Tween Bridge Solar Farm

A Nationally Significant Infrastructure Project in the Energy Sector

Environmental Impact Assessment Scoping Report

On behalf of RWE Renewables
Coordinated by Pegasus Group
January 2023

NATIONALLY SIGNIFICANT INFRASTRUCTURE PROJECT IN THE ENERGY SECTOR

REGULATION 10(3) INFRASTRUCTURE PLANNING (ENVIRONMENTAL IMPACT ASSESSMENT) REGULATIONS 2017

ENVIRONMENTAL IMPACT ASSESSMENT SCOPING REPORT

TWEEN BRIDGE SOLAR FARM

On behalf of RWE Renewables

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1. INTRODUCTION

1.1. RWE Renewables (the "Applicant") has commissioned this Environmental Impact Assessment (EIA) Scoping Report for the Tween Bridge Solar Farm (the "scheme"). The scheme relates to the construction, operation and decommissioning of ground mounted solar photovoltaic electricity generating panels with a gross electrical output of more than 50 megawatts (megawatts) alternating current (AC). Associated development would include an electrical storage facility, electrical equipment, substations, and cabling, landscaping and biodiversity measures.

1.2. This Scoping Report has been prepared by Pegasus Group, with input from the EIA project team, on behalf of the Applicant. Due to its proposed generating capacity, the scheme is classified as a Nationally Significant Infrastructure Project (NSIP) and will therefore require consent via a Development Consent Order (DCO) under the Planning Act 2008.

1.3. The proposed scheme is located within the Yorkshire and Humber regions. The site extends to over 1500 hectares, centred at approximately 10 kilometres to the northeast of Doncaster and 14 kilometres to the west of Scunthorpe. The scheme straddles the administrative boundaries of Doncaster Council and North Lincolnshire Council. At a local level, the scheme is located on land east of Thorne; south of Tween Bridge Moors; west of Crowle; north and north west of Sandtoft & Sandtoft Industrial Estate; north of Hatfield Moors; and, north east of Hatfield. The project is located on land either side of the M180, High Level Banks (the A18) and the Stainforth and Keadby Canal.

1.4. A Site Location Plan showing the extent of the draft Order Limits is provided at Appendix 1.1.

1.5. Figures are either presented within or at the end of each chapter and technical appendices are presented at the of the report.

1.6. This Scoping Report forms part of a formal request for a Scoping Opinion from the Secretary of State under Regulation 10 of the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the "EIA Regulations"). Pursuant to Regulation 8(1)(b) of the EIA Regulations, the Applicant confirms that an Environmental Statement will be provided in support of an application for development consent for the scheme; and by virtue of Regulation 6(2)(a), that the proposed scheme constitutes EIA development.

1.7. The purpose of this Scoping Report is to ensure that the EIA accompanying the application for a DCO is focused on the key impacts likely to give rise to significant adverse effects. As well as identifying aspects to be considered in the EIA, this document also identifies those aspects that are not considered necessary to assess further.

The Applicant

1.8. RWE Renewables is one of the UK's, and the world's, leading producers of renewable energy. RWE Renewables is now the world's second largest offshore wind developer and third largest provider of renewable electricity across Europe. In the UK, this strengthens RWE's position as a leading energy player. RWE's UK & Ireland footprint extends over 80 sites, located across England, Scotland, Wales and Ireland, employing over 2,600 people and generating over 10% of the UK's electricity needs - enough power for over 10 million homes. This makes RWE the second largest generator in the UK as a whole. RWE has made

ambitious commitments to increase the generation of clean, reliable and affordable electricity.

1.9. Alongside the ambition to be carbon neutral by 2040, RWE Renewables continues to invest heavily in renewables, including solar. RWE's planned gross growth capex spend 2020-2022 will be €8-9bn globally, of which around 30-35% will be in the UK.

1.10. The Applicant has the necessary knowledge and experience in renewable energy to develop the scheme.

Consenting Regime

1.11. The Scheme falls within the definition of a 'nationally significant infrastructure project' (NSIP) under Section 14(1)(a) and 15(2) of the Planning Act 2008 (the "Act") as the construction of a generating station with a capacity of more than 50MW, with a potential capacity in the region of up to 600MW.

1.12. The EIA requirement for NSIP developments is transposed into law through the EIA Regulations. The EIA Regulations specify which developments are required to undergo EIA and schemes relevant to the DCO planning process are listed as either 'Schedule 1' or Schedule 2'. Those developments listed in Schedule 1 are always subject to an EIA, whilst developments listed in 'Schedule 2' must only be subject to an EIA if they are considered 'Likely to have significant effects on the environment by virtue of factors such as its nature, size or location[1].' The criteria on which this judgement must be made are set out in Schedule 3 of the EIA Regulations.

1.13. In consideration of the footprint of development, the developer has voluntarily proposed that an EIA will be required and will be submitting an Environmental Statement with the Development Consent Order application for the Scheme.

IEMA Quality Mark

1.14. Pegasus Group is an Institute of Environmental Management and Assessment (IEMA) Registered Impact Assessor and also holds the IEMA EIA Quality Mark as recognition of the quality EIA product and continuous training of our environmental consultants. A Statement of Competence will be included within the Environmental Statement, outlining the relevant expertise or qualifications of the experts who contributed to the preparation of the Environmental Statement.

1.15. The Applicant has appointed a team of specialist consultants to consider planning and environmental matters in relation to the scheme and to provide input into the production of this Scoping Report. The technical assessment work undertaken by each of the consultants listed has directly informed the consideration of likely significant effects. The preliminary consultants that have been involved with project to date are:-

[1] The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, Reg 3

- Pegasus Group - lead planning consultant, also providing planning advice, technical assessments of potential impacts of the environment in terms of landscape, transport, flooding / drainage, heritage, socio economic and coordinating the EIA.
- Avian Ecology – is providing ecological and nature conservation advice
- Daniel Baird Soils – providing technical input on agriculture and agricultural land
- Integrale - ground conditions and contamination
- Ion Acoustics – noise and vibrations
- Air Quality Consultants - air quality and carbon saving
- Barton Hyett Associates - arboriculture
- RWE - network and network constraints
- Pager Power - Glint & Glare

The Purpose of the Scoping Report

1.16. The EIA Regulations state at regulation 10(3) that a request for a Scoping Opinion should contain:

- A plan sufficient to identify the land;
- A description of the proposed development, including the location and technical capacity;
- An explanation of the likely significant effects of the Scheme on the environment; and
- Such other information or representations as the person making the request may wish to provide or make.

1.17. The guidance highlighted in Planning Inspectorate Advice Note 7 Environmental Impact Assessment: Process, Preliminary Environmental Information and Environmental Statements has also been taken into account in the preparation of this Scoping Report. Accordingly, this Scoping Report presents:

- A plan sufficient to identify the land for the main development (Appendix 1.1) and the wider Environmental Impact Assessment Area (chapters 4 to 13);
- A description of the scheme (Section 2); and
- An explanation of the likely significant effects of the Scheme on the environment (the Likely Environmental Effects sub-section of the technical sections 3 - 13 of this Scoping Report).

2. THE PROPOSED SCHEME

Introduction

2.1. The need for flexibility in design, layout and technology is identified in a number of National Policy Statements to address uncertainties inherent to the Scheme. This is very pertinent to solar due to the rapid pace of change in technology. It is proposed that the Environmental Statement will employ a 'maximum design envelope' which reflects the Rochdale Envelope. The parameters ranges would be defined in the project description chapter of the Environmental Statement.

2.2. The Planning Inspectorate's Advice Note 9 (Rochdale Envelope) clarifies in section 4 that at the Scoping stage certain matters on the design might not yet be resolved due to an iterative design process. These parameters will be considered in detail by technical authors in the Environmental Statement to ensure the realistic worst-case effects of the scheme are assessed for each potential receptor. This is of particular importance to maintain flexibility due to the rapid pace of change in solar PV and energy storage technology. The maximum design scenario assessed is therefore the scenario which would give rise to the greatest potential impact. For example, where several solar panel options are provided, then the assessment will be based on the solar panel type that would have the greatest impact. Where there is only a single design parameter put forward then this is deemed to be the worst-case scenario, for example (i) maximum development footprint and height of the substation compound; and (ii) the total area covered by the solar panels. As technology advances, it is possible that solar panels could become more efficient. This in turn could require the micro-siting of ancillary equipment to reflect such changes, i.e. the final locations of cabling and the number and location of inverters and transformers. This final detail would be secured by an appropriately worded requirement(s). The purpose of this submission would be to: -

- Clarify the construction and operational sequencing of the Scheme;
- Demonstrate compliance with the requirements included in the Development Consent Order; and
- Demonstrate that the final detailed design remains within the parameters of the design principles and therefore the Rochdale Envelope standards considered by the forthcoming Environmental Statement.

2.3. A similar approach has been used for the Little Crow Solar Park Order 2022[2] that was determined through the NSIP process. As a minimum, it is expected that the following aspects of the scheme will require design flexibility when the EIA is being carried out:

- The maximum development envelope for the type of PV module including their mounting and foundation structures.

[2] SI 2022 No. 436.

- The maximum development envelope of supporting infrastructures such as inverters, transformers and switchgears.
- The maximum development envelope for the type and arrangement of battery energy storage systems.
- The maximum development envelope for the type and arrangements of biodiversity and green infrastructure.
- The maximum development envelope for location and arrangements of temporary construction and decommissioning compounds.
- The maximum development envelope for the location and arrangements of grid infrastructure works, including substations.
- The maximum development envelope for the phasing of the scheme.

Scheme overview

2.4. The main element of the proposal is the construction, operation, maintenance and decommissioning of a ground mounted solar park with an export capacity of over 50MW with associated development.

2.5. An operational lifespan of 45 years would be sought linked to the first export date from the Scheme. The Scheme will progress in accordance with a phasing plan. The Scheme may be carried out thorough a single continuous phase or in multiple of phases. Detailed description of all the construction phase options will be set out in the Environmental Statement.

2.6. A single main substation compound will serve the whole development, and this will be required for the duration of the Scheme and retained thereafter. The substation compound would be located within the main development area, to the north of the Stainforth and Keadby Canal, adjacent to the existing overhead electricity pylons which traverse the site.

2.7. At this stage of the project, it is anticipated that the scheme would comprise the following works:

- Arrays of Ground Mounted Solar Panels
- Battery Energy Storage System
- Formation of Ecological Corridors and Green Infrastructure
- Substation Building and Compounds
- Upgrade to Main Access Track
- Temporary Construction and Decommissioning Compounds
- Open trench cabling works

- Directional drilling for cable works under the extant canal, railway and adopted highway, including the M180
- Fencing and Security Measures
- Upgrade to existing culverts

2.8. The preliminary works area is set out below and this will be refined during the iterative design process taking into account the environmental constraints and opportunities of the site together with consultation with consultees and the community. The indicative works plan is provided at Appendix 2.1.

2.9. During the construction phase, one or more temporary construction compound(s) will be required as well as temporary roadways to facilitate access to all parts of the site.

Arrays of Ground Mounted Solar Panels

2.10. The solar panels would convert solar irradiance into direct current (DC) electricity. A solar panel consists of a layer of silicon cells, an anodised aluminium frame and various wiring to allow current to flow from the silicon cells. Silicon is a non-metal with conductive properties that allow it to absorb and convert sunlight into electricity. When light interacts with a silicon cell, it causes electrons to be set into motion, which initiates a flow of electric current1. The solar panels would be connected in series and set out on south facing arrays. The arrays will be laid out in multiple parallel rows running east to west across the various field enclosures. The mounting structure and solar panels will be static. The distance between the arrays would respond to topography and typically be between 3.5 metres to 6 metres. Land between and beneath the arrays would be used for biodiversity mitigation and enhancement measures and / or seasonal sheep grazing. Within areas in areas where sheep grazing is not proposed, then grassland will be managed through a grass cutting regime.

2.11. The maximum height of the arrays is not yet known and is expected to be up to 3.5m. The design parameters for the PV modules works area will be clearly set out within the Environmental Statement. In areas around the solar array and on other parts of the order limits, opportunities for landscaping, biodiversity enhancements and habitat management will be explored. The insulated DC cables from the solar panels will be routed in channels fixed on the underside of the mounting structure. The DC string cables will run along the entire underside of each row. The electrical cabling from each array will be concealed through shallow trenches linking the solar panels to the inverters and transformers and then to the main substation.

2.12. The cable trench will typically be between 0.5m to 1.1m in depth and up to 1.0m wide. The cable trench may also carry earthing and communications cables and will be backfilled with fine sands and excavated materials to the original ground level.

2.13. The inverters, 132kv transformers and associated switch gear are required to convert the DC energy produced by the arrays into AC energy, these will be located across the solar modules area. The AC cable will also be laid in trenches and would run from the arrays to the feeder substations and then to the main substation compound.

2.14. Underground cables will connect the various land parcels and this will predominantly involve an open trench. Where the crossing point relates to the canal or major infrastructure (road or rail) then these will require directional drilling. All works will be within the order limits. At this time, it is being determined if all the onsite cables can be laid underground or if some sections will need to be above ground.

2.15. Data cables will also be installed, typically alongside electrical cables in order to allow for the monitoring of the scheme.

Substation Building and Compound

2.16. A single main substation compound will be required for the Scheme and this will likely be constructed at the start of the Scheme. The substation compound will comprise a customer substation compound (indicative development footprint of 200m by 100m) and a National Grid substation compound (indicative development footprint of 200m by 100m). Following construction and commissioning, the substation compound will be partly adopted and become the property of the National Grid, who will maintain their compound throughout the lifetime of the Scheme. The Customer substation compound will be retained by the developer. The decommissioning of the National Grid substation may be outside the scope of the DCO application.

2.17. The function of the new substation will be to take power from the solar arrays and connect this to National Grid's existing 400kv Keadby to Drax overhead line circuit that runs through the main development site. The Applicant is liaising with National Grid regarding the design and delivery mechanism of the substation. If the works is not progressed through a single application, then the Applicant will explain the reasons for the separate applications. The grid connection offer secured for Tween Bridge Solar Park is independent of any another grid connection offer relating to other potential energy projects in the same region.

2.18. The indicative location of the substation compound is shown on the indicative works plan Under normal conditions the compound would be unmanned. Whilst external lighting will be installed at the substation for emergency work during hours of darkness, the substation will not normally be lit. Infrastructure with the gated compound would include control room and welfare unit with WC; Customer Switchroom; NPG 400KV pad-mounted transformers; Gantry with voltage and current transformers; Circuit breakers; Earthing circuits; Cable circuits; car parking; and cess pit.

Battery Energy Storage System

2.19. The battery energy storage system consists of containerised battery units that can store energy and are able to release or absorb energy from the power network. Being able to absorb and release energy, the battery energy storage system at Tween Bridge can be used to contribute towards the frequency balancing services, where the power is being generated or absorbed statically or dynamically depending on the system frequency. When there is not enough power, batteries are discharged to balance under frequency preventing black and brown outs. To balance over frequency batteries are charged to prevent dangerous spikes across electricity infrastructure. The anticipated energy storage capacity is circa 200MW. The indicative size for the battery compound is 200m by 200m.

Fencing and Security Measures

2.20. A fence will enclose the operational areas of the scheme. The fence is likely to be a metal mesh fence of approximately 3m in height. Pole mounted closed circuit television (CCTV) system, which will face towards the scheme and away from any land outside of the order limits will also be deployed around the perimeter of the site. These cameras will be mounted on poles of around 3.5m height located within the perimeter fence.

2.21. It is likely that emergency lighting on sensors for security purposes will be deployed around the substation compound and other key infrastructure. No areas of the scheme are proposed to be continuously lit during the operational phase of this development.

Construction

2.22. The Environmental Statement will consider the options of the scheme being constructed through either a single phase or a multiple of phases (i.e., phased approach to the construction of the solar arrays / development parcels). If all elements were constructed at the same time, then it is anticipated that the main construction phase would last around 24 months to 36 months. The Environmental Statement will provide a full description of the potential construction, operational and decommissioning variances. All variances will be assessed within the Environmental Statement. For clarification, the construction of the solar arrays would not take place in a single continuous phase.

2.23. A main temporary construction compound will likely be established close to the site entrance for each phase of development. Smaller temporary compounds will be located across the site as the scheme is built out in its various phases. Depending on weather conditions during construction, temporary roadways (e.g., plastic matting) may be utilised to access parts of the scheme.

2.24. During the construction phase, one main construction compound will serve the scheme and this will be located off the main site entrance, thus reducing the distance delivery vehicles will need to travel after reaching the site's entrance.

2.25. The Environmental Statement will include a detailed description of the construction compound(s) including its/their size and duration required on site.

Operational Lifespan

2.26. An operational lifespan of 45 years would be sought, the operational period would start following the final commissioning for the full scheme.

2.27. During the operational phase, the activities on site would amount to servicing and maintenance of plant and equipment associated with the Scheme, including solar panels, inverters, transformers, substation compound and vegetation and biodiversity management. Landscape, ecological and biodiversity benefits could include the installation of barn owl boxes, bird nesting boxes, bee hives, log piles and other hibernacula such as small buried rubble piles suitable for reptile species, amphibians and insect life. Land between and beneath the panels would be used for biodiversity enhancements and agricultural use would continue through sheep grazing. Tree planting would be introduced along field boundaries where required.

2.28. The Applicant will also consider the potential options for allowing permissive public access to selected areas set aside for community uses, such as green infrastructure / space. The potential for this will be discussed with the community and local planning authorities as part of the iterative design process. An outline landscape and ecological management plan would be submitted as part of the Environmental Statement and this document would set out how the land would be managed throughout the operational phase of development.

Public Rights of Way

2.29. Temporary diversions of Public Rights of Way may be required during the construction and decommissioning periods.[3]

Compulsory Purchase

2.30. A compulsory purchase provision may be incorporated into the draft DCO to reflect any rights within the order limits at time of submission.

Statutory Undertakers

2.31. The provision of easements for the existing services that traverse the site, such as water pipes and overhead powerlines, will be incorporated into the layout design. The Environmental Statement will include a description of how easements will be maintained through the draft Development Consent Order.

[3] A number of other public rights of way pass close to the site, however, only one route passes through the site, namely FP19 (Thorne) to the east of Thorne.

3. EIA Methodology

Introduction

3.1. This section sets out the approach that would be taken to complete the EIA of the proposed development. Chapter 2 of the Environmental Statement will explain the everchanging methodology that will be applied to all the technical chapters of the Environmental Statement.

3.2. The Environmental Statement will identify key changes in the parameters / options of the scheme as presented in this Scoping Report, following a consultation process. The Environmental Statement will also contain a table demonstrating how the maters raised in the Scoping Opinion have been addressed within the Environmental Statement.

3.3. The content of the Environmental Statement will be based on the following:

- Review of the baseline situation through existing information, including data, reports, site surveys and desktop studies;
- Consideration of the relevant National Policy Statement (NPSs), National Planning Policy Framework (NPPF) and accompanying National Planning Practice Guidance (NPPG), and the statutory extant and emerging development plan policies;
- Consideration of potential sensitive receptors;
- Identification of likely significant environmental effects and an evaluation of their duration and magnitude;
- Expert opinion and local knowledge;
- Modelling;
- Use of relevant technical and good practice guidance; and
- Specific consultations with appropriate bodies.

3.4. Environmental effects will be evaluated with reference to definitive standards and legislation where available. Where it has not been possible to quantify effects, assessments will be based on available knowledge and professional judgement.

Determining Significance

3.5. The purpose of the EIA is to identify the likely 'significance' of environmental effects (beneficial or adverse) arising from a proposed development. In broad terms, environmental effects are described as:

- Adverse – detrimental or negative effects to an environmental resource or receptor;
- Beneficial – advantageous or positive effect to an environmental resource or receptor; or

- Negligible – a neutral effect to an environmental resource or receptor.

3.6. It is proposed that the significance of environmental effects (adverse, negligible/ neutral or beneficial) would be described in accordance with the following 7-point scale[4]:-

3.7. Significance reflects the relationship between two factors:

- The magnitude or severity of an effect (i.e., the actual change taking place to the environment); and
- The sensitivity, importance or value of the resource or receptor.

3.8. The broad criteria for determining magnitude are set out in Table 3.1.

3.9. It is worth noting that the degrees of magnitude defined in the table below can be both positive and negative, as a development can result in a positive effect on the environment. The sensitivity of a receptor is based on the relative importance of the receptor using the scale in Table 3.1.

Table 3.1 Degrees of Magnitude and their Criteria

Magnitude of Effect	Criteria
High	Total loss or major/substantial alteration to elements/features of the baseline (pre-development) conditions such that the post development character/composition/attributes will be fundamentally changed.
Medium	Loss or alteration to one or more elements/features of the baseline conditions such that post development character/composition/attributes of the baseline will be materially changed.
Low	A minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible/detectable but the underlying character/composition/attributes of the baseline condition will be similar to the pre-development.

[4] Unless specified by topic specific methodology

Negligible	Very little change from baseline conditions. Change not material, barely distinguishable or indistinguishable, approximating to a 'no change' situation.

3.10. The sensitivity of a receptor is based on the relative importance of the receptor using the scale in Table 3.2.

Table 3.2: Degrees of Sensitivity and their Criteria

Sensitivity	Criteria
High	The receptor/resource has little ability to absorb change without fundamentally altering its present character, or is of international or national importance.
Medium	The receptor/resource has moderate capacity to absorb change without significantly altering its present character, or is of high and more than local (but not national or international) importance.
Low	The receptor/resource is tolerant of change without detrimental effect, is of low or local importance.
Negligible	The receptor/resource can accommodate change without material effect, is of limited importance

3.11. Placement within the 7-point significance scale would be derived from the interaction of the receptor's sensitivity and the magnitude of change likely to be experienced (as above), assigned in accordance with Table 3.3 below, whereby effects assigned a rating of Major or Moderate would be considered as 'significant'. It is noted that not all environmental factors use the matrix based approach but instead use numerical values (such as noise impacts). The approach towards numerical values would be detailed within the relevant individual technical chapter.

Table 3.3: Levels of Effect Degrees of Significance

Magnitude of Change	Sensitivity of Receptor				
		High	Medium	Low	Negligible
	High	Major	Major	Moderate	Negligible

	Medium	Major	Moderate	Minor to Moderate	Negligible
	Low	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

3.12. The above magnitude and significance criteria are provided as a guide for specialists to categorise the significance of effects within the ES. Where discipline-specific methodology has been applied that differs from the generic criteria above, this will be clearly explained within the given technical chapter. As can be seen from Table 3.3 when an environmental effect is assessed as having a major or moderate degree of significance it is deemed to be "significant". These are the shaded cells in Table 3.3. When such a significant effect occurs consideration of mitigation solutions or enhancements to minimise the effect (which can include design alterations) will be considered.

3.13. It should be noted at this point that mitigation can come in the form of embedded design through design alteration to resolve a significant effect and mitigation through additional measures. Once these mitigations and enhancements have been assessed the degree of significance may decrease to minor/moderate, minor or negligible. If such a level of environmental effect occurs the Scheme is no longer considered as creating a "significant effect". If an environmental effect remains "significant" (i.e. major/moderate) the determining authority must weigh up the planning balance and determine if this significant, negative/positive environmental effect is outweighed by some other planning gain prior to determining the application.

3.14. A level of effects would be assigned both before and after mitigation.

Mitigation

3.15. All measures proposed to minimise likely significant effects will be consulted with the relevant consultation body, these include the informal and formal pre-application consultation phases.

3.16. Standard measures and the adoption of construction best practice methods to avoid, minimise or manage adverse environmental effects, or to ensure realisation of beneficial effects, will be incorporated into the design and development of the scheme. The assessment of the scheme would include the mitigation measures where required noting any residual effects.

3.17. All mitigation measures would be specified as a requirement within the Draft Development Consent Order. Where the assessment of the scheme would identify potential for adverse environmental effects, the scope for mitigation of those effects, for example by way of compensatory measures, will be considered and outlined in the appropriate technical chapter.

3.18. Where the effectiveness of the mitigation proposed will be considered to be uncertain, or where it depends upon assumptions of operating procedures, then data and/or professional judgement will be introduced to support these assumptions.

Residual Effects

3.19. The assessment process will conclude with an examination of the residual effects after mitigation has been applied, i.e., the overall predicted (likely) effects of the scheme.

Cumulative and In-Combination effects

3.20. In accordance with the EIA Regulations, the Environmental Statement will also give consideration to cumulative effects. Cumulative impacts are those effects of the scheme that may interact in an additive or subtractive manner with the impacts of other developments including those that are not currently in existence but may be by the time the Scheme is implemented. Examples of these kinds of effects that can be readily appreciated could include:

- Traffic generated from developments, affecting the surrounding road network;
- Air quality effects from developments; and
- Discharges to the water environment.

3.21. The Environmental Statement will set out the projects to be included in the assessment and this will be agreed with the host local planning authorities. The assessment will consider all relevant project types, including other DCO projects registered with the Inspectorate's National Infrastructure Team. Any operational schemes will be assessed as part of the relevant baseline study. The study areas for each technical topic are discussed at chapters 4 to 13 of this report.

Proposed Scope of the EIA

3.22. The proposed scope of information and assessment to be supplied within the Environmental Statement is set out below and is considered to provide a clear understanding of the potential significant effects of the scheme upon its environment and the mitigation measures proposed to avoid or ameliorate those effects. The Applicant will keep the scope of works under review during the development of the Environmental Statement, for example, to ensure that it remains relevant if there are any changes in the parameters of the scheme as originally presented in the Scoping Report. The application will consider the need to revisit the scope of works if there are any material changes to the draft order limits as set out at Appendix 1.1.

Site selection and consideration of alternatives

3.23. The EIA Regulations (Schedule 4, Paragraph 2) require for inclusion in an Environmental Statement:

A description of the reasonable alternatives (for example in terms of development design, technology, location, size and scale) studied by the developer, which are relevant to the proposed project and its specific characteristics, and an indication of the main reasons for selecting the chosen option, including a comparison of the environmental effects

3.24. Paragraph 4.4.2 of NPS EN-1 makes clear that an applicant is obliged to include in its Environmental Statement, as a matter of fact, information about the man alternatives that have been studied and indication of the main reasons for the applicant's choice, taking account of the environmental, social and economic effects and including, where relevant, technical and commercial feasibility. The main alternatives to the scheme which the Applicant has or is considering include:

- The 'No Development' Alternative; and,
- Alternative Designs.

3.25. Availability of alterative land to accommodate the scheme (including lower quality agricultural land). This will be applied to land form within a similar distance to the point of connection to the electricity network to determine if another area of land would be a viable alternative site for a solar park development of this scale and with this generation capacity.

Scope of Environmental Impact Assessment

3.26. Table 3.4 sets out the proposed scope of the environmental parameters to be considered in the Environmental Statement. Where a topic has been scoped out of the Environmental Statement the appropriate reasoning has been provided. The scope takes int account the factors influencing the siting of a solar farm as set out in the Draft National Policy Statement for Renewable Energy Infrastructure (EN-3).

Table 3.4 Proposed Environmental Parameters

EIA Topic	Scoped In / Out	How / Where addressed / Reason for Scoping Out
Accidents and Emergency	In	Article 8 of Schedule 4 of the EIA Regulations requires an Environmental Statement to consider the vulnerability of the scheme to risk of major accidents and/or disasters which are relevant to the project concerned. Since the nature, scale and location of the scheme is not considered to be vulnerable to or give rise to significant impacts in relation to the Risk of Accidents and Major Disasters, the Environmental Statement will include a proportionate description and assessment of the likely significant effects resulting from potential accidents or disasters applicable to the scheme during construction, operations and decommissioning. During all phases of the scheme (construction, operation and decommissioning) the

		developer would implement measures to be in accordance with the relevant health and safety legislation, regulations, and industry guidance to ensure that risks are suitably controlled and managed (for instance in relation to working near to overhead power lines or electrical infrastructure). An Outline Construction Methodology will be appended to the scheme description chapter, which would inform the Construction and Environmental Management Plan (CEMP). It is therefore considered that appropriate measures and controls could be achieved in line with the relevant legislation and processes to minimise risks to human and environmental receptors.
Climatic Factors	In	To be assessed within the relevant technical assessments such as flood risk. It is not proposed to provide a specific technical chapter on climatic factors.
Human Health	In	To be assessed within the relevant technical assessments such as Air Quality and Noise. There is not to be a specific chapter within the Environmental Statement that considers Human Health.
Population	In	To be assessed within the Socio-Economic Chapter.
Landscape and visual	In	To be assessed within the proposed Landscape and Visual Impact Chapter.
Cultural Heritage including Archaeological Aspects	In	To be assessed within the proposed Cultural Heritage Chapter.
Ground Conditions	In	To be assessed within the proposed Ground Conditions Chapter.
Ecological/ornithological or biodiversity impact	In	To be assessed within the proposed Ecological Chapter.
Water, Hydrology and Flood Risk	In	To be assessed within the proposed Hydrology Chapter.

Socio Economics	In	To be assessed within the proposed Socio-Economic Chapter.
Transport and Access	In	To be assessed within the proposed Transport Chapter.
Acoustics Considerations	In	To be assessed within the proposed Acoustics Chapter.
Air Quality and Carbon Saving	In	To be assessed within the proposed Air Quality Chapter.
Agriculture	In	To be assessed within the proposed Agricultural Circumstances Chapter.
Waste	In	Article 1(d) of Schedule 4 of the EIA Regulations requires an Environmental Statement to consider the quantities and types of waste to be produced during the construction and operational phases. The potential for waste during construction would be proportionately considered in the Environmental Statement. Waste during construction and decommissioning would be recycled in line with good practice and market conditions. The Environmental Statement will provide a proportionate assessment of the likely impact of component replacement and outline what measures, if any, are in place to ensure that these components are able to be diverted from the waste chain. An Outline Decommissioning Plan would support the Environmental Statement.
Interrelationship between above factors	In	To be assessed within each topic chapter under the heading 'Cumulative and Interactive Effects'.

3.27. The proposed structure of the Environmental Statement would follow the structure of the preliminary environmental information report and informal pre-application consultation with Doncaster Council, North Lincolnshire Council and other prescribed bodies.

3.28. The Environmental Statement will comprise studies on each of the aspects of the environment identified as likely to be significantly affected by the Scheme (the 'technical chapters'). It is anticipated that the Environmental Statement will be structured into three volumes: -

- Non-Technical Summary (NTS) [Volume 1] - this would provide a concise summary of the Environmental Statement identifying the likely significant environmental effects and the measures proposed to mitigate or to avoid adverse effects of the Scheme.

- Main Report [Volume 2] - Comprising the main volume of the Environmental Statement, including 'general chapters' that describe the EIA context, provide a description of the order limits and scheme, and set out the scope of the Environmental Statement, followed by the 'technical chapters' for each environmental theme. Figures will be provided with or at the end of each chapter. Each chapter will conclude with a summary.

- Technical Appendices [Volume 3] - this would provide the technical appendices supporting the Main Report.

3.29. The organisational presentation of the Environmental Statement for final submission will accord with the Planning Inspectorate's Advice Note 6 (Preparation and Submission of Application Documents). For example, each chapter will be submitted as a separate paper / document. This will be clearly set out within the Application Index whereby, each chapter will have its own document reference number. Each technical appendix would also have its own document reference number.

3.30. For continuity, the figures and appendices will be arranged and presented using the same reference numbers as the chapters as a means of providing supportive background and technical information.

Table 3.5 Proposed Structure of Environmental Statement

Chapter	Topic
Chapter 1	Introduction
Chapter 2	Site Description
Chapter 3	Proposed Development, Site Selection, Alternatives, the iterative design process and draft DCO Requirements
Chapter 4	EIA Methodology
Chapter 5	Legislative & Policy Context
Chapter 6	Landscape and Visual (with technical appendices to include Residential Visual Amenity Assessment)
Chapter 7	Nature Conservation and Biodiversity
Chapter 8	Cultural Heritage and Archaeology

Chapter 9	Ground Conditions
Chapter 10	Hydrology and Flood Risk
Chapter 11	Socio Economics
Chapter 12	Transport and Access
Chapter 13	Acoustics Considerations
Chapter 14	Air Quality and Carbon Saving
Chapter 15	Agricultural Circumstances and Agricultural Land
Chapter 16	Other Environmental Topics - to include accident and emergency, waste and climate change
Chapter 17	Summary of Environmental Effects
Chapter 18	Glossary

Structure of Introductory Chapters

3.31. For completeness the opening section of the environmental statement will present the following information.

3.32. Chapters 1, 2 and 4 of the Environmental Statement will provide an introduction to the Environmental Statement, the assessment scope and methodology and details of the order limits and its current use.

3.33. Chapter 3 will provide a comprehensive description of the scheme including consideration of construction, operational management and the decommissioning phases. It will also outline the main reasonable alternatives studied by the Applicant which are relevant to the scheme and is specific characteristics and an indication of the main reasons for selecting the chosen option.

3.34. Chapter 5 of the Environmental Statement will set out the legislative and planning framework.

Structure of Technical Chapters

3.35. Throughout the EIA process, the likely significant environmental effects of the scheme will be assessed. Within each of the technical chapters the information which will inform the EIA process will generally follow the structure below:

- Introduction – to introduce the topic under consideration, state the purpose of undertaking the assessment and set out those aspects of the scheme material to the topic assessment, and provide a summary of the relevant consultation responses;
- Assessment Approach – to describe the method and scope of the assessment undertaken and responses to consultation in relation to method and scope in each case pertinent to the topic under consideration;
- Baseline Conditions – a description of the baseline conditions pertinent to the topic under consideration including baseline survey information;
- Assessment of Likely Significant Effects - identifying the likely effects, evaluation of those effects and assessment of their significance, considering both construction and operational and direct and indirect effects;
- Mitigation and Enhancement - describing the mitigation strategies for the significant effects identified and noting any residual effects of the proposals;
- Cumulative and In-combination Effects - consideration of potential cumulative and in-combination effects with those of other developments; and
- Summary – a non-technical summary of the chapter, including baseline conditions, likely significant effects, mitigation and conclusion.

Confidential Information

3.36. In some circumstances it will be appropriate for information to be kept confidential.

3.37. Where documents are intended to remain confidential, the Applicant will provide these as separate papers with their confidential nature clearly indicated on the document[5] and application index.

Legislative Process

3.38. The main legislative and procedural requirements relating to NSIPs are set out within the following:

- The Planning Act 2008;

[5] And watermarked as such on each page.

- The Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009 (as amended) (the APFP Regulations); and

- The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (the 2017 EIA Regulations).

3.39. The Planning Act is the principal legislation governing the Examination of an application for a Nationally Significant Infrastructure Project (NSIP) and the decision whether to grant development consent.

3.40. The development consists of a solar photovoltaic (PV) generating station with an output in excess of 50 megawatts (MW) and this currently comprises an NSIP to which sections (s)14(1)(a) and s15(2) of the act apply. Section 104(1) of the Act applies if 'a NPS has effect in relation to development of the description to which the application relates' (a 'relevant National Policy Statement'). In such a case, the SoS would have to determine an application in accordance with the relevant National Policy Statement (NPS), subject to where specific exceptions apply (s104(3)).

3.41. Where s104 does not apply, an application falls to be decided under s105 of the Planning Act 2008. Section 105(2) requires the SoS to have regard to:

- any LIR (within the meaning given by the Act s60(3)) submitted to the SoS before the specified deadline for submission;

- any matters prescribed in relation to development of the description to which the application relates; and,

- any other matters which the SoS thinks are both important and relevant to the decision.

3.42. It is noted that solar generation has been excluded from the scope (paragraph 1.4.5) of the Overarching National Policy Statement for Energy (EN-1) (NPS EN-1) and the coverage (section 1.8) of the National Policy Statement for Renewable Energy Infrastructure (EN-3) (NPS EN-3). Accordingly, there is no designated NPS that has effect with respect to the consideration of the proposed solar arrays. Nevertheless, under the provisions of s105, policy included in an NPS that does not have effect, can be considered amongst the matters that are considered to be important and relevant for the purposes of decision making. The applicant considers that EN-1 is capable of being treated as a matter that is important and relevant for the decision-making process of the scheme.

3.43. In 2021 The Department for Business, Energy, and Industrial Strategy (BEIS) consulted on a suite of new draft national policy statements for energy infrastructure. These include specific policies relating to, and supporting, solar energy[6,7]. The emerging drafts are capable of being important and relevant considerations in the decision-making process.

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[6] Draft Overarching National Policy Statement for Energy (EN-1) – September 2021

[7] Draft National Policy Statement for Renewable Energy Infrastructure (EN3) – September 2021

The extent to which they are relevant is a matter for the relevant Secretary of State to consider within the framework of the Planning Act and with regard to the specific circumstances of each development consent order application. If the draft documents are enacted before the scheme is determined, then s104 will be engaged.

3.44. The legal requirement under s38(6) of the Planning and Compulsory Purchase Act 2004 to determine applications for development consent in accordance with development plan documents does not apply to NSIP applications submitted pursuant to the Planning Act 2008. The Development Plan can be a matter that is both important and relevant to the determination of the scheme. The development plan for the site comprises a number of documents and the pertinent parts are:

- Doncaster Local Plan 2015 - 2035
- The saved policies of the North Lincolnshire Local Plan of May 2003 (the NLLP); and
- The Lincolnshire Local Development Framework Core Strategy of June 2011 (the CS).

4. Landscape and Visual

Introduction

4.1. The landscape and visual chapter of the ES will review the scheme, order limit and its surrounding context in order to describe and identify the relative level of effects arising as a result of the proposed development, in relation to the landscape features, the character of the local landscape and the visual amenity of people who view the site and surrounding landscape. The scoping report has been informed by desktop study and site visits to the site and surrounding area.

Baseline Conditions

Site Context

4.2. The site broadly lies between the settlements of Thorne and Crowle, occupying separate parcels of land within a relatively flat agricultural landscape in arable use. Site parcels are dissected by a number of major roads and routes, including the M180 motorway, the A18, the South Humberside Main Line railway route and Stainforth & Keadby Canal. Numerous other minor roads cross the landscape connecting scattered residential properties and farmsteads, many of which lie adjacent or in proximity to the site. Tween Bridge Wind Farm lies to the north of the site. The landscape has relatively limited areas of vegetation, largely limited to field boundaries in the form of hedgerows and scattered trees.

Landscape Designations

4.1. The site is not covered by any designation at a national, regional or local level that recognises a specific landscape importance.

4.2. The Peatlands Way, a 71km long circular route, passes close to the site in a number of locations, particularly where it passes through the towns of Thorne and Crowle, as well as where the route passes through the Thorne and Hatfield Moors. A number of other public rights of way pass close to the site, however, only one route passes through the site, namely FP19 (Thorne) to the east of Thorne. The Stainforth and Keadby Canal passes to the south of Crowle and Thorne in proximity to the site, with the southern towpath publicly accessible.

4.3. A number of ecological designations lie within or adjacent to the draft order limits. A map showing the nearby statutory designates sites is provided within the Chapter 5 at Figure 5.1. The Hatfield Chase Ditches Site of Special Scientific Interest (SSSI) straddles a section of the order limits. The Thorne and Hatfield Moors Special Protection Area (SPA), which is also designated as a Site of Special Scientific Interest (SSSI), Special Area of Conservation (SAC) and National Nature Reserve (NNR), as well as forming open access land, is located adjacent to part of the site to the north-east of Thorne. The Thorne and Hatfield Moors SPA continues to the south of the M180, which lies in proximity to south-western parts of the site and which is also designated as a SSSI, SAC, NNR and open access land. A number of other local wildlife sites or sites for nature conservation lie close or within the site which are primarily associated with linear drainage ditches.

4.4. There are no listed buildings or scheduled monuments within the draft order limits, however, 74 listed buildings and two scheduled monuments within 2km of the scheme

boundary. There are no registered parks and gardens within 2km of the draft order limits. Thorne Conservation Area covers the historic core of the town and includes 14 listed buildings and the scheduled Peel Hill Motte and Bailey., There are no registered parks and gardens within Thorne but Memorial Park is a park of Local Historical Interest. Crowle Conservation Area covers the historic core of the settlement and also includes 14 listed buildings. Listed buildings within 2km of the site are listed in the Cultural Heritage section of this scoping report.

Landscape Character

4.5. The site lies centrally within National Character Area (NCA) 39: Humberhead Levels.

4.6. The Doncaster Landscape Character & Capacity Study (March 2007) defines landscape character within the administrative boundary of Doncaster Council at a local scale. The site lies within the Peat Moorlands Character Type and specifically within G2 - Thorne and Hatfield Peat Moorlands landscape Character area (LCA). The site lies in proximity to other LCA's including H2 - Blaxton to Stainforth Sandland Heaths and Farmland and E3 - East Don and Dun River Carrlands.

