceiling**: 7,000m
**Muzzle Velocity**: 881m/s
**Remarks**: Mobile batteries – normally few records of where these guns were located

# Appendix 2.15

Generic Types of British / Allied Anti-Aircraft Ordnance

Additional Notes:

Sources:
Various news sources
Open source images

# 3.7” Anti-Aircraft Projectile

**Weight**: 12.7kg (28lb)

**Dimensions**: 94 x 360mm (3.7 x 14.7in)

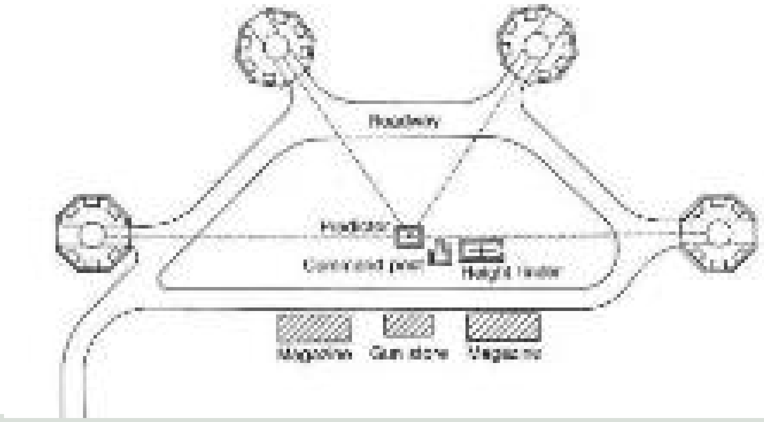
**Carriage**: Mobile and Static Versions

**Rate of Fire**: 10-20 rounds per minute

**Ceiling**: 9-18,000m (29-59,000ft)

**Muzzle Velocity**: 792m/s (2,598ft/s)

**Remarks**: 4.5 inch projectiles were also commonly utilised




Layout plan for a typical HAA battery site.

3.7 inch AA Projectile, Minus Fuze.

This AA shell was uncovered on a construction site in North London in February 2009.

Hyde Park 1939 3.7 Inch QF gun on mobile mounting.

# Appendix 2.16

Generic Types of British / Allied Anti-Aircraft Ordnance

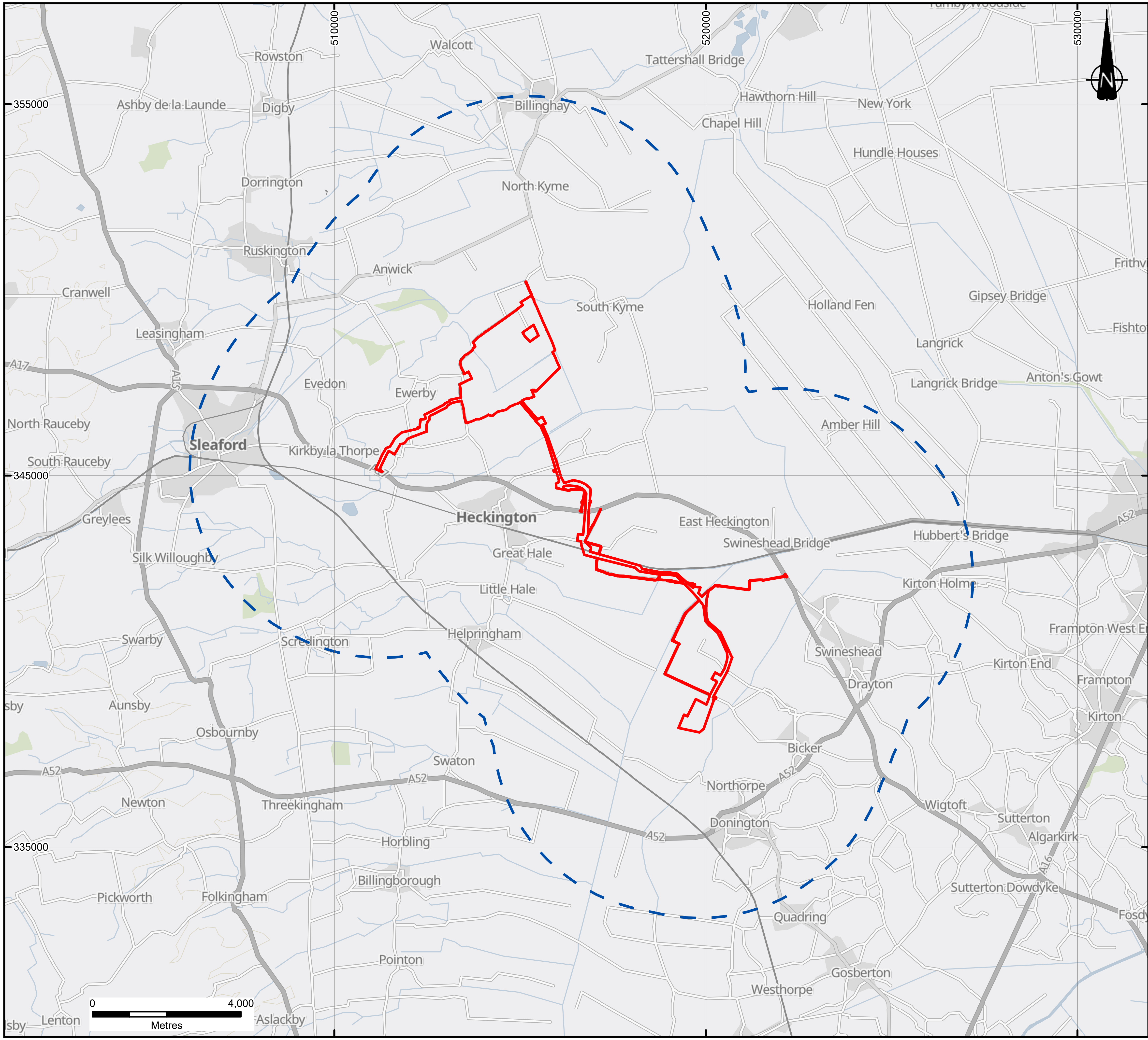
Additional Notes:

Sources:
Various news sources
Open source images

We invite you to contribute to our continuous improvement efforts by sharing your feedback. Your insights are invaluable to us in enhancing the quality of our services. Kindly take a moment to fill out our customer feedback form through the following link:

[redacted]

# Drawings




## KEY

DCO Order Limits

5km Buffer

Notes:

DCO Order Limits provided by Ardent Management on 04/02/2025.

Contains OS data © Crown Copyright and database right 2025. Contains data from OS Zoomstack

| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|
| 1 | FIRST ISSUE | 05/03/25 | CP | SG | MW |

CLIENT

BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

SITE LOCATION WITH 5KM BUFFER

| DRG No. | | REV |
|---|---|---|
| ST19595-120 | | 1 |
| DRG SIZE: A3 | SCALE: 1:100,000 | DATE: 05/03/2025 |
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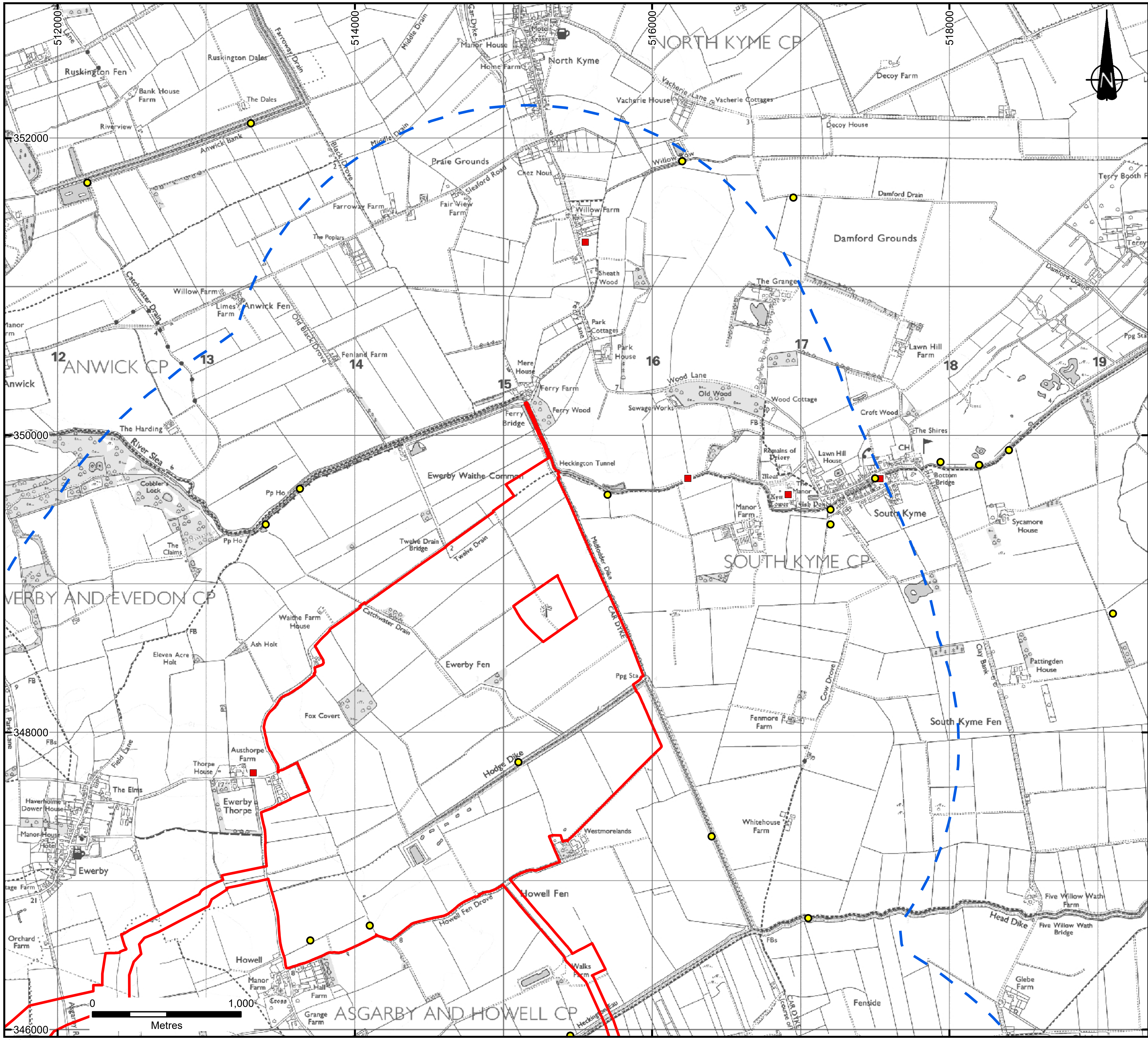