4.7. The North Lincolnshire Landscape Character Assessment (September 1999) defines landscape character within the administrative boundary of North Lincolnshire Council at a local scale. The site is identified as being within the Trent Levels LCA. North-eastern parts of the site are located within the Flat Open Remote Farmland (Crowle Common, Dirtness Levels, Eastoft Carr) local landscape type. Most of south-eastern parts of the site is located within the Flat Drained Treed Farmland (Carrhouse, Eastoft, Sandoft, Westwoodside) local landscape type. A small portion of the site also lies within the Flat Drained Farmland (Althorpe, Amcotts, East and West Butterwick, Owston Ferry) local landscape type, where in proximity to Hirst Priory Park Golf Club.

Landscape Features

4.8. The site is primarily located between the settlements of Thorne and Crowle, dissected by a number of major roads including the M180 motorway and the A18, as well as by a railway line. Tween Bridge Wind Farm is located within the northern part of the draft order limits and the site is crossed by the Stainforth and Keadby Canal.

4.9. The landscape is generally flat and open in nature, made up of large scale agricultural fields, often separated by drainage ditches of varying scales and depths. Occasional hedgerows and woodlands define field boundaries, or surrounding local farmsteads. Development is largely limited to Thorne and Crowle, with other areas predominantly isolated farmsteads, however, some areas of industry are located in proximity to the M180 motorway and on the nearby Sandtoft Airfield.

4.10. A number of large scale pylons with associated powerlines cross the landscape.

Relevant Policy Context

4.11. A full review of all planning policy will be undertaken as part of the Planning Statement. Those policies of relevance to the landscape and visual ES chapter are set out below.

National Policy Statement

4.12. Landscape and visual effects are referenced generally within the National Policy Statement (NPS) for Overarching National Policy Statement for Energy (EN-1), July 2011, however, only in respect of onshore wind and biomass power in the NPS for Renewable Energy (EN-3), July 2011.

4.13. An update to the EN-3 (2011) was published in September 2021 (Draft 2021 EN-3) and is currently undergoing a consultation process. The Draft 2021 EN-3 considers solar photovoltaic generation impacts of landscape, visual and residential amenity, setting out the requirements for a landscape and visual assessment within an ES, including visualisations, good design, future maintenance and mitigation.

National Planning Policy

4.14. Government revised the National Planning Policy Framework (NPPF) in July 2021. This document sets out a general presumption in favour of sustainable development (paragraph 11) and guides the Local Planning Authorities in the production of Local Plans and in decision making.

4.15. Paragraph 174 of the NPPF in relation to valued landscapes, states:

'Planning policies and decisions should contribute to and enhance the natural and local environment by:

a) protecting and enhancing valued landscapes, sites of biodiversity or geological value and soils (in a manner commensurate with their statutory status or identified quality in the development plan);

b) recognising the intrinsic character and beauty of the countryside, and the wider benefits from natural capital and ecosystem services – including the economic and other benefits of the best and most versatile agricultural land, and of trees and woodland…'

Doncaster Council

4.16. The Doncaster Local Plan 2015-2035 (adopted September 2021) sets out the current planning policy for Doncaster Council. The site is located within the Countryside Policy Area, with Policy 25 of the local plan in relation to development of new non-residential development stating the following:

'Proposals for non-residential developments will be supported in the Countryside Policy Area provided that:

A) the rural location of the enterprise is justifiable to support a prosperous rural economy in accordance with national policy in the NPPF;

B) the location of the enterprise would not have a significant adverse effect on neighbouring uses or on highway safety;

C) the development is of a size (including floorspace) and scale commensurate with an existing use, or that reasonably required for a new use, and with the rural character of the location; and

D) the scale and design of the proposal would not have a significant adverse impact on the landscape.'

'Policy 58 of the local plan in relation to Low Carbon and Renewable Energy, states:

'In all cases, low carbon and renewable energy proposals will be supported where they…

…5. have no unacceptable adverse impacts, including cumulative impacts, on the built and natural environment (including landscape character, and historic and nature conservation assets, such as Thorne and Hatfield Moors)…'

4.17. Other policies of relevance to the site include the following:

- Policy 18: Development Affecting Public Rights of Way;
- Policy 26: Green Infrastructure;
- Policy 32: Woodlands, Trees and Hedgerows;
- Policy 33: Landscape;
- Policy 43: Views, Gateways and Taller Buildings; and
- Policy 48: Landscaping of New Developments.

North Lincolnshire Council

4.18. The North Lincolnshire Local Development Framework sets out the current planning policy for North Lincolnshire Council, with the Core Strategy (adopted June 2011) setting out the long term vision for the council and the Housing and Employment Land Allocations Development Plan Document (adopted March 2016) setting out future housing and employment allocations.

4.19. A number of saved policies from the North Lincolnshire Local Plan (adopted May 2003) were retained in September 2007, which are relevant to the site. Saved policy LC7 of the local plan in relation to landscape protection states:

'Where development is permitted within rural settlements or within the open countryside, special attention will be given to the protection of the scenic quality and distinctive local character of the landscape. Development which does not respect the character of the local landscape will not be permitted.'

4.20. The site lies adjacent to an Area of Special Historic Landscape Interest, with policy LC14 of the local plan stating:

> **'The Isle of Axholme is designated as an area of Special Historic Landscape Interest.**
>
> **Within this area, development will not be permitted which would destroy, damage or adversely affect the character, appearance or setting of the historic landscape, or any of its features...**
>
> **...A high standard of design and siting in new development will be required reflecting the traditional character of buildings in the area and the character of the historic landscape, and using materials sympathetic to the locality.**
>
> **Schemes to improve, restore or manage the historic landscape will be sought in connection with, and commensurate with the scale of, any new development affecting the area of Special Historic Landscape Interest.'**

4.21. North Lincolnshire Council have adopted the Planning for Renewable Energy Development Supplementary Planning Document (SPD) in November 2011. Policy 2 of the SPD in relation to landscape, states:

> **'Developers should consider the landscape impacts of their proposal for renewable energy development. Consideration should be given at the earliest stage in the design process to the character and quality of the landscape, the extent of the physical change involved, and the ability of the landscape to accommodate the change.**
>
> **Proposals in areas of high landscape value or which affect their setting will be rigorously assessed in relation to their impacts on these important landscapes. If adverse impacts are identified these should be avoided or mitigated. Should this prove impossible the proposal will be refused.**
>
> **A Landscape and Visual Impact Assessment (LVIA), which must be agreed with the council, should be prepared and submitted alongside any planning application. Developers should also consult the council's approved Supplementary Planning Guidance on Landscape Character Assessment and Guidelines, and Countryside Design Summary.'**

4.22. Policy 3 of the SPD in relation to visual effects, states:

> 'The impact on visual amenity is a key consideration for developers in preparing schemes for renewable energy development. The size and appearance of the development should be taken into account from the earliest stage in the design process.

A Landscape and Visual Impact Assessment (LVIA), which must be agreed with the council, should be prepared and submitted alongside any planning application. Developers should consult the council's approved Supplementary Planning Guidance on Landscape Character Assessment and Guidelines, and Countryside Design Summary.

Where unacceptable negative impacts on visual amenity are identified, developers should ensure that they are satisfactorily addressed. If this cannot be done, the development will be refused.'

4.23. North Lincolnshire Council have adopted the Planning for Solar Photovoltaic (PV) Development SPD in January 2016. Policy D of the SPD in relation to landscape and visual impact, states:

'Developers must consider the landscape impacts of their proposal for solar PV arrays at the earliest stage in the design process. They should examine the character and quality of the landscape, the extent of the physical change involved, and the ability of the landscape to accommodate the change.

All proposals will be rigorously assessed in relation to their impacts on the areas' landscapes. Proposals should be sensitively located in order to minimise impacts landscape and visual amenity as well as surrounding communities. If adverse impacts are identified, these should be avoided or mitigated. Should this prove impossible the proposal will be refused.

A Landscape and Visual Impact Assessment (LVIA), which must be agreed with the council, should be prepared and submitted alongside any planning application. Developers should also consult the council's approved Supplementary Planning Guidance on Landscape Character Assessment and Guidelines, and Countryside Design Summary, alongside relevant landscape and conservation policies in the adopted Core Strategy DPD (June 2011) and the adopted North Lincolnshire Local Plan (Saved Policies) (May 2003).'

Thorne & Moorends Neighbourhood Plan

4.24. North-western parts of the site are located within the boundaries of the Thorne and Moorends Neighbourhood Plan, although, despite undergoing consultation in 2016, is not yet adopted. Policy RE1 of the neighbourhood plan in relation to Solar Power Energy Schemes states:

In all cases, large scale ground-mounted solar photovoltaic farms will be supported where they:

Avoid the best and most versatile agricultural land and allow for continued agricultural use wherever possible;

Preserve the inherent openness of designated countryside areas and do not conflict with the purposes for which such areas have been designated;

Avoid undulating landscapes where the scope for effective mitigation measures may be reduced;

Have no significant adverse impacts on built or natural heritage assets, including on any views important to the setting of such assets;

Do not create or aggravate local amenity problems;

Are not visually detrimental by reason of siting, materials or design, particularly in respect of the effects of glint and glare on neighbouring uses, and including as a result of security measures such as lighting and fencing;

Are subject to landscape and visual mitigation measures, such as screening with native hedges, with the aim of completing negating any adverse visual influence.

Likely Significant Effects (construction, operation and decommissioning)

4.25. It is proposed that the chapter will consider the potential effects of the scheme upon:

- Individual landscape features and elements;
- Landscape character; and
- Visual amenity and the people who view the landscape.

4.26. The chapter will address all phases of the scheme and effects will be considered both during the construction phase, when the Scheme is being built (temporary effects) and following completion of the Scheme (permanent effects). Permanent landscape and visual effects would be assessed both in the winter of year 1 (the year in which the construction is completed and development becomes operational) and also in the summer of year 15 (15 years of operation). In the Year 15 scenario it is assumed that vegetation planted as part of the scheme will have established and exhibit a degree of maturity. In addition, consideration to the decommissioning would also be undertaken.

4.27. Consideration shall be given to seasonal variations in the visibility of the scheme and these will be described where necessary.

4.28. Both beneficial and adverse effects shall be identified in the assessment and reported as appropriate. Effects shall be described as 'neutral' where beneficial effects are deemed to balance the adverse effects. The adverse and beneficial effects shall be communicated in each case so that the judgement is clear.

4.29. The type of receptors which would be considered include residential, recreational and road users.

Study Area

4.30. In order to assist with defining the study area a Screened Zone of Theoretical Visibility (SZTV) has been produced at a range of up to 10km, which identifies the potential locations from which the scheme may be visible. The SZTV has been produced using Digital Terrain Modelling (DTM) and LIDAR data. Existing built development (8m tall) and larger blocks of woodland have also been modelled (15m tall) to take account of the screening effect that these would provide. However, the screening effect provided by smaller blocks of woodland and hedgerows/hedgerow trees, particularly those within and surrounding the site, have not been taken into account, and consequently the actual extent of the area from which the scheme is visible is likely to be much smaller.

4.31. The SZTV has been run at an average height of 3m across the site for the elements which form the proposed development.

4.32. The SZTV is a useful tool used to provide a focus on the area and receptors that are most likely to be affected by a proposed development but should always be subject to verification in the field. In this regard, site visits were undertaken in 2022 to understand the actual likely visibility of the scheme at the site.

4.33. Following a review of the 10km SZTV and further on-site analysis it is proposed that an appropriate study area for the assessment is 3km. In locations beyond 3km where the site and any development on it would be visible, the Scheme is unlikely to result in any visual effects greater than minor. This is due to the minimal degree to which the Scheme would alter the overall view, which at this distance and when considering the local topography, would be more heavily influenced by other features and characteristics of the view.

Assessment Viewpoints

4.34. The assessment of visual effects will be undertaken with reference to viewpoint analysis as recommended by best practice guidelines. It is however acknowledged that viewpoints are simply snap shots of the view from a small number of the potential locations where the proposals would be visible. The visual assessment will therefore provide a broader discussion of visual effects on a range of visual receptors throughout the study area with reference made to the views represented by the selected viewpoints.

4.35. Based on initial site work, a provisional list of viewpoints has been developed which it is considered would be appropriate for the assessment. The proposed locations are set out in the table below and are illustrated on the 3km SZTV plan at Appendix 4.1. The list of viewpoints has been selected to represent a range of views and viewer types. The viewpoints cover a variety of different landscape character types and different visual receptor groups.

Viewpoint No.	Approximate Coordinates	Viewpoint Description
1	469934 , 414868	Public right of way (Thorne No. 15)

Viewpoint No.	Approximate Coordinates	Viewpoint Description
2	471144 , 415159	Public right of way (Thorne No. 15)
3	470792 , 412954	Public right of way (Thorne No. 19)
4	472815 , 412993	Public right of way (Thorne No. 19)
5	472066 , 412207	Stainforth and Keadby Canal towpath
6	474102 , 412141	Stainforth and Keadby Canal towpath
7	470342 , 411836	Clay Bank Road
8	469747 , 411292	High Levels Bank (A18) at Double Bridges Road
9	468734 , 410513	Tudworth Road (A18)
10	468505 , 409738	Sandtoft Road
11	468850 , 409013	Bull Moor Road / Public right of way (Hatfield No. 39)
12	470550 , 408475	Stainforth Moor Road
13	471454 , 410739	High Levels Bank (A18) adjacent to Tithe Farm
14	471596 , 409974	Crow Tree Bank
15	471470 , 409339	Crow Tree Bank on bridge over M180
16	473739 , 409980	High Levels Bank (A18) looking north
17	473904 , 409913	High Levels Bank (A18) looking south
18	473506 , 408356	Low Levels Bank
19	474656 , 411818	Jaque's Bank near Groves Cottage
20	475057 , 412634	Crook o'Moor Road (BOAT)

Viewpoint No.	Approximate Coordinates	Viewpoint Description
21	476375 , 413806	Moor Road / Peatlands Way
22	476567 , 412886	Bridleway No.18 nr. Crowle
23	474520 , 408856	Idle Bank on bridge over M180
24	475892 , 410099	Minor Road adjacent to North Engine Drain looking south-east
25	477290 , 410600	Minor Road adjacent to North Engine Drain looking south-west
26	477479 , 409454	Public right of way No. 21

Supporting Visual Material

4.36. It is proposed that the LVIA be accompanied by visualisations of the proposals to illustrate the view from three of the viewpoints in the area surrounding the site. The proposed locations are set out below:

- Viewpoint 1 – Public right of way (Thorne No. 15);
- Viewpoint 3 – Public right of way (Thorne No. 19);
- Viewpoint 5 – Stainforth and Keadby Canal towpath;
- Viewpoint 15 – Crow Tree Bank on bridge over M180;
- Viewpoint 21 – Moor Road / Peatlands Way;
- Viewpoint 23 – Idle Bank on bridge over M180; and
- Viewpoint 26 – Public right of way No. 21.

4.37. The visualisations would be undertaken using landscape institute guidance, namely 'Visual Representation of Development Proposals, Technical Guidance Note 06/19, September 2019'. Visualisations would be produced during two different time periods at both Year 1 and at Year 15 with the benefit of maturing vegetation.

Mitigation and Enhancement

4.38. As part of the proposed development, areas of new planting would be introduced. Newly planted vegetation takes a number of years to mature and average growth rates shall be

taken into consideration in the assessment. The effectiveness of vegetation would improve over time (both in terms of integrating the Scheme into the surrounding landscape and in providing visual screening) and this shall be considered appropriately. Consideration to local landscape character and vernacular would be taken account of, to avoid creating landscape features which are not apparent in the locality.

4.39. Strategic landscape would be included as part of the Scheme parameters.

Assessment Methodology

4.40. It is acknowledged from the outset that, in common with almost all commercial solar energy development proposals, some landscape and visual effects would occur as a result of the proposals.

4.41. A key principle of the European Landscape Convention is that all landscapes matter and should be managed appropriately. It is also acknowledged that landscapes provide the surroundings for people's daily lives and often contribute positively to the quality of life and economic performance of an area.

4.42. It is therefore proposed that a landscape and visual chapter is undertaken as part of the planning application submission. This assessment will be undertaken by Chartered Landscape Architects at Pegasus Group who are experienced in the assessment of landscape and visual effects of solar energy developments and are familiar with the local landscape.

Overview of Approach and Methodology

4.43. It is proposed that the main objectives of the LVIA will be as follows:

- To identify, evaluate and describe the current landscape character of the site and its surroundings and also any notable individual or groups of landscape features within the site;
- To determine the sensitivity of the landscape to the type of development proposed;
- To identify potential visual receptors (i.e. people that would be able to see the Scheme) and evaluate their sensitivity to the type of changes proposed;
- To identify and describe any impacts of the scheme in so far as they affect the landscape and/or views of it and evaluate the magnitude of change due to these impacts;
- To identify and assess any cumulative landscape and visual effects;
- To identify and describe mitigation measures that have been adopted to avoid, reduce and compensate for landscape and visual effects;

  and

- To evaluate the level of residual landscape and visual effects.

Published LVIA Guidance

4.44. The chapter shall be undertaken in accordance with the principles of best practice, as outlined in published guidance documents, notably the third edition of the Guidelines for Landscape and Visual Assessment (GLVIA3), (Landscape Institute and the Institute for Environmental Management and Assessment, 2013).

4.45. The methodology and assessment criteria for the assessment shall be developed in accordance with the principles established in this best practice document. It should be acknowledged that GLVIA3 establishes guidelines, not a specific methodology. The preface to GLVIA3 states:

> **'This edition concentrates on principles and processes. It does not provide a detailed or formulaic 'recipe' that can be followed in every situation – it remains the responsibility of the professional to ensure that the approach and methodology adopted are appropriate to the task in hand.'**

4.46. The approach shall therefore be developed specifically for this assessment to ensure that the methodology is fit for purpose.

Distinction between Landscape and Visual Effects

4.47. In accordance with the published guidance, landscape and visual effects shall be assessed separately, although the procedure for assessing each of these is closely linked. A clear distinction has been drawn between landscape and visual effects as described below:

- Landscape effects relate to the effects of the proposals on the physical and perceptual characteristics of the landscape and its resulting character and quality; and
- Visual effects relate to the effects on specific views experienced by visual receptors and on visual amenity more generally.

Residential Visual Amenity Assessment

4.48. A detailed consideration with regard to the visual amenity of the nearest residential properties to the site shall be included within the LVIA. For any residential properties located within 0.5km of the Proposed Development, a separate standalone Residential Visual Amenity Assessment (RVAA) will therefore be prepared as an Appendix to the chapter. The RVAA will be prepared in line with the principles set out in best practice guidance 'Residential Visual Amenity Assessment (RVAA) -Technical Guidance Note 02/19, Landscape Institute (2019).

Significance Criteria

4.49. The level (relative significance) of landscape and visual effects is determined by combining judgements regarding the sensitivity of the landscape or view, magnitude of change, duration of effect and the reversibility of the effect. In determining the level of residual effects, all mitigation measures are taken into account.

4.50. The relative level of effect is described as major, moderate/major, moderate, moderate/minor, minor or minor/no effect. No effect may also be recorded as appropriate where the effect is so negligible it is not even noteworthy. Those effects described as

major, major/moderate and in some cases moderate, may be regarded as significant effects as required by the Infrastructure Planning (Environmental Impact Assessment) Regulations 2017, however the final conclusions are as a result of professional judgement.

Assessment of Cumulative Effects

4.51. Landscape and visual cumulative effects would be considered for all proposed energy based schemes within 5km of the site boundary.

5. Nature Conservation and Biodiversity

Introduction

5.1. The Nature Conservation and Biodiversity Chapter of the Environmental Statement will assess the potential effects of the scheme on important ecological features and will detail any proposed mitigation and/or compensation measures required to avoid, minimise, restore or offset adverse effects.

5.2. This section of the EIA Scoping Report details the approach to baseline information gathering and to the assessment of potential effects on ecology, in accordance with current best practice. An overview of likely significant effects proposed to be assessed within the Environmental Statement chapter is also provided.

Baseline data has been compiled from a desk study, as well as from habitat and species surveys undertaken at the site.

Site Context

5.3. The Site is situated between Doncaster and Scunthorpe, east of the town Thorne. Thorne Moors is located north of the Site and the M180, High Level Banks Road (A18) and Stainforth and Kneadby Canal intersect the Site. The dominant habitat within the Site is arable farmland with field boundary features primarily consisting of drainage ditches and occasional hedgerows.

Study Area

5.4. The study area for the project has been based on 'zones of influence' for different ecological features which may be affected by biophysical changes as a result of the scheme and associated activities (refer to Figures 5.1-5.3). The zones of influence that extend beyond the direct land-take required for the scheme have been identified based upon the nature of the project and the construction, operation and decommissioning activities to be undertaken. These are also informed by the consultation and Scoping process and Chartered Institute of Ecology and Environmental Management ('CIEEM') and Natural England guidance, where available[8]&[9].

5.5. Whilst they cover the large majority of the scheme's boundaries, it is acknowledged that in some instances the breeding bird survey study area does not include the entire scheme boundaries; this is due to the evolution of scheme boundary design since the surveys were undertaken. Additional parcels of land have been added, including extension of parcels to the west, north east, south west and south of the Site.

[8] Chartered Institute of Ecology and Environmental Management 'Guidelines for Ecological Impact Assessment in the UK and Ireland, Terrestrial, Freshwater, Coastal and Marine'. CIEEM (2018).

[9] Where specific guidance documents do not stipulate specific required zones of influence from a proposed Site, professional judgement has been applied based on the understanding of the site and developments similar in nature, size, and scale to the Proposed Development.

5.6. The extent of the Site and surveyed areas can be seen in Figures 5.2 and 5.3. However, it is considered that the baseline data gathered during the surveys provides an appropriately sufficient amount of information regarding breeding bird assemblages within the Site and wider environment to reliably inform an Ecological Assessment Process. Any limitations to surveys will be acknowledged in the Environmental Statement and conclusions of impacts fully justified.

5.7. The zone of influence will therefore vary for different ecological features depending on their sensitivity to an environmental change. The identified zones of influence were used to establish the scope of baseline ecological surveys and the extent of survey area and desk study.

5.8. Zones of influence for the site that have been considered comprise (refer to Figures 5.1, 5.2 and 5.3):

- Statutory designated sites - within 5km from the site, extended to 10km for European-designated Sites (comprising Special Protection Areas ('SPA'), Special Areas of Conservation ('SAC') and Ramsar sites[10]);
- Non-statutory designated sites, protected and priority habitats and species - within 2km from the site (e.g. Natural Environment and Rural Communities Act 2006 Section 41 Species of Principal Importance and Priority Habitats)[11];
- Habitats - land within the site and immediately surrounding habitats where these could be surveyed from within the site[12] ;
- Great crested newts - on-site ponds/water bodies and accessible ponds/waterbodies within 250m of the site[13] ;
- Wintering birds - the site and surrounding fields up to 600m from the site where access was possible, or where land could be viewed from publicly accessible locations[14] ; and
- Breeding birds - the site and adjacent boundary habitats viewable from within the site[15] .

[10] Based on professional judgement and guidance provided within Nature Scot. (2016). Assessing Connectivity with Special Protection Areas (SPAs) – Version 3.

[11] This is a standard requirement to inform planning applications, as detailed within CIEEM (2020) Guidelines for Accessing, Using and Sharing Biodiversity Data in the UK. 2nd Edition. Chartered Institute of Ecology and Environmental Management. Winchester, UK.

[12] Undertaken in adherence to the guidance provided in Butchery, B. Carey, P. Edmonds, R. Norton, L. Treweek, J. (2020). The UK Habitat Classification Manual Version 1.1.

[13] Based on the guidance provided in the Natural England's Method Statement Template for Great Crested Newt Mitigation Licence provided here: https://www.gov.uk/government/publications/great-crested-newts-apply-for-a-mitigation-licence (accessed on: 21 November 2022).

[14] Based on professional judgement and guidance provided within M. Ruddock & D.P. Whitfield. (2007). A Review of Disturbance Distances in Selected Bird Species. Nature Scot.

[15] The methodology employed was based-upon a scaled-down version of the British Trust for Ornithology (BTO) Common Bird Census (CBC) technique, as detailed in Gilbert et al. (1998).

Figure 5.1 Statutory Designated Site Study Area

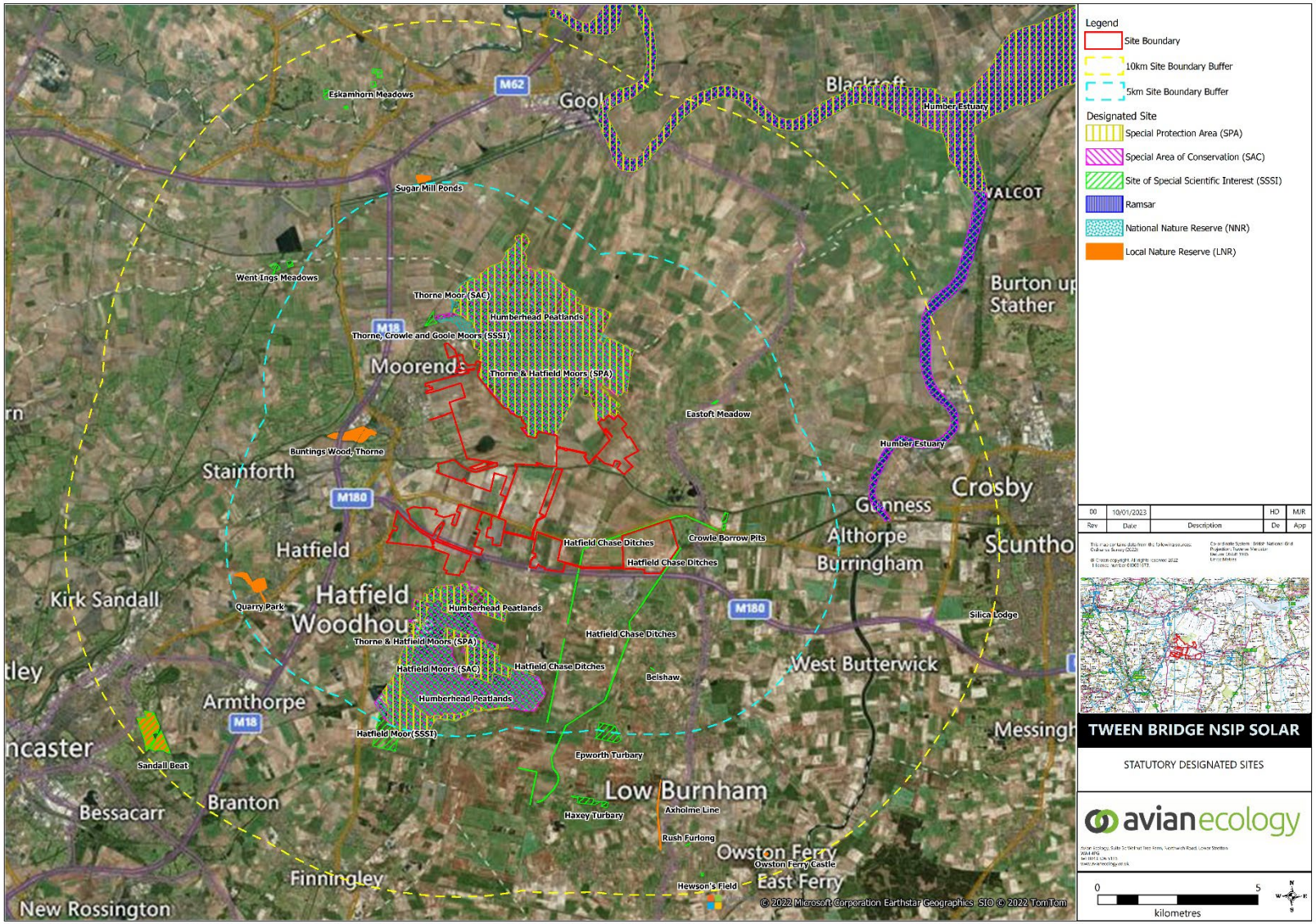


Figure 5.2 Survey Study Areas 1

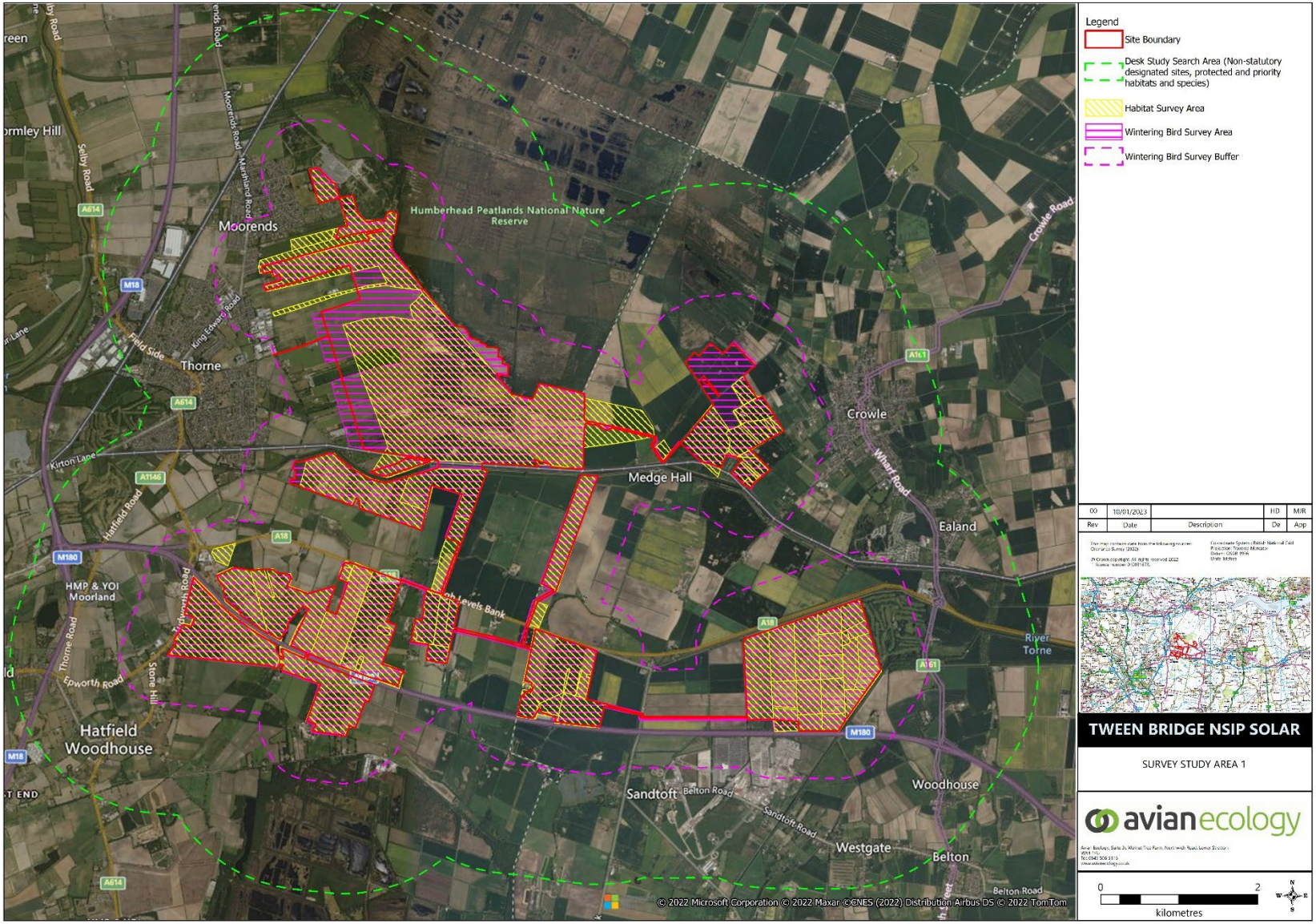
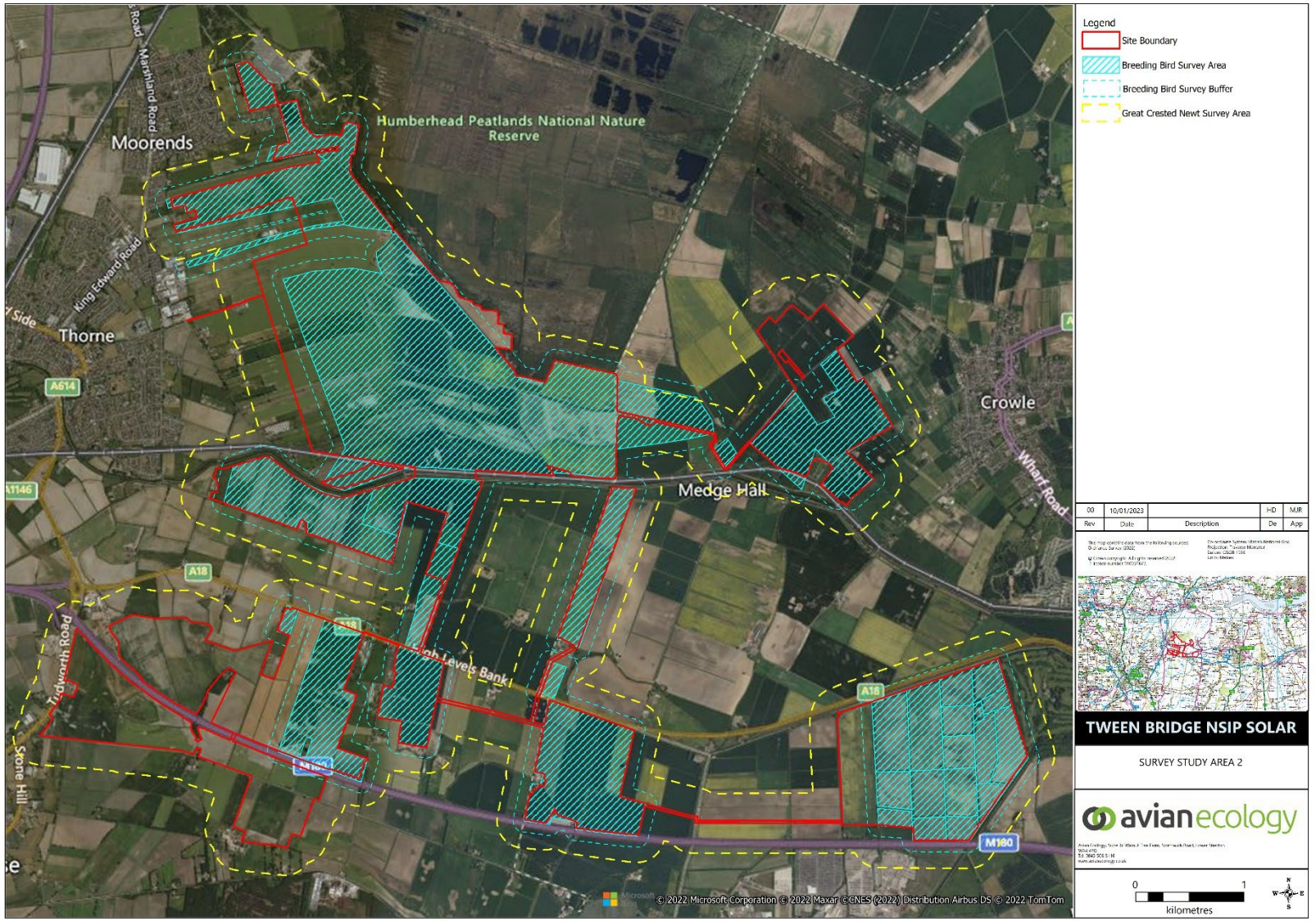


Figure 5.3 Survey Study Areas 2



Baseline Environment

5.9. Baseline information in relation to ecological features which may be affected by the scheme has been collected through desk study and ecological field surveys.

5.10. Full details of baseline studies, field surveys and any consultation will be provided within the ES. Appropriate survey areas have been adopted or will be adopted or updated as necessary during the preparation of the EIA to account for any changes to the design of the scheme as it evolves, and where permitted land access allows.

Initial Desk Study

5.11. An initial desk study was undertaken in February 2022 to inform the proposed approach to baseline information gathering, including the scope and requirement for baseline ecological surveys. This was updated in November 2022.

5.12. The following key sources were consulted in November 2022:

- Natural England Designated Sites View[16] and Joint Nature Conservation Committee ('JNCC') websites[17];
- The Multi Agency Geographic Information for the Countryside ('MAGIC') website[18];
- The Natural England Open Data Geoportal[19] ; and
- Aerial imagery.

5.13. In addition, biological data (including non-statutory designated site data) will be requested from Doncaster Environment Record Centre ('DERC'), Lincolnshire Environment Record Centre ('LERC') and North and East Yorkshire Ecological Data Centre ('NEYEDC'). Full results obtained from the desk study will be provided in the Environmental Statement.

Baseline Ecology Surveys

5.14. The following field surveys, which are typically required by statutory organisations and Local Planning Authorities to inform similar renewable energy developments within lowland England, have been undertaken to establish the baseline ecological features within the site, and surrounding area:

- Ecological constraints walkover survey (March & August 2022);
- Breeding bird survey (April to July 2022); and
- Wintering bird surveys (September 2022 to March 2023 [ongoing]).

[16] Available at: https://designatedsites.naturalengland.org.uk/ Accessed in Nov 2022
[17] Available at: http://jncc.defra.gov.uk/ Accessed in Nov 2022
[18] Available at: https://magic.defra.gov.uk/MagicMap.aspx Accessed in Nov 2022
[19] Available at: https://naturalengland-defra.opendata.arcgis.com/ Accessed in Nov 2022

5.15. All surveys have been undertaken by suitably competent and qualified ecologists in accordance with industry standard guidance. Full details of survey methodologies will be presented within the ES.

5.16. Additional targeted ecological surveys will be undertaken in the appropriate survey season in 2023, these include:

- UK Habitat Survey including additional areas of the Site boundary not covered within the walkover survey;
- UK Habitat Condition Assessment Survey (during the optimal habitat survey season);
- Great crested newt eDNA surveys;
- Badger surveys;
- Wintering bird surveys (ongoing);
- Water vole surveys; and
- Otter surveys.

5.17. Full details of ecological survey methodology, results and analysis will be provided within the Environmental Statement.

Designated Sites

5.18. A review of MAGIC found that the site is located within one statutory designated site; Hatfield Chase Ditches Site of Special Scientific Interest (SSSI). The search identified six internationally statutory designated sites within 10km of the site and a further seven UK statutory designated sites located within a 5km radius of the site boundary. These sites are detailed in Table 5.1 below.

Table 5.1 Designated Sites

Designated Site Name	Designation type and level	Approximate Distance and Direction from the Site (at closest point)	Description
Hatfield Chase Ditches SSSI	SSSI – national designation	Within the Site	Ditch network within land that was formerly marsh and wetland at the head of the Humber Estuary. They support a range of aquatic plant species, rare invertebrates including and water voles.

Thorne Moor Special Area of Conservation	SAC – International designation	Adjacent to the Site	Thorne Moor is England's largest area of raised bog. Although recent management has increased the proportion of active raised bog at Thorne Moors, the inclusion of Goole Moors, where peat-extraction has now ceased, means that the Thorne Moor SAC is still predominantly degraded raised bog. The restored secondary surface is rich in species of active raised bogs.
Thorne & Hatfield Moors Special Protection Area	SPA – international designation	Adjacent to the Site	A breeding population of European nightjar *Caprimulgus europaeus*, which is of European importance is present at the Thorne & Hatfield Moors SPA.
Thorne, Crowle and Goole Moors SSSI	SSSI – national designation	Adjacent to the Site	The Moors forms the largest extent of lowland raised mires in England. Habitats present include canals and fenland. The SSSI also supports a range of invertebrates as well as breeding and wintering bird species.
Hatfield Moors SAC	SAC – International designation	0.27km south	Similar to Thorne Moors SAC, this is a lowland raised bog, the second largest in England. The bog is being restored and it support a diverse assemblage of plant species and invertebrates including the mire pill beetle.
Hatfield Moors SSSI	SSSI – national designation	0.27km south	Lowland raised bog with a system of drainage ditches. It supports a range of flora and fauna, including breeding heathland birds including nightjars and nightingales and invertebrates.
Crowle Burrow Pits SSSI	SSSI - national designation	1.9km east	The SSSI is located adjacent to an embankment of a disused railway line and supports a variety of habitats including scrub, fen and

			open water. It is noted to support rare plant species including the marsh fern.
Buntings Wood, Thorne Local Nature Reserve	LNR – national designation	2.5km west	A reserve that supports a range of habitats and species including native trees, water voles, small mammals, amphibians and birds.
Eastoft Meadow SSSI	SSSI – national designation	2.7km east	A small herb rich hay meadow which is under traditional management of hay cropping. It supports a range of plant species including a number of orchids.
Belshaw SSSI	SSSI - national designation	2.9km south	This is a short length of disused railway with neutral grassland that supports the nationally rare greater yellow rattle.
Quarry Park LNR	LNR – national designation	4km south west	A LNR that contains a variety of habitats including wildflower meadows and woodlands.
Epworth Turbary SSSI	SSSI – national designation	4.8km south	An area of relict peat vegetation which now contains heathland, fen and birch scrub. Recent management has controlled the scrub encroachment opening it up so it is now heathland and fen. Species present include breeding birds.
Humber Estuary SAC	SAC – International designation	6.2km east	The Humber is the second-largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain, including extensive intertidal mudflats and sandflats not covered by seawater at low tide. The SAC upstream from the Humber Bridge includes extensive mud and sand bars which in places form semi-permanent islands.