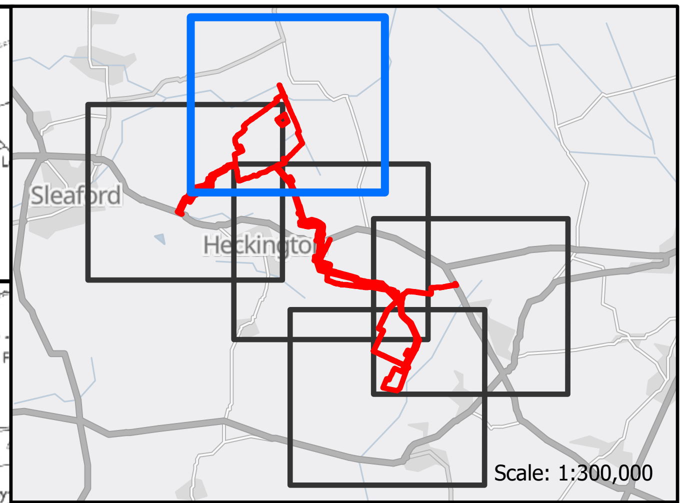


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KEY

- DCO Order Limits
- 2km Site Buffer
- Surfacewater Abstractions
- Discharge Consents

Notes:

DCO Order Limits provided by Ardent Management on 04/02/2025.

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BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

RECORDED POLLUTION INCIDENTS, WATER ABSTRACTIONS AND DISCHARGES SHEET 1 OF 5

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-132 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:25,000 | 05/03/2025 |

| DRAWN BY | CHECKED BY | APPROVED BY |
|---|---|---|
| CP | SG | MW |

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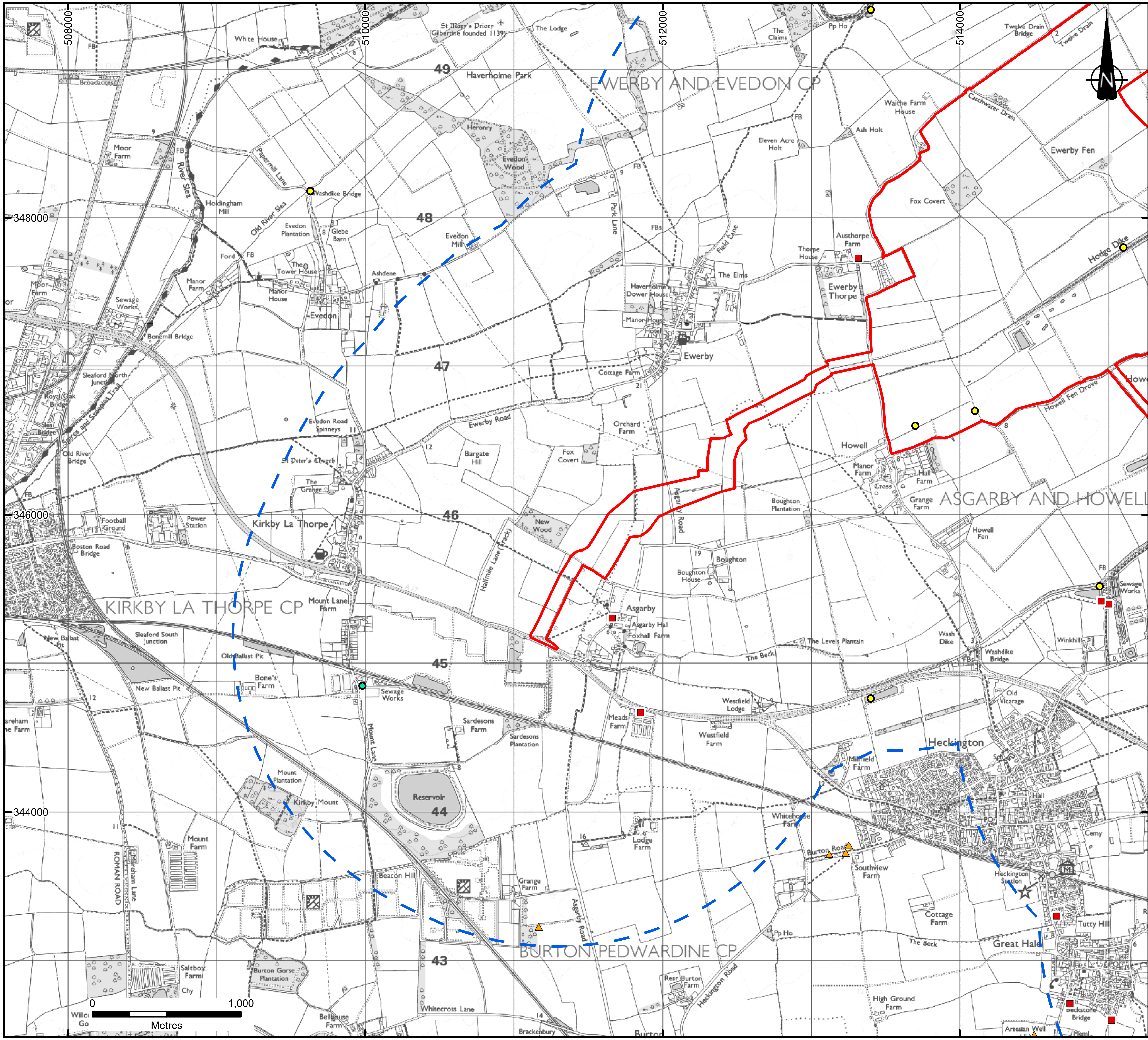


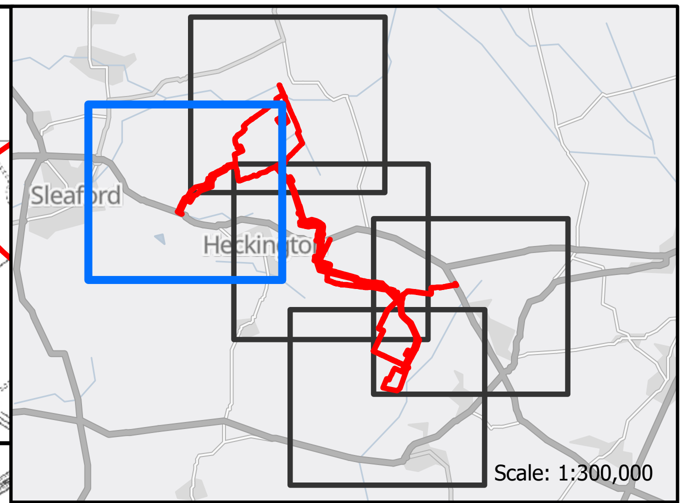


KEY

- DCO Order Limits
- 2km Site Buffer
- Groundwater Abstractions
- Surfacewater Abstractions
- Discharge Consents
- Recorded Historical Pollution Incidents

Notes:

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BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