Humber Estuary Ramsar	Ramsar – International designation	6.2km east	An estuary with a maximum 7.4m tidal range exposing vast mud and sand flats at low tide. Vegetation with the Ramsar site includes extensive reedbeds, areas of mature and developing saltmarsh, backed by grazing marsh or low sand dunes with marshy slacks and brackish pools. The area regularly supports internationally important numbers of various species of breeding and wintering waterbirds. Many passage birds, notably internationally important populations of ringed plover, and sanderling stage in the area. The Ramsar site supports Britain's most south easterly breeding colony of grey seal.
Humber Estuary SPA	SPA – international designation	7.6km north east	The Humber Estuary comprises extensive wetland and coastal habitats. The estuary within the SPA supports extensive areas of reedbed, with areas of mature and developing saltmarsh backed by grazing marsh in the middle and outer estuary. On the north Lincolnshire coast, the saltmarsh is backed by low sand dunes with marshy slacks and brackish pools. Parts of the estuary are owned and managed by conservation organisations. The estuary supports important numbers of waterbirds (especially geese, ducks and waders) during the migration periods and in winter. In summer, it supports important breeding populations of bittern, marsh harrier, avocet and little tern.

5.19. Data regarding non-statutory designated sites will be requested from Local Record Centres within 2km of the Site and will be provided in the Environmental Statement.

Habitats

5.20. The site is dominated by arable land. Most fields consisted of cereals crops with some fields to the south containing non-cereal crops or left fallow at the time of the surveys.

5.21. The Site contains few modified grassland fields, as well as modified grassland field margins, trackways etc. These appeared to be species poor.

5.22. The site is drained by a network of ditches, and they are the dominant field boundary habitat within the Site. They appear to be well maintained and of biodiversity interest, with steep earth banks generally vegetated by grass with some tall ruderal vegetation and scrub in places. There are also a number of ponds present within, and adjacent to the site.

5.23. Stainford & Kneadby Canal intersects the Site and the invasive species, *Azolla* was recorded as present in patches along this water course. The A18, High Levels Bank road intersects the southern half of the Site, as does the M180 motorway.

5.24. Hedgerows are predominantly species-poor, with dominant hawthorn. Other species present include, cherry, field maple, oak, willow and beech. Some of the hedgerows contained scattered trees, conditions varied with some intact and others defunct and some hedgerows appeared to be under management regimes.

5.25. Scattered trees and tree lines are present within the Site, occasionally associated with dense scrub and/or ditch boundaries. Age composition varied from immature to mature and species included oak, birch, alder, willow, ash and sycamore.

5.26. Small blocks of broadleaved woodland are scattered within the Site and also present adjacent to the Site including within Thorne Moors SAC. Species are varied but included oak, ash, elder, hazel, willow, cherry and species often present within ground flora included bracken and bramble. Rhododendron was found to be present adjacent to the Site.

Protected and Priority Species

Breeding Birds

5.27. The methodology for the breeding bird surveys was based-upon a scaled-down version of the British Trust for Ornithology (BTO) Common Bird Census (CBC) technique, as detailed in Gilbert *et al.* (1998)[20].

5.28. A breeding bird survey was undertaken between April and July 2022. The breeding bird assemblage recorded within the site is representative of farmland habitats within the Humber region. Thirty nine species were recorded showing breeding behaviour within the survey area. Of these, 15 were notable 'red-listed' species; grey partridge, lapwing, curlew, turtle dove, cuckoo, skylark, swift, mistle thrush, starling, house sparrow, tree sparrow, yellow wagtail, greenfinch, linnet and yellowhammer. A further 17 were notable 'amber-listed' species including crane.

[20] Gilbert, G., Gibbons, D.W. and Evans, J. (1998) *Bird Monitoring Methods*. RSPB, Sandy

5.29. Additionally, several Schedule 1 species were recorded showing signs of breeding within the survey area in low numbers, including: crane, turtle dove, hobby and Cetti's warbler.

5.30. The notable species breeding assemblage was almost entirely associated with vegetation along field boundaries on-site, principally hedgerows, scrub, watercourses, tree-lines, woodland habitats and urban structures located outside of the site boundary.

5.31. Notable ground-nesting breeding species, which use open fields on-site, consisted of grey partridge, lapwing, curlew, skylark and yellow wagtail. Yellow wagtail and skylark were recorded in moderate to high breeding numbers, with 47 to 55 yellow wagtail territories and 121 to 164 skylark territories located throughout and immediately adjacent to the site. Low to moderate breeding numbers of lapwing were recorded within the site, with 13 estimated territories. Low breeding numbers of grey partridge and meadow pipit were recorded on-site, with a maximum of six and seven territories, respectively.

Wintering Birds

5.32. The methodology employed for wintering bird surveys comprises a 'walk-over' survey adopting the 'look-see' methodology described in Gilbert *et al*. (1998), where surveyors observed each field within the survey area, walking the boundaries and stopping at intervals and scanning the fields for Target Species, with binoculars. Two visits per month are being carried out between September 2022 and March 2023, with three of these visits comprising of nocturnal surveys, using night vision equipment.

5.33. Wintering bird activity in September and October 2022, within the site has been with activity consisting of small to moderate flocks of birds associated with open arable farmland. Pink-footed geese were recorded in both months with an increase into October with the largest single flock recorded being 752 birds. Additionally, wetland birds using the habitats within the survey area to forage included: lapwings with a maximum flock size of 390 in September and golden plover with a largest flock of 480 birds in October 2022. Other wetland birds recorded comprised of very low numbers of mallard, teal, little egret, grey heron, green sandpiper, yellow-legged gull, Caspian gull, herring gull, lesser black-backed gull, black-headed gull and common gull.

5.34. Several Schedule 1 listed birds were recorded during winter surveys so far including: peregrine, hen harrier, marsh harrier, kingfisher, crane and fieldfare. Other notable species included kestrel, mistle thrush, starling and buzzard.

Mammals

5.35. An ecological walkover survey was undertaken within the study area in March and August 2022 by suitably competent ecologists. The survey sought to identify the presence or potential presence of protected and priority species within the site. This will be updated in 2023, when further surveys are undertaken on site such as the UKHab survey.

5.36. The ecological walkover survey confirmed the presence of badger within the site and the potential presence (due to habitat suitability) was also noted for water vole and otter along ditch and canal networks within and surrounding the site.

5.37. Further species-specific surveys will be undertaken, where required to ensure legislative compliance and to inform the assessment of likely significant effects from the Proposed Development, as well as any embedded mitigation within its design. These surveys will consist of surveying watercourses which may be potentially impacted (where works are situated within 3-5m of the top of the ditch).

5.38. A survey will be undertaken between May and September 2023 and this will use detection dogs to determine presence/absence of water voles within the Site. Any evidence found during the survey will be recorded and photographed and signs will be verified by an ecologist. Evidence of otter will also be recorded during these surveys.

5.39. It is acknowledged that this is not a standard methodology; however the use of detection dogs within conservation is not new. It is considered the use of this methodology will ensure the surveys are thorough, covering potentially steep, densely vegetated and hard to reach areas in a far more effective manner than traditional 'human' surveys. It is considered that the combination of this methodology alongside suitably trained ecologists is the best approach to determine presence/absence on the Site and therefore that the methodology is extremely robust.

5.40. Data collected will be sufficient to determine the potential for significant effects on water voles and otters. The Application will include commitment to further detailed surveys in advance of construction so as to determine accurate and current information on population extents and densities. Such surveys would be targeted to areas specifically impacted by the scheme (and which are not yet known as design is on-going).

5.41. In addition, it is considered that the site may potentially support the following priority species:

- Brown hare;
- Hedgehog;
- Western polecat; and,
- Harvest mouse.

5.42. A number of mature trees were noted to have potential bat roosting features during the ecological baseline walkover survey. The likelihood of impacts upon potential roost sites and the requirement for further survey work pre-construction in line with 'Bat surveys for professional ecologists: good practice guidelines' (2016) best practice guidance will be considered in the ES.

Amphibians and Reptiles

5.43. The arable fields are considered to be of sub-optimal value to amphibians and reptiles. The boundary hedgerows, ditches, field boundaries, ponds, brash pile and woodlands are considered to offer more suitable habitat for amphibians and reptiles if present, providing breeding, foraging, refuge and commuting opportunities.

5.44. Ponds in and within 250m of the Site, will be surveyed using eDNA methodology (in line with Biggs *et al.,* 2014[21]) between April and June 2023, the results of which will be considered within the ES.

5.45. No specific surveys for reptiles are proposed.

Project Basis for Scoping Assessment

5.46. The Proposed Development's design evolution will seek to avoid areas of significant biodiversity value, such as field boundary hedgerows and ditch networks. Habitat enhancement measures and ongoing management practices will be proposed in line with guidance published by the Building Research Establishment (Biodiversity Guidance for Solar Developments) ('the BRE Guidance') that will enhance and safeguard key habitats for the benefit of wildlife, and enhance the ecological value of land currently under agricultural use.

5.47. The BRE Guidance states that:

'with appropriate land management, solar farms have the potential to support wildlife and contribute to national biodiversity targets. Indeed, solar farms may have several additional advantages in that they are secure sites with little disturbance from humans and machinery once construction is complete. Recent research suggests biodiversity gains on solar farms can be significant'.

5.48. The site-specific approach within the Environmental Statement chapter will provide recommendations for long-term management of the land. With the aim to conserve and improve landscape habitat connectivity with the wider landscape for wildlife through protecting and enhancing potentially important wildlife corridors and habitats. This will contribute to the establishment of coherent ecological networks, supporting the biodiversity net-gain targets of the Environment Act 2021 and the current Draft Overarching NPS for Energy (EN-1)[22].

Embedded Mitigation

5.49. Due to the 'constraints-led' iterative design process for the proposed development, most mitigation measures are considered likely to be embedded mitigation rather than additional measures to ameliorate significant environment effects.

5.50. Measures to avoid or otherwise minimise potentially adverse impacts upon ecological features will include:

[21] Biggs J., Ewald N., Valentini A., Gaboriaud C, Griffiths R.A., Foster J., Wilkinson J., Arnett A., Williams P and Dunn F (2014). Analytical and methodological development for improved surveillance of the Great Crested Newt. Defra Project WC1067. Freshwater Habitats Trust: Oxford.

[22] Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47854/1938-overarching-nps-for-energy-en1.pdf (accessed on: 21st November 2022)

- Species-specific buffer zones will be adopted, where required, further detailed information will be provided within the Environmental Statement;
- The most ecologically valuable habitats (such as woodland) will be avoided, where practicable;
- A Construction Environmental Management Plan (CEMP) will accompany the Environmental Statement. The CEMP will include an outline of all good practice measures, pollution controls and monitoring, where required;
- Commitment to the appointment of an Ecological Clerk of Works (ECoW) to oversee the construction phase;
- Pre-construction surveys for protected species, where required (e.g. terrestrial mammals);
- Wintering bird mitigation areas (focussed on qualifying features of SPA designated sites) details for which will be dependent on survey results; and,
- New watercourse / ditch crossings will be minimised and sensitively designed to allow the continued movement of wildlife along the watercourse.

Enhancements

- Enhancements within the Site will be discussed within the ES Chapter and may include;
- Species diverse grassland planting;
- Hedgerow planting;
- Native scrub planting;
- Pond/wetland creation; and/or
- Ditch management/creation.

Likely Significant Effects

5.51. The assessment will consider the potentially significant effects associated with the construction, operational and decommissioning phases of the Proposed Development. The assessment will be undertaken with reference to CIEEM guidelines (2018), and using professional judgement based on the best available evidence. Where gaps in, or limitations to, available data exists these will be acknowledged, and a precautionary approach adopted as appropriate.

5.52. Potential construction phase ecological effects associated with the scheme are considered to relate to:

- Direct land take (habitat loss) to accommodate the Proposed Development;
- Temporary disturbance and land take for laydown areas and construction compounds;

- Disturbance to, fragmentation or severance of connecting habitat or potential commuting routes within and adjacent to the site; and

- Disturbance and pollution (indirect effects such as noise and vibration, dust, pollution from surface water run-off) resulting from site clearance and construction, plant and vehicles movements and site workers' activities.

5.53. Operational phase effects are defined as effects following the construction of the Proposed Development. Operational phase effects generally relate to disturbance of habitats or species, on either a temporary or permanent basis. Some effects may reduce with habituation or remain for the lifetime of the Proposed Development.

5.54. There are no additional operational effects relating to land take or habitat loss other than those already addressed in the construction phase.

5.55. Decommissioning effects are defined as effects following the end of the operational period of the Proposed Development. Decommissioning effects relate to disturbance of habitats or species, on a temporary basis and disturbance and pollution (indirect effects such as noise and vibration, dust, pollution from surface water run-off) resulting from site decommissioning activities, plant and vehicles movements.

5.56. The CIEEM Guidelines (2018[23]) define a 'significant effect' as an effect that either supports or undermines biodiversity conservation objectives for 'important ecological features' or for biodiversity in general (i.e. the feature could be positively or negatively significantly affected).

5.57. In regard to ecological impact assessment, the CIEEM Guidelines note that:

'A significant effect does not necessarily equate to an effect so severe that consent for the project should be refused planning permission. For example, many projects with significant negative ecological effects can be lawfully permitted following EIA procedures as long as the mitigation hierarchy has been applied effectively as part of the decision-making process.'

5.58. Any potentially significant effects identified will be expressed with reference to an appropriate geographic scale. For example, a significant effect on a nationally designated site is likely to be of national significance. However, the scale of significance does not necessarily always relate to the importance of an ecological feature. For example, an effect on a species which is considered of national importance may not have a significant effect upon its national population.

5.59. In line with the principles of proportionate EIA, embedded mitigation, including avoidance through the design process and application of industry standard good practice, will be considered at the outset of the assessment. Important ecological feature status will only be assigned where there is still considered to be the potential for significant effects on the identified feature arising from the scheme after the application of embedded mitigation measures.

[23] CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (version 1.1). Chartered Institute of Ecology and Environmental Management, Winchester.

5.60. Where it is not possible to robustly justify a conclusion of no significant effect, a significant effect will be assumed as a precautionary approach to ensure that a realistic 'worst case' scenario has been assessed. Where uncertainty exists, this will be acknowledged.

5.61. Where the Environmental Statement chapter proposes measures to mitigate potentially significant adverse effects on ecological features, an assessment of residual ecological effects, taking into account any ecological mitigation recommended, will be undertaken.

Potential Effects Scoped out of the Assessment

5.62. CIEEM guidelines (2018) stipulate that it is not necessary to carry out a detailed assessment of impacts upon ecological features that are sufficiently widespread, unthreatened and/or resilient to impacts of a development proposal.

5.63. As such, the assessment will be restricted to consideration of the effects upon ecological features which are considered important on the basis of relevant guidance and professional judgement.

5.64. Where ecological features are unlikely to be so important in the context of the scheme as to warrant a detailed assessment or where they would be unlikely to be significantly affected on the basis of baseline information, it is proposed that these are 'scoped out' of the ecological impact assessment process. Embedded mitigation measures for such features may, however, still be outlined as appropriate, to reduce and/or avoid any potentially adverse effects, or to ensure legislative compliance.

5.65. It is proposed that the potential for indirect effects upon statutorily designated sites for nature conservation (without mobile qualifying criteria[24]) located greater than 2km from the site, or for which embedded mitigation and good practice will be sufficient to prevent any impacts, is scoped out of the assessment, due to the static nature of the sites' qualifying habitats interests, spatial separation and / or absence of hydrological pathways of connectivity.

5.66. Statutory designated sites within 10km of the site with associated qualifying bird assemblages will be scoped out of the assessment, unless suitable habitat for pertinent species is present within or surrounding the site (within 600m of the site boundary).

5.67. Impacts to existing common and widespread habitats of low sensitivity and/ or conservation interest, such as arable fields are proposed to be scoped out of the assessment.

5.68. Due to the presence of a largely arable, intensive farmland habitat within the site, it is not considered that the field parcels within the site provide suitable habitat mosaics to support locally or regionally important invertebrate assemblages and therefore impacts on invertebrate assemblages are proposed to be scoped out of the assessment.

[24] Qualifying species (or species assemblages) associated with a designated site that may regularly rely upon habitats located outside of the designated site boundary to sustain their population (such as waterbirds which regularly utilise farmland for foraging/roosting purposes), such supporting habitats are referred to as functionally linked land.

5.69. Baseline information collected via surveys has not identified the site as being sufficiently important to lead to the potential for significant effects on the following species/species groups and they are therefore scoped out of detailed assessment:

- brown hare;
- hedgehog;
- harvest mouse;
- reptiles; and,
- invertebrates.

5.70. Although these ecological features are proposed to be scoped out of the assessment, consideration will, however, be afforded to the provision of standard mitigation to be included in the CEMP and Operational Management Plans for the Proposed Development.

5.71. Any lighting required during construction, operation and decommissioning of the scheme will be temporary and / or low impact (e.g. PIR lighting). Lighting will be directed away from trees, hedgerows and other surrounding habitats. On the basis that lighting is designed in a sensitive manner, no discernible effects are anticipated on biodiversity during the construction, operational and decommissioning phases of the scheme and therefore an assessment of lighting effects is proposed to be scoped out of the ES chapter.

Proposed Approach to the Environmental Statement

5.72. The assessment of the likely significant effects of the scheme on ecological features to be presented within the Environmental Statement chapter will be based on the CIEEM Guidelines (2018). Please see Appendix 5.1 for the detailed adopted methodology that will be used within the ES Chapter to determine significant of effect. In brief summary;

5.73. The assessment process will include the following stages:

- determination and evaluation of important ecological features;
- identification and characterisation of impacts;
- outline of mitigation measures to avoid and reduce significant impacts;
- assessment of the significance of residual effects after the implementation of such measures;
- identification of appropriate compensation measures to offset significant residual effects; and
- identification of opportunities for ecological enhancement.

5.74. Whilst not yet a mandatory requirement, the EIA will seek to demonstrate 10% biodiversity net-gain in accordance with NERC obligations, the Environment Act 2021 and local planning

policy[25]. Therefore, the DEFRA Biodiversity Metric Calculator will be utilised in order to provide evidence of achievable biodiversity net-gains associated with the Proposed Development.

5.75. The ES chapter will be supported by Technical Appendices detailing the desk study results, consultation, survey methods and results, and will be further supported by relevant figures, tables and photographs, where necessary. Where sensitive data is recorded, the ES chapter will be supported by confidential appendices which will not be released into the public domain.

5.76. The assessment within the ES chapter will only assess in detail impacts upon important ecological features i.e., those that are considered important and potentially significantly affected by the Proposed Development.

5.77. If internationally designated site/s are potentially impacted by the Proposed Development, information will be provided to inform an Habitats Regulations Assessment (HRA), which can then be used by a competent authority to determine if likely significant effects could occur.

5.78. A detailed assessment of features that are sufficiently widespread, unthreatened and resilient to the Proposed Development's impacts will not be undertaken and justification for scoping such detailed assessment out of the ES chapter will be provided.

5.79. Relevant European[26], national and local legislation policy and guidance will be referred to in order to determine the importance (or 'sensitivity') of ecological features. In addition, importance will also be determined using professional judgement, the results of baseline surveys and the importance of features within the context of the geographical area.

5.80. Importance will not necessarily relate solely to the level of legal protection that a feature receives. Ecological features may be important for a variety of reasons, such as their connectivity to a designated site and the rarity of species, or the geographical location of species relative to their known range.

5.81. The importance of ecological features will be defined in a geographical context from "Local" to "International".

5.82. The identification and characterisation of impacts on important ecological features will be undertaken in accordance with the CIEEM Guidelines, with reference made to magnitude (e.g. area or number of individuals of a species to be impacted), extent, duration and reversibility, as appropriate. The tables utilised for the assessment methodology (refer to Appendix 5.1) differ slightly from those within Chapter 4 (EIA Methodology) of this Scoping Report.

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[25] Doncaster Local Plan 2015-2035; Policy 30; Valuing Biodiversity & Geodiversity (Strategic Policy) https://dmbcwebstolive01.blob.core.windows.net/media/Default/Planning/Documents/Local%20Plan/Submission/Doncaster%20Local%20Plan%20Adopted%2023%20Sept%202021.pdf Accessed 21st November 2022
and Supplementary Planning Document; Biodiversity Net Gain (Draft Aprill 2022)
https://dmbcwebstolive01.blob.core.windows.net/media/Default/Planning/Documents/Natural%20Environment/Biodiversity/Draft%20BNG%20SPD%20-%20April%202022.pdf Accessed 21st November 2022

[26] via the Conservation of Habitats and Species Amendment (EU Exit) Regulations 2019

5.83. Impacts will be considered during the construction and operational phases of the scheme and will be assessed on the basis that a clearly defined range of avoidance and standard best practice measures are implemented. The decommissioning phase will also be assessed within the ES Chapter, but not considered in isolation as impacts are anticipated to be less than those predicted for the construction period.

5.84. The assessment will consider the potentially significant effects associated with the construction, operation and maintenance, and decommissioning of the scheme as detailed in **Table 5.2** below.

Assessment of Cumulative Effects

5.85. Cumulative effects would be considered for all proposed energy based schemes within 5km of the site boundary; however this may be extended for mobile qualifying interest species of internationally designated sites (e.g. SPA bird species).

Table 5.2

Receptor, Project Activity & Potential Impact	Anticipated Magnitude	Anticipated Importance / Sensitivity	Likely Significance of effect at Scoping Stage (Pre-Mitigation)	Proposed Approach – Scoped In/ Scoped Out
Statutory Designated Sites (without mobile qualifying criteria) located greater than 2km from the site - construction, operational and decommissioning phases	Negligible	High	Negligible	Scoped Out
Statutory Designated Sites (within 2km of the site) - construction, operational and decommissioning phases	Moderate	High	Minor Adverse	Scoped In
Statutory Designated Sites (with mobile qualifying criteria) up to 10km from the site - construction, operational and decommissioning phases	Low	High	Negligible	Scoped In
Non-statutory Designated Sites (within 2km of the site) - construction, operational and decommissioning phases	Low	Medium	Negligible	Scoped In
Impacts to common and widespread habitats of low sensitivity and/or conservation interest - construction, operational and decommissioning phases	Negligible	Negligible	Negligible	Scoped Out

Impacts to priority habitats (or otherwise of biodiversity importance) - construction, operational and decommissioning phases	Low	Low/Medium	Minor Adverse	Scoped In
Off-site habitats - construction, operational and decommissioning phases	Low	Low	Negligible	Scoped In
Breeding Birds - construction, operational and decommissioning phases	Moderate	Medium	Minor Adverse	Scoped In
Wintering Birds - construction, operational and decommissioning phases	Moderate	High	Moderate Adverse	Scoped In
Bats (roosting) - construction, operational and decommissioning phases	Moderate	Medium	Minor Adverse	Scoped In
Bats (foraging / commuting) - construction, operational and decommissioning phases	Moderate	Medium	Minor Adverse	Scoped In
Otter and water vole - construction, operational and decommissioning phases	Moderate	High	Minor Adverse	Scoped In

Badger - construction, operational and decommissioning phases	Moderate	Medium	Minor Adverse	Scoped In
Other small mammals including; brown hare, polecat, harvest mouse and hedgehog - construction, operational and decommissioning phases	Low	Medium	Negligible	Scoped Out
Amphibians - construction, operational and decommissioning phases	Moderate	Medium	Minor Adverse	Scoped In
Reptiles - construction, operational and decommissioning phases	Low	Medium	Minor Adverse	Scoped In
Invertebrates - construction, operational and decommissioning phases	Negligible	Low	Negligible	Scoped Out
Lighting Impacts on Sensitive Ecology - construction, operational and decommissioning phases	Negligible	Low-Medium	Negligible	Scoped Out

6. Cultural Heritage

Introduction

6.1. The Heritage Statement and ES chapter on the Historic Environment would cover potential effects relating to both archaeology and built heritage. Both the Heritage Statement and ES chapter will use 1km study areas for non-designated heritage assets and 2km study areas for designated heritage assets. The assessments will be prepared by a full member of the Chartered Institute for Archaeologists (MCIfA.)

6.2. Key heritage statute, policy and professional guidance will inform and guide the assessment works, notably including:

- The Ancient Monuments and Archaeological Areas Act 1979;
- The Planning (Listed buildings and Conservation Areas) Act 1990;
- The National Planning Policy Framework;
- The National Planning Practice Guidance;
- 'Conservation Principles' (English Heritage 2008);
- Historic England 2015 'Managing Significance in Decision-Taking in the Historic Environment: Historic Environment Good Practice Advice in Planning 2';
- Historic England 2017 'The Setting of Heritage Assets' (Historic Environment Good Practice Advice in Planning: 3);
- Historic England, Statements of Heritage Significance: Analysing Significance in Heritage Assets, Historic England Advice Note 12 (Swindon, October 2019); and
- Chartered Institute for Archaeologists professional guidelines.

Baseline conditions

Archaeology

6.3. The following potential non-designated heritage assets and findspots have been identified within the Site:

- Romano-British Pottery, N of Common Middle Road (MLS17318)
- Romano-British Pottery, N of Common Middle Road, 1988 (MLS17319)
- Romano-British Pottery, S of Common Middle Road, 1988 (MLS17320)
- Romano-British Pottery, N of Marsh Road, 1988 (MLS17321)
- Romano-British Pottery, S of Common Middle Road, 1988 (MLS17322)

- Romano-British Pottery, N of Marsh Road, 1988 (MLS17328)
- Undated Ditches, Possible Enclosure, Belton Grange (MLS18343)
- World War II Decoy (Site of), N of Airfield (MLS18438)
- Late Mesolithic/ Early Neolithic Flint Scatter (MLS19442)
- Late Neolithic/ Early Bronze Age Flint Flake (MLS19451)
- Neolithic/ Bronze Age Flint Flake (MLS19453)
- Romano-British Greyware Sherd (MLS19545)
- Romano-British Greyware Sherd (MLS19546)
- Romano-British Dalesware Sherd (MLS19549)
- Neolithic/ Bronze Age Flint Nodule (MLS19550)
- Neolithic/ Bronze Age Flint Flake (MLS19551)
- Neolithic/ Bronze Age Flint Flakes (MLS19574)
- Medieval Pottery (MLS19575)
- New Idle Drain (MLS19586)
- Romano-British Pottery, Hatfield Chase (MLS20019)
- Romano-British Cropmarks, Crowle Common (MLS20927)
- Peat Deposits, Neolithic Land Surface, West of Medge Hall (MLS21214)
- Romano-British Pottery, Lovers Ground (MLS21793)
- Site of Medge Hall Farm (MLS25262)
- Lover's Ground Farmstead (Site of) (MLS25265)
- Hains Farm, Crowle and Ealand (MLS25280)
- Site of Unnamed Farmstead, Belton (MLS25555)
- Belton Grange, Belton (MLS25556)
- Lancaster ND639 Crash Site, Marsh Road Area (MLS25882)
- Bronze Age Worked Flint (MLS25883)
- Undated Worked Flint (MLS25884)
- Bomb Stores (Site of), Sandtoft Airfield (MLS26024)

- Former Barnsley to Barnetby Railway (MLS8828)
- Romano-British Settlement Site, Sandtoft (MLS901)
- Undated Wooden Building, 1975 (MLS917)
- Neolithic Rough Flint End-Scraper, 1964-5 (MLS940)
- Stainforth and Keadby Canal (MLS9485)
- Old River Don (MLS9488)
- Possible Neolithic Flint Flake, Hatfield (MSY10053)
- Possible Neolithic Flint Graver, Hatfield (MSY10054)
- Possible Neolithic Flint Flake Tool, Hatfield (MSY10055)
- Mesolithic Flint Scatter, Thorne (MSY10092)
- Romano-British Pottery from Hatfield Chase (MSY10834)
- Mesolithic Tranchet Axe, Hatfield Levels (MSY12666)
- Early Bronze Age Flints, Thorne (MSY9396)

6.4. The layout of much of the Site is recorded on the 1840 Thorne tithe map which records a drained, enclosed agricultural landscape. The layout of the site is recorded on the Ordnance Survey maps of 1854, 1908 and 1949 with no substantial differences recorded when compared to the 1840 tithe. The modern introduction of the M180 motorway has traversed the study area from east to west and has severed the historic inter-relationship of the farming landscapes to the north and south.

6.5. There is moderate potential across the Site for evidence of prehistoric occupation dating from between the Mesolithic to the Bronze Age. The peat deposits within the Site have the potential to inform our understanding of the palaeoenvironment in this area. There is also moderate potential for archaeological remains dating to the Romano-British period to be encountered. Modern remains relating to the Second World War also have the potential to be identified, notably the remains of a crashed Lancaster which would need to be treated as a war grave were it to be discovered.

6.6. There are two Scheduled Monuments within 2km of the site boundary:

- Peel Hill motte and bailey castle, Thorne (1013451), *c.* 1550m west of the site.
- Lindholme Neolithic timber trackway and platform (1443481), *c.* 1470m south of the site.

6.7. There are no Registered Parks and Gardens in the vicinity of the Site.

Built Heritage

6.8. There are no built heritage assets within the Site. The following built heritage assets are within 2km of the Site:

- Thorne Conservation Area, *c.* 770m south-west of the site
- Hatfield High Street Conservation Area, *c.* 1575m west of the site
- Crowle Conservation Area, *c.* 910m east of the site
- Grade II Listed number 1 and gate piers to left (1063740), *c.* 970m east of the site
- Grade II Listed 1 and 3, Cross Street (1065721), *c.* 1050m east of the site
- Grade II Listed 49, High Street (1068609), *c.* 990m east of the site
- Grade II Listed stable/granary range approximately 50 metres south east of Tetley Hall (1068640), *c.* 1210m north-east of the site
- Grade II Listed 5, Cross Street (1083262), *c.* 1050m east of the site
- Grade II Listed 61, Ealand Outgate (1083263), *c.* 1835m north-east of the site
- Grade II Listed Sand Hall Lodge Cottage (1083264), *c.* 525m south of the site
- Grade II Listed 84, High Street (1083265), *c.* 1060m east of the site
- Grade II Listed White Hart Inn (1083266), *c.* 1060m east of the site
- Grade II Listed 2, Cross Street (1083267), *c.* 1045m east of the site
- Grade II Listed 47 High Street, Crowle (1083268), *c.* 1015m east of the site
- Grade II Listed the Cross Keys Inn (1083269), *c.* 1040m east of the site
- Grade II Listed carriage house/granary approximately 70 metres south east of Tetley Hall (1083270), *c.* 1185m north-east of the site
- Grade II Listed font approximately 30 metres south of Tetley Hall (1083271), *c.* 1200m north of the site
- Grade II Listed Dirtness Pumping Station (1083284), *c.* 745m north of the site
- Grade II Listed Dirtness Cottage (1083285), *c.* 775m north of the site
- Grade II Listed farmhouse approximately 100 metres east of Mosswood Grange farmhouse (1083286), *c.* 1055m east of the site
- Grade II Listed Hirst Priory (1083287), *c.* 395m east of the site
- Grade II Listed farmhouse and adjoining barn approximately 20 metres north of Fern Cottage (1083292), *c.* 1560m south of the site

- Grade II Listed syphon carrying north idle drain under Hatfield waste drain approximately 280 metres north of Sandtoft Grange (1083296), *c.* 395m south of the site

- Grade II Listed cartshed range at Sandtoft Grange farm approximately 110 metres north east of Sandtoft Grange farmhouse (1083297), *c.* 600m south of the site

- Grade II Listed farmbuildings at Grove Farm (1083298), *c.* 1325m south of the site

- Grade II Listed Curlews farmhouse (1083299), *c.* 1205m east of the site

- Grade II Listed the Old Vicarage (1083300), *c.* 920m east of the site

- Grade II Listed bridge on former Crowle Belton Road over north engine drain (108315), *c.* 855m east of the site

- Grade II Listed syphon carrying Hatfield waste drain below north level engine drain approximately 580 metres east of A18-A161 road junction (1084319), *c.* 1290m east of the site

- Grade II Listed mill tower at the windmill (1084348), *c.* 1375m south of the site

- Grade II Listed pair of farm cottages at Sandtoft Grange farm approximately 75 metres north east of Sandtoft Grange farmhouse (1084376), *c.* 610m south of the site

- Grade II Listed Travis Studio (1151562), *c.* 1330m south-west of the site

- Grade II Listed Lockermarsh (1151563), *c.* 1355m west of the site

- Grade II Listed premises of Richard Law fruit shops and flat above (1151564), *c.* 1465m south-west of the site

- Grade II Listed Sandhill farmhouse (1151565), *c.* 360m east of the site

- Grade II Listed outbuilding to rear of number 44a (1151566), *c.* 1365m south-west of the site

- Grade II Listed Crimean War memorial pump situated approximately 20 metres to west of north east entrance to park (1151567), *c.* 1520m north-east of the site

- Grade II Listed tower mill immediately to east of junction with Millfield Road (1151568), *c.* 1225m south-west of the site

- Grade II Listed number 1 Silver Street including number 31 bridge street (1151570), *c.* 1530m north-west of the site

- Grade II Listed the Old Vicarage (1151571), *c.* 1535m north-west of the site

- Grade II Listed tower mill at Mill House (1151590), *c.* 1735m south-west of the site
- Grade II Listed Elmtree House (1151618), *c.* 1615m south-west of the site
- Grade II Listed Glen Cottage (1151619), *c.* 1720m south-west of the site
- Grade II Listed outbuildings to south-west of house at Hepworths Yard (1151620), *c.* 1735m south-west of the site
- Grade II Listed number 54 (Pyenest flat 1-4 inclusive) (1151622), *c.* 1920m west of the site
- Grade II Listed cartshed with dovecote approximately 40 metres to east of Stonehill farmhouse (1192295), *c.* 735m south of the site
- Grade II Listed Grove House farmhouse (1192943), *c.* 225m west of the site
- Grade II Listed 44a and 44b, King Street (1192950), *c.* 1390m south-west of the site
- Grade II Listed the White Hart Inn (1192964), *c.* 1645m north-west of the site
- Grade II Listed Crimean War memorial pump (1192983), *c.* 1460m south-west of the site
- Grade I Listed Church of St Nicholas (1193076), *c.* 1305m south-west of the site
- Grade II Listed remains of medieval coffin approximately 3 metres to south of porch to Church of St Nicholas (1193099), *c.* 1340m south-west of the site
- Grade II Listed Stonegate House (now masonic hall) (1193117), *c.* 1390m north-west of the site
- Grade II Listed Micklethwaite Farmhouse (1193126), *c.* 660m west of the site
- Grade II Listed 12, North Street (1241087), *c.* 1070m east of the site
- Grade II Listed Thorne Hall, Ellison Street, Thorne (1286376), *c.* 1430m west of the site
- Grade II Listed stable-block approximately 20 metres to rear of the mews (1286620), *c.* 1830m west of the site
- Grade II Listed Bawtry Road farmhouse (1286647), *c.* 1590m south of the site
- Grade II Listed barn approximately 10 metres to rear of Elmtree House (1286682), *c.* 1435m south-west of the site
- Grade II Listed Stonehill Farmhouse (1314804), *c.* 705m south of the site

- Grade II Listed mortuary chapel at Hatfield Cemetery (1314805), *c.* 1470m south-west of the site
- Grade II Listed Settings farmhouse (1314818), *c.* 1635m south-west of the site.
- Grade II Listed churchyard gatepiers approximately 12 metres south west of porch to Church of St Nicholas (1314819), *c.* 1390m south-west of the site
- Grade II Listed front garden wall and gatepiers to number 20 (1314820), *c.* 1475m south-west of the site
- Grade II Listed barn and adjoining horse mill at Sandtoft Grange farm approximately 90 metres north east of Sandtoft Grange farmhouse (1338864), *c.* 600m south of the site
- Grade II Listed coach house/stables at Sandtoft Hall (1338872), *c.* 850m south of the site
- Grade II Listed Sandtoft Hall (1346669), *c.* 850m south of the site
- Grade II Listed barns, stables and adjoining ranges at Sandtoft Grange farm approximately 60 metres north of Sandtoft Grange farmhouse (1346670), *c.* 610m south of the site
- Grade II Listed bridge on former Crowle Belton Road over Hatfield waste drain (1346671), *c.* 860m east of the site
- Grade I Listed Church of St Oswald (1346672), *c.* 910m east of the site
- Grade II Listed 7 and 9, Cross Street (1346694), *c.* 1055m east of the site
- Grade II Listed Tetley Hall (1346695), *c.* 1205m north-east of the site
- Grade II Listed pyramid monument approximately 50 metres north of Tetley Hall (1346696), *c.* 1200m north-east of the site
- Grade II Listed barn/cartshed/stable range at Selby Farm (1346723), *c.* 1845m south of the site
- Grade II Listed gravestones and graveyard wall approximately 50 metres north of Tetley Hall (1356163), *c.* 1280m north-east of the site
- Grade II Listed Fernlea (1356167), *c.* 1070m east of the site
- Grade II Listed churchyard cross approximately 5 metres south of Church of St Oswald (1359670), *c.* 935m east of the site

Likely significant effects (construction, operation and decommissioning)

6.9. The construction phase of the scheme has the potential to disturb or remove buried archaeological remains within the site. The scale of effect may be significant in some cases.

6.10. The operation phase of the scheme has the potential to alter the settings of listed buildings in the vicinity of the site. The scale of effect may be significant in some cases.

6.11. It is not envisaged that decommissioning will result in any significant effects in relation to the historic environment.

Mitigation and Enhancement

6.12. Appropriate mitigation measures will be formulated in order to minimise the impacts of the proposed development. Such measures might include the placement of development including its exclusion from key areas and the appropriate use of offsets of built form or establishment of screening or filtering planting.

Assessment Methodology

Archaeology

6.13. Proposed assessment works comprise completion of a full Archaeological Desk-Based Assessment covering the site which would be completed in line with Chartered Institute for Archaeologists (CIfA) standards. The assessment will consider non-designated heritage assets within 1km of the site boundary and designated assets within 2km of the site boundary. This would consult:

- Historic England data sets;
- The South Yorkshire Historic Environments Record (SYHER);
- The North Lincolnshire Historic Environment Record (NLHER);
- Maps and other historic documents held by the Lincolnshire Archives;
- Online resources;
- Aerial photographs; and
- A site visit.

6.14. The results would be compiled into a report describing the recorded archaeological resource, and assess the potential for previously unrecorded remains in the Site, as well as impacts.

6.15. Following the completion of the desk-based assessment, consultation will be made with the LPA Archaeological Officers on the necessity of any further investigative works.

6.16. The desk-based assessment, and any further archaeological survey or fieldwork reports relating to further investigative works will be appended to the ES.

Built Heritage

6.17. The setting of the above assets will be considered with reference to the guidance given in Historic England's GPA3 The Setting of Heritage Assets (Second Edition) 2017.

6.18. The GPA3 guidance stresses the need to place setting and significance in their historical context so that any connections between heritage assets and their environs can be considered and recorded.

6.19. GPA3 advocates a five-step approach to proportionate decision-taking which will form the basis of the settings assessment methodology. The steps are:

- Step 1: Identify which heritage assets and their settings are affected
- Step 2: Assess the degree to which these settings and views make a contribution to the significance of the heritage asset(s) or allow significance to be appreciated
- Step 3: Assess the effects of the proposed development, whether beneficial or harmful, on the significance or on the ability to appreciate it
- Step 4: Explore ways to maximise enhancement and avoid or minimise harm
- Step 5: Make and document the decision and monitor outcomes

6.20. No Conservation Areas, Registered Parks and Gardens, Scheduled Monuments or Battlefield are present in the vicinity of the Site that are considered to be sensitive to development within the order limits. None of the three Conservation Areas or two Scheduled Monuments within the study area are within the site boundary nor are they intervisible with the proposed development. These assets do not derive any significance from a connection, either current or historic, to the land within the scheme boundary.

Articulating Value (Significance)

6.21. As defined in the NPPF, significance is 'the value of a heritage asset to this and future generations because of its heritage interest'. Historic England provides advice on assessing significance and advocates considering four types of heritage value: evidential, historical, aesthetic and communal. Significance results from a combination of any, some or all of these values. These four values essentially cover the heritage 'interests' given in the glossary of the NPPF, which comprise archaeological, architectural, artistic and historic interest.

<u>Levels of Significance</u>

6.22. Significance will be articulated in terms that directly relate to key policy, principally the NPPF. Four levels of significance may be identified:

- Designated heritage assets of the highest significance, as identified in paragraph 200 of the NPPF comprising Grade I and II* Listed buildings; Grade I and II* Registered Parks and Gardens; Scheduled Monuments; Protected Wreck Sites and Registered Battlefields (and also including some Conservation Areas);

- Designated heritage assets of less than the highest significance, as identified in paragraph 200 of the NPPF, comprising Grade II Listed buildings and Grade II Registered Parks and Gardens (and also some Conservation Areas);

- Non-designated heritage assets; and

- Sites, buildings or areas which have little or no heritage significance and thus do not constitute heritage assets.

6.23. Footnote 68 of the NPPF clarifies that 'Non-designated heritage assets of archaeological interest, which are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets'.

Assessment of Cumulative Effects

6.24. For cultural heritage, the potential for cumulative and in-combination effects will be considered within 2km of the site boundary. The Doncaster and North Lincolnshire planning portals and the register of applications for Nationally Significant Infrastructure Projects will be searched to identify any potential development that may result in cumulative or in-combination effects and these will be assessed using professional judgement.

7. Ground Conditions

Introduction

7.1. The Ground Conditions chapter of the ES will be prepared by Integrale Limited. This ES chapter will assess the likely effects of the scheme on the geology and ground conditions at the Site and immediate surroundings. It will consider geological soils and bedrock, hydrogeology and groundwater conditions, contaminated land, and geohazards/geotechnical risks associated with the proposed development.

7.2. The ES chapter will describe the methods used to assess the effects, the baseline conditions currently existing, the potential direct and indirect effects for the Scheme from construction, operation and decommissioning with regards to contaminated land and groundwater, superficial soils and bedrock resources. It will then identify the mitigation measures required to prevent, reduce, or offset the effects, and any residual impacts will then be considered.

7.3. Key policy and professional guidance will inform and guide the assessment works, including:

- Environment Agency's Approach to Groundwater Protection, 2018 Vers 1.2.
- CIRIA Environmental Good Practice on Site (C741) 2015 and CIRIA Control of Water Pollution from Construction Sites (C532).
- Part 2A of the Environmental Protection Act 1990, to ensure a site is suitable for its new use and to prevent unacceptable risk from pollution, and the implications of contamination for development.
- National Planning Policy Framework (update 2021) paragraphs 183-185 in regard to land stability and contamination.
- BS 10175 Code of Practice for Investigation of Potentially Contaminated Sites.
- BS 5930: 2015 + A1 2020 Code of Practice for Ground Investigation.

7.4. The assessment of geohazards and geotechnical risk is not a formal EIA requirement, but at this Site are required to inform foundation design and approach and assess constraints on the Scheme, and therefore the associated impacts.

Preliminary Baseline Conditions

7.5. An initial desk study and site visit was undertaken in October-November 2022 to inform the proposed approach to baseline information gathering, including the scope and requirements for baseline ground investigations. That initial study is included in Appendix 7.1. Full results from the ongoing detailed Phase 1 Baseline Desk Study will be included in the Environmental Statement.

7.6. This southern part of the Vale of York and Humberhead Levels is low-lying, low to very low relief ground, underlain by thick stratified sequences of complex late

Quaternary period superficial deposits. Centrally it includes the former courses of the Rivers Don and Idle and older Flandrian period channels, infilled with Alluvium, which overlaps marginal peat deposits. Blown Sutton Sand and the sands and laminated clays and silts of the formerly named '25 Foot Drift of the Vale of York' occur in the west, southwest and southeast, renamed as Breighton Sand and Hemingbrough Formation. Artificial deposition of alluvium as man-made Warp has taken place historically.

7.7. Bedrock occurs at several to many metres depth and comprises Triassic Mercia Mudstone Group in the east, Triassic Chester Formation Sandstone in the southern part of the western area, and Permo-Triassic Sherwood Sandstone Group in the northern part of the western area.

7.8. The majority of near surface soils are loamy and clayey, helping to maintain a naturally high groundwater table, draining to ditches and streams, or slowly permeable and seasonally wet with more impeded drainage. Several areas are mapped on geological sheets as peat, but none of the land area being considered includes soils classed on LandIS Soilscapes as bog peat soils.

7.9. The Coal Authority interactive mapping indicates the majority of the Site lies within the Coal Reporting Area, but none of the Site lies within the Development High Risk Area (DHRA). Immediately northwest at the former Thorne Colliery, two shafts form a DHRA, but the Site is beyond the calculated Zone of Influence of these shafts.

7.10. Peat Deposits have been worked to the south on Hatfield Moors and north on Thorne Moors. It is reportedly completely worked out across Tween Bridge Moors and South or Sand Moors. Other irregular peat outcrops within the Site thin out against, are interbedded with, or lie beneath the superficial deposits.

7.11. Initial assessment of Minerals Resources maps indicates one area at Tudworth Field Road of former sand and gravel workings. There are recorded landfill and waste management uses at Tudworth Hall Farm and Tudworth Landfill.

7.12. There were two World War II airfields outside the site at RAF Lindholme and RAF Sandtoft, and a WWII Decoy site in the southeastern area. A preliminary Unexploded Ordnance risk map indicates Low Risk for UXO. Anecdotal evidence of air crashes on or near the Site is reported.

7.13. Other than the above, the existing infrastructure of roads, canal and railway, widespread agricultural use and peat workings, no evidence for past potentially contaminative activities has been identified to date.

7.14. Evidence of the natural river meanders and artificial diversions is preserved on historical mapping, published literature and most importantly Digital Terrain Modelling (DTM) and LIDAR data. This is supplemented by British Geological Survey borehole data which has proven deep channels in places.

7.15. The Sherwood Sandstone bedrock at depth forms a Principal Aquifer, dipping eastwards and confined beneath increasingly thick Mercia Mudstone. Some of the superficial deposits form a Secondary A Aquifer. The peat deposits and Hemingbrough Formation at Tween Bridge Moors are Unproductive as an aquifer. Overall groundwater vulnerability to pollution is Low or Medium.

7.16. Groundwater is to some extent controlled by engineered and maintained drainage or natural water courses. Overall it potentially stands at 1-3m below ground level in summer and 0-2m below ground level in winter, outside of flood conditions. The zone of capillarity above this shallow water table will depend on local soil types.

7.17. British Geological Survey (BGS) borehole and Memoir data, GD Gaunt's published work and LIDAR data have been used to make an initial assessment of anticipated ground conditions for the Site field parcels and link corridors, with details given in Appendix 7.1. A summary of the shallow depth geological strata is shown in Table 7.1.

Table 7.1 Anticipated Shallow Soils

Area	Shallow Geological Formation	Anticipated Description	Anticipated Thickness
Area 1: Old River Don northwest	Artificial Warp	Silty clay (soft or firm and overlying soft or very soft alluvial clay and peat)	1m
Area 1: Old River Don southeast	Flandrian Alluvium and Peat	Very soft organic alluvial Clay/Silt or soft clayey Peat	1-10m
Area 1: Old River Don Course	Channel organic deposits	Silty clay on levees, over peaty clay, silt and sand	5-15m+
Area 2: North Engine Drain to River Torne	Sutton Sand (Blown Sand). Clayey Peat or Peat on peripheries	Medium dense Sand, or very soft or soft clayey Peat and Peat	1-4m+
Area 3: Plains Lane	Flandrian Alluvium	Soft peaty Clay or loose Sand	2-5m
Area 3: Old River Don Course	Channel organic deposits	Silty clay on levees, over peaty clay, silt and sand	3-6m+
Area 4: Bletchers Drain north	Sutton Sand (Blown Sand)	Medium dense silty Sand	0-4m
Area 4: south	Flandrian Alluvium	Very soft or soft organic Clay/Silt	1-5m+
Area 4: Old River Don Course	Channel organic deposits	Silty clay on levees, over peaty clay, silt and sand	3-6m+
Area 5: Elder Gates, High Levels	Flandrian Alluvium and Peat	Soft silty clay or medium dense silty Sand with organics	2-4m+

Area 5: Old River Don Course	Channel organic deposits	Silty clay on levees, over peaty clay, silt and sand	3-11m+
Area 6: Hatfield Chase	Flandrian Alluvium	Medium dense silty Sand or firm silty sandy Clay	1-3m+
Area 6: Old River Don Course	Channel organic deposits	Silty clay on levees, over peaty clay, silt and sand	5-10m+
Area 7: Ferne Carrs	Sutton Sand or Breighton Sand	Loose silty Sand over soft or firm laminated Silt/Clay	2-5m
Area 7: Ferne Carrs extreme west	Possible Glaciofluvial Sand & Gravel	Loose or medium dense Sand/Gravel	1-5m?
Area 8: Clay Bank east	Flandrian Alluvium	Soft or firm peaty sandy Clay	1-3m
Area 8: Clay Bank west	Hemingbrough Formation	Soft or firm laminated Silt/Clay	2-5m+
Area 9: Tween Bridge Wind Farm	Warp or (remains of) Peat	Soft to firm loamy Clay/Silt, or Soft clayey Peat	1-1m+
Area 10: Tween Bridge Moors	Hemingbrough Formation	Silt/Clays with some Sands?	Sparse data
Area 11: Moorends	Warp	Soft to firm loamy Clay/Silt	Sparse data

Likely Significant Effects (construction, operation and decommissioning)

7.18. The baseline data obtained from desk study and ground investigation will be used to assess likely effects of the scheme on geology and soils, groundwater and potentially contaminated land within the order limits and within 250m of the site boundary. The justification for this area is to include receptors and sensitive land uses that might be impacted, or past activities that may contribute to contamination. Those aspects which could create effects and are to be assessed in the ES include, but are not limited to:

7.19. Construction activities such as topsoil stripping, temporary compound and access track construction, foundation excavation for structures, and trenches for cabling.

Directional drilling work is likely required where crossing points relate to the canal, rail line and major roads.

7.20. During construction there is potential for loss of soil resource, ground compaction, and contamination of surface water courses or groundwater via spills and leaks, or through disturbance of existing contaminated soils.

7.21. During operation it is unlikely that the limited activities will affect ground or groundwater conditions, but this aspect requires further consideration in the ES as the project scheme develops.

7.22. During decommissioning there is some likely effect if in-ground plant and infrastructure is removed, and this aspect will be assessed in the ES.

Mitigation and Enhancement

7.23. The scheme will include mitigation measures to preclude, reduce or offset significant adverse effects on ground conditions. Since these mitigation measures will be embedded within the scheme design, this will limit the requirement for specific additional mitigation.

7.24. The application will include a Construction Environmental Management Plan (CEMP) to secure construction phase mitigation measures.

7.25. Additional mitigation measures specific to ground conditions aspects are not currently anticipated required during operation or decommissioning, but this will be considered following further assessment and in the ES.

Assessment Methodology

7.26. The initial desk study will be continued to supplement existing information, in particular for historical maps, borehole data, environmental parameters including pollution incidents, and landfill and waste sites, and detailed study of LIDAR data.

7.27. A site walkover will be completed to supplement the desk-based findings, and to identify key features and soils in relation to proposed solar arrays, substations and crossing points.

7.28. A Conceptual Site Model (CSM) will be produced to anticipate ground conditions at this stage of the study. A Phase 1 Baseline Desk Study of Ground Conditions will be appended within the ES.

7.29. The desk study will conclude on the need for specific phased ground investigation to address and confirm key aspects. These will include but not be limited to: very low strength soils, the extent and nature of deep incised former drainage courses, typical occurrence and nature of peaty organic soils, and shallow soils permeability and drainage.

7.30. At this stage it seems likely that intrusive investigation via transects of shallow and deeper boreholes at critical locations within each area of the Site will be appropriate. Standpipe installations within boreholes will allow a programme of groundwater and

gas monitoring. Where crossing points are proposed, a separate drilling investigation will be designed to provide data and parameters to scope the directional drilling requirements.

7.31. Areas of peat are mapped within the site, however those shallow deposits have been degraded by long-term working and agricultural use. In conjunction with ecological and agricultural soil specialists, an assessment approach will be developed to identify areas of potential thicker shallow depth peat or active peat forming habitat (if any), where development constraints may apply. Based on this, the scope of peat probing surveys will be determined.

7.32. A Phase II Ground Investigation Report will be prepared on the findings to include an updated CSM and qualitative risk assessment of contaminated land risks, assess geotechnical risks, discuss foundation options and other geotechnical aspects. This report will inform the ES and be appended within it.

Significance Criteria

7.33. An impact assessment matrix will be adopted to assess effect significance, guided by professional judgement as appropriate. Magnitude and significance criteria specific to geology and soils, groundwater and contaminated land will be adopted.

Assessment of Cumulative Effects

7.34. For ground conditions, it is proposed that the potential for cumulative and in-combination effects will be considered within 1 km of the order limits. These will be assessed using professional judgement.

8. Hydrology and Flood Risk

Introduction

8.1. This section of the ES will be prepared by Pegasus Group and the scoping assessment details below provides information in terms of the scoping for the hydrology, hydrogeology, and flood risk section with the relevant chapter of the ES. The ES chapter will identify and describe the nature and significance of the effects likely to arise in relation to hydrogeology during both the construction and operational phases. The chapter will set out the existing baseline environment in relation to hydrogeology and assesses the potential impacts of the construction and operation of the scheme on groundwater quality and levels.

Preliminary Baseline Conditions

Location and Topography

8.2. The proposed order limits are located in various parcels covering a large area centred around Tween Bridge Farm, Thorne, Doncaster.

8.3. The majority of the scheme is located within Flood Zone 3 (>1% probability of flooding from rivers or >0.5% probability of flooding from the sea) or Flood Zone 3 benefitting from flood defences. There are a few areas within Flood Zone 1.

Figure 8.1 – GOV.uk Flood Map for Planning

8.4. Topographical survey was not available at the time of writing this report however online data suggest levels vary across the site from around 0m to 7m AOD which highlights the ease in which the site floods from the main River Ouse to the north of the site.

Geology and Soils

8.5. Information on the soils and geology of the site and surrounding areas has been derived from Soilscapes online viewer, British Geological Survey (BGS) geology mapping (BGS online map viewer) and the BGS online borehole archive.

Soils

8.6. Soils are described as a range of "slowly permeable seasonally wet slightly acid but base-rich loamy and clayey soils" to "raised bog peat soils" to "loamy and clayey soils of coastal flats with naturally high groundwater".

Made Ground

8.7. Made ground is likely to be present in areas of historic and present residential and industrial buildings, where the ground may have been prepared for construction. Also, it is commonly contained in areas of landfill or other waste management sites. It is unlikely that Made Ground exists beneath the site boundary.

Superficial Geology

8.8. The BGS mapping indicates that the scheme has a range of superficial geology ranging from "Hemingborough glaciolacustrine formation, clay – silty" to "peat" to "warp – clay and silt" to "alluvium – clay, silt, sand and gravel".

Bedrock Geology

8.9. BGS mapping also noted the scheme has bedrock ranging from "Sherwood sandstone group – sandstone" to "Mercia mudstone group – mudstone".

Hydrogeology

Aquifer Designation and Vulnerability

8.10. Defra online mapping tool "magic" was used to determine aquifer designation and vulnerability for the site which does range across the whole development. The site is within a superficial drift Secondary A aquifer and a bedrock Principal and Secondary B aquifer. Soilscapes has noted groundwater as being high with the development having areas of high water table, due to the proximity to the River Ouse to the north, groundwater vulnerability ranges from low to medium-high.

Groundwater Source Protection Zones

8.11. As above Defra mapping tool "magic" notes part of the site to be in a Zone 3 total catchment Source Protection Zone (SPZ).

Likely Significant Effects

8.12. Construction works are likely to include vegetation clearing, topsoil removal, foundations, excavation, and re-levelling.

8.13. Compaction of the ground caused by construction plant and an increase in the extent of impermeable areas have the potential to impact upon the rate of surface water infiltration to the ground below.

8.14. Construction activities also have the potential to give rise to the contamination of waters resulting from spilled hydrocarbons/petrochemicals from construction plant.

8.15. During the operational phase, there is the potential for the contamination of water resulting from the flushing of silts and hydrocarbons from areas of hardstanding.

Likely Mitigation Measures

8.16. The scheme will include measures to prevent, reduce and offset significant adverse effects upon hydrology, drainage, and flood risk with regards to the surface water receptors. Being "built-in" to the proposals from the outset, the assessment of the significance of effects will include consideration of these "embedded" mitigation measures. Such measures are likely to include protecting critical infrastructure from flood risk. However, specific measures are not anticipated to be required from the groundwater environment.

8.17. The EIA supporting the application will be accompanied by a Construction Environmental Management Plan (CEMP). Any construction phase mitigation measures would be secured through implementation of the measures set out in this document.

8.18. In terms of operational phase mitigation measures, whilst a surface water management strategy is anticipated, again measures relating to groundwater are unlikely to be required for the proposed development.

Assessment Methodology

8.19. Characterisation of the hydrogeological baseline will depend on a review of the readily available online resources such as geological and hydrogeological mapping.

8.20. Consultation with key stakeholders (LLFA, EA and IDB) has begun and will confirm the scope of any technical work required to inform the chapter, agree assessment methodologies, and the design principles to be applied to ascertain compliance with the relevant policy, legislation and guidance in response to hydrogeological issues.

8.21. The assessment will be undertaken in accordance with the current legislation and policy guidance that is relevant to groundwater environment.

8.22. The methodology for the assessment of potential impacts follows the generic EIA methodology guided by IEMA (2016) and current government guidance, and is based on the following principles:

8.23. The type of effect (long-term, short-term, or intermittent; positive, negative or neutral);

- The probability of effect occurring;
- Receptor sensitivity; and
- The magnitude (severity) of the effect.

8.24. In addition, this assessment will look to follow the planning policy guidance in the National Policy Statement, NPPF and NPPG . Land Drainage Act 1991 and the Water Environment (Water Framework Directive)(England and Wales) Regulation 2017.

8.25. A Sequential Test for the implication for the development for Flood Risk will be completed as required under the Planning Policy. This will form part of the planning bundle but will site outside of the EIA. This is required as the scheme is mainly within Flood Zone 3 and Flood Zone 3 in an area benefitting from flood defences. Planning Policy requires the need for any Flood Risk Assessments to demonstrate that it can pass such a Sequential Test and show that despite the increased flood risk of the site it is still the "best" location for the development.

Significance Criteria

Principal Receptors and Their Sensitivity

8.26. Following the data gathering and analysis, potential hydrogeological receptors have been identified. These include groundwater features downstream / down gradient of the development areas that may be potentially affected by activities associated with the proposed development.

8.27. A sensitivity classification has been allocated to each identified hydrogeological receptor, and these are set out in the table below:

Summary of Potential Environmental Receptors

Receptor Type	Receptor	Sensitivity	Reasoning
Groundwater	SPZ noted below Thorne	Low	Groundwater movement unidentified as site is "flat", most runoff will move through watercourses towards the River Ouse

Assessment of Cumulative Effects

8.28. In accordance with national planning policy, other development schemes within the catchment will be expected to incorporate measures to ensure that development does not increase the flood risk elsewhere. This area will, in some locations, expand beyond the proposed 5km cumulative assessment area. Similarly, and relevant to the groundwater environment, these other development schemes will be required to include measures to provide pollution control such that water quality is not adversely affected.

8.29. On account of policy requirements, it is envisaged that the scheme will be categorised as "nil detriment" in terms of off-site/downstream hydrogeology related impacts. On this basis, it is unlikely that there will be any cumulative effects within the catchment due to the type of scheme and should therefore be scoped out.

9. Socio Economics

Introduction

9.1. This chapter of the ES will provide an assessment of the likely significant socio-economic effects generated by the scheme. This will include the identification and assessment of likely effects during the construction phase, during the operational phase, during the decommissioning phase, and including cumulative effects.

Relevant Policy and Guidance

National Policy Statements

Overarching National Policy Statement for Energy (EN-1)

9.2. The Overarching National Policy Statement (NPS) for Energy (EN-1) notes that where a project is likely to have socio-economic impacts at local or regional levels, an assessment of such impacts should be undertaken. The existing socio-economic conditions in the areas surrounding the scheme should be described as well as how the Proposed Development's socio-economic impacts correlate with relevant local planning policies. EN-1 stipulates the importance of evidence-based socio-economic assessment.

9.3. EN-1 notes that the Infrastructure Planning Commission (IPC) (now superseded by the Secretary of State (SoS)) should consider any relevant positive provisions and legacy benefits made by the Applicant in relation to socio-economics.

9.4. An update to the EN-1 (2011) was published in September 2021 (2021 Draft EN-1) and is currently in consultation. Key updates in the 2021 Draft EN-1 compared to the 2011 publication relate to range of impacts to be considered and suggested specific mitigation relating to potential impacts during each of the phases of development.

9.5. Firstly, 2021 Draft EN-1 makes reference to an extended list of potential impacts to consider (as relevant) including (but not limited to) creation of jobs and training opportunities, contribution to low-carbon industries, provision of additional local services and improvements to local infrastructure, any indirect beneficial impacts for the region, effects on tourism, impact of a changing influx of workers, and cumulative effects.

9.6. Secondly, the Draft EN-1 (2021) makes reference to the need to consider development of accommodation strategies, if appropriate, to address any potential impacts during the construction and decommissioning phases. In addition, it also refers to the potential for the SoS to require the approval of an employment and skills plan detailing arrangements to promote local employment and skills development opportunities.

National Policy Statement for Renewable Energy (EN-3)

9.7. Socio-economic impacts were referenced only in respect of onshore wind and biomass power in the National Policy Statement (NPS) for Renewable Energy (EN-3)

published in July 2011. An update to the EN-3 (2011) was published in September 2021 (Draft 2021 EN-3) and is currently in consultation. In this latest draft, consideration of solar and potential for associated socio-economic effects is referenced in respect of the potential for socio-economic benefits of the site infrastructure being retained after the operational life of solar photovoltaic generation.

National Planning Policy Framework

9.8. The most recent NPPF was published in July 2021. A key focus of the framework is to achieve sustainable development which requires three interdependent objectives that need to be pursued in a mutually supportive way:

- Economic Objective: Ensure that the economy is strong, responsive and competitive to support growth.
- Social Objective: Ensure there is a sufficient supply and range of homes available to meet present and future demand.
- Environmental Objective: Ensure the natural, built and historic environment is protected including mitigating and adapting to climate change.

Levelling Up White Paper

9.9. The strategy presented by the UK Government's Levelling Up White Paper is underpinned by the fact that, although the UK as a whole is successful when compared to other countries globally, there is great disparity in respect of the shared value of that success within the UK itself and realising each communities' potential. As such, the White Paper sets out a programme to 'level up' the UK to transform places and boost local growth, including through, but not limited to, encouraging strong innovation, private sector investment, climate conducive development, and improvement in workers' skill and transport systems. The key missions set by the White Paper are, in summary:

- Boost in productivity, wages, jobs and living standards by investment and growth in the private sector.
- Provide opportunities and improvement in public services.
- Contribute to and encourage a sense of community, local pride and belonging.
- Empowerment of local leaders and communities.
- It is imperative that the needs of an area are reflected in the proposals made, so that the benefits brought by development will appropriately contribute to, and ultimately result in, true levelling up of the economy, the environment, and society within the UK.

Doncaster Local Plan 2015-35

9.10. The Doncaster Local Plan 2015-2035 (adopted September 2021) sets how out the Borough will grow and develop in the period between 2015 and 2035. It identifies focus on new jobs growth, proposed location of new homes and services, promotes investments and development, encourages sustainable and inclusive economic growth, protects the environment and promotes social inclusion.

9.11. The Local Plan identifies the maximisation of opportunities in renewable energy, including solar power, as being one of the key priority areas in respect of meeting its overall goals.

South Yorkshire Mayoral Combined Authority (SYMCA) Strategic Economic Plan

9.12. The South Yorkshire Mayoral Combined Authority (SYMCA) Strategic Economic Plan (SEP) 2021-2041[27] covers Doncaster, Rotherham, Sheffield, and Barnsley. The vision set out in the SEP is to grow an economy that works for everyone, developing inclusive and sustainable approaches to help contribute more to UK prosperity and enhance quality of life for all.

9.13. The plan includes three overarching policy objectives which are growth, inclusion, and sustainability. The aim is to grow the economy and enhance its strength and resilience, while ensuring everyone has a fair opportunity to contribute from economic growth with people having a greater stake in their economy, and driving low carbon, green and circular economic opportunities within the economy, delivering net-zero emissions and a lower overall environmental impact.

Preliminary Assessment of Baseline Conditions

9.14. The assessment will establish baseline socio-economic conditions within those areas likely to be affected by the Proposed Development. Study areas are defined based on an understanding of relevant local and wider economic geographies, and the extent to which socio-economic and health effects are likely to be contained within these established statistical geographies. It is proposed to analyse data (where available) for the following geographies:

- Doncaster OO3G (E01007642) (Lower Super Output Area (LSOA)).
- Thorne (ward).
- Doncaster (borough).
- Yorkshire and Humber (region).
- Great Britain/UK (national).

9.15. Baseline socio-economic conditions will be established using the most up-to-date available secondary data, establishing the extent to which the following key

[27] South Yorkshire Mayoral Combined Authority Strategic Economic Plan 2021-2041. Available at: SCR_SEP_Full_Draft_Jan_21-(accesssible).pdf (southyorkshire-ca.gov.uk).

indicators have changed over time. Baseline information will be sought from, but will not be limited to, the following sources:

- Overarching National Policy Statement for Energy (EN-1).
- National Policy Statement for Renewable Energy (EN-3).
- The National Planning Policy Framework (NPPF).
- Office for National Statistics (ONS) data.
- Ministry of Housing, Communities & Local Government (for deprivation data).
- The Government's Levelling Up White Paper[28][29].
- The adopted Central Lincolnshire Local Plan[30].
- The Greater Lincolnshire Local Enterprise Partnership[31].
- Information obtained from the Applicant.

9.16. A summary of key baseline characteristics of the relevant geographies at this present time is as follows:

- **Population:** Between 2011 and 2020 the population of Doncaster grew by 3.4%. This compares to a population growth of 4.6% in Yorkshire and The Humber and 6% in Great Britain. The fastest growing age group in Doncaster in this time was those aged 65+ with an increase of 17.2%. Between 2018 and 2038, the population of Doncaster is projected to increase by 7.1%, compared to increases in Yorkshire and The Humber and England of 6.2% and 8.6% respectively. The group aged 0-15 in Doncaster is the only age group projected to fall in this time.
- **Employment:** based on data from the Office for National Statistics, as of 2021, 131,000 people worked in Doncaster. This was a rise of 4.8% (6,000) since 2015. This increase was above the rate that was seen in Yorkshire and The Humber (4.3%) between 2015 and 2020 but was below the increase seen in Great Britain (5.2%).
- **Economic Output:** Between 2009 and 2019, the gross value added (GVA) in Doncaster grew by 42.7% (£1.8 billion) to reach £5.9 billion. This was below the growth in GVA that was seen in Yorkshire and The Humber (31.5%) and the United Kingdom (40.2%).

[28] *Doncaster Local Plan 2015-2035, adopted 23 September 2021. Available at: https://dmbcwebstolive01.blob.core.windows.net/media/Default/Planning/Documents/Local Plan/Submission/Doncaster Local Plan Adopted 23 Sept 2021.pdf.*
[29] *Levelling Up. HM Government (2022).*
[30] *The Central Lincolnshire Local Plan (April 2017).*
[31] *Greater Lincolnshire Local Enterprise Partnership. Accessed 3 May 2022. Available at:* Home | Greater Lincolnshire LEP.

- **Deprivation:** Based on data from the Index of Multiple Deprivation, Doncaster has an overall rank of 5,208 putting it in the top 20% most deprived LSOAs in England. Doncaster 003G has its' highest rank in barriers to housing and services with an overall rank of 28,603, putting it in the top 20% least deprived LSOAs. It has its lowest rank education with a rank of 1,391, putting it in the top 10% most deprived LSOAs for this domain.

9.17. Other key indicators that will be included in the baseline analysis are:

- Unemployment, including the claimant count.
- Business base.
- Qualifications and skills.
- Economic activity.
- Commuting.

Potential Effects (including identification of specific receptors)

9.18. During construction, it is anticipated that the scheme will generate the following socio-economic effects:

- Employment – direct, indirect and induced jobs based in the local and wider impact areas.
- Economic output – measured in gross value added (GVA, generated by the employment supported during the construction phase).
- Housing – potential impacts on available housing as a result of construction workers required during the construction phase.

9.19. Once completed and fully operational, it is anticipated that the socio-economic effects associated with the scheme will include the following:

- Employment – direct, indirect and induced jobs based in the local and wider impact areas.
- Economic Output – measured in gross value added (GVA, generated by the employment supported once operational).
- Business rates revenue – measured in terms of the business rates generated by the scheme comparing to existing levels, where available.

9.20. During decommissioning, it is anticipated that the scheme will generate the following socio-economic effects:

- Employment – direct, indirect and induced jobs based in the local and wider impact areas.

- Economic output – measured in gross value added (GVA, generated by the employment supported during the decommissioning phase).

- Housing – potential impacts on available housing as a result of workers required during the decommissioning phase.

9.21. Table 9.1 presents a summary of the scope of the assessment, including consideration of potential effects, the study areas within which the effect is applicable, and the relevant receptors.

Table 9.1: Summary of assessment scope

Potential effect	Relevant study area	Potential receptor(s)
CONSTRUCTION		
Employment	• Borough scale	• Borough workforce
Economic contribution	• Borough scale	• Borough economy
Housing	• Borough scale	• Borough existing residents
OPERATION		
Employment	• Borough scale	• Borough workforce
Economic contribution	• Borough scale	• Borough economy
Business rates	• Borough scale	• Borough economy
DECOMMISSIONING		
Employment	• Borough scale	• Borough workforce
Economic contribution	• Borough scale	• Borough economy
Housing	• Borough scale	• Borough existing residents

9.22. Cumulative effects will be considered in respect of each of the potential effects within each of the development phases listed in Table 9.1.

Scope and Methodology of Assessment (including significance criteria)

9.23. There is no overarching Government guidance that sets out the preferred methodology for assessing the likely socio-economic effects of schemes. Accordingly, the approach adopted for the assessment will be based on professional experience and best practice, and in consideration of the policy requirements/tests set out within the NPPF and the Local Plan.

9.24. The first step in the assessment will be to identify the sensitivity of the receptors. In socio-economic assessments, receptors are not sensitive to changing environmental conditions in the same way as many environmental receptors are. To address this, the assessment will draw on a combination of measurable indicators (jobs, population, etc.) and a consideration of the importance of the receptor in policy terms to gauge the receptor's sensitivity. The sensitivity criteria proposed to be used in the Socio-Economics ES chapter is presented in Table 9.2.

9.25. The magnitude of change upon each receptor will then be determined by considering the predicted deviation from baseline conditions, both before and, if required, after mitigation. The magnitude of effect criteria proposed to be used in the Socio-Economics ES chapter is presented in Table 9.3.

9.26. Wherever possible the magnitude of change will be quantified. Where this is not possible, for example, for a number of the social and health related considerations, consideration of magnitude of change will be on a qualitative basis and justified through baseline research, review of relevant policy, and consultation undertaken.

9.27. There are no industry standard significance criteria for the assessment of socio-economic effects. The assessment is quantitative where possible. In circumstance where this is not possible, the assessment is qualitative in nature based on professional judgement. The significance of effect is identified by combining the sensitivity of the receptor against the magnitude of impact using the matrix in Table 9.4. The shaded cells in Table 9.4 indicate those effects which are considered significant (Moderate and Major effects).

Table 9.2 Criteria for Sensitivity of Receptor

Sensitivity	Evidence for Sensitivity Assessment
High	Evidence of direct and significant socio-economic challenges relating to receptor. Accorded a high priority in local, regional or national economic regeneration policy. Evidence of direct and significant socio-economic challenges including: • Areas with levels of unemployment well in excess of / below regional / national averages and high levels of relative deprivation (i.e. top 10%). • Areas with claimant count well in excess of / below regional / national averages. • Areas with economic activity rate well in excess of / below regional / national averages. • Areas with a significant oversupply / undersupply of housing against the housing target.

Sensitivity	Evidence for Sensitivity Assessment
Medium	Some evidence of socio-economic challenges linked to receptor, which may be indirect. Change relating to receptor has medium priority in local, regional and national economic and regeneration policy. Some evidence of socio-economic challenges, including: • Areas with levels of unemployment above / below regional / national averages and levels of relative deprivation (i.e. top 50%). • Areas with claimant count well above / below regional / national averages. • Areas with economic activity rate above / below regional / national averages. • Areas with a moderate oversupply / undersupply of housing against the housing target.
Low	Little evidence of socio-economic challenges relating to receptor. Receptor is accorded a low priority in local, regional and national economic and regeneration policy. Little evidence of socio-economic challenges, including: • Areas with levels of unemployment in line with regional / national averages and levels of relative deprivation (i.e. bottom 50%). • Areas with claimant count in line with regional / national averages. • Areas with economic activity rate in line with regional / national averages. • Areas with an oversupply / undersupply of housing against the housing target.
Negligible	No socio-economic issues relating to receptor. Receptor is not considered a priority in local, regional and national economic development and regeneration policy. No socio-economic issues relating to a receptor, including: • Areas with levels of unemployment less than regional / national averages and low levels of relative deprivation (i.e. bottom 10%). • Areas with claimant count higher than average regional / national averages. • Areas with economic activity rate higher than average regional / national averages. • Areas with housing supply in line with housing target.

Table 9.3: Criteria for Magnitude of Effect

Magnitude of Impact	Description / Criteria
High	Scheme would cause a large change to existing socio-economic conditions in terms of absolute and/or percentage change. • Greater than 5% increase / decrease on existing baseline levels of employment. • Greater than 5% increase / decrease in GVA from baseline. • Greater than 5% increase / decrease in business rates from baseline. • Greater demand required than available accommodation supply.
Medium	Scheme would cause a moderate change to existing socio-economic conditions in terms of absolute and/or percentage change. • 1% - 5% increase / decrease on existing baseline levels of employment. • 1% - 5% increase / decrease in GVA from baseline. • 1% - 5% increase / decrease in business rates from baseline. • Increased demand in respect of accommodation but below available supply.
Low	Scheme would cause a minor change to existing socio-economic conditions in terms of absolute and/or percentage change. • Limited increase / decrease on existing baseline levels of 0.1% - 0.99% increase / decrease on existing baseline levels of employment. • 0.1% - 0.99% increase / decrease in GVA from baseline. • 0.1% - 0.99% increase / decrease in business rates from baseline. • Limited increase in demand in respect of accommodation.
Negligible	No discernible change in baseline socio-economic conditions.

Table 9.4: Significance of Effect

Magnitude of Change	Sensitivity of Receptor			
	High	**Medium**	**Low**	**Negligible**
High	Major	Major	Moderate	Negligible
Medium	Major	Moderate	Minor to Moderate	Negligible

	Low	Moderate	Minor to Moderate	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible	Negligible

Preliminary Discussions of Potential Mitigation and Enhancement Measures

9.28. Requirements for mitigation and opportunities for enhancement measures will be identified and discussed with relevant consultees and the Applicant as soon as practicable.

10. Transport and Access

Introduction

10.1. The Transport and Access chapter of the EIA will be prepared with reference to the Institute of Environmental Assessment (IEMA) 'Guidelines for the Environmental Assessment of Road Traffic', as appropriate.

10.2. This section of the Scoping Report sets out the proposed methodology for the assessment of the scheme against transportation matters. In particular, the methodology would consider the potential effects of the scheme on the local and strategic highway network.

Relevant Policy and Guidance

10.3. The transport impact of the scheme will be considered with reference to local and national guidance and policy contained in the National Planning Policy Framework (NPPF), National Planning Practice Guidance (NPPG), National Policy Statements (NPS), IEMA Guidelines for the Environmental Assessment of Road Traffic, the Design Manual for Roads and Bridges (DMRB), the North Lincolnshire Local Transport Plan (2011-2026) and the Doncaster Local Plan (2015-2035), as appropriate.

Preliminary Assessment of Baseline Conditions

10.4. As part of the assessment work, the transport chapter would consider baseline transportation conditions, including traffic flows and highway safety.

10.5. At this stage, it is proposed that Annual Average Daily Traffic (AADT) will be assessed at 18 points on the local highway network. A combination of Department for Transport (DfT) traffic count data and Automatic Traffic Count (ATC) surveys will be carried out to provide the baseline traffic flows at each link. The proposed link extents are indicatively shown within Appendix 10.1 alongside the indicative access locations.

10.6. Given the temporary nature of the construction traffic, it is considered appropriate to consider the impacts of the scheme against the baseline survey year, which is anticipated to be in 2023. A future year of 2029 is proposed for the consideration of operational traffic, on the basis that all construction activities at the site will be complete. The TEMPro growth rates will be determined through dialogue with the local highway authorities in due course.

Potential Impacts / Effects

10.7. Due to the size of the site, access is proposed via multiple new and upgraded junctions. These accesses will be used for construction purposes with some, but not all, accesses retained for operational purposes.

10.8. The proposals will be supported by a Transport Statement (TS) and a Construction Traffic Management Plan (CTMP). The CTMP will summarise the traffic movements anticipated throughout the construction period and the associated mitigation measures to be agreed with the local highway authorities at North Lincolnshire Council (NLC) and Doncaster Council (DC) and National Highways. A scope for the CTMP will be agreed with the relevant authorities in due course.

Scope and Methodology of Assessment

10.9. IEMA rules will be applied to define the threshold impacts for development traffic which will inform the scale and extent of the transport chapter work. On this basis, links where the traffic flows are expected to increase by more than 30%, or where HGV flows are expected to increase by more than 30% as a result of the scheme will be considered. Links in proximity to sensitive receptors, where traffic flows are expected to increase by more than 10% as a result of the scheme will also be considered. Sites that are considered to be sensitive receptors with reference to IEMA are Conservation Areas, schools, health facilities, community facilities and congested junctions. Any sensitive receptors will be agreed with the highway authority at NLC and DC in due course.

10.10. Where the predicted increase in traffic and HGV flow is lower than these thresholds then the significance of the effects can be considered to be low or not significant, then it is considered that detailed assessment is not required.

10.11. The transport chapter would provide an assessment of the predicted impact on the local and strategic highway network by using pre-defined significance criteria set out within the IEMA guidance. Those criteria will be based on the net change in journeys as a result of construction and operational traffic values and any mitigation to be delivered as part of the proposals. The significance criteria would establish the magnitude of any beneficial or adverse effects the scheme will have on the transport network.

10.12. Liaison will take place with highway officers at the local highway authorities and National Highways, as appropriate.

10.13. In summary, with reference to the IEMA guidance, it will consider the forecast impacts of the proposed solar development on the following throughout both the construction, operational and decommissioning phases of the Scheme:

i. driver severance and delay;

ii. accidents and safety;

iii. hazardous and dangerous loads; and

iv. dust and dirt.

10.14. Given that there are anticipated to be limited pedestrians within the vicinity of the site (noting the absence of footway provision for the majority of the local highway network within the vicinity of the site), it is not considered necessary to consider the impacts of the scheme on:

i. pedestrian severance;

ii. pedestrian delay;

iii. pedestrian amenity; and

iv. fear / intimidation.

10.15. It is noted that one Public Right of Way (PRoW) routes across the Site; Doncaster footpath Thorne 19. The temporary diversion or stopping up of the PRoW will be considered in conjunction with PRoW officers in due course.

10.16. The residual impacts of the scheme, accounting for any proposed mitigation would then be assessed and confirmed. It is anticipated that other impacts including noise and vibration will be considered by other disciplines throughout the EIA.

Preliminary discussions of mitigation and enhancement measures

10.17. With regards to the completed and operational Proposed Development, many mitigation measures are embedded into the design of the scheme. If likely significant effects are determined even with such embedded mitigation, where possible, mitigation measures will be proposed so that residual effects are not significant.

Cumulative effects

10.18. Consideration will be given to the cumulative effects of the transport impact associated with the Proposed Development. This will include for the traffic generated from committed developments within an agreed study area, which will be agreed with the local planning and highway authorities.