RECORDED POLLUTION INCIDENTS, WATER ABSTRACTIONS AND DISCHARGES SHEET 2 OF 5

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-132 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
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|---|---|---|
| CP | SG | MW |

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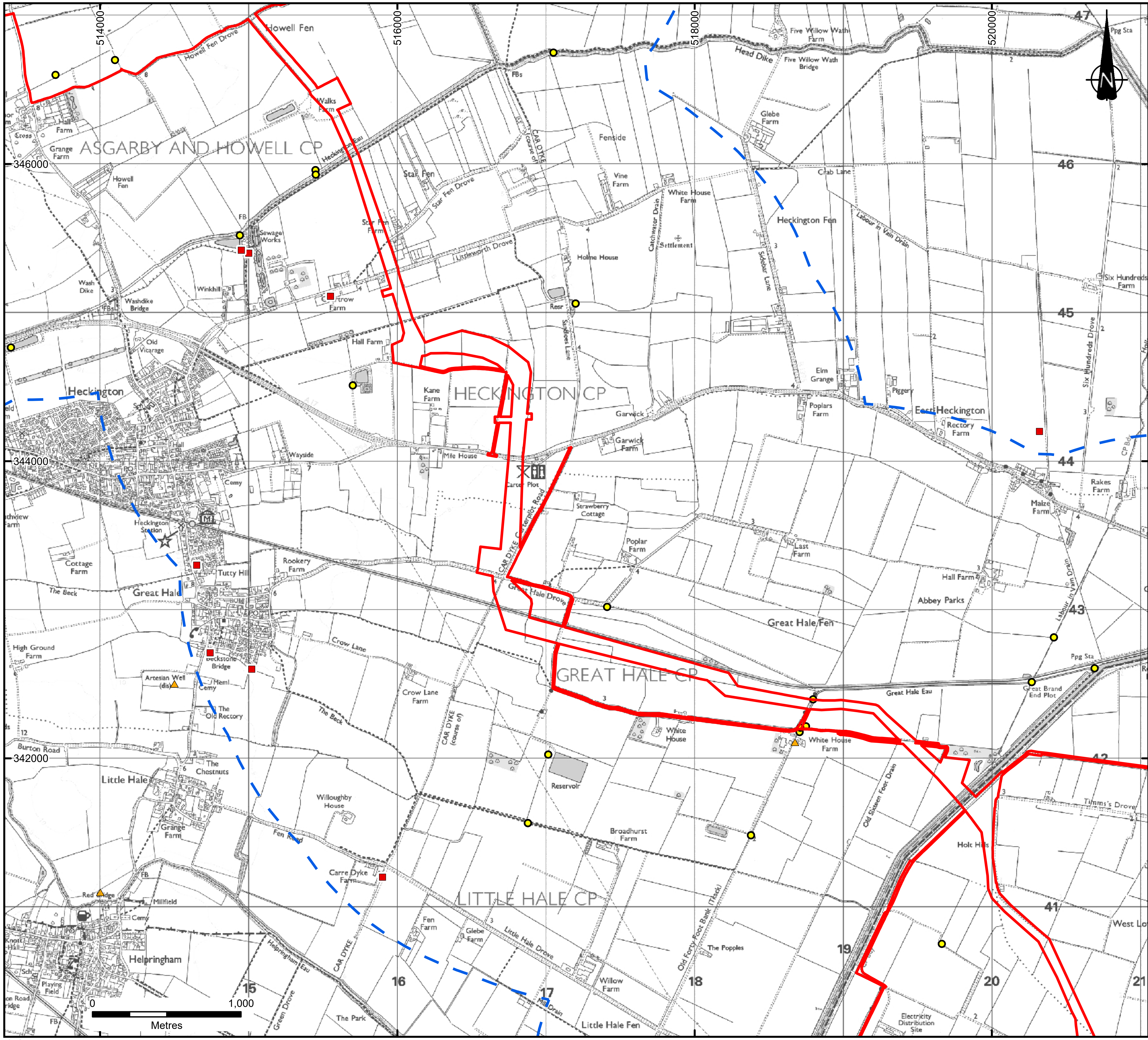


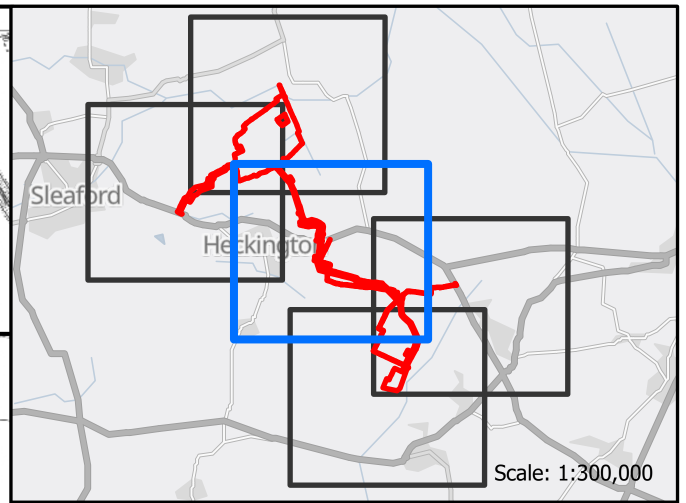


## KEY

- DCO Order Limits
- 2km Site Buffer
- Surfacewater Abstractions
- Discharge Consents
- Recorded Historical Pollution Incidents

Notes:

DCO Order Limits provided by Ardent Management on 04/02/2025.



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PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

RECORDED POLLUTION INCIDENTS, WATER ABSTRACTIONS AND DISCHARGES
SHEET 3 OF 5

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-132 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:25,000 | 05/03/2025 |

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| CP | SG | MW |

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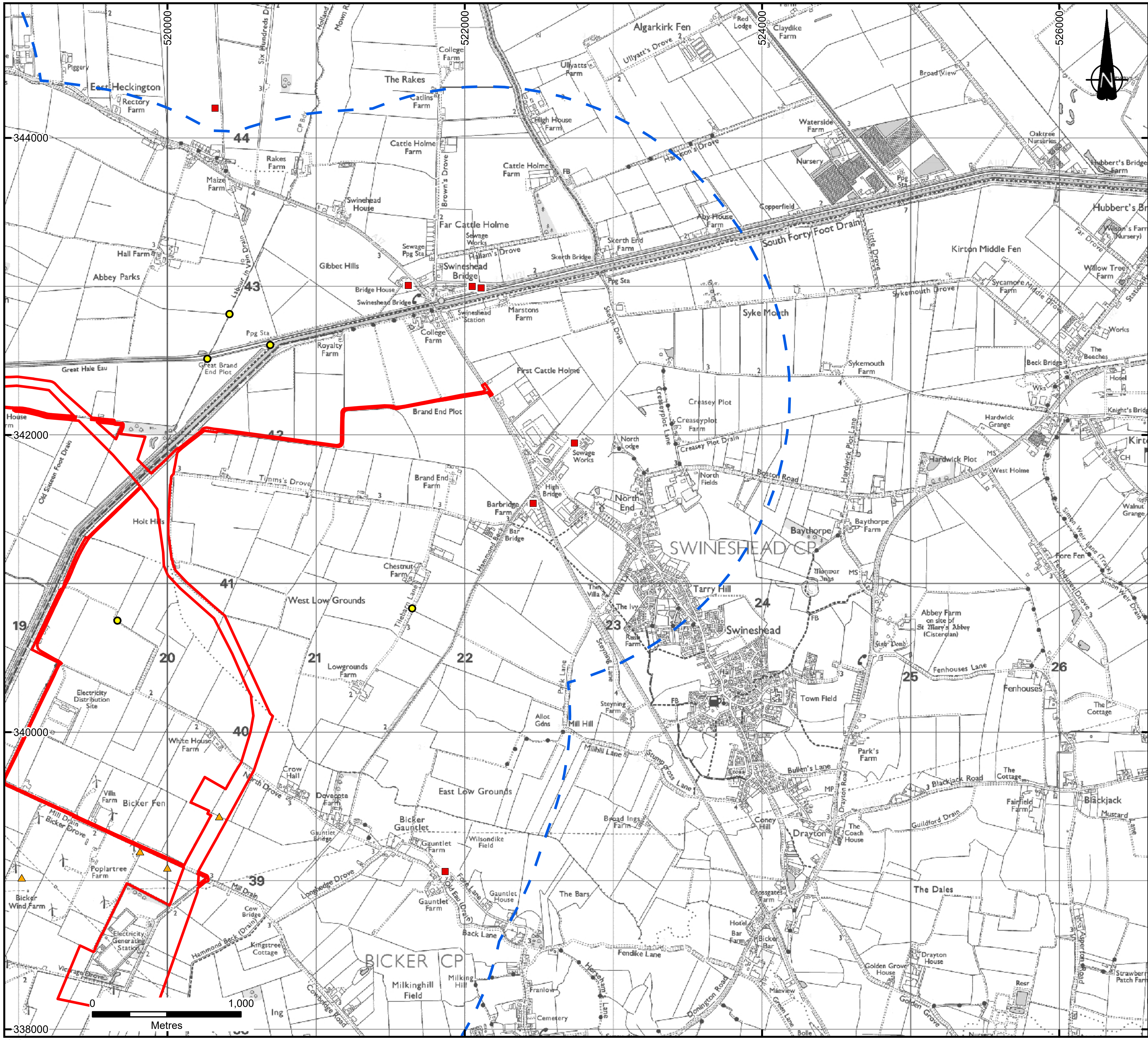


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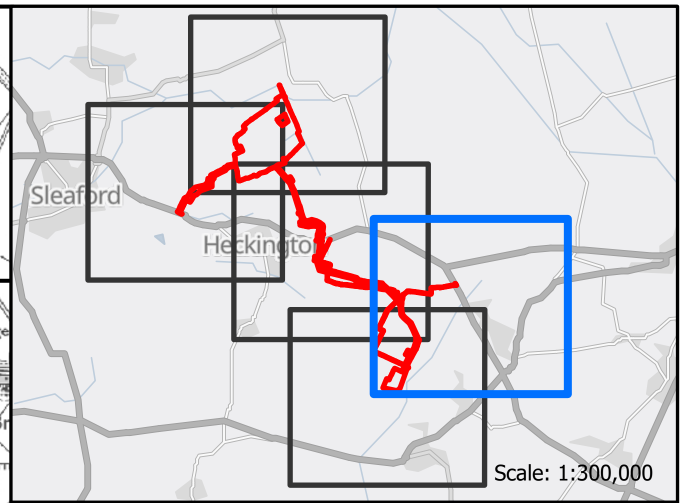


KEY

- DCO Order Limits
- 2km Site Buffer
- Surfacewater Abstractions
- Discharge Consents
- Recorded Historical Pollution Incidents

Notes:

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BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

RECORDED POLLUTION INCIDENTS, WATER ABSTRACTIONS AND DISCHARGES
SHEET 4 OF 5

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-132 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:25,000 | 05/03/2025 |

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| CP | SG | MW |

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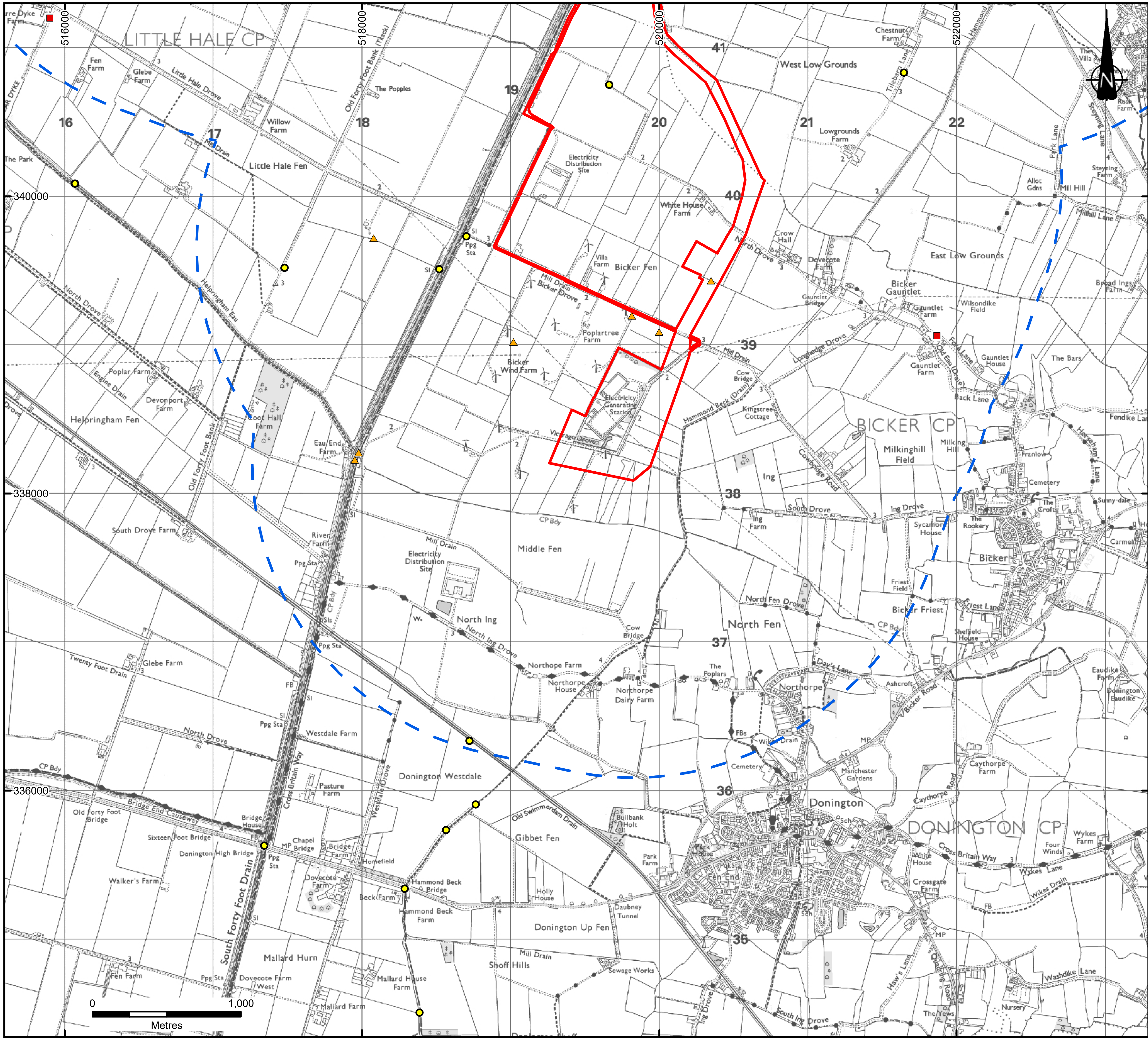



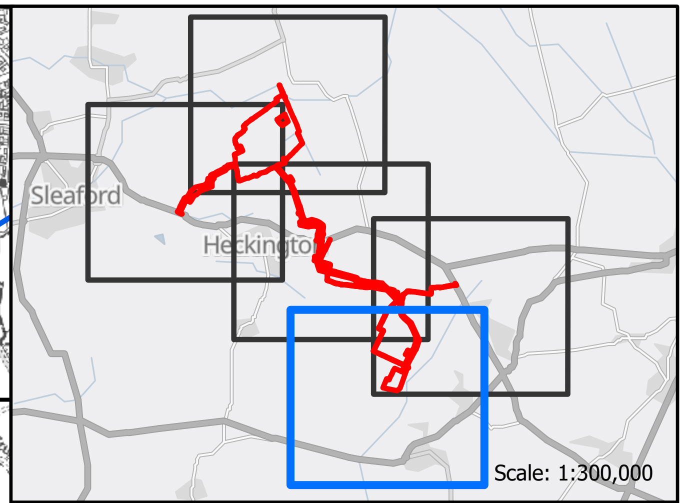


## KEY

- DCO Order Limits
- 2km Site Buffer
- Surfacewater Abstractions
- Discharge Consents
- Recorded Historical Pollution Incidents

Notes:

DCO Order Limits provided by Ardent Management on 04/02/2025.



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|---|---|---|---|---|---|
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BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

RECORDED POLLUTION INCIDENTS, WATER ABSTRACTIONS AND DISCHARGES SHEET 5 OF 5

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-132 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:25,000 | 05/03/2025 |