11. Acoustics Considerations

Introduction

11.1. Ion Acoustics is appointed to advise on noise issues in relation to the Tween Bridge Solar Farm project. A description of the project is presented in Chapter 2 of this Scoping Report.

11.2. Solar farms are not normally considered noisy and the panels themselves do not generate any noise. However, various electrical components, such as inverters, transformers, and cooling systems within battery units (if provided) can emit low levels of noise. As such operational noise levels will be assessed against noise limits set to protect residential amenity. Operational noise will be predicted using computer modelling to determine noise levels at nearby noise-sensitive receptors.

Baseline Conditions

11.3. The site is in a largely rural area between Thorne and Crowle and comprises agricultural land with isolated farms between the two villages. Much of the site is located directly north of the M180. It is likely that this motorway along with the M18 further to the west will be the dominant noise sources in the area.

11.4. The Tween Bridge Wind Farm and the Twin Rivers Wind Farm are also located across the site. As such the noise generated by the wind turbines will also affect noise levels.

11.5. As the proposed site is fairly large, it is likely that the noise levels across the site will vary. A noise survey will be carried out as part of the EIA assessment to determine background noise levels at the nearest residential locations. The noise monitoring positions will be selected on the basis of preliminary noise predictions and agreed with the local authorities.

Relevant Policy Context

National Planning Policy Framework (NPPF)

11.6. In 2012 the National Planning Policy Framework (NPPF) replaced a number of Planning Policy Statements with a single document which is intended to promote sustainable development. The NPPF was revised in July 2021 and certain aspects of the guidance changed.

11.7. The NPPF sets out the Government's planning policies for England. The document is generally not prescriptive and does not provide noise criteria. Instead, it places the onus on local authorities to develop their own local plans and policies. Sections of the NPPF relating to noise are stated below:

'174. Planning policies and decisions should contribute to and enhance the natural and local environment by:

e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability…

185. Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. In doing so they should:

a) mitigate and reduce to a minimum potential adverse impacts resulting from noise from new development – and avoid noise giving rise to significant adverse impacts on health and the quality of life;

b) identify and protect tranquil areas which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason;…'

Noise Policy Statement for England (NPSE)

11.8. The Noise Policy Statement for England (NPSE) sets out the Government's policy on environmental, neighbourhood and neighbour noise for England. The policy has three aims:

- *"avoid significant adverse impacts on health and quality of life;*
- *mitigate and minimise adverse impacts on health and quality of life; and*
- *where possible, contribute to the improvement of health and quality of life."*

11.9. The NPSE introduces the following terms which are also used in the NPPF:

"NOEL – No Observed Effect Level

This is the level below which no effect can be detected. In simple terms, below this level, there is no detectable effect on health and quality of life due to the noise.

LOAEL – Lowest Observed Adverse Effect Level

This is the level above which adverse effects on health and quality of life can be detected.

SOAEL – Significant Observed Adverse Effect Level

This is the level above which significant adverse effects on health and quality of life occur."

11.10. However, neither the NPSE nor the NPPF defines numeric bounds for NOEL, LOAEL or SOAEL. The boundary of each effect level should be defined for each situation and location.

11.11. Further Government planning advice is available online. The online guidance refers to the NPPF and NPSE and presents a noise assessment hierarchy table to provide further information on the boundaries between NOEL, LOAEL and SOAEL. This is shown below in Table 1.

Table 1: Noise Assessment Hierarchy Table

Perception	Examples of Outcomes	Increasing Effect Level	Action
No Observed Effect Level			
Not noticeable	No Effect	No Observed Effect	No specific measures required
No Observed Adverse Effect Level			
Present and not intrusive	Noise can be heard, but does not cause any change in behaviour, attitude or other physiological response. Can slightly affect the acoustic character of the area but not such that there is a change in the quality of life.	No Observed Adverse Effect	No specific measures required
Lowest Observed Adverse Effect Level			
Present and intrusive	Noise can be heard and causes small changes in behaviour, attitude or other physiological response, e.g. turning up volume of television; speaking more loudly; where there is no alternative ventilation, having to close windows for some of the time because of the noise. Potential for some reported sleep disturbance. Affects the acoustic character of the area such that there is a small actual or perceived change in the quality of life.	Observed Adverse Effect	Mitigate and reduce to a minimum
Significant Observed Adverse Effect Level			
Present and disruptive	The noise causes a material change in behaviour, attitude or other physiological response, e.g. avoiding certain activities during periods of intrusion; where there is no alternative ventilation, having to keep windows closed most of the time because of the noise. Potential for sleep disturbance resulting in difficulty in getting to sleep, premature awakening and difficulty in getting back to sleep. Quality of life diminished due to change in acoustic character of the area.	Significant Observed Adverse Effect	Avoid
Present and very disruptive	Extensive and regular changes in behaviour, attitude or other physiological response and/or an inability to mitigate effect of noise leading to psychological stress, e.g. regular sleep deprivation/awakening; loss of appetite,	Unacceptable Adverse Effect	Prevent

	significant, medically definable harm, e.g. auditory and non-auditory.		

The Energy National Policy Statements (NPS).

11.12. The energy National Policy Statements (NPS) set out the government's policy for the delivery of energy infrastructure and provide the legal framework for planning decisions. They were first designated and published in 2011.

11.13. The NPS do not provide limits and specific guidance for the assessment of acoustic Impacts however, policies EN-1, EN-3, EN-5 and the Habitats Regulations Assessment (HRA) document do reference acoustics and offer generic advice without specific criteria.

BS4142: 2014 +A1: 2019 – Assessment Principles

11.14. The standard method for assessing noise of a commercial or industrial nature affecting housing, is British Standard BS 4142 "Method for rating and assessing industrial and commercial sound". A BS 4142 assessment is typically made by determining the difference between the industrial noise under consideration and the background sound level as represented by the L_{A90} parameter, determined in the absence of the industrial noise. The L_{A90} parameter is defined as the level exceeded for 90% of the measurement time, representing the underlying noise in the absence of short duration noise events such as dog barks or individual cars passing.

11.15. The industrial noise under consideration is assessed in terms of the ambient noise level, L_{Aeq}, but a character correction penalty can be applied where the noise exhibits certain characteristics such as distinguishable tones, impulsiveness or, if the noise is distinctively intermittent. The ambient noise level, L_{Aeq} is defined as the steady-state noise level with the same energy as the actual fluctuating sound over the same time period. It is effectively the average noise level during the period. The industrial noise level (L_{Aeq}) with the character correction (if necessary) is known as rating level, L_{Ar}, and the difference between the background noise and the rating level is determined to make the BS 4142 assessment. The standard then states:

a) *"Typically, the greater the difference, the greater the magnitude of the impact.*

b) *A difference of around +10dB or more is likely to be an indication of a significant adverse impact, depending on the context.*

c) *A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.*

d) *The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact, depending on the context."*

11.16. The standard outlines a number of methods for defining appropriate 'character corrections' to determine the rating levels to account for tonal qualities, impulsive qualities, other sound characteristics and/or intermittency.

11.17. The standard also highlights the importance of considering the context in which a sound occurs. The standard indicates that factors including the absolute sound level, the character of the sound, the sensitivity of the receptor and the existing acoustic character of the area should be considered when assessing the noise impact. The absolute sound level is of particular importance where the measured background sound levels are low, which is typically taken as L_{A90} 30dB and below. In regard to low sound levels, the standard states:

"Where background sound levels and rating levels are low, absolute levels might be as, or more, relevant than the margin by which the rating level exceeds the background. This is especially true at night."

BS 8233: 2014 and WHO criteria

11.18. British Standard BS 8233: 2014 and the World Health Organisation (WHO) provide absolute noise criteria to protect residential amenity. These are detailed in Table 2 below.

Table 2: WHO / BS 8233: 2014 Guideline Noise Levels for External Noise

Location	Critical Health Effect	07:00 to 23:00	23:00 to 07:00
Outside Bedroom Windows	Sleep Disturbance (Windows Open)	--	45dB $L_{Aeq, 8hours}$ (1)
Amenity Spaces (Gardens / Patios)	Moderate Annoyance Serious Annoyance	50dB $L_{Aeq, 16\ hours}$ (2) 55dB $L_{Aeq, 16\ hours}$ (2)	--
Notes: (1) From WHO Community Noise Guidelines (1999) (2) BS 8233: 2014 and WHO Community Noise Guidelines			

11.19. The daytime limits apply to relatively anonymous noises without character and are commonly applied to traffic noise. The WHO night-time threshold of 45 dB $L_{Aeq, 8hr}$ represents an 8-hour L_{Aeq} outside noise-sensitive rooms to prevent sleep disturbance. The WHO limit is a level at 1m from the façade. Therefore, the equivalent free-field level would be approximately 3dB lower, that is 42 dB L_{Aeq}.

Significance Criteria

11.20. In accordance with the NPPF, the NPSE, and PPG for noise, the LOAEL and SOAEL have been proposed for each noise and vibration source which has been assessed.

11.21. The positive ('beneficial') and negative ('adverse') noise and vibration effects have been defined in accordance with the significance criteria presented in Chapter 2: EIA Methodology. Based on the descriptions of the adverse effect levels in the PPG for noise, recommended actions for each significance level have been provided. The noise and vibration significance criteria are presented in Table 3.

Table 3 EIA Significance Level and Noise and Vibration Adverse Effect Level

EIA Significance Level	Noise and Vibration Adverse Effect Level	Impact and Action (to be applied to potential effects)
Major	SOAEL	Noise causes a material change in behaviour and/or attitude. This level should be avoided.
Moderate	-	Noise can be heard and causes small changes in behaviour or attitude. Noise should be mitigated and reduced to a minimum.
Minor	LOAEL	Noise can be heard but does not cause a change in behaviour or attitude. No specific mitigation measures are required.
Negligible	NOEL	Noise has no effect. No specific measures required.

Potential Significant Effects

Construction Noise

11.22. The following legislation and standards are of particular relevance to construction noise:

- The Control of Pollution Act 1974 (CoPA 1974);
- BS 5228: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites.

11.23. CoPA 1974 provides local authorities in England and Wales with powers to control noise and vibration from construction sites. Section 60 of the Act enables a Local

Authority to serve a notice to a contractor of its requirements for the control of site noise. Section 61 of the Act allows for those carrying out construction work to apply to the Local Authority in advance for consent to carry out the works.

11.24. Construction noise can be assessed using British Standard BS 5228 which provides a calculation method and general guidance on controlling noise and vibration from construction sites. This standard:

- Refers to the need for the protection against noise and vibration of persons living and working in the vicinity of and those working on construction sites;
- Recommends procedures for noise and vibration control in respect of construction operations; and
- Stresses the importance of community relations, stating that early establishment and maintenance of these relations throughout the site operations will go some way towards allaying people's fears.

11.25. There are no noise limits within the main text of BS 5228 and in fact, the preferred approach is to use best practicable means to reduce noise rather than setting limits. This means that everything practicable should be done to reduce noise.

11.26. The acceptability of construction noise is likely to be affected by the location of the site relative to the noise sensitive premises; existing ambient noise levels; the duration and working hours of site operations; the characteristics of the noise produced and the attitude of local residents to the site operator.

11.27. It is acknowledged that construction noise could result in an adverse noise effect in certain situations (i.e. close proximity to noise sensitive receptors), however it should be noted that potential adverse effects due to construction noise are temporary in nature. Construction activities will be controlled via a construction environmental management plan (CEMP) which will set out best practicable means measures to control noise.

11.28. Given that construction noise is temporary, typically occurring in the daytime, it is not always necessary to consider construction noise within the scope of an Environmental Impact Assessment and it is proposed that a construction noise assessment is excluded from the EIA. This assumes that the solar panel frame supports can be installed using a push-piling rig such that impact-driven piles are not necessary. Similarly it is not proposed to assess the effects of construction traffic. This should be confirmed by the local planning authority.

Operational Noise

11.29. An assessment of operational noise will be undertaken to describe the noise impact at the nearest noise-sensitive receptors (dwellings).

11.30. A computer noise model will be constructed using a computer noise modelling software package to calculate the operational noise levels at the nearest identified assessment positions. Within the modelling software, propagation of noise will be calculated in accordance with ISO 9613-2 with the following input parameters:

- Downwind propagation (noise levels under crosswind and upwind conditions will be less);
- Soft ground between the noise source and the receiver locations (G = 1.0);
- Ambient air temperature of 10°C and 70% Relative Humidity; and,
- Barriers and screening influence including the effect of the solar panels calculated in accordance with ISO 9613-2. The screening effect of the solar panels will be included in the model. This can reduce noise from string inverters which are normally provided behind the panels.

11.31. Noise information on the equipment will be taken from manufacturer's data where provided, and from library data used on previous assessments. In most cases, the manufacturer's information does not provide any information on tonality. However, it is known that inverters and transformers can produce tones. For the inverters, this would be generally high frequency tones which are readily dissipated by atmospheric absorption. Tonality will be considered in the noise assessment.

BS 4142 Assessment

11.32. In instances of low rating noise levels, BS4142 indicates that assessment in line with absolute noise limits might be as, or more, appropriate than a relative assessment.

11.33. Such criteria would be relevant if the noise survey indicates that existing noise levels are low and can be set separately for the day and night-time periods. While the solar farm will be operational mainly during the day, during the summer months the solar farm might operate from 5am in a period normally considered to be part of the night. The electricity held in the battery units would be available to be released to the grid at any time of the day or night. The battery units may also be charged at any time of the day or night.

Proposed Operational Noise Targets

11.34. Noise targets will be derived on the basis of the noise survey. To ensure a low impact in accordance with BS 4142, a noise target dB L_{Ar} will be set at parity with the background noise derived from the survey for both the daytime and night-time periods.

11.35. The noise limits are set in terms of the BS 4142 rating noise level dB L_{Ar} and therefore include any character penalties in the noise (tonality etc). These noise limits should be agreed with the local authorities.

Potential Mitigation

11.36. In principle, mitigation, where required, is best provided at source. A more detailed assessment of the equipment noise levels will be carried out during the EIA stage.

11.37. The string inverters for the solar farm will be screened to some extent by the panels but further information on the noise levels and the layout can be considered. The noise model will include an even distribution of the noise sources around the site but

it will be possible to a certain extent to position the inverters away from the most sensitive properties.

11.38. If these methods of mitigation are not sufficient further options such as acoustic barriers can be considered. This would also be considered for the battery storage element.

11.39. All of these factors will be considered during the EIA process.

Assumptions, Limitations and Uncertainties

11.40. A noise survey will be carried out during the EIA process so that the operational noise levels can be assessed relative to existing baseline noise levels. This will provide a more robust assessment.

11.41. At present, it is not intended to address construction noise during the EIA as construction noise levels are temporary and noise occurs during the daytime only. Best practicable means can be used to control construction noise and a Construction Environmental Management Plan (CEMP) will be prepared detailing how environment effects can be managed. This will include noise.

Assessment of Cumulative Effects

11.42. To fully assess the potential cumulative effects, consideration should be given to existing and committed developments of a similar nature within a study area of 1 km. These developments will be identified and agreed with the local authority.

12. Air Quality and Carbon Saving

Baseline Conditions

Air Quality

12.1. Doncaster Council (DC) monitors air quality throughout its area using eight automatic monitoring stations, none of which are in close proximity to the proposed development. The Council also measures concentrations of nitrogen dioxide (NO_2) at a number of locations using diffusion tubes. 0 shows the latest year of diffusion tube monitoring data unaffected by changes in travel patterns due to the Covid-19 pandemic[32] for sites within 5 km of the proposed development. The monitoring locations are shown in Table 12.1.

12.2. The results presented in 0 show that there were no measured exceedances of the annual mean NO_2 objective of 40 µg/m^3 at any of the monitoring sites within 5 km of the Site in 2019. Furthermore, concentrations were below 60 µg/m^3 at all monitoring sites, which indicates that exceedances of the 1-hour mean objective are unlikely[33].

Table 12.1 Summary of Annual Mean NO_2 Monitoring (2019)[34]

Site No.	Site Type	Location	2019 (µg/m^3)
DT33	Rural	Hatfield Moors, off A614 Thorne Road	8.7
DT34	Roadside	A614 Bawtry Road, Hatfield Woodhouse	18.5
DT35	Rural	Hatfield Moors, Hollinbridge Lane	9.9
DT38	Urban Background	Church Road, Stainforth	15.6
DT50	Roadside	A614 King Street, Thorne	38.0

[32] The Covid-19 pandemic has generally led to a reduction in measured pollutant concentrations due to reduced activity levels.
[33] Defra (2022) Review & Assessment: Technical Guidance LAQM.TG22 August 2022 Version, Available: https://laqm.defra.gov.uk/wp-content/uploads/2022/08/LAQM-TG22-August-22-v1.0.pdf
[34] Doncaster Council (2022) 2022 Air Quality Annual Status Report

Objective	40

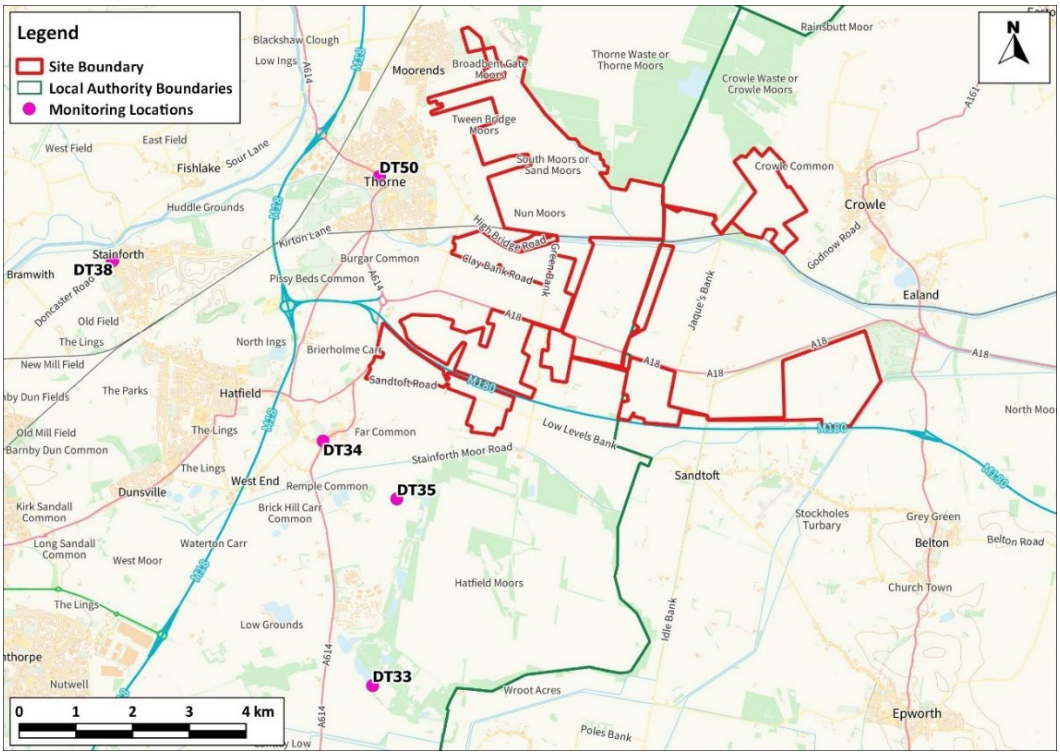

Figure 12.2 Air Quality Monitoring Locations and the Proposed Development

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12.3. Doncaster Council measures PM_{10} concentrations at three automatic monitors within its area, and one also measures $PM_{2.5}$ concentrations. The monitors are all located more than 10 km from the proposed development. There have been no exceedances of the PM_{10} or $PM_{2.5}$ objectives measured at these monitors in recent years.

12.4. Further baseline air quality conditions at the Site will be determined via:

- Consultation with both DC and North Lincolnshire Council (NLC);
- A review of DC's and NLC's air quality Review and Assessment reports and collation of published data, as well as any unpublished data made available by DC and NLC;
- Background pollutant concentrations will be determined from Environment, Food & Rural Affairs (Defra's) background maps[35];
- Examination of maps and aerial photographs;

[35] Defra (2022) Local Air Quality Management (LAQM) Support Website

- A review of nearby industrial operations using the Government's Pollutant Release and Transfer Register; and
- If required, detailed dispersion modelling, as described below.

Greenhouse Gases

12.5. The majority of the Site is currently used as agricultural land, and portions of the Site contain peatland. Agricultural activities are a net emitter of Greenhouse Gas (GHG) emissions, although the amount of carbon released per hectare of farmland will vary depending on specific farming types and practices. A report by Natural England on UK carbon sequestration[36] estimates average net GHG emissions from land under arable agricultural to be 0.29 tCO_2e/ha/yr. Based on a total Site area of over 1500 hectares, this would result in baseline annual GHG emissions of approximately 435 tCO_2, which is a very small amount. The areas of peatland are likely to act as a carbon sink, reducing the overall baseline emissions from the Site. In any event, the baseline GHG emissions will be very small and as such, baseline GHG emissions will be considered to be zero for the purposes of the assessment. The assessment will though acknowledge the importance of agricultural soils and peatland as soil carbon stores, and consider the measures taken to protect the carbon already stored in soils on the Site.

12.6. In order to demonstrate the potential GHG savings to the power sector as a result of the zero-emission electricity that will be provided by the proposed development, an alternative baseline to the GHG assessment will be considered, which will take account of electricity currently provided to the national grid via non-renewable means e.g., primarily from natural gas fired power stations. It will be assumed that electricity fed into the national grid from the scheme will displace existing provision from non-renewable means.

Relevant Policy Context

Air Quality

National Policies

12.7. The National Policy Statement (NPS) for Renewable Energy Infrastructure (EN-3)[37], together with the Overarching National Policy Statement for Energy (EN-1)[38], provides a policy basis for decisions regarding nationally significant renewable energy infrastructure projects. There is no specific NPS for solar projects. In terms of the assessment of air quality impacts, paragraphs 5.2.6 and 5.2.7 in EN-1 state:

[36] Natural England (2021) Carbon storage and sequestration by habitat: a review of the evidence (second edition)
[37] Her Majesty's Stationary Office (2011) National Policy Statement for Renewable Energy Infrastructure (EN-3)
[38] Her Majesty's Stationary Office (2011) Overarching National Policy Statement for Energy (EN-1)

"*Where the project is likely to have adverse effects on air quality the applicant should undertake an assessment of the impacts of the proposed project as part of the Environmental Statement (ES).*

The ES should describe:

- *any significant air emissions, their mitigation and any residual effects distinguishing between the project stages and taking account of any significant emissions from any road traffic generated by the project;*
- *the predicted absolute emission levels of the proposed project, after mitigation methods have been applied;*
- *existing air quality levels and the relative change in air quality from existing levels…"*

12.8. In terms of dust emissions, paragraphs 5.6.4 to 5.6.6 state:

"*The applicant should assess the potential for… emissions of… dust… to have a detrimental impact on amenity, as part of the Environmental Statement.*

In particular, the assessment provided by the applicant should describe:

- *the type, quantity and timing of emissions;*
- *aspects of the development which may give rise to emissions;*
- *premises or locations that may be affected by the emissions;*
- *effects of the emission on identified premises or locations; and*
- *measures to be employed in preventing or mitigating the emissions.*

The applicant is advised to consult the relevant local planning authority and, where appropriate, the EA about the scope and methodology of the assessment."

12.9. The draft EN-1 document[39], for which consultation closed on 29 November 2021, adds (in paragraph 5.2.9) that "*where a project is located within, or in close proximity to, a Local Air Quality Management Area or Clean Air Zone, applicants should engage with the relevant local authority to ensure the project is compatible with the local air quality plan. In the event that a project will lead to non-compliance with a statutory limit the Secretary of State should refuse consent*".

12.10. The draft EN-3 document[40] includes a section on the impacts of solar photovoltaic generation, however that section does not refer to air quality.

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[39] Department for Business, Energy & Industrial Strategy (2021) Draft Overarching National Policy Statement for Energy (EN-1)

[40] Department for Business, Energy & Industrial Strategy (2021) Draft National Policy Statement for Renewable Energy Infrastructure (EN-3)

12.11. The National Planning Policy Framework (NPPF)[41] sets out planning policy for England. It states that the purpose of the planning system is to contribute to the achievement of sustainable development, and that the planning system has three overarching objectives, one of which (Paragraph 8c) is an environmental objective:

"*to protect and enhance our natural, built and historic environment; including making effective use of land, improving biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy*".

12.12. To prevent unacceptable risks from air pollution, Paragraph 174 of the NPPF states that:

"Planning policies and decisions should contribute to and enhance the natural and local environment *by…(e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air … quality…."*

12.13. Paragraph 185 states:

"Planning policies and decisions should also ensure that new development is appropriate for its location taking into account the likely effects (including cumulative effects) of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development".

12.14. More specifically on air quality, Paragraph 186 makes clear that:

"Planning policies and decisions should sustain and contribute towards compliance with relevant limit values or national objectives for pollutants, taking into account the presence of Air Quality Management Areas and Clean Air Zones, and the cumulative impacts from individual sites in local areas. Opportunities to improve air quality or mitigate impacts should be identified, such as through traffic and travel management, and green infrastructure provision and enhancement. So far as possible these opportunities should be considered at the plan-making stage, to ensure a strategic approach and limit the need for issues to be reconsidered when determining individual applications. Planning decisions should ensure that any new development in Air Quality Management Areas and Clean Air Zones is consistent with the local air quality action plan".

12.15. The NPPF is supported by Planning Practice Guidance (PPG)[42], which includes guiding principles on how planning can take account of the impacts of new development on air quality. The PPG states at paragraph 001 that:

[41] Ministry of Housing, Communities & Local Government (2021) National Planning Policy Framework

[42] Ministry of Housing, Communities & Local Government (2019) Planning Practice Guidance

"Defra carries out an annual national assessment of air quality using modelling and monitoring to determine compliance with Limit Values. It is important that the potential impact of new development on air quality is taken into account where the national assessment indicates that relevant limits have been exceeded or are near the limit, or where the need for emissions reductions has been identified".

12.16. Regarding plan-making, the PPG states at paragraph 002:

"It is important to take into account air quality management areas, Clean Air Zones and other areas including sensitive habitats or designated sites of importance for biodiversity where there could be specific requirements or limitations on new development because of air quality".

12.17. Regarding the need for an air quality assessment, the PPG states at paragraph 005 that:

"*Whether air quality is relevant to a planning decision will depend on the proposed development and its location. Concerns could arise if the development is likely to have an adverse effect on air quality in areas where it is already known to be poor, particularly if it could affect the implementation of air quality strategies and action plans and/or breach legal obligations (including those relating to the conservation of habitats and species). Air quality may also be a material consideration if the proposed development would be particularly sensitive to poor air quality in its vicinity*".

12.18. The PPG sets out the information that may be required in an air quality assessment, making clear at paragraph 007 that:

"Assessments need to be proportionate to the nature and scale of development proposed and the potential impacts (taking into account existing air quality conditions), and because of this are likely to be locationally specific."

12.19. The PPG also provides guidance on options for mitigating air quality impacts, as well as examples of the types of measures to be considered. It makes clear at paragraph 008 that:

"Mitigation options will need to be locationally specific, will depend on the proposed development and need to be proportionate to the likely impact. It is important that local planning authorities work with applicants to consider appropriate mitigation so as to ensure new development is appropriate for its location and unacceptable risks are prevented".

Road To Zero Strategy[43]

12.20. The Road to Zero Strategy affirms the Government's pledge to end the sale of new conventional petrol and diesel cars and vans by 2040. It states that the Government expects the majority of new cars and vans sold to be 100% zero tailpipe emission

[43] DfT (2018) The Road to Zero: Next steps towards cleaner road transport and delivering our Industrial Strategy

and all new cars and vans to have significant zero tailpipe emission capability by this year, and that by 2050 almost every car and van should have zero tailpipe emissions. The Government has since announced that the phase-out date for the sale of new petrol and diesel cars and vans will be brought forward to 2030 and that all new cars and vans must be fully zero emission at the tailpipe from 2035. If these ambitions are realised, then road traffic-related NOx emissions can be expected to reduce significantly over the coming decades.

Local Policies

12.21. The Doncaster Local Plan 2015 - 2035[44] was adopted in September 2021 and includes Policy 54, 'Pollution', which states that:

"*Development proposals that are likely to cause pollution, or be exposed to pollution, will only be permitted where it can be demonstrated that pollution can be avoided, or where mitigation measures (such as those incorporated into the design and layout of development) will minimise significantly harmful impacts to acceptable levels that protect health, environmental quality and amenity. When determining planning applications, particular consideration will be given to:*

an assessment of the risks to public health and the impact of cumulative effects and where necessary that the provision for mitigation against the total effects has been provided…

…C) the impact on national air quality; especially but not limited to Air Quality Management Areas, areas potentially close to the EU limit value, other sensitive areas and the aims and objectives of the Air Quality Action Plan. An Air Quality Assessment will be required to enable clear decision making on any relevant planning application."

12.22. DC have produced an Air Quality Technical Planning Guidance[45]. This document sets out guidance on air quality requirements for developers, including the required content for air quality assessments.

12.23. The North Lincolnshire Core Strategy[46] was adopted in June 2011, and within this, Spatial Objective 7: '*Efficient Use and Management of Resources'*, and aims "T*o ensure the efficient use of resources, maximising recycling of minerals and waste products, minimising pollution, maintaining and improving air, soil and water quality, and employing sustainable building practices in new development.*" It states that *"The framework will also support measures to minimise pollution and improve air…quality"*.

[44] Doncaster Council (2021) Local Plan 2015-2035
[45] Doncaster Council (2022) Air Quality Technical Planning Guidance 2022
[46] North Lincolnshire Council (2011) Core Strategy

Greenhouse Gases

National Policies

12.24. The National Policy Statement (NPS) for Renewable Energy Infrastructure (EN-3)[37], together with the Overarching National Policy Statement for Energy (EN-1)[38], provides a policy basis for decisions regarding nationally significant renewable energy infrastructure projects. There is no specific NPS for solar projects.

12.25. The draft EN-1 document[39] includes Section 5.3 on the assessment of Greenhouse Gas Emissions. Paragraph 5.3.4 states:

"All proposals for energy infrastructure projects should include a carbon assessment as part of their ES (See Section 4.2). This should include:

- *A whole life carbon assessment showing construction, operational and decommissioning carbon impacts*
- *An explanation of the steps that have been taken to drive down the climate change impacts at each of those stages*
- *Measurement of embodied carbon impact from the construction stage*
- *How reduction in energy demand and consumption during operation has been prioritised in comparison with other measures*
- *How operational emissions have been reduced as much as possible through the application of best available technology for that type of technology*
- *Calculation of operational energy consumption and associated carbon emissions*
- *Whether and how any residual carbon emissions will be (voluntarily) offset or removed using a recognised framework*
- *Where there are residual emissions, the level of emissions and the impact of those on national and international efforts to limit climate change, both alone and where relevant in combination with other developments at a regional or national level, or sector level, if sectoral targets are developed*".

12.26. The draft EN-3 document[40] includes a section on the impacts of solar photovoltaic generation, however that section does not refer to greenhouse gas emissions.

12.27. Part 14 of the NPPF[41] is titled *"Meeting the challenge of climate change, flooding and coastal change"* and sets out the strategy for minimising the climate change effects of new development. Paragraph 154 states that:

"New development should be planned for in ways that […] can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards."

12.28. Paragraph 155 states further that:

"*To help increase the use and supply of renewable and low carbon energy and heat, plans should:*

a) provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);

b) consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and

c) identify opportunities for development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers."

12.29. Paragraph 158 states that, when determining planning applications for renewable and low carbon development, planning authorities should:

"a) not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and

b) approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas."

Climate Change Act 2008[47]

12.30. The overarching Act in relation to climate is the Climate Change Act 2008. The Act introduces a legally binding target to reduce the UK's GHG emissions to at least 80% below 1990 levels by 2050. It also provides for a Committee on Climate Change (CCC) with power to set out carbon budgets binding on the Government for five-year periods.

12.31. In the 2009 budget, the first three carbon budgets were announced which set out a binding 34% CO_2e[48] reduction by 2020; and the Government has since adopted the fourth and fifth carbon budgets to reduce CO_2e by 50% by 2025 and 57% by 2030.

12.32. The CCC also produces annual reports to monitor the progress in meeting these carbon budgets. Consequent upon the enactment of the Climate Change Act, a raft

[47] Her Majesty's Stationery Office (2008) Climate Change Act 2008

[48] Carbon dioxide equivalent (CO_2e) is a term for describing different greenhouse gases in a common unit. For any quantity and type of greenhouse gas, CO2e signifies the amount of CO_2 which would have the equivalent global warming impact.

of policy at national and local level has been developed aimed at reducing carbon emissions.

Climate Change Act 2008 (2050 Target Amendment) Order 2019[49]

12.33. In June 2019, the Government passed an order to amend the 2050 carbon emissions target in the Climate Change Act 2008 from 80% below 1990 levels to zero net carbon (i.e. 100% below 1990 levels). This new target will essentially end the UK's contribution to climate change by 2050.

Carbon Budget Order 2021[50]

12.34. The Carbon Budget Order 2021 came into force in June 2021. It sets a legal obligation to meet the targets of the Climate Change Act 2008 and subsequent amendment to cut GHG emissions by 78% by 2035.

Energy Act (2013)[51]

12.35. The Energy Act makes a provision for the setting of a decarbonisation target range, duties in relation to it and for the reforming of the electricity market for the purposes of encouraging low carbon electricity generation.

Net Zero Strategy[52]

12.36. The UK Government's Net Zero Strategy sets out the strategy for achieving the UK's binding commitment to net zero carbon emissions by 2050.

12.37. The strategy sets out a number of key aims and objectives to decarbonise the UK economy across all sectors. In relation to residential development the strategy includes commitments for heat and buildings which include phasing out natural gas heating (and other fossil fuels) and maximising energy efficiency of buildings.

12.38. The strategy also covers transport, setting a mandate to decarbonise road transport through the use of zero emission (electric) vehicles.

Decarbonising Transport[53]

12.39. The Department for Transport (DfT) published the Decarbonising Transport plan in 2021, setting out how transport emissions reductions will be delivered in order to reach net zero by 2050. This includes phasing out the sale of all non-zero tailpipe emission vehicles by 2040; for Heavy Goods Vehicles (HGVs), sales of all new medium sized vehicles are to be zero tailpipe emission from 2035, with the largest vehicles being zero tailpipe emission by 2040.

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[49] Her Majesty's Stationery Office (2019) The Climate Change Act 2008 (2050 Target Amendment) Order 2019
[50] Her Majesty's Stationery Office (2021) The Carbon Budget Order 2021
[51] Her Majesty's Stationery Office (2013) Energy Act 2013
[52] HM Government (2021) Net Zero Strategy: Build Back Greener
[53] DfT (2021) Decarbonising Transport. A Better, Greener Britain

Energy White Paper[54]

12.40. The Government's energy white paper sets out the plan for growth and decarbonisation of the UK's energy supply out to 2050, in line with the 2050 net zero target. The white paper provides a framework of policies and incentives to accelerate investment in renewable energy infrastructure and acknowledges that "*onshore wind and solar will be key building blocks of the future generation mix"* [55].

Local Policies

12.41. DC's Local Plan[44] contains Strategic Policy 58: Low Carbon and Renewable Energy states:

"*The Council aims to increase the supply of low carbon and renewable energy generated in the Borough, in accordance with the principles set out below:*

A) Proposals will be supported which give priority to:

1. community energy schemes that are in full or part community ownership;

2. biomass and energy crop schemes especially to the north and south east of the main urban area, for example mixed woodland, single species short rotation forestry and large-scale forestry, outside of areas of high quality arable farmland;

3. heat or power generation from light, water, waste and other low carbon heat sources;

4. landfill and sewage gas energy generation schemes;

5. wind power projects which meet the criteria of Policy 59; and

6. micro-renewable energy technologies and decentralised heat and power systems within new development.

B) In all cases, low carbon and renewable energy proposals will be supported where they:

1. have undertaken community engagement and demonstrate how they will deliver environmental, social and economic benefits;

2. have no unacceptable adverse effects on local amenity and air quality, and include appropriate stand-off distances between technologies and sensitive receptors, such as residential areas;

3. allow the continued safe and efficient operation of Doncaster Sheffield Airport;

[54] HM Government (2020) Energy White Paper. Powering our Net Zero Future
[55] See Page 45 of the Energy White Paper.

4. would have no unacceptable adverse effects on highway safety and infrastructure;

5. have no unacceptable adverse impacts, including cumulative impacts, on the built and natural environment (including landscape character, and historic and nature conservation assets, such as Thorne and Hatfield Moors); and

6. reclaim the site to a suitable and safe condition and use (such as agriculture or nature conservation) within a defined and agreed period should the development cease to be operational."

12.42. The North Lincolnshire Core Strategy[46] contain Policy CS18: Sustainable Resource Use and Climate Change. It states:

"*The council will actively promote development that utilises natural resources as efficiently and sustainably as possible. This will include:*

…4. Meeting required national reductions of predicted CO_2 emissions by at least 34% in 2020 and 80% in 2050 by applying the following measures on development proposals. Requiring all industrial and commercial premises greater than 1000 square metres to provide 20% of their expected energy demand from on site renewable energy until the code for such buildings is applied nationally. Where developers consider these Codes and targets cannot be met on the basis of viability they will be required to provide proof through open book discussions with the council at the planning application stage.

6. Supporting development that minimises the consumption and extraction of minerals by making the greatest possible reuse or recycling of materials in new construction, and by making best use of existing buildings and infrastructure.

7. Supporting development that seeks to minimise waste and facilitates recycling and using waste for energy where appropriate.

8. Ensuring that development and land use in areas close to the Humber Estuary and rivers responds appropriately to the character of the area, in the interests of preserving and making best use of limited resources.

…10. Ensuring development and land use helps to protect people and the environment from unsafe, unhealthy and polluted environments, by protecting and improving the quality of the air, land and water.

11. Supporting renewable sources of energy in appropriate locations, where possible, and ensuring that development maximises the use of combined heat and power, particularly at the South Humber Bank employment site and where energy demands for more than 2MW are required for development.

12. Supporting new technology and development for carbon capture and the best available clean and efficient energy technology, particularly in relation to the heavy industrial users in North Lincolnshire, to help reduce CO_2 emissions.

13. Promote the use of a greenspace strategy and a green infrastructure plan, where applicable, which could help reduce the effects of climate change."

Likely Significant Effects

Air Quality

Construction

12.43. Potential air quality effects that will be considered in relation to the construction of the proposed development include:

- Impacts of NO_2, PM_{10} and $PM_{2.5}$ emissions from vehicles associated with the construction of the proposed development on existing sensitive receptors in the local area. It is anticipated that the construction traffic movements will be mainly associated with staff trips and HGV trips to transport materials to site;
- Impacts of dust and PM_{10} generated during the construction of the proposed development on nearby sensitive receptors; and
- Impacts of emissions from Non-Road Mobile Machinery (NRMM) on nearby sensitive receptors.

12.44. The Institute of Air Quality Management's (IAQM's) Guidance on the Assessment of Dust from Demolition and Construction[56] advises that, with appropriate mitigation in place, the effects of construction dust will be 'not significant'. The assessment will, therefore, focus on determining the appropriate level of mitigation to be applied so as to ensure that effects will normally be 'not significant'.

Operation

12.45. Potential air quality effects associated with the operation of the proposed development that will be considered are the impacts of NO_2, PM_{10} and $PM_{2.5}$ emissions from vehicles associated with the operation of the proposed development on existing sensitive receptors in the local area. It is anticipated that operational traffic movements will be minimal, with low numbers of movements expected to be associated with the maintenance of the site.

Decommissioning

12.46. The lifetime of the proposed development is anticipated to be 45 years. Based on DfT's Decarbonisation Strategy[53], the Net Zero Strategy[52] and Road to Zero Strategy[43], exhaust emissions from road traffic in the far future are likely to be zero at the latest by 2050. Furthermore, the baseline air quality 45 years from the opening of the proposed development cannot be accurately predicted.

12.47. It is therefore not considered practical or necessary to undertake an assessment of the air quality effects associated with the decommissioning of the scheme.

[56] IAQM (2016) Guidance on the Assessment of Dust from Demolition and Construction v1.1

Greenhouse Gases

12.48. The scheme will lead to the release of GHGs from its construction and operation. The key GHG emitted during the construction and operation of the scheme will be carbon dioxide (CO_2), however the assessment will include quantification of GHG emissions that will be released as carbon dioxide equivalent (CO_2e), which includes the contribution of all other GHGs (i.e. gases with a Global Warming Potential (GWP)).