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| CP | SG | MW |

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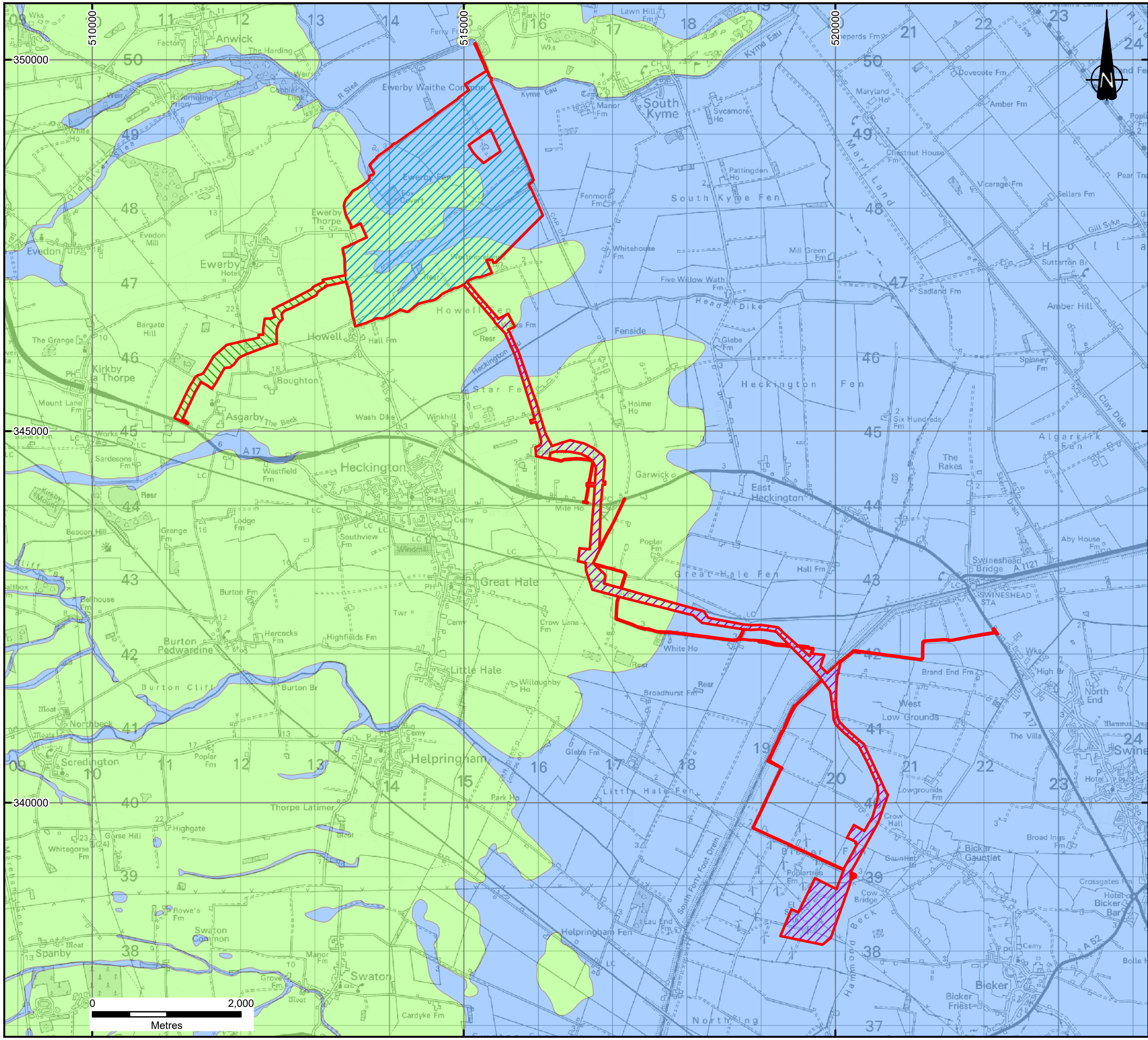


## KEY

- DCO Order Limits
- Solar Array Area
- Bespoke Access Corridor
- Cable Route Corridor

**GeoSure Hazard Class**

- A - Not believed to be present
- B - Unlikely to be present

**Notes:**

Excluding the DCO Order Limits, boundaries shown are indicative.

DCO Order Limits provided by Ardent Management on 04/02/2025.



| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
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BEACON FEN ENERGY PARK

DRAWING TITLE

# BGS GEOSURE HAZARDS: COLLAPSIBLE DEPOSITS

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-133 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

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| CP | SG | MW |

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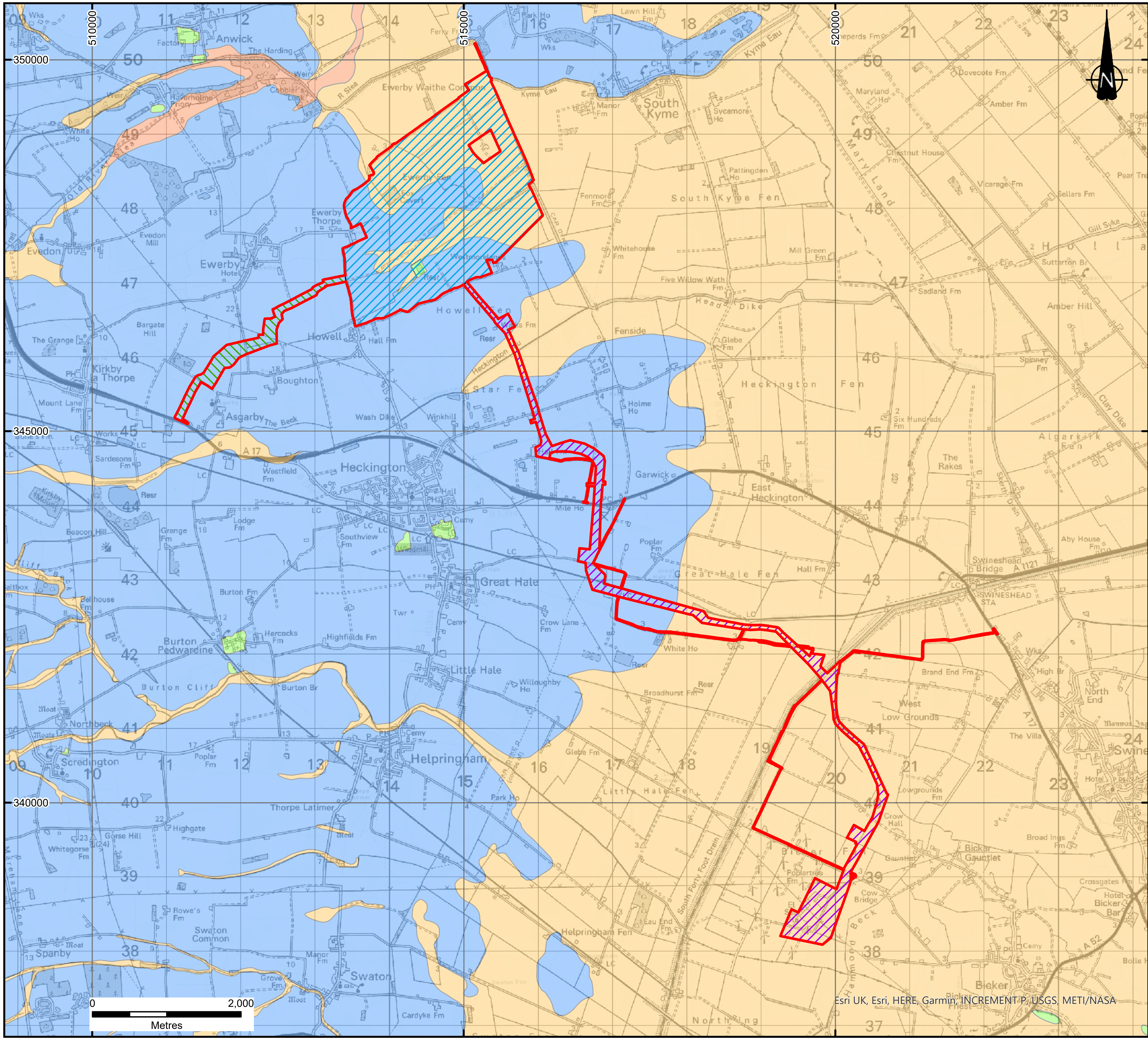


## KEY

- DCO Order Limits
- Solar Array Area
- Bespoke Access Corridor
- Cable Route Corridor

**GeoSure Hazard Class**

- A - Not believed to be present
- B - Unlikely to be present
- D - Probably present
- E - Present, significant constraint

**Notes:**

Excluding the DCO Order Limits, boundaries shown are indicative.

DCO Order Limits provided by Ardent Management on 04/02/2025.



| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
|---|---|---|---|---|---|
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DRAWING TITLE

BGS GEOSURE HAZARDS: COMPRESSIBLE DEPOSITS

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-134 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

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| CP | SG | MW |

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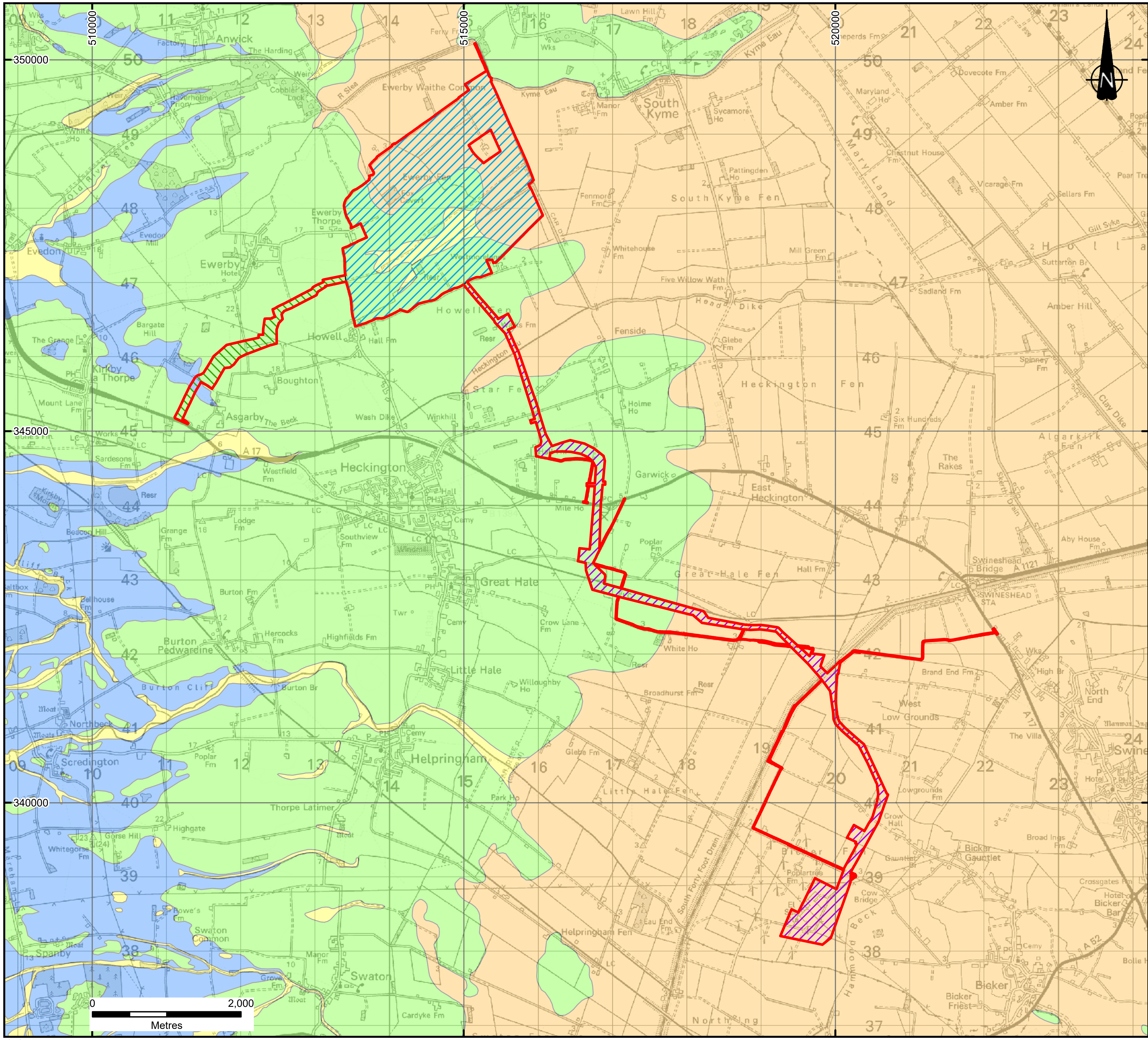


KEY

- DCO Order Limits
- Solar Array Area
- Bespoke Access Corridor
- Cable Route Corridor

GeoSure Hazard Class

- A - Not believed to be present
- B - Unlikely to be present
- C - Possibly present
- D - Probably present

Notes:

Excluding the DCO Order Limits, boundaries shown are indicative.

DCO Order Limits provided by Ardent Management on 04/02/2025.



| REVISION | DETAILS | DATE | DRAWN | CHK'D | APP'D |
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BEACON FEN ENERGY PARK LTD

PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

BGS GEOSURE HAZARDS:
RUNNING SANDS

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-135 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

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| CP | SG | MW |

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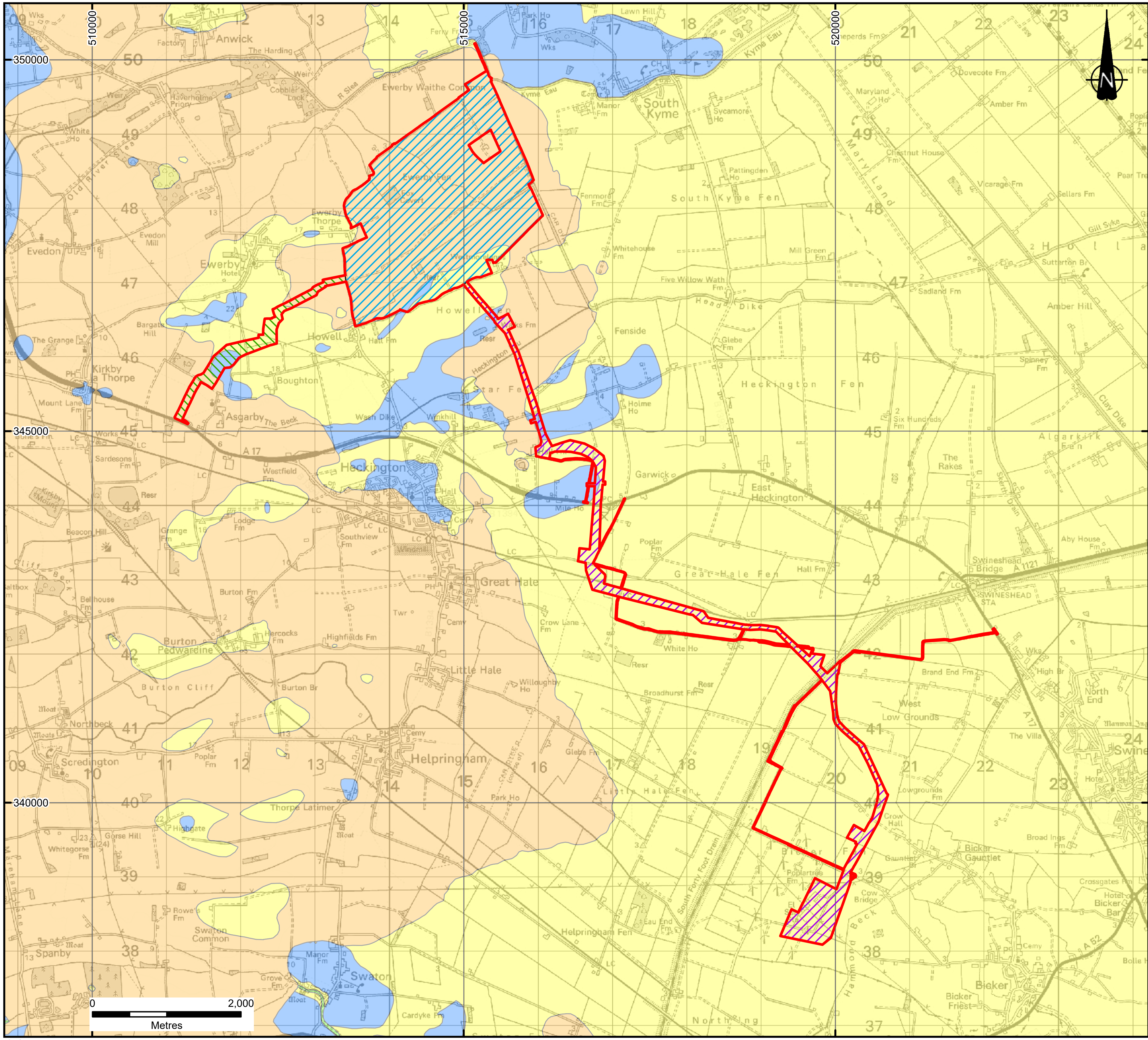


KEY

- DCO Order Limits
- Solar Array Area
- Bespoke Access Corridor
- Cable Route Corridor

GeoSure Hazard Class

- A - Not believed to be present
- B - Unlikely to be present
- C - Possibly present
- D - Probably present

Notes:

Excluding the DCO Order Limits, boundaries shown are indicative.