Construction

12.49. Potential GHG effects associated with the construction of the proposed development include:

- CO_2e embedded in materials used for constructing the proposed development (e.g. manufacture of PV cells and frames);
- CO_2e emitted from transport activities associated with the construction of the proposed development; and
- CO_2e emitted from site activities associated with the construction of the proposed development (e.g. fuel use by site machinery, electricity consumption and waste).

Operation

12.50. Potential GHG effects associated with the operation of the proposed development include CO_2e emitted from transport. It is, however, expected that the traffic movements associated with the maintenance of the proposed development will be minimal and therefore quantification of operational transport emissions will be scoped out of the GHG assessment.

Decommissioning

12.51. The 2050 Climate Change Act 2008 (2050 Target Amendment) Order 2019 sets a target to be net zero carbon by 2050. The estimated lifetime of the proposed development is 45 years, which would mean decommissioning after 2070. It is therefore reasonable to assume that the GHG emissions associated with the decommissioning of the proposed development will be least net zero, and the decommissioning will have a minimal contribution to the overall GHG footprint.

12.52. It is therefore proposed to scope out the GHG emissions associated with the decommissioning of the proposed development.

Mitigation and Enhancement

Air Quality

12.53. Where possible, mitigation measures will be proposed for the construction and operation of the scheme in order to ensure that residual effects are ‘not significant’.

12.54. Appropriate mitigation measures, as listed in the IAQM guidance document on demolition and construction dust, will be proposed for the earthworks and construction phase of the proposed development, based on the level of risk identified by the dust assessment.

Greenhouse Gases

12.55. Where possible, mitigation measures will be proposed to reduce emissions of CO_2e associated with installation, operation and maintenance of the proposed development. This will include CO_2e embedded in materials used for constructing the scheme and materials manufacturing, to transport activities associated with the construction and operation of the proposed development. Consideration will also be given to methods and measures to protect the existing soil carbon stocks at the Site.

Assessment Methodology

Air Quality

Construction

12.56. The potential effects from dust generated during the earthworks and construction of the scheme will be considered using the approach presented in the Institute of Air Quality Management (IAQM) guidance for assessing effects from demolition and construction activities[56]. The site is currently agricultural land; there will, therefore, be no demolition phase. Cumulative effects arising from other committed developments in the study area being constructed concurrently with the earthworks and construction of the scheme will also be considered.

12.57. The study area for the assessment of construction phase effects will include sensitive receptors (e.g. residential properties) located within 350m of the Site boundary or near to roads within 500m of the Site exit(s). It will also consider ecological sites within 50m of the Site boundary or roads along which dust and dirt may be tracked.

12.58. Emissions from construction plant (NRMM) will not be explicitly modelled, as relevant guidance from the IAQM[56] states that *"experience from assessing the exhaust emissions from on-site plant (also known as non-road mobile machinery or NRMM) […] suggests that they are unlikely to make a significant impact on local air quality and in the vast majority of cases they will not need to be quantitatively assessed"*. Significant effects as a result of NRMM emissions can thus likely be discounted. However, suitable mitigation measures for site plant will be presented as part of the mitigation measures based on advice presented in the IAQM guidance.

12.59. The number of construction vehicles (including heavy duty vehicles (HDVs)) that will travel on the local road network during the construction phase of the scheme will be considered in the context of the screening criteria provided in guidance from IAQM

and Environmental Protection UK (EPUK)[57], applicable for outside an Air Quality Management Area (AQMA) (i.e., >500 Light Duty Vehicles (LDVs) Annual Average Daily Traffic (AADT) flows and/or >100 HDV AADT flows).

12.60. If it is not possible to screen out the impacts of emissions from construction traffic, impacts will be predicted using the ADMS-Roads dispersion model. Predictions will be made for NO_2, PM_{10} and $PM_{2.5}$ concentrations. The model requires a variety of inputs, including road traffic data (flows, speeds and vehicle fleet composition) and meteorological data. The model will be used to predict pollutant concentrations for the following scenarios:

- Baseline year (2019 – which is the latest calendar year of monitoring data in the public domain avoiding the impact of the Covid-19 pandemic on measured pollutant concentrations; therefore, using this baseline year is considered to be the most robust and worst-case baseline scenario);
- Peak construction year without the proposed development, but including traffic generated by relevant cumulative schemes; and
- Peak construction year with the proposed development, including traffic generated by relevant cumulative schemes.

12.61. An important element of the modelling study will be to verify the ADMS-Roads model output against measurements. This will be undertaken by identifying suitable roadside air quality monitoring locations within the vicinity of the proposed development, against which the model performance can be compared. An adjustment factor will be determined in line with methodology set out in Defra's Local Air Quality Management Technical Guidance (LAQM.TG22)[33].

12.62. Consideration of the air quality impacts from construction traffic will focus on the area identified for the Transport Assessment and based on published screening thresholds. Air quality will be assessed at a range of worst-case receptors closest to busy roads, particularly those close to junctions, and where the changes in traffic flows will be greatest. The scale, nature and significance of the air quality effects will be determined following the EPUK & IAQM guidance[57] and appropriate mitigation measures will be recommended as necessary, based on the outcomes of the assessment.

12.63. Background pollutant concentrations will be determined using data derived from the background maps published by Defra[35].

12.64. In terms of the impacts of emissions from construction vehicles on air quality at ecological sites, the Joint Nature Conservation Committee (JNCC) has published Decision Making Thresholds (DMTs) to identify those projects which can immediately be discounted as unlikely to have a significant effect on biodiversity, either alone or

[57] Moorcroft & Barrowcliffe et al. (2017) Land-Use Planning & Development Control: Planning For Air Quality v1.2

in combination with other projects and plans[58]. With limited exceptions, no further assessment is required wherever:

- The roads affected by the scheme are more than 200m from any designated site, or in some cases, from the notified features within those sites; or
- The affected roads are part of the Strategic Road Network (SRN), unless the scheme is itself a highways improvement scheme; or
- The increase to traffic flows caused by the scheme alone, on any road within 200m of a designated site, is less than 0.15% of the existing AADT flow on that road.

12.65. The guidance also explains, in the context of assessing land use plans, that it is necessary to avoid legislative overkill when assessing the effects of traffic emissions. It thus defines a zone of influence extending 10km from the boundary of a land use plan, beyond which no assessment is required. This reflects the point that, beyond this distance, changes to traffic relate less strongly to the precise location and nature of a new development. National-level growth has already been accounted for in the modelling which underpins JNCC's DMTs[59]. Following the concepts which underpin JNCC's guidance, roads which are more than 10km from the scheme will not require assessment, nor will sites within 200m of the M18 and M180, which form part of the SRN.

12.66. The Thorne Moor SAC/SPA/SSSI is located adjacent to the site boundary, but is more than 200m from any roads. It is thus not anticipated that a detailed assessment of the impacts on the Moor will be required and construction traffic impacts on designated ecological sites can be scoped out of the assessment.

Operation

12.67. The number of vehicle movements generated as a result of the operation of the scheme is expected to be low, and it is therefore anticipated that the impacts of emissions from these vehicles will screened out of the assessment, following the EPUK & IAQM guidance[57].

Greenhouse Gases

12.68. The assessment will be undertaken in line with the latest Institute of Environmental Management and Assessment (IEMA) guidelines, taking account of all relevant national, regional and local policies relating to GHG emissions and climate change, and will include a summary of mitigation measures designed into the scheme to prevent, reduce and offset its CO_2e emissions.

[58] Chapman and Kite (2021) Guidance on Decision-Making Thresholds for Air Pollution, JNCC Report No. 696 (Main Report), JNCC, Peterborough, ISSN 0963-9091
[59] AQC (2021) *Decision-making Thresholds for Air Pollution*, JNCC Report No. 696 (Technical Report), JNCC, Peterborough, ISSN 0963-809

Construction

12.69. The assessment will utilise the following approaches:

- The embedded carbon from construction will be calculated using carbon factors published by the University of Bath, which are applied to the individual construction materials used. This will include CO_2e emissions arising from the manufacture and production of construction materials. The assessment of embedded carbon covers "cradle to gate" emissions (i.e. carbon emissions from the extraction of raw materials through to finished construction products);

- Emissions from construction site activities will be estimated, based on the approach recommended in guidance on whole life carbon assessment from the Royal Institute of Chartered Surveyors (RICS); and

- CO_2e emissions from construction transport will be calculated using Department for Business, Energy and Industrial Strategy (BEIS) carbon factors for road vehicles based on the predicted volume of HGV movements generated by the construction works, the loaded weight of the vehicles and travel distances to their origin/destination.

12.70. Damage to or drainage of peatland at the Site could lead to emissions of GHG that is currently stored in the peat. CO_2e associated with disturbance of the peat during construction will be estimated based on the best available information from the project team in relation to the volume of peat damaged or drained during construction works.

Operation

12.71. The assessment will estimate the net saving in GHG emissions during the proposed development's operational lifetime by comparison to the emissions associated with other current power generation methods. A comparison of the lifetime GHG intensity of the scheme to other forms of UK power generation will be provided for context.

12.72. The GHG assessment will provide a whole lifetime carbon footprint for the proposed development, which will be compared to appropriate benchmarks (including published national and regional GHG emissions and/or benchmarks) in order to provide context for the scale of the carbon footprint.

12.73. The assessment will include an appraisal of the conformance of the scheme to relevant national and local policies relating to GHGs and climate change as described in Paragraphs 12.24 to 12.42.

12.74. The assessment will set out the carbon mitigation being proposed, which will follow the principles of the carbon management hierarchy (avoid, reduce, off-set), in order to reduce, as far as reasonably practicable, the anticipated GHG emissions over the lifecycle of the scheme.

Significance Criteria

Air Quality

12.75. The predicted concentrations will be compared with the relevant air quality objectives as defined within the Air Quality (England) Regulations 2000 (as amended).

12.76. There are no statutory objectives for dust. It is therefore common practice to provide a qualitative assessment based largely on experience of the distances over which impacts may occur.

12.77. The evaluation of significance of impacts for operation and construction will be based on criteria recommended by the IAQM & EPUK[57], and will be determined based on predicted impacts at receptors, alongside using professional judgement. Where possible, mitigation measures will be proposed to ensure that residual effects are 'not significant'.

Greenhouse Gases

12.78. The significance of GHG effects will be assessed following IEMA guidance. The approach examines the scale and nature of GHG emissions, contextualised using established carbon budgets. The assessment of significance also includes a review of the policy compliance of the scheme (with respect to key GHG and climate change policies) and the robustness, efficacy and timeliness of mitigation, with focus on the ability of the scheme to align with local, regional and national trajectories to achieve net zero.

Cumulative Effects

Air Quality

12.79. The potential for the scheme and existing and cumulative schemes to cumulatively impact upon air quality at sensitive receptors during the construction of the scheme will be considered. The peak construction year traffic data 'without proposed development' and 'with proposed development' scenarios will both include vehicle trips associated with general growth from the baseline situation, as well as from specific relevant cumulative schemes. The inclusion of relevant cumulative schemes in the traffic data utilised in the assessment will allow an inherently cumulative assessment of the construction of the scheme to be undertaken.

Greenhouse Gases

12.80. As set out in the IEMA guidance "*GHG emissions from all projects will contribute to climate change; the largest interrelated cumulative environmental effect*". This statement relates to 'cumulative' on a global scale as all emissions of GHG's contribute to climate change. The definition of 'cumulative effects' in the context of greenhouse gases and climate change therefore goes far beyond the typical definition of cumulative effects for EIA, which tends to focus on other proposed projects in the vicinity of the proposed development. The GHG assessment is therefore intrinsically a cumulative assessment and no consideration to specific local cumulative schemes is required.

13. Agriculture

Introduction

13.1. This topic considers the potential effects of the scheme on agricultural land and businesses. In particular the topic considers the agricultural land quality of the area, and the extent to which land quality and soil resources will be affected.

Preliminary Baseline Conditions

13.2. The Agricultural Land Classification (ALC) system is the approved method for assessing the quality of farmland to enable informed choices to be made about its future use within the planning systems of England and Wales. The ALC system classifies land into five grades, with Grade 3 subdivided into Subgrades 3a and 3b. The best and most versatile (BMV) land is defined as Grades 1, 2 and 3a by policy guidance (see Annex 2 of NPPF). This is the land which is most flexible, productive and efficient in response to inputs and which can best deliver future crops for food and non-food uses such as biomass, fibres and pharmaceuticals.

13.3. The site is largely agricultural land. Data provided on the Natural England interactive mapping service MAGIC.gov.uk shows no existing ALC site survey work at the site using the current MAFF ALC methodology. Natural England provide regional plans of Likelihood of BMV Agricultural Land[60]. The plan for the Yorkshire and Humber Region shows the site area to be a mix of High to Moderate likelihood of BMV land, High being a prediction of greater than 60% of land area being BMV, and Moderate being 20% to 60%. These plans are however prepared for strategic planning purposes only and should not be used for site specific assessment.

13.4. Natural England Document TIN049[61] Agricultural Land Classification: protecting the best and most versatile agricultural land, provides guidance on the assessment of ALC grade to inform planning decisions on agricultural land with the aim of protecting it from inappropriate development. Site survey work is being undertaken in line with the guidance of TIN049, to map the distribution of ALC grades within the site area.

13.5. ALC site survey work will also gather data on soil physical characteristics which will be used to inform appropriate measures in a Soil Management Plan (SMP) to conserve soil functional capacity through construction, decommissioning and operational activities.

13.6. In addition to the agricultural land and the soil resource associated with that land, an assessment will be made of Farming Circumstances. This will review the nature and scale of the farm businesses occupying land within the site, and the potential impact of development on these.

[60] http://publications.naturalengland.org.uk/category/5208993007403008
[61] http://publications.naturalengland.org.uk/publication/35012

Likely Significant Effects

13.7. The scheme has the potential to affect the agricultural land quality of the site. This could result in the temporary loss of the arable use of the agricultural land of BMV or lower quality (operational life is 45 years) on the Scheme. Land within the order limits would continue to be farmed during the operational lifetime and this will include sheep grazing. The panels area will be farmed in conjunction with other requirements of the scheme.

13.8. The scheme has the potential for adverse and beneficial economic impacts for the businesses affected, and this will be considered and assessed.

Assessment Methodology

13.9. As noted above, Natural England document TIN049 provides guidance on the appropriate assessment of ALC grade for the purpose of informing land use planning decisions. Field survey work of agricultural land within the Sites will be conducted at the detailed level, as per TIN049 recommendations.

13.10. The assessment will consider the agricultural land quality of the site, and the extent to which the scheme will affect the inherent land quality. It will consider the method of construction and the impact this would have on soil qualities. It will consider the potential for removal of the panels and therefore the reversibility of the impact, and it will consider the extent to which agricultural use can continue during the life of the scheme.

13.11. The potential loss of agricultural land will be considered by reference to the guidance in the NPPF (2021). Planning Practice Guidance, the Local Plans, and NPSs including current drafts.

13.12. Implications of solar farm developments on agricultural land are considered further in draft NPS EN-3 and the national Planning Practice Guidance (PPG): Renewable and Low Carbon Energy, June 2015. Paragraph 013 of this guidance sets out a number of factors that should be considered by local planning authorities in the determination of a planning application for large-scale solar farms. The second bullet of which states that:

> ***where a proposal involves greenfield land, whether (i) the proposed use of any agricultural land has been shown to be necessary and poorer quality land has been used in preference to higher quality land; and (ii) the proposal allows for continued agricultural use where applicable and/or encourages biodiversity improvements around arrays. See also a speech by the Minister for Energy and Climate Change, the Rt Hon Gregory Barker MP, to the solar PV industry on 25 April 201330 and written ministerial statement on solar energy: protecting the local and global environment made on 25 March 2015***

13.13. Draft EN-3, at paragraph 2.48.13, however recognises that "*land type should not be a predominating factor in determining the suitability of the site location*".

13.14. In addition to field survey, options to apply the Welsh Government Predictive ALC model to the area will be explored. Where sufficient existing data is available this model can make a good estimate of ALC grade across an extensive area. This estimate will provide additional regional context for the results of the site assessment of ALC grade and contribute towards justification for site selection.

Significance Criteria

13.15. Land of "best and most versatile" quality is considered to be a receptor of high sensitivity. Land of subgrade 3b, 4 and 5 is considered to be a resource of moderate/ medium sensitivity.

13.16. Full-time farm businesses are considered to be a resource of moderate/medium sensitivity. Farms can normally adapt to change brought about by a raft of different factors, and accordingly are not highly sensitive to change. Part-time farm businesses are considered to be of low sensitivity. The economic effects the scheme on agricultural circumstances will be considered.

13.17. In terms of magnitude of impacts, for this assessment it is proposed that the permanent loss of more than 50 ha of BMV land will be considered to be a large/major magnitude, losses of 20-50 ha are of moderate/medium magnitude and losses of less than 20 ha to be of low magnitude. Importantly, this threshold is directed principally at permanent, irreversible development. Where land use change is temporary and does not result in the permanent loss of BMV resource the standard or depth of alternative site assessments should arguably be less stringent, as the harm will not result. It is understood that ALC grades do not decline during the lifetime of the operational phases of solar farms, therefore, with the panels in place for 45 years, it is expected that there would be no permanent loss of ALC resource or downgrading.

13.18. This magnitude criteria is set by Natural England advice that within the Local Authority planning system they only seek to be consulted on planning application where 20+ha of agricultural land is to be lost through a change of use. Below 20ha (even if the land in BMV) Natural England do not require to be consulted.

Assessment of Cumulative Effects

13.19. Consideration will be given to the cumulative sites. For this topic, a 5km study area is proposed. Consideration will not be given to non-energy development that may be removing 20ha or more of BMV agricultural land for their development.

13.20. Sites which come forward which are smaller than 20ha will not be included within the cumulative assessment as a development of this size would not normally be considered for its impact for loss of agricultural land within the UK planning system as Natural England do not require to be consulted on areas of agricultural land less than 20ha (regardless of agricultural grade).

14. Topics Scoped out of EIA

Glint & Glare

14.1. The Draft National Policy Statement for Renewable Energy Infrastructure (EN-3) identifies how solar panels may reflect the sun's rays, causing glint and glare.[62] The draft statement goes on to identify how *"In some instances, it may be necessary to seek a glint and glare assessment as part of the application"*[63]. The Applicant proposes to present a Glint & Glare Assessment as standalone report submitted as a technical appendix to the Environmental Statement Chapter 4 – Development Description. The Applicant does not propose the provision of a 'technical chapter' on glint and glare.

14.2. The remainder of this section discusses the proposed approach for the G&G Assessment.

14.3. The Assessment will describe and identify the potential level of effects arising as a result of the scheme in relation to:

- Road users – specifically drivers of motor vehicles;
- Occupants of surrounding dwellings;
- Railway operations and infrastructure; and
- Aviation activity.

Assessment Methodology

14.4. There is no formal guidance with regard to the maximum distance at which glint and glare should be assessed. From a technical perspective, there is no maximum distance for potential reflections. However, the significance of a solar reflection decreases with distance. This is because the proportion of an observer's field of vision that is taken up by the reflecting area diminishes as the separation distance increases. In most instances. terrain and shielding by vegetation are also more likely to obstruct an observer's view at greater distances.

14.5. The above parameters and extensive experience over a significant number of glint and glare assessments undertaken shows that a 1km buffer is considered appropriate for glint and glare effects on local dwellings and road users, 500m for railway operations and infrastructure and 15km for aviation activity for a development of this size, scale and significance. In most cases the assessed distance is much less than this.

14.6. The initial judgement is made based on high-level consideration of aerial photography and mapping i.e. receptors are excluded if it is clear from the outset

[62] Draft National Policy Statement for Renewable Energy Infrastructure (EN-S) paragraph 2.52.1
[63] Paragraph 2.52.2

that no visibility would be possible. A more detailed assessment is made if the modelling reveals a reflection would be geometrically possible.

Assessment Process

14.7. Pager Power's glint and glare assessment methodology has been derived from the information provided to Pager Power through consultation with stakeholders, assessment experience and by reviewing the available guidance and studies. The methodology for the glint and glare assessments is as follows:

- Identify the key receptors in the area surrounding the Proposed Development;
- Consider direct solar reflections from the Proposed Development towards the identified receptors by undertaking geometric calculations;
- Consider the visibility of the panels from the receptor's location. If the panels are not visible from the receptor then no reflection can occur;
- Based on the results of the geometric calculations, determine whether a reflection can occur, and if so, at what time it will occur;
- For aviation receptors consider the solar reflection intensity;
- Consider the intensity of the solar reflection from the Proposed Development in relation to aviation activity;
- Consider both the solar reflection from the Proposed Development and the location of the direct sunlight with respect to the receptor's position;
- Consider the solar reflection with respect to the published studies and guidance - including intensity calculations where appropriate;
- Determine whether a significant detrimental impact is expected in line Pager Power's standard process and recommended methodology.

14.8. A 1km distance surrounding the proposed ground mounted solar work areas is considered appropriate for road users and dwellings.

14.9. The assessment area for rail operations and infrastructure is defined by the maximum distance considered appropriate for glint and glare effects and where solar reflections are considered geometrically possible and by the consultation with the rail operator (this for signals only). A 500m assessment area surrounding the proposed ground mounted solar work areas is considered appropriate for rail operations and infrastructure which is triggered by the Proposed Development being within the statutory consultation area for Network Rail infrastructure (understood to be within 100m-200m from their assets). Receptors within this zone are identified based on mapping, aerial photography of the region and consultation with the relevant stakeholder (railway signals only).

14.10. The assessment area for aviation receptors is primarily dependent on the type of aerodrome. Concerns are most often raised for developments within 10km of a licensed aerodrome. Modelling requests aviation effects at ranges of 10-20km are far

less common for licensed aerodromes, and even less common for unlicensed aerodromes at this range. The assessment area for aviation receptors of 15km is therefore considered appropriate. As a starting point, a detailed analysis will be conducted for Sandtoft Airfield (the nearest licensed aerodrome). The remaining aerodromes will be assessed at a high-level.

14.11. The 15km assessment area surrounding the order limits contains the following aviation infrastructure:

- Sandtoft Airfield – 1.2km south;
- Finningley Village Airstrip – 6.6km south;
- Haxey Airstrip – 8.7km south;
- Robin Hood Doncaster Sheffield Airport – 10.3km south;
- Low Hill Farm Airstrip – 10.6km east;
- Askern Airfield – 11.4km west; and
- Bridge Cottage Airstrip– 11.8km north-west.

Relevant Policy Context

14.12. Guidelines exist in the UK (produced by the Civil Aviation Authority) and in the USA (produced by the Federal Aviation Administration) with respect to solar developments and aviation activity. The UK CAA guidance is relatively high-level and does not prescribe a formal methodology. Pager Power has reviewed existing guidelines and the available studies to define its own glint and glare assessment guidance document and methodology[64]. This methodology defines a comprehensive process for determining the impact upon road safety, residential amenity, railway operations and infrastructure, and aviation activity.

14.13. Pager Power's approach is to undertake geometric reflection calculations and, where a solar reflection is predicted, consider the screening (existing and/or proposed) between the receptor and the reflecting solar panels. For aviation activity, where a solar reflection is predicted, solar intensity calculations are undertaken in line with the Sandia National Laboratories' FAA methodology[65]. The scenario in which a solar reflection can occur for all receptors is then identified and discussed, and a comparison is made against the available solar panel reflection studies to determine the overall impact.

14.14. The available studies have measured the intensity of reflections from solar panels with respect to other naturally occurring and manmade surfaces. The results show

[64] Pager Power Glint and Glare Guidance, Fourth Edition (4.0), September 2022
[65] Formerly mandatory for on-airfield solar developments in the USA under the FAA's interim policy, superseded in 2021 with a policy that effectively requires individual airports to sign-off their on-airfield development as they see fit.

that the reflections produced are of intensity similar to or less than those produced from still water and significantly less than reflections from glass and steel[66].

14.15. The following guidance documents will inform the approach to the design and assessment of the Proposed Development:

- Pager Power Glint and Glare Guidance, Fourth Edition (4.0), August 2022;
- Renewable and Low Carbon Energy, Ministry of Housing, Communities & Local Government, 18 June 2015; and
- Technical Guidance for Evaluating Selected Solar Technologies on Airports, Federal Aviation Administration (FAA), 04/2018.

Mitigation and Enhancement

14.16. Any predicted impacts towards the ground-based infrastructure can likely be solved with relatively simple mitigation strategies – the most common being the provision of screening at the site perimeter to obstruct views of potentially reflecting panels. Where views of reflecting panels are obstructed, no effects can be experienced. Other solutions such as layout modifications (including changing of panel alignments or removal of panels) can be considered but are much more rarely required in practice, and are typically reserved for mitigating aviation impacts. It is unknown whether the panels within the development will be static or tracking, or a combination thereof. If the panels are tracking, a mitigation technique may be to change the back-tracking angle.

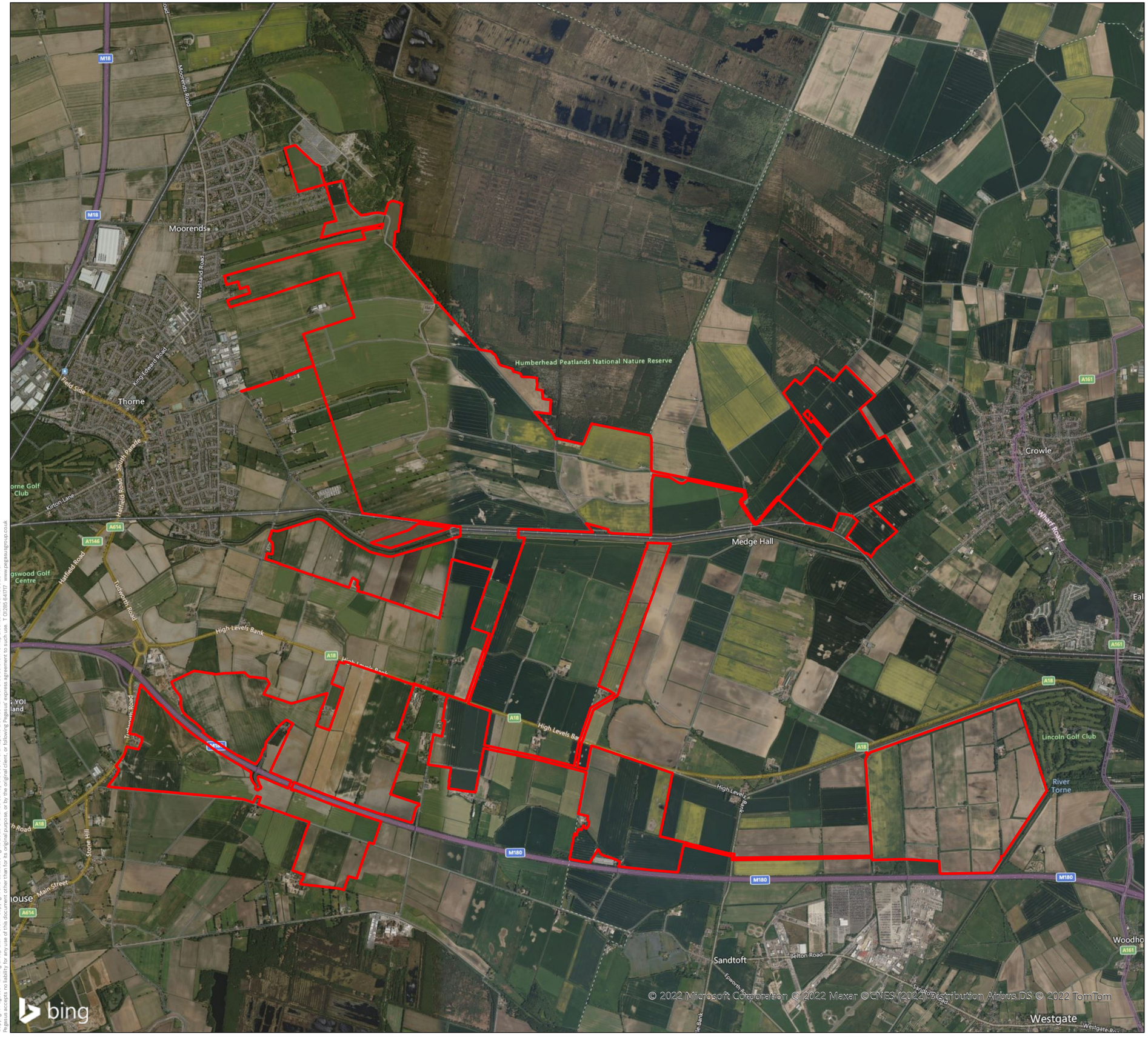
14.17. Due to the distance and likely views of the Proposed Development, technical mitigation for approaching pilots at Sandtoft Airfield might be more invasive and significantly change the Proposed Development structure, specifically the area of panels directly north of the airfield. Whilst formal guidance within the UK for quantifying impacts is sparse, the industry standard is to evaluate effects on aviation receptors based on their intensity (specifically the potential for a temporary after-image) as well as their duration and operational sensitivity.

Conclusions

14.18. The Proposed Development is predicted to have 'moderate' effects, at worst, upon surrounding road users, dwellings, aviation, and railway receptors. The developer has however committed to mitigating any significant impact to acceptable levels through design and/or screening prior to the submission of the application. Therefore, it is recommended that glint and glare is to be scoped out of the Environmental Statement, however a full technical glint and glare assessment will support the application.

[66] SunPower, 2009, SunPower Solar Module Glare and Reflectance (appendix to Solargen Energy, 2010).

Appendix 1.1 – Draft Order Limits



KEY

AREA EXCLUDED FROM DRAFT ORDER LIMITS

DRAFT ORDER LIMITS

NOTES:
REVISIONS:
21/09/22 - ADDED EASEMENTS
29/09/22 - ADDED EASEMENTS & PARCELS
11/10/22 - REMOVED PARCEL
21/10/22 - ADDED PARCELS
25/10/22 - ADDED AND REMOVED PARCELS
29/11/22 - REMOVED PARCEL
19/12/22 - ADDED ACCESS TRACK & AMMENDED BOUNDARY

SITE BOUNDARY PLAN

TWEEN BRIDGE SOLAR

CLIENT
RWE

DATE	DRAWN	APPROVED	SCALE
20/12/2023	RL	HS	1:36,000@A3

SHEET	REVISION	DRAWING NUMBER
-	G	P21-3484_06_G

N

0 1.5 km

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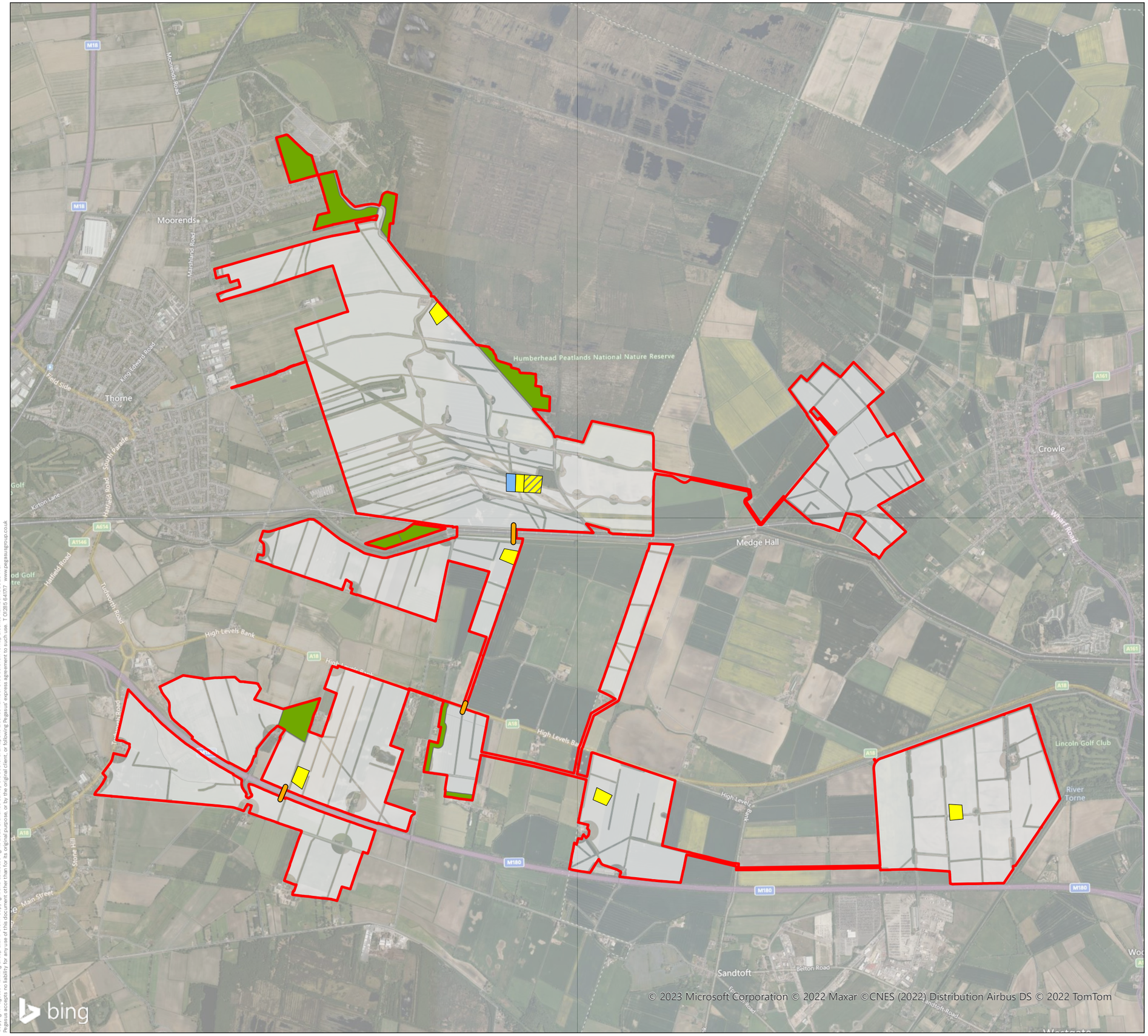
Appendix 2.1 – Draft Works Plan



KEY

- ORDER LIMITS
- INDICATIVE SUBSTATION LOCATION
- INDICITIVE NATIONAL GRID SUBSTATION
- INDICATIVE BATTERY ENERGY STORAGE SYSTEM
- INDICATIVE HORIZONTAL DIRECTIONAL DRILLING
- INDICATIVE ECOLOGICAL & LANDSCAPE MITIGATION / ENHANCEMENT AREAS
- INDICATIVE COMBINED SOLAR ARRAYS / ECOLOGICAL AND LANDSCAPE ENHANANCEMENT AREAS

NOTES:
REVISIONS:
16/01/23 - BOUNDARY ALTERATION
24/01/23 - NATIONAL GRID SUBSTATION
25/01/23 - BATTERY ENERGY STORAGE SYSTEM

ZONING PLAN

TWEEN BRIDGE SOLAR

CLIENT
RWE

DATE	DRAWN	APPROVED	SCALE
25/01/2023	RL	HS	1:35,000@A3

SHEET	REVISION	DRAWING NUMBER
-	C	P21-3484_08_C

N

0 1 km

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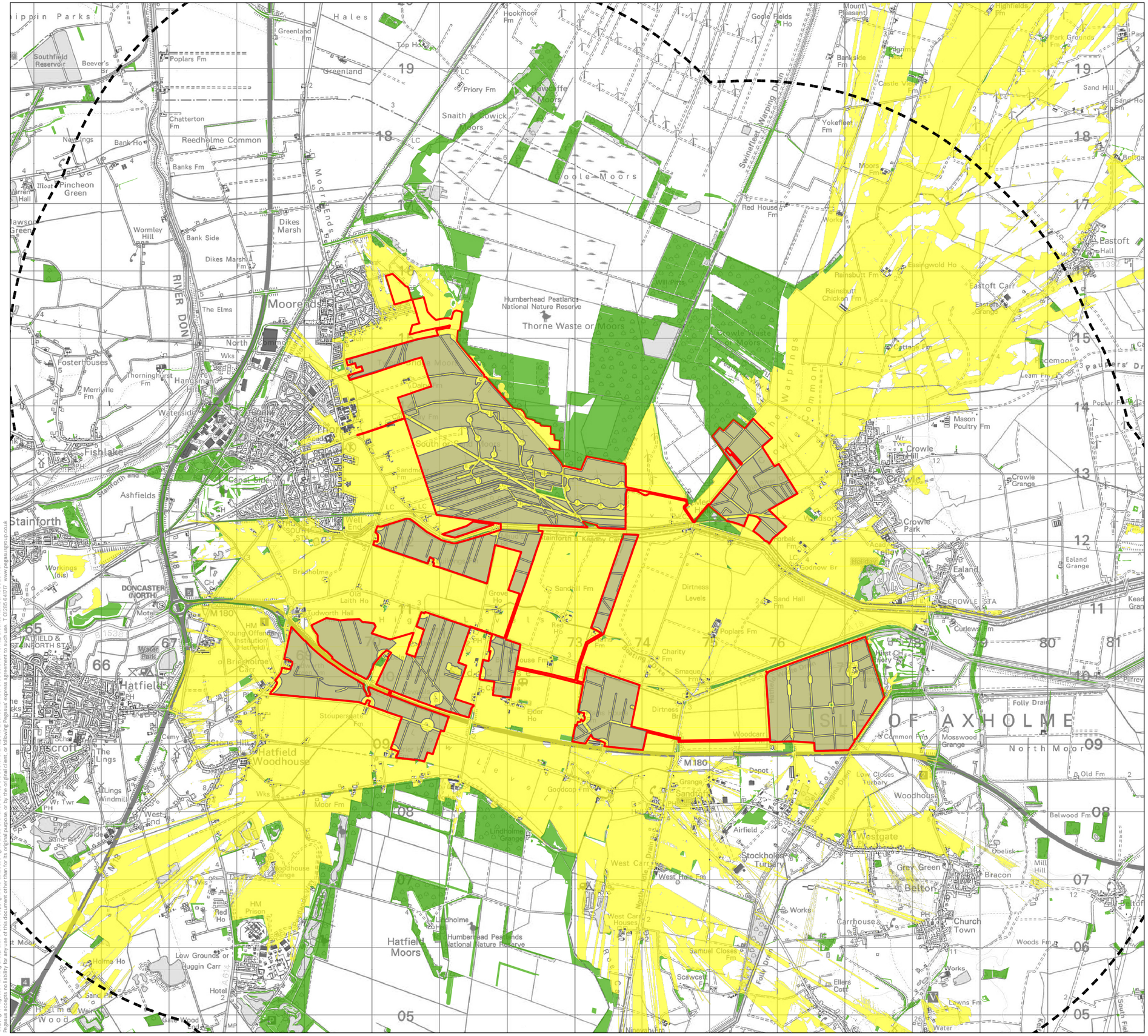
Appendix 4.1 – Landscape Screened Zone of Theoretical Visibility



KEY

- Site Boundary
- 5km Buffers
- Indicative Solar Works
- Zone of Theoretical Visibility – 3m Development Height
- OS Local Buildings
- OS Local Woodland

Screened ZTV Production Information -
- DTM data used in calculations is OS Terrain 5 that has been combined with OS Open Map Local data for woodland and buildings to create a Digital Surface Model (DSM).

- Indicative woodland and building heights are modelled at 15m and 8m respectively.
- Viewer height set at 1.7m (in accordance with para 6.11 of GLVIA Third Edition)
- Calculations include earth curvature and light refraction

N.B. This Zone of Theoretical Visibility (ZTV) image illustrates the theoretical extent of where the development may be visible from, assuming 100% atmospheric visibility, and includes the screening effect from vegetation and buildings, based on the assumptions stated above.

NOTES:
REVISIONS:

Screened Zone of Theoretical Visibility with Viewpoints – 3km

Tween Bridge Solar Farm

CLIENT
RWE

DATE	DRAWN	APPROVED	SCALE
13/01/2023	CR	HS	1:55,000@A3

SHEET	REVISION	DRAWING NUMBER
-	**A**	P21_3484_EN_012

N 0 2 km

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Appendix 5.1 – Ecology Significance of Effect Adopted Methodology

Tween Bridge Solar Farm

on behalf of RWE Renewables Limited

Appendix 5.1: Sensitivity, Magnitude and Significance of Effect Adopted Methodology

avianecology

Document Control				
Project Name:	Tween Bridge Solar Farm			
Project Number:	EnsoE-517-1435			
Report Title	Appendix 5.1: Sensitivity, Magnitude and Significance of Effect Adopted Methodology			
Issue	**Date**	**Notes**	**Prepared**	**Reviewed**
V1	04/01/2023	V1 Issue	B. Walker *MSc MCIEEM*	H. Fearn *MSc MCIEEM*

1 INTRODUCTION

1.1.1 This Technical Appendix[1] sets out the significance of effect assessment methodologies that will be adopted within the Environmental Statement (ES) Biodiversity chapter required to inform Tween Bridge Solar Farm ('the Proposed Development') application.

1.1.2 The Proposed Development comprises the proposed construction, operation and maintenance, and decommissioning of a renewable energy generating project on over 1500 hectares of land located to east of the town Thorne and west of the town Crowle ('the site'), within the administrative areas of Doncaster Council ('DC') and North Lincolnshire Council ('NLC').

2 ASSESSMENT OF SIGNIFICANCE

2.1.1 Ecological Impact Assessment (EcIA) is defined within the Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines[2] as

> *"…a process of identifying, quantifying and evaluating the potential effects of development-related or other proposed actions on habitats, species and ecosystems*".

2.1.2 The EIA Regulations[3] require the description of the 'likely significant environmental effects of the proposed development on the environment' (Regulation 18(3)(b)). To determine the overall significance of each ecological effect, judgements on the sensitivity of the receptor(s) and the magnitude of impact from the Proposed Development are considered together in order to determine whether or not an effect is likely to be significant. This involves a combination of quantitative and qualitative assessment and the application of professional judgement.

2.1.3 For the purposes of the assessment, effects will be categorised as 'significant' or 'not significant', in line with the EIA Regulations. The assessment considers effects at different geographic scales i.e. where effects may be discernible at a local scale but are not considered significant in the context of the EIA Regulations. For the purpose of the assessment, moderate and major effects are deemed to be 'significant' in EIA terms unless stated otherwise.

2.1.4 A 'significant effect' is considered to be one that either supports or undermines biodiversity conservation objectives for 'important ecological features', or for biodiversity in general.

2.1.5 CIEEM guidelines on ecological impact assessment note that:

> *"A significant effect does not necessarily equate to an effect so severe that consent for the project should be refused planning permission. For example, many projects with significant negative ecological effects can be lawfully permitted following EIA procedures."*

2.1.6 For ease of reference, **Table 2.1** sets out adapted CIEEM terminology, which also shows the equivalent EIA terms to be used in the ES Biodiversity Chapter.

[1] Technical Appendix 8.1 of the Helios Renewable Energy Project Environmental Impact Assessment Scoping Report

[2] CIEEM (2018) *Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine* (version 1.1). Chartered Institute of Ecology and Environmental Management, Winchester.

[3] Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (as amended).

Table 2.1: Summary of Significance Levels

Effect (Standard EIA-related terminology and associated assigned significance)		Equivalent CIEEM terminology adapted for Ecological Assessment
Negligible	**Neutral**	No discernible or significant on ecological integrity or conservation status (e.g. species or habitat).
Minor Adverse	**Not Significant**	Adverse effect on ecological integrity or conservation status, discernible/significant in ecological terms at a Local geographic scale only.
Moderate-Major Adverse	**Significant**	Adverse effect on ecological integrity or conservation status at a County, National or International geographic scale.

2.1.7 The Proposed Development has been assessed as having an operational lifespan of up to 40 years for the purpose of the assessment. Ecological effects will be described in terms of their duration as short, medium term and long-term as follows:

- Short term effects are defined as 0 - 3 years;
- Medium term effects are defined as 3 - 15 years; and
- Long term effects are defined as > 15 years

2.1.8 The ecological impact assessment will include:

- An evaluation of identified important ecological features and potential receptors; faunal species, habitats and vegetation (as appropriate) on an international, national and regional basis;
- A description and evaluation of the potential effects of the Proposed Development on statutory and non-statutory sites designated for nature conservation;
- A description and evaluation of the potential effects of the Proposed Development on species and habitats;
- Mitigation measures implemented to address any identified significant adverse effects;
- An assessment of cumulative effects;
- Identification of any residual effects after mitigation; and,
- Identification of opportunities for biodiversity enhancement.

2.1.9 For the purposes of the assessment the importance or sensitivity of an ecological feature will be considered within the context of a defined geographical area, ranging from International (high value) to Site (low/negligible), as detailed in **Table 2.2**.

Table 2.2: Value/Sensitivity Assessment

Value or Sensitivity of Receptor / Geographic Scale of Importance	Definition Examples
High - International / European	Greater than a UK scale, typically valued at a European level such as internationally designated sites (Special Protection Areas (SPA), Special Areas of Conservation (SAC) and/ or Ramsar sites) or proposed/candidate site (pSPA or cSAC), large area of a habitats listed in Annex I of the Habitats Directive or smaller areas of such habitat which are essential to maintain the viability of the larger whole, large population of an internationally important species or site supporting

Value or Sensitivity of Receptor / Geographic Scale of Importance	Definition Examples
	such a species (or supplying a critical element of their habitat requirement) or species listed in Annex IV of the Habitats Directive.
High - National (England/UK)	England/UK: A nationally designated site (e.g. Site of Special Scientific Interest) or a discrete area which meets the selection criteria for national designation. An area of a priority habitat listed under the Section 31 of the Natural Environment and Rural Communities Act 2006 (NERC) which constitutes a significant proportion of the resource of that habitat in England or the UK as a whole. A regularly occurring, regionally significant population of any nationally important species listed as a UK BAP / Biodiversity List and priority species listed under the Section 31 of the NERC Act 2006, and Species listed under Schedule 1 or Schedule 5 of the Wildlife and Countryside Act or Annex II or Annex IV of the Habitats Directive.
Medium Regional / County	Locally designated sites (Local Nature Reserves, County or Local Wildlife Sites). Areas of priority habitat which constitutes a significant proportion of the County's resource of that habitat. A regularly occurring, locally significant population of any nationally important species listed as a UK BAP / priority species and priority species listed under Section 31 of the NERC Act 2006, and Species listed under Schedule 5 of the Wildlife and Countryside Act or Annex II or Annex IV of the Habitats Directive.
Low - Local	Local area around the Site. For example areas of priority habitat which are not large enough to meet the criteria for County value, or small but sustainable populations of a protected or notable species.
Low/Negligible - Site	Within the Site. Features present but of value in relation to the Site only.

2.1.10 Effects on ecological features will be assessed based upon the interaction between the importance, or sensitivity, of the feature and the magnitude of change it is likely to experience. In accordance with the CIEEM guidelines (2018), an EcIA need only assess in detail, impacts upon important ecological features i.e. those that are considered important and potentially affected. It is not necessary to carry out detailed assessment of features that are sufficiently widespread, unthreatened and resilient to project impacts and will remain viable and sustainable. Where ecological features are not considered important enough to warrant further consideration, or where they will not be significantly affected, these are scoped out of the assessment process, and justification for exclusion is provided.

2.1.11 Relevant European, national and local guidance from governments and specialist organisations will be referred to in order to determine the importance (or 'sensitivity') of ecological features. Importance will also be determined using professional judgement and taking account of the results of baseline surveys and the functional role of features within the context of the geographical area.

2.1.12 Importance does not necessarily relate solely to the level of legal protection that a feature receives and ecological features may be important for a variety of reasons, such as their connectivity

to a designated site and the rarity of species or the geographical location of species relative to their known range.

2.1.13 Once identified, potential impacts are described making reference to the following characteristics as appropriate: positive or negative, extent, magnitude, duration, timing, frequency, and, reversibility. The judgements on magnitude may need to be adjusted (either up or down) to reflect the duration of the change (i.e. short, medium or long term) and whether it is potentially reversible. The assessment also identifies areas where no change is anticipated and the resulting effect is described as 'not discernible' or 'none'.

2.1.14 Ecological effects are described as far as possible and where available information allows in terms of the parameters detailed in **Table 2.3**.

2.1.15 Magnitude of effect, based on the effects that the Proposed Development would have upon the resource/receptor, is considered within the range of high, medium, low, negligible. Consideration is given to scale, duration of impact/effect (and extent of Proposed Development with reference to the definitions in **Table 2.2**). The assessment will consider how existing baseline conditions may change over time, as for example the baseline conditions could alter through operational land use, in the form of differing management and natural growth or succession of habitats.

Table 2.3: Environmental Parameters

Environmental Parameter	Description
Magnitude	The 'size' or amount of the effect is referred to as the magnitude and is determined on a quantitative basis where possible supported by professional judgement.
Extent	The area over which an effect occurs. The magnitude and extent of an effect may be synonymous
Duration	The time over which an effect is expected to last prior to the recovery or replacement of the ecological receptor. This can be considered in terms of life cycles of species or regeneration of habitats. The duration may be longer than the duration of an activity.
Reversibility	Reversible (or temporary) effects are those that occur during the lifetime of the development and where spontaneous recovery or mitigation allows recovery within a reasonable timescale. Permanent effects are those which cannot be recreated within the proposed development or there is no reasonable chance that actions can be undertaken to reverse it.
Timing and Frequency	The timing of effects in relation to important seasonal and/or life cycle constraints. The frequency with which activities and simultaneous effects would take place can be an important determinant.

2.1.16 The assessment of effects is based upon the assessments of magnitude of effects and sensitivity of the resource/receptor to come to a professional judgement of how important this effect is. The magnitude of change effected on ecological receptors is described as set out in **Table 2.4**. The likelihood or probability that an effect will occur is addressed as far as possible based on available information. Whilst it is reasonably straightforward to identify effects that are certain to occur, or conversely will not occur, it is generally more difficult to assign a quantified level to occurrences defined as likely, unlikely or highly unlikely. In these circumstances, professional judgement has been used, with reasoning supported by available evidence.

Table 2.4: Magnitude of Impact/Change

Magnitude	Criteria
High	The change may negatively or positively affect the conservation status of a site or species population, in terms of the coherence of its ecological structure and function, that sustains the habitat, complex of habitats and/or the population levels of species of interest.
Moderate	Conservation status of a site or species population will not be negatively or positively affected, but some element of the functioning of the site or population might be affected and the change to the site/ population is likely to be significant in terms of its ability to sustain some part of itself in the long term.
Low	Neither of the above applies, but some minor negative or positive change is evident on a temporary basis, or the change affects extent of habitat or individuals of a species abundant in the local area.
Negligible	No observable effect in either direction

2.1.17 For an effect to be significant, the ecological integrity or conservation status of a sensitive feature must be influenced in some way. It may be that the effect is substantial in magnitude or scale, irreversible, has a long-term effect, or coincides with a critical period in a species' life-cycle. Where uncertainty or limitations exist, this is acknowledged.

2.1.18 It is recognized that discernible effects can also occur at a local geographic scale which are not sufficiently severe to be assessed as 'significant' in accordance with the EIA approach, and do not require specific mitigation, but nonetheless merit discussion. In the interest of completeness these effects will be discussed within the ES Biodiversity Chapter in relation to general construction good practices to be adopted to avoid or minimise low-level or minor disruption to local features, including for example standard pollution prevention and control measures.

Appendix 7.1 – Ground Conditions Study Area

Intégrale
Understanding Ground Conditions

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Proposed Solar Energy Scheme
Land at Tween Bridge
Thorne, South Yorkshire

INITIAL PHASE I GROUND CONDITIONS DESK STUDY

REPORT NO. 22072 Vers. 2, January 2023

GEOLOGICAL • GEOTECHNICAL • ENVIRONMENTAL • ENGINEERING

Intégrale is a trading name of Integrale Limited
Registered Office: The Granary, Chewton Fields, Ston Easton,
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Initial Phase 1 Ground Conditions Desk Study
Land at Tween Bridge
Thorne, South Yorkshire

Client: RWE Renewables UK Limited

Intégrale Report No. 22072, Version 2, January 2023

		Signature/Date
Project Co-ordinator & Report Preparation:	Dr Kay Boreland	
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1.0 INTRODUCTION

1.1 General

RWE Renewables UK Limited are considering construction, operation, maintenance and decommissioning of a ground mounted solar photovoltaic electricity generating scheme with a maximum design capacity of up to 600MWp (megawatts peak) with associated development, on land between Thorne, South Yorkshire and Crowle, North Lincolnshire. Their planning consultants are Pegasus Planning Group.

Integrale Limited are commissioned to undertake an Initial Phase 1 Desk Study, concentrated on ground conditions, geotechnical and contamination aspects. The aim of the current initial report is to assist with preparation of the Environmental Impact Assessment (EIA) Scoping document.

This report therefore describes the geological setting, soils, groundwater, and preliminary historical and environmental data. An initial site visit has allowed outline assessment of the topography, drainage and access to inform the desk studies. The range of ground and groundwater conditions are anticipated and used to establish a conceptual model of potential pollutant linkages. Implications for the development are considered, recommendations for further desk study, assessment and investigation made, and preliminary comments made on contaminated land and geotechnical risk aspects.

This Initial Version 1 of the desk study accompanies the EIA Scoping report, and will be updated further at the next project stage.

1.2 Data Sources

The principal data sources used to inform this Initial Version 1 comprise mainly Open Government Licence data, including:

Multi-Agency Geographic Information for the Countryside (MAGIC) interactive map (available under Open Government Licence (OGL) on-line https://magic.defra.gov.uk) accessed November 2022.

British Geological Survey (BGS) GeoIndex Onshore for mapping and exploratory records (available under OGL on-line)
https://mapapps2.bgs.ac.uk/geoindex/home.html accessed November 2022

LandIS Soilscapes map for soils mapping and data (available on-line https://www.landis.org.uk/soilscapes accessed November 2022

Coal Authority Interactive map for mining information (available on-line
https://mapapps2.bgs.ac.uk/coalauthority/home.html accessed November 2022

South Yorkshire & North Lincolnshire Mineral Resources reports and plans (available on-line, accessed November 2022
https://www2.bgs.ac.uk/mineralsuk/download/england/southYorkshire.pdf
https://www2.bgs.ac.uk/mineralsuk/download/england/lincolnshireMap.pdf

National Library of Scotland for historical maps (available on-line https://maps.nls.uk accessed November 2022

LIDAR data files (available on-line Under OGL)
https://environment.data.gov.uk/DefraDataDownload/?Mode=survey
Accessed November 2022

2.0 THE SITE

2.1 Location and General Description

As shown in Appendix A, the study area is located to the east of Thorne and west of Crowle, bounded to the north by the Humberhead Peatlands National Nature Reserve, and to the south by Hatfield Moors and the Isle of Axholme. It has an approximate central Ordnance Survey Grid Reference of SE 73000 11000.

The study area includes a series of land parcels and link corridors shown bounded in red in the appendices. Where a red outline is given on drawings it is indicative of the Site and does not represent the Order Limits unless specifically annotated as such. Elsewhere in this report, for ease of study and comparison, the wider setting of these land parcels is illustrated by a rectangular zone approximately 10kms east-west by 10 kms north-south (between grid kilometre co-ordinates Easting 68000 to 78000 and grid Northing 8000 to 16000).

An initial reconnaissance visit was completed by Integrale Limited in early November 2022, and typical photographs are included in Appendix B, along with on-line Google Earth imagery. The main features and pertinent aspects on the Site and immediately adjacent land forming the study area can be summarised as:

Current Use	Predominantly large-scale agricultural fields with isolated farmsteads.
Site Area & Plan Shape	1100-1200 Hectares (11 - 12 km^2).
Maximum Dimensions	Very irregular but approximately 6.25 km N-S by 8.75 km E-W.
Ground Slopes & Topography	Lowland basin of former east flowing River Don and north flowing River Idle Low-lying between typically 1-4mAOD, with overall very low to negligible natural gradients. Lowest lying areas in southwest, northwest, centrally and to northeast at 0-2mAOD. Mid Elevations in south and northwest at 2-4mAOD Higher land occurs beyond the study area to the east (Crowle), southeast (Isle of Axholme), west (Thorne), and southwest (Hatfield) at >4 to 6mAOD.
Major Features & Infrastructure	Bounded to north by Humberhead Peatlands National Nature Reserve (Thorne Waste or Moors). Tween Bridge Wind Farm centrally in north with large-scale overhead pylons. Rail line, closely aligned with: Stainforth & Keadby Canal running east-west centrally. A18 road (High Levels Bank) east-west centrally. M180 motorway east-west in southern boundary area.
Surfacings & Condition Vegetation & Trees	Agricultural soils predominate, with occasional hedgerows and woodland.
Water Courses	Mapping shows numerous drainage ditches forming a rectilinear grid of linked water channels across complete study area. Larger water courses include (from north to south):

	Stainforth & Keadby Canal (Sheffield and South Yorkshire Navigation) with North and South Soak Drains parallel on either side. Boating Dyke Drain centrally, flowing into Old Dun/Don Drain, North Engine Drain and Wood Carr Drain. River Torne forming extreme southeast boundary of study area.

2.2 Areas & Land Parcels

For the purposes of the current report, various Areas have been defined based on their location and outline scheme proposals, referred to throughout the text as follows, along with Land Parcel Numbers where appropriate, and as shown in Appendix A:

Area 1. Old River Don

Northeast – to West of Crowle
Low lying – 1-3mAOD

Area 2. North Engine Drain to River Torne

Southeast – between A18 and M180 roads
Mid elevations – typically 2-4mAOD

Area 3. Plains Lane

Central South – between A18 and M180 roads
Low lying – 2-3mAOD

Area 4. Bletchers Drain

Central
Low lying – 2-3mAOD

Area 5. Elder Gates, High Levels

Central South
Low lying – 2-3mAOD

Area 6. Hatfield Chase

Southwest
Very low lying – 0-2mAOD

Area 7. Ferne Carrs

Southwest
Mid elevations – 2-3mAOD

Area 8. Clay Bank

Central west
Very low lying – 1-2mAOD

Area 9 Tween Bridge Wind Farm

Central north
Mid elevations – 2-4mAOD

Area 10. Tween Bridge Moors

Northwest
Low lying – 1-3mAOD

Area 11. Moorends

Extreme Northwest
Mid elevations – 2-4mAOD

Where link corridors for services are considered, these are referred to by adjacent land parcels, eg Area 1 Old River Don to Area 9 Tween Bridge Wind Farm.

2.3 Published Geology

2.3.1 British Geological Survey (BGS) Mapping

This area of the southern part of the Vale of York and the Humberhead Levels, is low-lying, low to very low relief ground underlain by thick stratified sequences of complex late Quaternary Period superficial deposits (Drift). It is defined by BGS as a Lowland Basin Domain.

It comprises the former courses of the Rivers Don and Idle, the initial channels of which were incised during low Quaternary sea levels, then infilled from the late Devensian, when glacial blockage of the Humber Gap occurred. This caused deposition of thick ponded (lake) deposits, sands and gravels, and infill sediments mapped historically as the '25 Foot Vale of York Drift'. Around 10,000 years ago at the end of the Devensian cold period, aeolian (wind blown) sands were deposited, followed by further river channel incision.

Those channels were then infilled during the Flandrian by Alluvium, which overlaps marginal Peat deposits. During historical times artificial river diversions (particularly of the meandering multi-channel Rivers Don, Idle and Torne) and redeposition of Alluvium as 'Warp' material have taken place.

Whilst the larger Lowland Basin Domain is typically dominated by glaciofluvial sand and gravel and glaciolacustrine clay and silt at depth, the current study area at surface is masked by wide spreads of the younger Flandrian Alluvium and marginal Peat. BGS geological maps indicate the following strata beneath and adjacent to the study area, as shown in Appendix C:

Map / Scale	Sheet 79 Goole and Sheet 88 Doncaster at 1:63,360 scale (Solid & Drift Sheets).	
BGS On-Line Viewer	BGS GeoIndex Maps Portal Accessed September – November 2022	
BGS Memoir	Geology of the Country around Goole, Doncaster and the Isle of Axholme, Memoir for one inch sheets 79 & 88 (England & Wales) British Geological Survey, 1994.	
Artificial Ground	None mapped in study area or immediately beyond (see below however) under Minerals. Warp soils are mapped in the east and northwest, which is historically artificially created Alluvium (see below)	
Superficial Deposits (Quaternary sequence)		Warp (Historically artificially induced Alluvium)
	Flandrian	Alluvium (Fluvial Clay & Floodplain Sands and Gravels) Peat (Lowland raised bog)
	Devensian	Blown Sand (Aeolian) Sutton Sand Formation River Terrace Deposits (Sands & Gravels) Breighton Sand Formation (formerly Sand of 25 Foot Drift of Vale of York*) Hemingbrough Glaciolacustrine Formation (Clays & Silts – formerly Silt and Clay of the 25 Foot Drift of Vale of York) Glacial Sand & Gravel (Fluvioglacial Sand & Gravel) (Concealed sand and gravel deposits of Gaunt 1976/2020) (Older River Sand & Gravel Beneath 25 Foot Drift)

Solid Geology	Triassic age Mercia Mudstone Group – Mudstones- beneath eastern Areas 1 & 2 (East of Easting 75000) Triassic age Chester Formation Sandstone - Gravelly Sandstone – beneath Areas 3-8 Inclusive (West of Easting 75000 and South of Northing 12000) Permo-Triassic age Sherwood Sandstone Group – Sandstone - beneath Areas 9-11 (West of Easting 75000 and North of Northing 12000)
Geological Features	Two geological faults inferred across Areas 1 & 2

* (The term 25 Foot Drift referred to the elevation restriction of this deposit, being largely confined to areas below 8mAOD).

The BGS Memoir for the district was compiled by G D Gaunt, along with other contributors. Much of the Quaternary section was based on data collected in preparation of his 1976 doctoral thesis on "The Quaternary Geology of the southern part of the Vale of York". This was published in 2020 by the Thorne & Hatfield Moors Conservation Forum, with the aim of making his primary data available, to aid interpretation of the Quaternary sequence. Much of the information below is based on both the Memoir and his thesis.

2.3.2 Flandrian Deposits and Thicknesses

Alluvium is a river deposited clay, silt, sand and gravel, sorted or semi-sorted in a water course or on a floodplain. It is generally soft to firm, compressible silty clay, but with silt, sand, peat and basal gravel. A somewhat firmer, desiccated surface zone or 'crust' may be present locally. The numerous rivers converging on the Humber Estuary have deposited wide spreads of Alluvium in the study area over the Holocene / Flandrian Quaternary period. This is typically less than 1-5m thick across the former floodplains of the Rivers Don and Idle, but where it infills those incised channels cut during the previous Devensian glacial period, can be in excess of 15m within the study area. The lower deposits are coarser basal gravels, becoming increasingly finer sands, overlain by silts, becoming clayey near surface.

2.3.3 Devensian Superficial Deposits and Thicknesses

Those Devensian age Superficial Deposits given above are described in the BGS rock lexicon as follows:

Sutton Sand Formation:
Fine-grained silty sand.
Upper Boundary: present land surface.
Lower Boundary: unconformable on older superficial deposits, mainly Devensian glacial lake deposits and glacial till or underlying bedrock.
Thickness: to about 7m.

Breighton Sand Formation: Dominantly yellow to pale brown and reddish yellow slightly clayey sand to silty sand with a variably developed very dusky red to black compressible peat to clayey sandy peat base. Typically composed of moderately well-sorted medium quartz grains with minor bands of finer, coarser or poorly sorted material, including finely comminuted flint and lithic clasts. Thin beds of clayey sandy peat and poorly developed fine to medium-grained slightly gravelly clayey sand are noted towards the base of the formation.
Upper Boundary: Typically exposed at surface beneath a thin (0.2 to 0.5m thick) sandy soil or locally overlain by alluvial and aeolian deposits.
Lower Boundary: Sharp to gradational (over several tens of cms) transition to underlying clay, silt or sand of the Hemingbrough Glaciolacustrine Formation, or directly to bedrock
Thickness: Average 1 to 2m, but can exceed 6m.

Hemingbrough Formation:
Unfossiliferous laminated clays, silts and sands with rare dropstones (typically fine-grained pale coloured sandstone, grey limestone and dark mudstone).
Upper Boundary: either the present land surface or overlain by later superficial deposits, commonly represented by sand deposits of the Breighton Sand Formation.
Lower Boundary: unconformable, resting directly on bedrock or underlain by basal glaciofluvial deposits.
Thickness: to 30m.

Inferred contours on the base of the Devensian deposits in the study area indicate the Flandrian infilled valleys, whilst typically 1-5m deep, extend in mid channel down to 15m+ below OD, and potentially locally 20-30m below OD. The more recent meandering channels of the Rivers Don and Idle have cut through this Flandrian Alluvium, also depositing deep channels of organic material, with slightly raised levees of silty clay built up during flood episodes. This sequence is critical to an assessment of shallow depth ground conditions across the southern parts of the study area, as discussed further below.

2.3.4 Historical Warp / Floodwarp

The BGS Memoir confirms that Warp is artificial improved soil created by historical 'floodwarping', or occasionally 'cartwarping', undertaken between the 1700's to mid 20th Century. It used the suspended silt and clay in rivers and reversal of flow during high tides. An area is embanked and a warping drain cut from it to the nearest river. Sluice gates at the river end of the drain are opened at high tide, allowing sediment-rich water to flood in and deposit silt. The water is let back slowly into the river at low tide.

Each flooding creates c. 2mm of deposit, and up to 300mm could be left in a single year. The thickest known floodwarp is 1.5m. The soil deposited is light, silty and well-drained. It is recognisable by laminations below plough level, pre-existing soil beneath, traces of old embankments, differences in field levels or documentary evidence.

Cartwarping is manual spreading of silt or clay carried on carts on rails. Small areas are shown in the Memoir (Figure 46) within Area 1 at approximately SE 755 135.

2.3.5 Mapped Surface Strata by Area

The published geological strata mapped at surface for each Area are as follows:

Area 1. Old River Don

Flandrian Alluvium in south and centre. Northwest of Moorbottom Drain is Warp (artificially induced Alluvium created by Floodwarping and Cartwarping*)
Marginal Peat to northwest (Land Parcels 26, 42, 62, 68, 163) south of Moorbottom Drain

Area 2. North Engine Drain to River Torne

Sutton Sand Formation.
Marginal Peat on northern, western and southern peripheries (Land Parcels 123-5, 127,132-3,135-6).
Small pocket of Alluvium and peat in central north (Land Parcel 124-5 boundary)

Area 3. Plains Lane

Flandrian Alluvium.
Peat in southeast (Land Parcel 113)
Sutton Sand Formation alongside M180 (southern half of Land Parcel 113)

Area 4. Bletchers Drain

Flandrian Alluvium in south and centre (Land Parcels 98-101).
Sutton Sand Formation in northern third (Land Parcel 94).
Peat on north boundary with South Soak Drain and Canal (Land Parcel 92)

Area 5. Elder Gates, High Levels

Flandrian Alluvium (Land Parcels 103-105, 107, 137-39)

Area 6. Hatfield Chase

Flandrian Alluvium (Land Parcels 102, 108-11, 140, 152, 154-161)

Area 7. Ferne Carrs

7a) River Terrace Deposits in west (part Field 151) Breighton Sand Formation with channels of Peat in south (part Land Parcels 149, 151) Glaciofluvial Sand and Gravel in north (west Land Parcel 153) Sutton Sand and Flandrian Alluvium (east Land Parcel 153)
7b) Flandrian Alluvium north of Low Levels Bank (Land Parcels 142, 145, 146, 148) Sutton Sand Formation south of Low Levels Bank (Land Parcels 143, 144, 147) Peat in extreme southeast alongside Crow Trees Moor Drain (part Land Parcel 147)

Area 8. Clay Bank

Hemingbrough Glaciolacustrine Formation in west (Land Parcels 81-2,85-6,95) with pockets Sutton Sand Formation Flandrian Alluvium in east (Land Parcels 89-91, 93,95,97)

Area 9 Tween Bridge Wind Farm

Warp east of centre (Land Parcels 28, 47, 80, 122) Peat on west periphery (Land Parcels 28, 45,69,122)

Area 10. Tween Bridge Moors

Hemingbrough Glaciolacustrine Formation Peat in southwest and east (Land Parcels 55, 59, 63-4, 67, 70, 75-6, 84) Sutton Sand Formation to south (Land Parcels 70, 72, 77, 84)

Area 11. Moorends

Warp Peat in south (part Land Parcels 4-6)

2.4 Soils Information

Data available on the LandIS Soilscapes Viewer is summarised in Appendix D and indicates:

Area 1. Old River Don

Typically Soilscape 20: loamy and clayey floodplain soils with naturally high groundwater, draining to the groundwater and rivers. (The northwestern and northern parts overlap with Natural England mapped peat) **Northwest of Moorbottom Drain Soilscape 21:** loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches. (Superficial Floodwarp alluvial soils)

Area 2. North Engine Drain to River Torne

Typically Soilscape 15: naturally wet, very acid sandy and loamy soils, draining to the shallow groundwater table. Subject to wind erosion when dry and to rapid leaching. Winter working leads to damaged soil structure and compaction. **Northern and northwestern area Soilscape 23:** loamy and sandy soils with naturally high groundwater and a peaty surface. (Overlaps with Natural England mapped peat).

Area 3. Plains Lane

Typically Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Extreme southeast includes small areas of Soilscape 15 and 23, and Natural England mapped peat.

Area 4. Bletchers Drain

Southern half Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Northern half Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches.

Area 5. Elder Gates, High Levels

Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Area 6. Hatfield Chase

Typically Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Northern area of western half Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches.

Area 7. Ferne Carrs

Typically Soilscape 15: naturally wet, very acid sandy and loamy soils, draining to the shallow groundwater table. Subject to wind erosion when dry and to rapid leaching. Winter working leads to damaged soil structure and compaction. (Narrow channels of peat mapped by Natural England in western area)

Peripheral northern area adjacent motorway: Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Area 8. Clay Bank

Typically Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches.

Western third Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Area 9 Tween Bridge Wind Farm

Soilscape 20: loamy and clayey floodplain soils with naturally high groundwater, draining to the groundwater and rivers. (Western periphery overlaps with Natural England mapped peat).

Area 10. Tween Bridge Moors

Typically Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

Southern area Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches. (Includes southwestern and southeastern areas with Natural England mapped peat).

Area 11. Moor Ends

Typically Soilscape 21: loamy and clayey soils of coastal flats with naturally high groundwater. Drains to local groundwater so risk of pollution including marginal ditches.

Southern periphery Soilscape 18: slowly permeable, seasonally wet, slightly acid but base rich, loamy and clayey soils. Impeded drainage to streams network. Risk of poached fields and damage to soil structure so timeliness of fieldwork important due to wet conditions.

It can therefore be seen that the majority of soils are loamy and clayey, which either help maintain a naturally high groundwater table, and drain into ditches and streams, or they are only slowly permeable and seasonally wet with more impeded drainage to the ditches and streams. Several areas are mapped separately by Natural England as peat, but none of the land parcels being considered include Soilscapes classed as bog peat soils.

These soils can be prone to damage to soil structure or consolidation when worked, particularly during wet periods; this is highlighted for Soilscape 18, where timeliness of fieldwork is noted as important. Where drainage is into surrounding ditches, there is a risk of pollution to these water courses.

2.5 Past Mining, Quarrying and Peat Deposit Workings

2.5.1 Coal

The Coal Authority (CA) interactive map has been consulted, which indicates the majority of the study area is within the Coal Reporting Area (the known extent of coal mining activity used to determine whether a coal mining report is required for property transactions and the conveyance process). The boundary crosses the southeast, such that Area 2 lies outside it.

None of the study area lies within the Development High Risk Area, with the exception of two former shafts at Thorne Colliery, to the immediate northeast of Area 11. The Development High Risk Area is the part of the coal mining reporting area which contains one or more recorded coal mining related features which have the potential for instability or a degree of risk to the surface from the legacy of coal mining operations.

Thorne Colliery was open between 1925 and 1958 but operational issues including shaft water, caused the pit to be non-productive for much of its lifespan. Production ended in 1958 due to geological problems. There were two shafts, referred to by BGS as 470415-001 and -002, and shown in Appendix E. Such mine entries pose a risk due to their potential Zone of Influence, albeit both shafts appear to be capped. The Zone of Influence of these shafts can be calculated using a departure value of 10m to account for inaccuracy of recording position, the depth to rockhead and the entry radius. This calculates at <40m. Since the actual distance to the boundary of Area 11 of the current study area is c. 150m, this is not considered significant.

The shafts and colliery site were redeveloped as the Thorne solar farm in 2015; Google Earth imagery indicates the former shafts apparently concrete capped and surrounded by solar arrays.

BGS records of the shaft bores indicates rockhead at 20 and 27m depth and base of the Trias/top of Carboniferous at c. 280m depth.

2.5.2 Peat Deposits & Workings

Thick peat deposits occur to the south on Hatfield Moor and to the north on Thorne Moors, being exploited for many years, by both block cutting and more recently surface milling.

The deposits are the remains of raised bog, extending beyond the designated conservation moorland, such that they occur beneath parts of the study area, as shown in Appendix D. The peat lies both within and beneath the Alluvium, in areas flanking the deep incised river courses, in particular due to poor drainage and waterlogging in the late Flandrian period.

The BGS Memoir reports that Thorne Moor was formerly more extensive in area before peat cutting in the west and southwest, and floodwarping northeast, east and south. Original estimated thicknesses of 6m have been reduced by workings to around 3m, and some areas are flooded. **However peat cropping out between Crowle and Sandtoft has not been proven to more than 0.7m depth, despite a significant lateral extent.** Although there is locally thick Alluvium on Hatfield Chase, which is peaty at depth, BGS state there is little evidence of true concealed peat. This should apply to those parts of Areas 1, 2, 9 and 10 where peat is mapped either by BGS, or Natural England (Appendix D).

Gaunt (2020) also reported that *"…According to historical accounts, peat formerly extended across Tween Bridge Moors and South or Sand Moors, but has been complete worked off". On Nun Moors* (Area 10*) sandy peat up to 0.5m thick is sporadic* (Land Parcels 55,59,64,67)*….variably sandy and peaty clay over a metre thick in parts skirts the north edge of Hatfield Chase and the old course of the south branch of the River Don west of Crowle ..*" (parts of Areas 1 and 2).

Irregular peat outcrops between Thorne Moors and Hatfield Chase, thin out against the underlying Hemingbrough silts and clays or Blown Sutton Sand, or pass under floodwarp or natural alluvium of the old River Don.

Gaunt postulated that the peat formation was not simply due to high rainfall (as this area has a relatively lower rainfall for northern England) but also the low elevation, relative sea levels, and resulting high groundwater table. He considered that ground saturation in the lowest areas, initiated growth of peat, which then isolated the surface from base rock or subsoil nutrients. As this developed into raised bog above the water table, it becomes more dependent on rainfall.

2.5.3 Historical Mapping Evidence for Non-Coal Mining & Quarrying

Historical maps are discussed in more detail below. There is occasional evidence for small scale near surface workings where sand or sand and gravel deposits occur at the surface.

2.5.4 Humberside & South Yorkshire Minerals Resources (2006)

The Humberside and South Yorkshire Minerals Resources maps and reports obtained from the BGS website (extracts of which are included in Appendix E) indicate the following within the study area:

- Thorne Moors Peat areas are active workings, and nature conservation zones;
- A roughly triangular area at Tudworth Field Road (Area 7a, mainly Land Parcel 153) in glaciofluvial deposits was likely worked for sand and gravel but is now mapped as inactive. (This shows on Lidar imagery as lower lying than surroundings;
- The Crowle Brickworks (now lakes north of the Canal and Area 2) was worked in clay and shale and is inactive.

2.5.5 Hatfield Moors Gasfield

The Hatfield Moors Gasfields are located c. 2.5-3kms south of the southern Site boundary, and will be considered in more detail in the full Phase 1 Desk Study.

2.6 Outline History

2.6.1 Drainage and River Diversions

This low-lying district has been subject to ongoing artificial changes to the natural drainage pattern for centuries, if not longer, as widely reported in the literature. It is crossed by numerous drainage ditches forming a rectilinear grid of linked water channels. Larger water courses include (from north to south) the Stainforth & Keadby Canal (Sheffield and South Yorkshire Navigation) with the North and South Soak Drains parallel on either side; the Boating Dyke Drain centrally, flowing into the Old Dun/Don Drain, North Engine Drain and Wood Carr Drain; the River Torne forming the extreme southeast boundary of Area 2 and the study area.

Gaunt (2020) states that *".. in view of this vast drainage hinterland…. These rivers have to be contained within artificially elevated embankments to preclude flooding. Much of the drainage of the lowland itself is facilitated by artificial dikes, some of these going back to early medieval times; some appear to be of pre-Norman age and may be of Roman origin".*

The process of warping to produce better drained and elevated light soils for agriculture has been described in Section 2.3.3 above.

Major diversions of large rivers, cutting of additional drainage ditches and dykes, and minor improvements to drainage of individual fields to control flooding and run-off have been a pre-requisite for historical and current agriculture. These may date from the Roman period onwards, but the most substantial programme was undertaken in 1625-7 by Vermuyden. This included stopping up that part of the River Idle which previously flowed north to meet the River Don just south of Area 3. The River Don previously had (at least) two channels flowing east across Hatfield Chase and west of Crowle, but was stopped up at Thorne and channelled north instead. The New River Torne artificial channel now forms the southeast boundary.

Evidence of the former courses survives as topographic features identified in Lidar imagery, as discussed in Section 2.7, and in the deep channels proven in some boreholes (e.g. see Section 4.1, Areas 1, 2 and 6).

2.6.2 Historical Mapping

Historical maps provided on the National Library of Scotland website have been studied at this stage. Features pertinent to geological, geotechnical and contaminated land aspects will be shown as a summary plan in the full Phase 1 study (Appendix F). The maps studied to date indicate:

Area 1. Old River Don

Floodplain with peats in northwest and north. Floodwarp area northwest of Moorbottom Drain. The channel of the former River Don crosses mid south to northeast. A few additional ditches, and field boundaries from current day. Main drainage and ditches flow southwest to northeast, with rectilinear subsidiary drains

Peat Works at Medge Hall adjacent Area 1 to Area 9 link corridor from 1900's. Peat Works c. 250m northeast at Moor Middle Drain (on Peatlands Way).

Gas Works on western outskirts of Crowle approximately 500m east, from 1850's to early 20th Century (removed by mid century). Brickworks (clay pits) 300m southeast at Godnow Bridge marked as 'old' 1904.

Area 2. North Engine Drain to River Torne

West of Hirst Priory (now golf course). Large square field pattern with north-south and east-west drainage ditches. Small pond west of Belton Grange in 1850's removed by 1900.

An on-line Unexploded Ordnance risk search has identified a WWII Decoy Site at SE 76000 10000, although no evidence of this can be seen on current satellite imagery, Lidar, or the historical maps.

Western boundary Cataline drainage course, linked further south into Hatfield Waste Drain.

Area 3. Plains Lane

Crossed by meandering former course of River Don (likely a peaty clay-filled channel) Extreme southeast includes small areas of mapped peat. Small sand pit mapped c. 400m south in 1880's.

Area 4. Bletchers Drain

Additional field boundary shown centrally on 1904 mapping. Length of cutting slope parallel to southwest boundary on 1904 and 1948 maps.

Area 5. Elder Gates, High Levels

Length of the meandering course of former River Don close to southern boundary

Area 6. Hatfield Chase

Crossed by meandering course of former River Don (likely a peaty clay filled channel). Old buildings on 1850's map alongside river course later removed. Old Tudworth Fields Road forms south west boundary with higher land of Tudworth Hill.

Area 7. Ferne Carrs

Former pit south of motorway at Tudworth Field Road (Field 153 east) likely to have worked sands and gravels. Not shown on historical maps to mid 20th Century?

Area 8. Clay Bank

Drained by parallel north-south ditches into Canal

Area 9 Tween Bridge Wind Farm

No evidence of specific peat workings on mapping although western area mapped as peat

Area 10. Tween Bridge Moors

Elmhirst Plantation (woodland) and Cottage in northern area replaced by current Pumping Station

Area 11. Moorends

Thorne Colliery (1925-56) off-site mapped on 1930's and 1950's sheets, with extensive spoil mounds southeast to Thorne Moors fed by tramlines. One further tramway curved across Pighill Moors (Land Parcels 2 & 3) to north of current day allotments.

2.6.3 World War II airfields and UXO Risk

Two World War II airfields were located outside the study area. RAF Lindholme (Hatfield Woodhouse) was located c. 4m miles south of Thorne, east of the A614, with Bomber Command, training, and radar functions. It was later used as a gliding club and by 1985 became HM Prison Lindholme.

RAF Sandtoft was a satellite airfield to Lindholme and closed in 1945. It is now in commercial use for vehicle storage and a flying club, with Trolleybus Museum also on the site. The complete RAF station site is south of the M180.

According to the on-line Zetica unexploded ordnance (UXO) risk map the complete study area is Low Risk for UXO. A World War ii decoy site was located in Area 2 (see Section 2.6.2 above).

Anecdotal evidence of air crashes during WWII indicates several crashes associated with these airfields and operations, including a Lancaster referenced elsewhere.

It will be necessary to obtain a detailed UXO risk report for the individual land parcels and link corridors within the wider study area.