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PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

BGS GEOSURE HAZARDS:
SHRINK SWELL CLAYS

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-136 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

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| CP | SG | MW |

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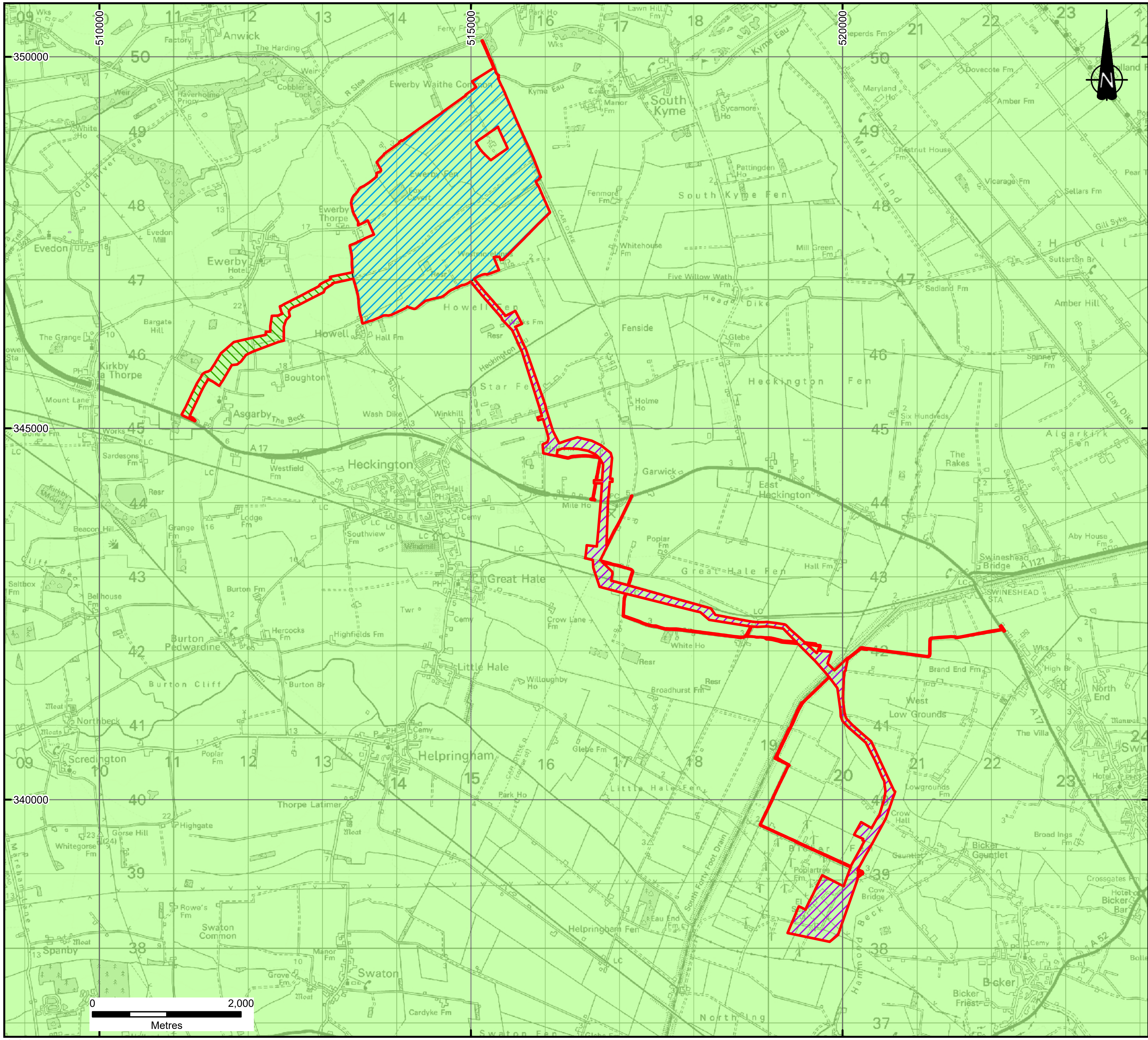


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## KEY

- DCO Order Limits
- Solar Array Area
- Bespoke Access Corridor
- Cable Route Corridor

GeoSure Hazard Class

- B - Unlikely to be present

Notes:

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BEACON FEN ENERGY PARK

DRAWING TITLE

BGS GEOSURE HAZARDS: LANDSLIDES

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-137 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

| DRAWN BY | CHECKED BY | APPROVED BY |
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| CP | SG | MW |

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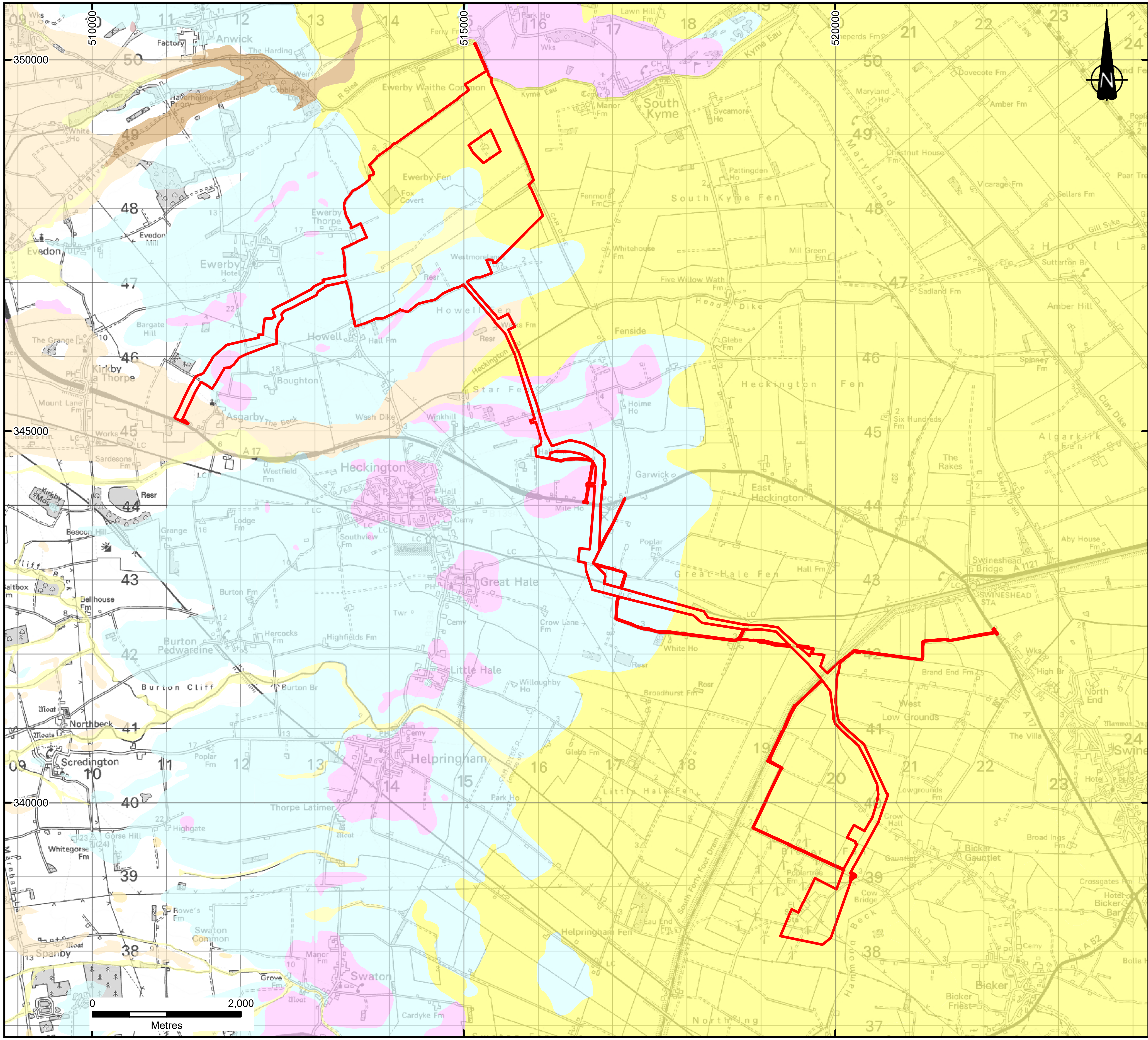


KEY

- DCO Order Limits
- ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
- TIDAL FLAT DEPOSITS - CLAY AND SILT
- GLACIOFLUVIAL DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL
- GLACIOFLUVIAL ICE CONTACT DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL
- GLACIOFLUVIAL SHEET DEPOSITS, MID PLEISTOCENE - SAND AND GRAVEL
- TILL, MID PLEISTOCENE - DIAMICTON
- BLOWN SAND - SAND
- HEAD - CLAY, SILT, SAND AND GRAVEL
- PEAT - PEAT
- SLEAFORD SAND AND GRAVEL - SAND AND GRAVEL
- SAND AND GRAVEL OF UNCERTAIN AGE AND ORIGIN - SAND AND GRAVEL
- TIDAL FLAT DEPOSITS, 1 - CLAY AND SILT

Notes:
Excluding the DCO Order Limits, boundaries shown are indicative.

DCO Order Limits provided by Ardent Management on 04/02/2025.



The colour symbology for different geological units / formations is provided by the British Geological Survey (BGS) using their standardised symbology. Some of the units / formations have very similar colours that may not be distinguishable in print or pdf form. For further distinction, refer to the BGS online GeoIndex https://mapapps2.bgs.ac.uk/geoindex/home.html.

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PROJECT
BEACON FEN ENERGY PARK

DRAWING TITLE
SUPERFICIAL GEOLOGY

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-161 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
| A3 | 1:50,000 | 05/03/2025 |

| DRAWN BY | CHECKED BY | APPROVED BY |
|---|---|---|
| RCB | SG | MW |

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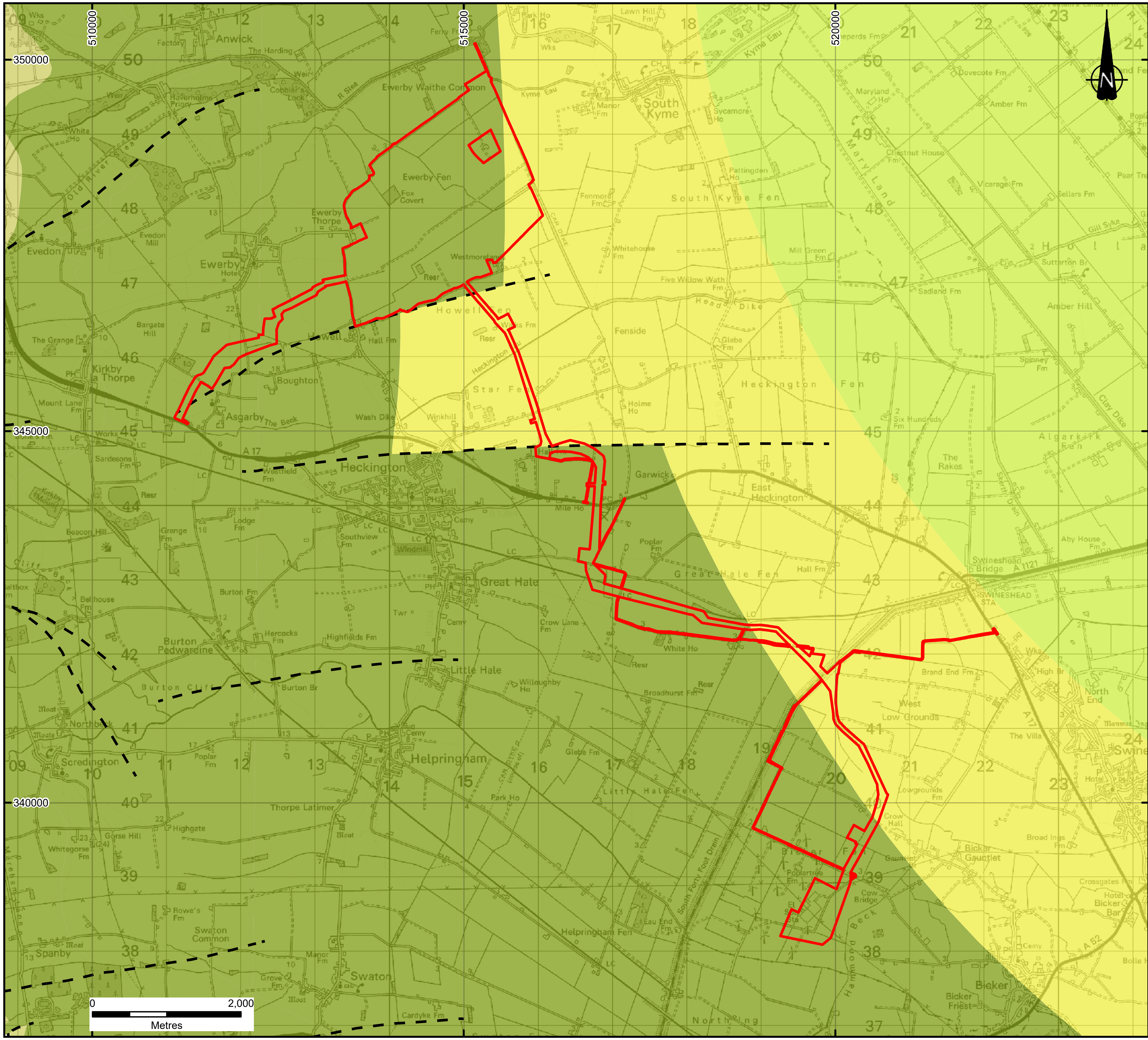


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KEY

- DCO Order Limits
- AMPTHILL CLAY FORMATION - MUDSTONE
- WEST WALTON FORMATION - MUDSTONE AND SILTSTONE
- KELLAWAYS SAND MEMBER - SANDSTONE AND SILTSTONE, INTERBEDDED
- OXFORD CLAY FORMATION - MUDSTONE
- PETERBOROUGH MEMBER - MUDSTONE
- FAULT

Notes:

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PROJECT

BEACON FEN ENERGY PARK

DRAWING TITLE

BEDROCK GEOLOGY

| DRG No. | | REV | SUIT. CODE |
| --- | --- | --- | --- |
| ST19595-162 | | 1 | -- |
| DRG SIZE: A3 | SCALE: 1:50,000 | DATE: 05/03/2025 | |
| DRAWN BY: RCB | CHECKED BY: SG | APPROVED BY: MW | |

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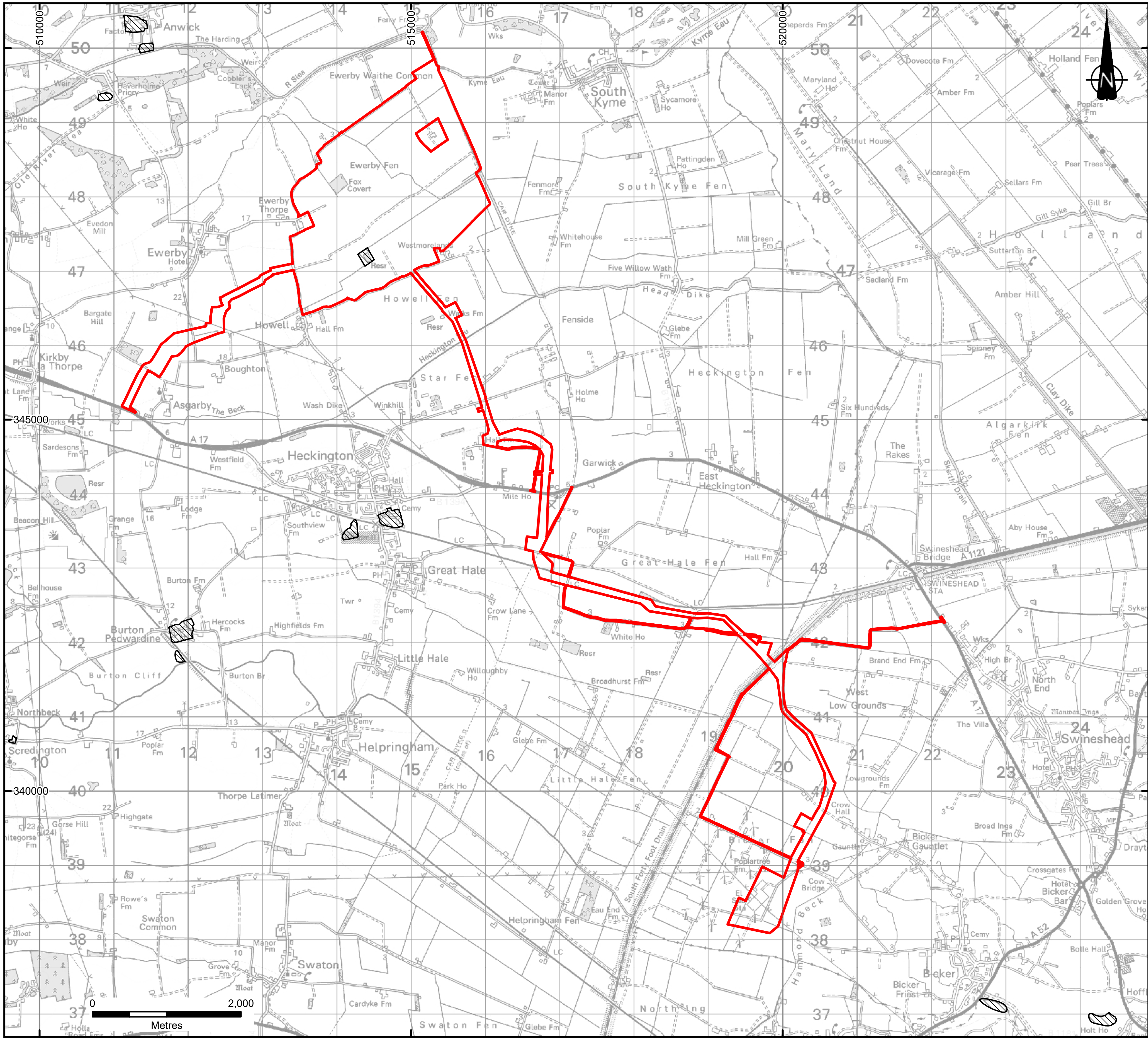


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**KEY**

- DCO ORDER LIMITS
- MADE GROUND (UNDIVIDED)

**Notes:**

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DRAWING TITLE

ARTIFICIAL GEOLOGY

| DRG No. | REV | SUIT. CODE |
|---|---|---|
| ST19595-163 | 1 | -- |

| DRG SIZE | SCALE | DATE |
|---|---|---|
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| RCB | SG | MW |

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