2.7 Lidar Imagery

Initial study of Digital Terrain Modelling (DTM) and LIDAR data has been undertaken to confirm the overall topography and occurrence of former river courses at this stage. Further detailed assessment for each land parcel will be completed within the full Phase 1 reporting.

The imagery included in Appendix G at this stage has been manipulated to indicate the extent of former drainage courses, including the Rivers Don and Idle across the southern area. **The main southerly course of the River Don formerly crossed Area 1 Old River Don, Area 3 Plains Lane, and Area 6 Hatfield Chase. Its earlier courses can be seen crossing the east side of Area 8 Clay Bank Field Parcels 90 & 97, and Area 4 Bletchers Drain Field Parcels 94 & 98.**

Further study of this aspect and the implications for anticipated ground conditions will be completed for the full Phase 1 Desk Study, in order to design appropriate ground investigation in these areas.

2.8 Hydrogeology & Groundwater Vulnerability

BGS hydrogeological and groundwater data available on-line is summarised in Appendix H and confirms:

The western and central area is underlain by Sherwood Sandstone bedrock at depth, which has a regional geological dip eastwards. This forms a Principal Aquifer of good quality water supply, which becomes more saline eastwards from Crowle Moors and Medge Hall, as it is confined beneath increasingly thick overlying Mercia Mudstone bedrock. Contouring on the estimated potentiometric (pressure) surface within the Sherwood Sandstone indicates 0mOD crossing the study area centrally.

Within the superficial drift deposits, the Alluvium, Warp and Sands and Gravels form a Secondary A Aquifer. Small supplies are reportedly obtained where the Alluvium is in hydraulic continuity with a river. Where sand and gravel are in hydraulic continuity with a river yields can be induced.

Those areas of Thorne Moors and Area 2 where peat occurs, and the large area of Hemingbrough Formation across Tween Bridge Moors are Unproductive as an aquifer, as the silts and clays are largely impermeable laminated lacustrine deposits.

The majority of the study area is of Medium Groundwater Vulnerability to pollution, whereas the peat within Area 2, and Tween Bridge Moors Area 10 south to Area 8 Clay Bank, and parts of Area 1 are of Low groundwater vulnerability.

From the above data, the geological information given above and topographic maps, the following can be anticipated:

Aquifer Type	Secondary A in permeable horizons of Warp and Alluvium superficial deposits. Unproductive Strata formed by peat and Hemingbrough Formation silt/clays Bedrock Principal Aquifer in Sherwood Sandstone at depth
Hierarchy of Surface Water Courses and Flow Direction	Main Rivers, large engineered or maintained drainage or natural courses eg North Engine Drain, Cataline Drain, Boating Dyke. Several metres deep and wide, may maintain groundwater level immediately adjacent at c. 2m below Ground Level (GL) and 1-2m below in winter, unless flood conditions. Intermediate engineered and maintained drains eg North and South Soak Drains, Boating Dyke. Between 2-4m wide and deep, may maintain groundwater level immediately adjacent at c. 2m summer and 1-1.5m below GL in winter, unless flood conditions.

	Minor Ditches variably maintained between fields, typically rectilinear pattern. Between 2-3m wide and deep and variably high or low level in spring-autumn. Probably near bank full in winter, unless flood conditions. Act as run-off catchment and only locally effective in lowering groundwater table immediately alongside.
Shallow Soils Permeability	Slowly permeable where intergranular flow possible, or relatively impermeable and seasonally wet within peaty or clayey soils, ie soils at or close to field capacity in worst winter periods.
Anticipated Groundwater Table Depth	Within 1-10m distance of drainage ditches, groundwater may be maintained at 1-2m below GL much of year and 0.5-1m below GL in winter. More remote than 8-10m probably between 0.5-2m below GL most of year in most areas. In some areas groundwater will stand at less than 0.5m below GL in winter, or at field capacity ie at ground surface in worst periods.
Anticipated Groundwater Flow Direction	Rectilinear drainage pattern controls, and little or no flow locally, but overall flow west to east across study area.
Hydraulic Continuity of Groundwater and Water Courses	Likely throughout site.

The overall groundwater level and flow pattern will be controlled by local factors such as backfilled old drainage channels, former river courses, historical features such as meers and artificial lakes. The zone of capillarity will also be dependent on soil types.

2.9 Environmental Information

No formal environmental data reports have been obtained for this large agricultural study area at the time of writing. However, the following additional pertinent information has been obtained on-line and from the various data sources given in Section 1 and 2.

Radon Gas	Most of area requires no radon protection for enclosed structures and buildings. Extreme eastern parts of Area 2 mapped in Indicative Atlas of Radon as elevated radon potential, maximum 1-3% of properties.
Known Landfills / Waste Management / Transfer Sites within study area	Historic Landfills at: Tudworth Hall Farm licenced 1996. Grid Ref. 469214 410949 Tudworth Landfill licenced 1993-2017 Grantham Bros Ltd, Grid Ref 468572 410554 Brickworks, King Edward Road, Thorne Grid Ref. 469293 414067
Source Protection Zones	Area of Sherwood Sandstone Principal Aquifer (as shown in Appendix H) is within EA Source Protection Zones (Merged) as Zone 3 (area around a supply source). Source /Abstraction protection site at Pumping Station at Sandtofts Road & A18 Junction
Flood Risk	Much of area at Low-Medium risk of surface water flooding, occasional small areas at High risk. All within Flood Zone 2, much within Flood Zone 3. Areas benefitting from Flood Defences limited to north of Canal. Flood defences along Canal, River Torne, Cataline & North Engine Drain (Main Rivers)

2.10 Conceptual Exposure Model

This section draws together desk study information, outlines an initial conceptual exposure model, and provides a qualitative assessment of potential contamination via a source-pathway-receptor framework for the proposed redevelopment.

2.10.1 Proposed Development

The scheme is likely to include the following key works:

- Arrays of ground mounted solar panels
- Underground cabling (open trench and directional drilling)
- Substation building(s) and Compound(s)
- Battery Energy Storage System
- Fencing and Security Measures
- Access Tracks and Construction of new accesses onto the highway
- Formation of ecological areas / corridors
- Temporary construction and decommissioning compound.

The arrays will be laid out in parallel rows running east to west across the field enclosures. The mounting structure and solar panels will be static. The distance between the arrays would respond to topography and typically be between 3.5 metres to 6 metres.

The insulated electrical cabling from each array will be concealed through shallow trenches linking the solar panels to the inverters and transformers and then to the main substation. The cable trench will typically be between 0.5m to 1.1m in depth and up to 1.0m wide. The cable trench may also carry earthing and communications cables and be backfilled with fine sands and excavated materials to original ground level.

The inverters, transformers and associated switch gear to convert DC energy into AC energy, will be located across the solar modules area, assumed typically on a permeable gravel bed. The AC cable will also be laid in trenches, running direct to the main substation compound.

Underground cables will connect the various land parcels via trenches. Crossing points at the canal, major infrastructure (road or rail) will require directional drilling. It is being determined if all the onsite cables can be laid underground or if some sections will need to be above ground.

2.10.2 Potential Sources of Contamination

The initial desk study has been used to identify the likely remnant contaminant sources and distribution. The potential current and historical on- and off-site sources and the contaminants associated with these, derived using CLR8 Potential Contaminants for the Assessment of Land, and through experience of industrial land uses, are detailed below.

Potential Contaminants Associated with On-Site Sources			
Description	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Ground Gases & Vapours
Localised small sand/gravel/clay/ peat pits, if backfilled	Range of metals possible, given age	Unlikely given age of likely backfilling	Unlikely given age of likely backfilling
Tudworth Sand/Gravel Workings, if backfilled	Range of contaminants possible	Range of contaminants possible	Dependent on backfill

Recent Agricultural Use & Maintenance	Unlikely significant given usage and historical development, and degradation cycle of agricultural fertilizers & chemicals

Potential Relevant Contaminants Associated with Off-Site Sources			
Description	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Ground Gases & Vapours
Sand/Gravel /Peat Workings, if backfilled	Range of contaminants possible, although unlikely mobile in site direction	Range of contaminants possible, although unlikely mobile in site direction	Unlikely given distance, topography and ground conditions
Electricity Substations and overhead cables/pylons infrastructure	Unlikely to impact at significant level		
Canal, railway and roads infrastructure	Unlikely to impact at significant level, but air borne particulates at surface possible		

The potential relevant contamination sources are therefore currently considered to be limited to backfill soils within any localised pits, and air borne derived particulates from the roads and railway remaining within shallow depth site topsoil.

2.10.3 Potential Receptors

A future solar scheme end use and known neighbouring agricultural land uses have been used to develop an understanding of the likely sensitive human receptors. In view of the very limited ground intrusion needed to install the panels, the shallow depth of any service runs, access track/roadways, and the limited areas for substations, it is envisaged that potential receptors to contamination (if present within the soils on-site, or via migration from adjacent sites) are limited to:

- Construction Workers during installation or maintenance. The most critical receptor would therefore be a adult goundworker.
- Future maintenance staff.

Information gathered during the site research has been used to develop an understanding of the likely sensitive controlled waters receptors. These are considered to be the drainage ditches and water courses, and the groundwater within the Secondary A aquifer. (Given the anticipated depth to the Principal Aquifer in the bedrock, this is discounted).

2.10.4 Potential Pathways

The presence of superficial deposits beneath both the Site and adjacent areas creates a direct potential pathway for cross-migration of ground gases, leachate or mobile contaminants. The presence of drainage water courses indicates a potential pathway for leachate or other mobile contaminants within the site to locally impact on water receptors.

To develop further an understanding of the potential risks posed by contaminants to human receptors, the pathways through which contaminants may impact sensitive receptors need to be identified. Potential exposure routes for assessing risks to human health for a solar array use can be limited to:

- Dermal exposure if contaminated soil exposed during groundworks (currently assumed only likely to apply to former aggregate workings/landill in southwest);
- Inhalation of particulates if contaminated soil exposed during groundworks.

It is considered that the potential pathways with respect to controlled waters will be limited to:

- Lateral migration of groundwater or leachate to surface water drainage ditches or courses during construction.
- Surface run-off to water courses if uncontrolled drainage allowed.

2.10.5 Conceptual Site Model with Respect to Human Health

The conceptual site model indicates the following potential source-pathway-receptor linkages:

SOURCE		PATHWAY		RECEPTOR
Contaminated soils	→	Dermal exposure (if exposed during groundworks).	→	On-site construction worker.
Contaminated soils	→	Outdoor inhalation of soil dust/particulates.	→	On-site construction worker.

The construction of foundations for the solar arrays typically comprises driving a short pre-formed steel pin into the ground, without production of spoil, or installation of a small diameter 'foot-pad' to support the steel legs. In view of the very limited groundworks required, and the minimal interaction with existing soils, it is considered that the actual risk to groundworkers, should contaminated soils be present within the topsoil and subsoil, is negligible for the majority of the Site. Further clarification of infilled workings and pits in the southwest is needed.

2.10.6 Conceptual Site Model with Respect to Controlled Waters

The conceptual site model has been developed, based upon the following potential source-pathway-receptor linkages:

SOURCE		**PATHWAY**		**RECEPTOR**
Contaminated soils (if present within construction depth)	→	Leaching from soils or migration of liquid contaminants through the unsaturated zone by means of new man-made or natural pathways	→	Surface Water Courses & Groundwater
Contaminated soils (if present within construction depth)	→	Run-off from disturbed surface soils	→	Surface Water Courses

The very limited groundworks required to install the solar arrays is considered to have negligible potential to cause or increase leaching, should any contaminated soils be present within the shallow depth of penetration. Further clarification is required at locations of substations, transformers, inverters or switch gear etc.

Run-off during construction works will need to be controlled and managed, as is standard practice. During future use, run-off is unlikely due to the predominant topsoil and turf cover, but requires consideration.

3.0 ANTICIPATED GROUND & GROUNDWATER CONDITIONS

3.1 Anticipated Strata

As described above, previous investigation records are available on the BGS GeoIndex under the Open Government Licence. Those pertinent boreholes or trial pits on or immediately surrounding the study area are included in Appendix C. The BGS modelled thickness of the buried valleys in the study area is typically 10-20m, with an area of 20-30m thickness within Areas 8, 9 10 and potentially 4.

As stated in Section 2, the late GD Gaunt's 1976 doctoral thesis on "The Quaternary Geology of the southern part of the Vale of York" was published in 2020 by the Thorne & Hatfield Moors Conservation Forum, with the aim of making his primary data available, to aid interpretation of the Quaternary sequence. Many of his original fieldwork and mapping sites were within the current study area, and the data is invaluable for interpreting the published investigation records and achieving an overall understanding of the stratigraphy. Details given in this seminal publication are therefore described or referenced below, largely as direct quotations in italics.

Finally, recent LIDAR imagery has been used to confirm the occurrence, elevations and topography of various features, in particular former drainage courses, but requires further study, as described above.

To anticipate the ground and groundwater conditions for each Area, the combined findings are summarised below, with tentative interpretations of the strata given in Capitals. The terminology of Gaunt (2020) for 'Concealed sand or sand and gravel' deposits beneath the 25 Foot Drift has been adopted.

Area 1. Old River Don

Near Surface: Flandrian Alluvium Marginal Peat to its northwest (Land Parcels 26, 42, 62, 68, 163) Warp Soils northwest of Moor Bottom Drain (Land Parcels 166-169)

Ground conditions based on the sparse boreholes beyond the Area could be:

Depth (m)	Description
GL to 0.3/1.0	TOPSOIL / SUBSOIL (peaty, loamy and clayey)
0.3/1.0 to 1.0/2.5	Very soft organic alluvial Clay/Silt
0.3/1.0 to 1.5/9.5	Very soft or soft clayey Peat and Peat
1.5/9.5 to 5.0/12.0	Soft organic alluvial Clay/Silt or firm clayey sandy Silt (FLANDRIAN ALLUVIUM & PEAT)
5.0/12.0 to 10.0/12.0	Loose becoming medium dense laminated clayey sandy Silt or firm Silt/Clay, gravelly in parts SPT N = 7/8 at top (HEMINGBROUGH FORMATION?)
Below 10/12.0+	Medium dense or dense red brown clayey SAND to very weak SANDSTONE/MUDSTONE (TRIASSIC MERCIA MUDSTONE GROUP)

Groundwater was typically struck and stood at between 1.5-3.5m depth.

The northwestern Land Parcels 166-169 are overlaid by Warp soils, typically laminated silts and clays, and very likely to overlie Peat deposits. Gaunt (2020) reports that *"…variably sandy and peaty clay over a metre thick in parts skirts the north edge of Hatfield Chase and the old course of the south branch of the River Don west of Crowle"*. (Assumed as that mapped beneath Land Parcels 26,42,62,68,163). He describes warp soils here

as pale brown silty clay up to 0.8m thick, resting on natural alluvial grey clay and peat. The Floodwarp was deposited between approximately 1850-1880 from an extension of Swinefleet Warping Drain.

There is no current information on the former River Don course other than its surface expression seen on Lidar and historical mapping boundary evidence. However further north the channel reportedly extends to more than 15m below OD, filled with peaty clay, silt and sand.

Gaunt (2020) in discussing the lower sand division of the Hemingbrough Formation (25 Foot Drift) concealed in this area, records a single borehole *"…on the southern side of Crowle Moors (SE7553 1371* [Land Parcel 166]*) penetrated 6.7m of pale brown silty sand"* (presumably beneath the 25 Foot Drift).

Area 2. North Engine Drain to River Torne

Near Surface; Sutton Sand Formation. Marginal Peat on northern, western and southern peripheries (Land Parcels 123-5, 127,132-3,135-6). Small pocket of Alluvium and peat in central north (Land Parcel 124-5 boundary)

Typical soils based on the existing boreholes are likely to be:

Depth (m)	Description
GL to 0.3/0.6	TOPSOIL / SUBSOIL (loamy and sandy with peat)
(0.3/0.6 to 1.0/1.5+	Very soft or soft clayey Peat and Peat anticipated in peripheries (based on mapping and Gaunt (2020)
0.3/0.6 to 1.5/4.0+	Medium dense yellow, brown or red brown slightly clayey or silty fine to medium SAND, soft and wet silty sand in parts (BLOWN SAND/SUTTON SAND FORMATION)
1.5/4.0+ to 7.0/11.0	Soft to firm laminated red or red brown very silty slightly sandy CLAY, becoming firm to stiff with fine sand or sandy silt bands in parts (HEMINGBROUGH FORMATION)
Below 7.0/11.0+	Medium dense or dense red brown clayey SAND to very weak SANDSTONE/MUDSTONE (TRIASSIC MERCIA MUDSTONE GROUP)

Groundwater was typically struck and stood at between 1.5-3.5m depth.

Gaunt (2020) reports that *"…variably sandy and peaty clay over a metre thick in parts skirts the north edge of Hatfield Chase and the old course of the south branch of the River Don west of Crowle".* (Assumed as that mapped beneath Land Parcels 123-5, 127,135).

Area 3. Plains Lane

Near Surface:
Flandrian Alluvium
Peat in southeast (Land Parcel 113)
Sutton Sand Formation alongside M180 (southern half of Land Parcel 113)

Typical soils based on the (sparse) existing boreholes are likely to be:

Depth (m)	Description
GL to 0.4/0.5	TOPSOIL / SUBSOIL (loamy and clayey with peat)
0.4/0.5 to 2.0/5.0	Soft grey brown peaty Clay or loose red brown Sand (FLANDRIAN ALLUVIUM)
2.0/5.0 to 2.0/7.0	Very soft or soft clayey Peat and Peat (FLANDRIAN ALLUVIUM & PEAT)
2.0/7.0 to 3.5/7.0+	Soft organic /peaty alluvial Clay/Silt (SPT N = 8) (FLANDRIAN ALLUVIUM & PEAT)
3.5/7.0 to 6.0/7.0+	Medium dense laminated clayey Sand or firm Silt/Clay, gravelly in parts (HEMINGBROUGH FORMATION)

Groundwater was typically struck and stood at between 1.5-3.5m depth.

Directly west of Area 3, through its central zone, and further north and east there is evidence of peat beds between 3 to 6m thick, underlying near surface peaty clays and sands. Whilst the surface expression of the former Don course is clear on Lidar, the extent of such thick peats is not shown by the mapping, where these are masked by relatively thin Alluvium.

Gaunt (2020) discussing sand, or sand and gravel concealed beneath the Hemingbrough Formation (25 Foot Drift) states that 2.7-3.3m of such concealed sand and gravel is present in the Plains Farm – Dirtness Bridge Farm area.

Area 4. Bletchers Drain

Near Surface:
Flandrian Alluvium in south and centre (Land Parcels 98-101).
Sutton Sand Formation in northern third (Land Parcel 94).
Peat on north boundary with South Soak Drain and Canal (Land Parcel 92)

Typical soils based on the (very sparse) existing boreholes are likely to be:

Depth (m)	Description
GL to 0.3/0.8	TOPSOIL / SUBSOIL (loamy and clayey)
0.3/0.8 to 0.5/4.0	Medium dense grey brown silty Sand (thin in south, thickening northwards) SPT N = 13-15 (BLOWN SAND/SUTTON SAND FORMATION)
0.5 to 3.5	Soft to firm brown laminated silty Clay with silt lenses (HEMINGBROUGH FORMATION)
3.5 to 6.5	Medium dense brown Sand and Gravel (CONCEALED SAND AND GRAVEL)
Below 6.5	Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater was typically struck and stood at between 1.5-3m depth.

The old River Don meandering east across Hatfield Chase had several courses or secondary channels. Drainage in this area is now concentrated along the Boating Dike Drain, forming the southern boundary of Area 4, although the absence of raised levee slopes along this relatively straight channel suggests it is modern and artificial. At least three former courses are identifiable on the Lidar imagery by levee ridges: firstly running north past Grove House and east to Sandhill Farm, before turning south to rejoin the main course at Jacques Bridge. This ridge is likely silty clay or silt and crosses Area 4 in a northeasterly direction through Land Parcel 98; secondly a less obvious channel flowed even further north of this, marked by a very low broad levee in Land Parcel 94; thirdly a broader levee between the Black Bull road junction and Red House Farm could be the edge of a wider channel.

Whilst the surface alluvial deposits are likely to be clayey, those associated with the old River Don channels are variably peaty, and silty on the old levee slopes.

Gaunt (2020) reports thick Sutton Sand beneath Alluvial deposits elsewhere on Hatfield Chase, being 3.4m thick to 5.2m depth south of Grove House, and at Red House being 4.6m thick under a veneer of alluvial clay, overlying Hemingbrough Formation.

He interprets the sands and gravels under the 25 Foot Drift (Hemingbrough Formation) as follows: "…*Most boreholes which penetrate below the clay of the 25 Foot Drift prove sand, with or without gravel, under the clay… a clear distinction can be made within these concealed deposits between pebble-free sand, generally fine grained and silty, and underlying sand and gravel. The pebble free sand is identified as the lower sand division of the 25 Foot Drift; the underlying sand and gravel include several different deposits….all these concealed deposits are considered together for convenience of description".* He suggests perhaps up to 6.4m of concealed sand and gravel is found in the Red House Farm area.

Area 5. Elder Gates, High Levels

Near Surface: Flandrian Alluvium (Land Parcels 103-105, 107, 137-39)

Typical soils based on the existing boreholes are likely to be:

Depth (m)	Description
GL to 0.3/0.6	TOPSOIL / SUBSOIL (loamy and clayey)
0.3/0.6 to 1.0/2.5 (Southeast only?)	Soft dark brown clayey PEAT
0.5/2.5 to 1.8/3.7	Soft brown silty Clay or medium dense grey brown silty Sand with organic traces SPT N = 17/22) (FLANDRIAN ALLUVIUM & PEAT)
1.8/3.7 to 6.0/12.0	Firm dark brown silty or silty Clay with silt laminations and fine sand lenses SPT N = 4-6 to 6m, 8 at 7m, 12 below 8.5m (HEMINGBROUGH FORMATION)
6.0/12.0 to 15+	Sand & fine Gravel (CONCEALED SAND & GRAVEL)
Below 15+	Red Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater was typically struck and stood at between 1.3-3m depth.

The former River Don Channel, traceable on Lidar imagery, was penetrated by a borehole at Elder House Farm (SE70 NW25) proving clay and clayey peat over silty clay with sand and organic debris to at least 10.7m below OD.

Area 6. Hatfield Chase

Near Surface: Flandrian Alluvium (Land Parcels 102, 108-11, 140, 152, 154-161)

Typical soils based on the existing boreholes are likely to be:

Depth (m)	Description
GL to 0.3/0.6	TOPSOIL / SUBSOIL (loamy and clayey)
0.3/0.6 to 1.3/3.0	Medium dense brown silty Sand or Firm silty sandy Clay, occasionally peaty SPT N = 8-30 (FLANDRIAN ALLUVIUM) *Possible thin Blown Sand centrally (Gaunt)*
1.3/3.0 to 3.0/4.2	Soft or firm brown silty Clay with silt laminations and fine sand lenses SPT N = 5-20 (typically c. 10) (HEMINGBROUGH FORMATION)
2.8/4.2 to 5.0/7.0+	Loose becoming medium dense and dense Sand with some fine to coarse Gravel, clayey pockets and cobbles in parts SPT N = 10-30 (CONCEALED SAND & GRAVEL)
Below 7.0+	Red Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater was typically struck and stood at between 1.0-2.5m depth.

The former River Don channel ran north of Tudworth Hall Farm, south of Levels Farm, between Dale Mount and Drain House, then east to Crow Tree and Elder Gates Farm. This is again traceable on Lidar imagery. Gaunt (2020) confirms this channel as deeply incised and filled with soft peaty silty and clay with wood fragments. The typical sequence of deposits given above are therefore cut across a substantial length of Area 6 by such deep and soft organic soils. For example at Crow Tree (SE70NW3) clay and silt to 11m overlay sand and gravel to 15m, with the rock head notably deeper than other boreholes. Borehole SE71SW11 on the west side of Land Parcel 157 (south of Drains House and near Askerns Drain) also appears to have intercepted the former course of the River Don. It proved Peat to 6.4m depth, underlain by sand and sand/gravel to 13.7m depth before reaching weathered Sandstone.

It is clear that the wide mapped extents of Alluvium somewhat mask the narrow, deep incised channels cut by the rivers.

Gaunt (2020) indicates several low ridges of sand rising to the surface, below 0.9m of alluvial clay in the western area and near Drain House. He reports the concealed sand and gravel is c. 3m thick at Crow Tree, in line with the above.

Area 7. Ferne Carrs

7a) Near Surface:
River Terrace Deposits in west (part Land Parcel 151)
Breighton Sand Formation with channels of Peat in south (part Land Parcels 149, 151)
Glaciofluvial Sand and Gravel in north (west Land Parcel 153)
Sutton Sand and Flandrian Alluvium (east Land Parcel 153)

Typical soils in the eastern area adjacent M180 based on the single relevant borehole are likely to be:

Depth (m)	Description
GL to 0.5	TOPSOIL / SUBSOIL (sandy and loamy with a little gravel)
0.5 to 2.3	Loose grey brown slightly silty fine and medium SAND SPT N = 10 (BLOWN /SUTTON SAND FORMATION? / BREIGHTON SAND?)
2.3 to 4.6	Soft or firm laminated brown very silty Clay to clayey Silt with some sand horizons, becoming gravelly below 4.3m (HEMINGBROUGH FORMATION)
4.6 to 7.5	Dense to very dense Sand with some gravel SPT N = 40 (CONCEALED SAND & GRAVEL)
Below 7.5+	Red Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater stood at c. 1m depth.

No relevant boreholes are available for the central and western zone, where mapped ground conditions should comprise GlacioFluvial Gravels, River Terrace Deposits and Blown Sand, cut by narrow peaty channels. However, Gaunt (2020) states that: *"…The older sand and gravel between Hatfield Woodhouse and Tudworth Hall…are not exposed…. Trial excavations in 1964 into the floor of the quarry (SE693 100) at the southern end of the ridge… which runs in a SSE direction from Tudworth Hall showed that beneath the younger (Pennine) glacial sand and gravel, here 5.2m thick, is a medium gravel consisting of pebbles of Carboniferous sandstone with a few pebbles of Bunter quartzite type".* This suggests more than 5m of sand and gravel was originally present, although it is not clear if this was subsequently worked out, or the quarry later landfilled.

Gaunt described the Tudworth ridge as: *"… A low but distinct ridge runs from Tudworth Hall (SE 6896 1097) to the SSE for a distance of 1.4km, reaching up to approximately 8mOD. The surface consists of pale brown sand with sporadic to locally abundant pebbles of Carboniferous sandstone and Permian limestone".* He also comments on up to a metre of pale brown Blown Sand (Sutton Sand) rests on top of this older sand and gravel.

7b) Near Surface:
Flandrian Alluvium north of Low Levels Bank (Land Parcels 142, 145, 146, 148)
Sutton Sand Formation south of Low Levels Bank (Land Parcels 143, 144, 147)
Peat in extreme southeast alongside Crow Trees Moor Drain (part Land Parcel 143, 147)

Typical soils based on three relevant boreholes are likely to be:

Depth (m)	Description
GL to 0.3	TOPSOIL / SUBSOIL (sandy and loamy)
0.3 to 1.8/3.7	Loose becoming medium dense grey brown slightly silty fine SAND SPT N = 14-20 (BLOWN /SUTTON SAND FORMATION)

1.8/3.7 to 5.3/6.0+	Soft or firm laminated brown very silty Clay with silt partings (HEMINGBROUGH FORMATION?)
Or in extreme SW)	
1.8 to 5.0	Gravel over
To 9.0	Sand (BREIGHTON SAND?)
Below 9.0+	Red Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater stood at c. 1m depth.

Gaunt (2020) reports a double ridge of crescentic dunes of yellow brown Blown Sand stetching across Low Levels. An intervening peat filled channel divides the ridge. That is assumed to refer to the channel in the extreme south east corner of Area 7b, Land Parcels 143,147.

Area 8. Clay Bank

Near Surface:
Sutton Sand Formation across northern periphery
Hemingbrough Glaciolacustrine Formation in west & centre (Land Parcels 81-2,85-6,95)
Flandrian Alluvium in east (Land Parcels 89-91, 93,95,97)

Typical soils based on four relevant boreholes are likely to be:

Depth (m)	Description
GL to 0.3/0.9	TOPSOIL / SUBSOIL (sandy and loamy)
0.3/0.9 to 1.0/2.6	Soft to firm or firm bround and grey mottled and peaty sandy Clay SPT N = 11 (ALLUVIUM)
1.0/2.6 to 2.4/3.3	Loose grey silty Sand SPT N = 5-6 (BLOWN /SUTTON SAND FORMATION)
2.3/3.3 to 6.5/7.6+	Soft or firm laminated brown Clay with silt partings and loose sand horizons (HEMINGBROUGH FORMATION)
6.5/7.6+ to 10.6+/16.0	Mixed grey silty Clay and Sand with some gravel becoming Medium dense silty Sand Sand SPT N = 5 & 23 (HEMINGBROUGH/CONCEALED SAND AND GRAVEL?)
Below 10/16+	Red Marl and Sandstone (TRIASSIC CHESTER FORMATION)

Groundwater stood at 2.0-3.5m depth.

In the eastern area of Flandrian Alluvium the single nearby borehole suggests alluvial soils to 13m, underlain by Hemingbrough Formation mixed silty Clay and Sand to 18m, over the marl and sandstone bedrock.

Area 9 Tween Bridge Wind Farm

Near Surface: Warp east and centre (Land Parcels 28, 47, 80, 122) Peat on west periphery (Land Parcels 28, 45,69,122)

Typical soils based on the (very sparse) existing boreholes in the extreme southern area are likely to be:

Depth (m)	Description
GL to 1.0/1.25	TOPSOIL /Made Ground /Warp? soils (loamy and clayey)
1.0/1.25 to 3.4	Soft to firm organic very silty sandy odorous Clay (Reworked PEAT/ALLUVIUM)
3.4 to 4.5/5.2	Very soft or firm brown silty sandy Clay with organic fragments (FLANDRIAN ALLUVIUM/ HEMINGBROUGH FORMATION)
4.5/5.2 to 6.8	Loose rapidly medium dense brown Sand SPT N= 21/24 (HEMINGBROUGH / CONCEALED SAND?)
6.8 to 9.6/10.0+	Dense red brown slightly silty Sand with occasional gravel SPT N = 38-43 (CONCEALED SAND & GRAVEL / WEATHERED BEDROCK?)

Groundwater was typically struck and stood at between 2.0-4.0m depth.

It is currently unclear why such a thickness of superficial Topsoil /soil deposits is present, since these boreholes are on the edge of that mapped as Warp soils, but also so close to the Canal that some placement of canal excavation spoil may have occurred.

Gaunt (2020) records the large area of Warp soils forming Area 9 as *"…being former peat workings on the former southern edge of Thorne Moors, flood warped directly from the southern end of Swinefleet Warping Drain at various times between 1900-1918, possibly later in parts, producing up to a metre of pale brown silt".*

Area 10. Tween Bridge Moors

Near Surface: Hemingbrough Glaciolacustrine Formation Peat in southwest and east (Land Parcels 55, 59, 63-4, 67, 70, 75-6, 84) Sutton Sand Formation to south (Land Parcels 70, 72, 77, 84)

No relevant boreholes were identified within this area to date.

Gaunt (2020) refers to the area east and southeast of Thorne as 1.8m of clay, (within the Hemingbrough Formation) becoming increasingly sandy further east (at Sand Moors). A ditch south of Thorne Colliery tip is cut into grey brown clay to 0.5m, passing into clayey sand at 0.9m. Again, near Causeway Farm grey brown clay to 0.6m overlies sand and sandy clay with thin sand beds.

He refers to the overlying (Breighton Sand) of the 25 Foot Drift occurring in one location close to Leonards Drain on the northern boundary as a low ridge of silty and clayey sand.

Area 11. Moorends

Near Surface: Warp Peat in south (part Land Parcels 4-6)

No relevant boreholes were identified within this area to date.

3.2 Anticipated Groundwater

It is anticipated that the majority of soils are either poor or slow draining and seasonally wet. Better drainage is likely in areas of either Warp soils, Blown Sutton Sand or some of the less clayey Hemingbrough Formation.

Initial judgement based on the early autumn site visit suggests that within 1-10m of drainage ditches, groundwater may be maintained at 1-2m below GL much of year and 0.5-1m below GL in winter. More remote from drainage, the groundwater could be between 0.5-2m below GL for most of year in most areas. In some very low lying or poorly drained areas, groundwater may stand at less than 0.5m below GL in winter, or at field capacity ie at ground surface in worst periods.

3.3 Anticipated Ground Gas Regime

To date the only potential identified for abnormal ground gas development is locally in the southwest at the recorded sand and gravel workings at Tudworth Hill.

Elsewhere the more organic or peaty soils can potentially give rise to somewhat raised carbon dioxide as a natural occurrence. At shallow depth this is unlikely to be significant. However deep Alluvium and buried peat can give higher ground gas concentrations, as discussed in Card G, Wilson S, Mortimer S. 2012. A Pragmatic Approach to Ground Gas Risk Assessment. CL:AIRE Research Bulletin RB17. Methane and carbon dioxide often occurs in monitoring wells from historically generated gas trapped in porespaces with low diffusion potential. Methane accumulates at increasing depth in peat columns, but this does not indicate high rates of production There is no, or very little, current gas generation and the carbon dioxide has dissolved out which causes a higher percentage of methane to be recorded.

Card et al. concluded that sites on Alluvial soils or buried peat (well decomposed and woody) do not generate sufficient hazardous gas flows to exceed Characteristic Situation 2 as defined in BS 8485: 2007. Therefore if gas monitoring is not undertaken it is generally considered acceptable to simply install Characteristic Situation 2 protection for structures and confined spaces on sites where Alluvial or peaty soils are present.

4.0 CONTAMINATED LAND CONSIDERATIONS

4.1 General

The desk study has indicated that the majority of the study area has a prolonged history of agricultural usage. There is no specific evidence of significant large-scale aggregate workings or landfilling within the boundaries proven to date, with the exception of the extreme southwestern Tudworth area. There has however been prolonged historical peat working within the north and northwest in particular. Major river diversions and drainage schemes, continuing as maintenance of drainage courses to the present day have created levees of alluvial material and organic deposits alongside water courses.

4.2 Qualitative Risk Assessment

The currently proposed solar farm is likely to involve construction activity within the uppermost 500-1500mm of ground level. The likelihood of solar array construction creating an adverse, or worsening impact on the contaminant exposure model given above, is therefore considered negligible for most of the site and low for potential backfilled features.

There is a negligible risk of a new controlled waters pollutant linkage being created due to the very shallow depth of construction activity, and the non-polluting nature of the development.

It is not currently anticipated that shallow depth soils include significant remnant contamination, however this will need confirmed where specific features occur. The majority of proposed construction involves minimal ground intrusion, and it is considered that the pathway for exposure of groundworkers during construction is unlikely to create a significant contaminant linkage, with standard practice.

The overall ground gas regime beneath the site is likely to be normal or near normal. The proposed construction of solar arrays will not have any overall adverse impact on that gas regime. Where very organic Alluvium or buried peat may be present, this requires further consideration where structures or confined spaces are proposed, and generally in view of the proposal for buried electrical plant and cabling.

4.3 Conclusions

In view of the low level of risk and proposed change of use, it is advised that the detailed Phase 1 desk study findings are used to design specific targeted investigation for contaminated land purposes:

- Confirmatory intrusive contamination investigation is recommended, targeted at any specific features shown on historical maps or environmental searches. This will provide data on the occurrence and variation in shallow depth soils conditions (typically between ground level to 1m depth, and with deeper investigation at limited locations). The most technically appropriate method of investigation would be with shallow open-drive sampling boreholes.

- If these boreholes confirm the absence of significant extraction or landfilling, it seems unlikely to be necessary to undertake further investigation for this aspect across the remainder of the site. However where other geotechnical or drainage investigations are to be undertaken to provide data for design and construction, the opportunity to inspect and sample at those locations can be taken, to confirm deeper ground conditions and obtain additional soils samples for confirmatory analyses.

- Near surface gas monitoring should confirm the typical gas regime for any significant peat areas proposed for solar arrays or plant and cabling. This can be achieved by gas measurements within the borehole standpipes, which should have a variety of response zone depths. A sufficient programme of gas and groundwater monitoring would be 1- 2 visits initially during low or rapidly falling atmospheric pressure periods. That should identify if further monitoring is required.

Following intrusive investigations the conceptual model can be updated to identify any specific areas of concern and the need for any further investigation, risk assessment or design measures.

5.0 GEOTECHNICAL CONSIDERATIONS

5.1 Solar Array Foundations

The majority of this site will be populated with ground mounted solar arrays. On many sites their construction of lightweight materials ensures that axial compression loads are of little concern, on moderate or high strength soils. Although their foundations do not need to be designed to withstand compression and bending loads, in most cases wind loading is a critical design feature, which produces uplift forces on the long linear panel arrays. When arrays fail, it is generally because those uplift wind loadings pull them from the ground. Wind loading is directionally random, but system performance generally remains operational even with small lateral movements. Of primary concern is that tension in the foundation can counteract the wind loading uplift.

Due to sustainability, cast in situ 'in-ground' foundations are likely to be unsuitable, as will conventional cast in-ground piers or piles, which produce much drilling spoil for disposal and whose construction is slow and messy.

The easiest foundations to place are **ballast foundations,** adequate size blocks of concrete which will prevent not only differential settlement on poor soils, but counteract upward wind loadings. Their disadvantages are manoeuvrability and production costs.

The common foundations adopted for ground mounted solar arrays in soils of adequate strength are simple **steel 'pin' piles**, often only taken to shallow depth. Installation is with lightweight plant, with little ground disturbance and minor clean up. However, these can have limited side friction to resist wind uplift forces. They are easy to install, and presumably easy to extract (on decommissioning). Other driven pile types can be suitable.

An increasingly popular foundation for solar arrays are **steel helical or screw piles,** consisting of a base steel pipe shaft with one or more helical plates welded to the bottom end. They can be manufactured in a wide range of sizes and lengths and can be adjusted to suit variable ground conditions. They can be installed in a few minutes, produce no spoil with little ground disturbance and no clean up. Installation is with conventional construction equipment such as min-excavator or backhoe, fitted with a hydraulic torque head. Uplift is developed as combined side resistance along the pipe, and end bearing from the helical plate. This helix produces large uplift resistance in most soils. They will be easy to unscrew and recover on decommissioning.

A review of the available literature leads to the tentative conclusion that any form of pile foundation is likely to between 1-3m length and unlikely to be longer for these lightweight arrays, however there is a significant difference in cost between 1-2m pin piles and similar length screw piles. Local ground conditions will determine which is the most technically efficient and the embedded pile length may need to change along a single array if the ground conditions are similarly variable.

At this Site the shallow depth soils are believed to be frequently soft, clayey and silty, although the reported surface soils textures suggest they could be more silty and fine sandy. The presence of a discontinuous, variable depth (perhaps 0.5-1.5m) **'desiccated crust'** will enhance the foundation characteristics. Its occurrence will need to be understood if the preferred foundation type is to not only be technically suitable, but also economically attractive. Locally the shallow depth soils will be predominantly sandy and (as seen at the existing solar farm on Thorne Colliery) concrete ballast foundations the most suitable option. This Site is sufficiently large to consider a variety of foundation types to suit the soil conditions in various areas.

It is likely that in areas of complex alluvial soils, such as where old river channels have been abandoned, backfilled and new channels excavated, the ground conditions will change along the anticipated 30-40m length of a solar array. This could necessitate different lengths of piles to overcome potential variations in differential movement.

5.2 Foundations for Substations and Larger Structures

It seems unlikely that conventional shallow footings will be suitable where alluvial soils are soft and thick. Piles seem the most likely option. It would be appropriate to obtain the ground investigation report for the Tween Bridge Wind Farm, as piling was adopted here (albeit for larger turbines). Floor slab design will be critical, as these also may need to be piled for moderate or heavy loadings.

5.3 Site Preparation and Groundworks for Access, Compounds and Cable Routes

Sustainable solar schemes need to be designed so as to minimise the site preparation works normally required on general construction sites. The adoption of piled foundations for the extensive solar arrays can provide the benefit of allowing grazing stock beneath. These types of foundations minimise disturbance, and it is assumed that attendant plant can be tracked on temporary matting.

New access with a predictable design life will be designed on conventional principles, although the use of geogrid should be optimised to minimise pavement thicknesses, and hence import of materials. Design CBR values will frequently be low, in the order of 1-3% over soft clays and silts. The water table will be high during winter months, so cable trenching should be scheduled for drier periods.

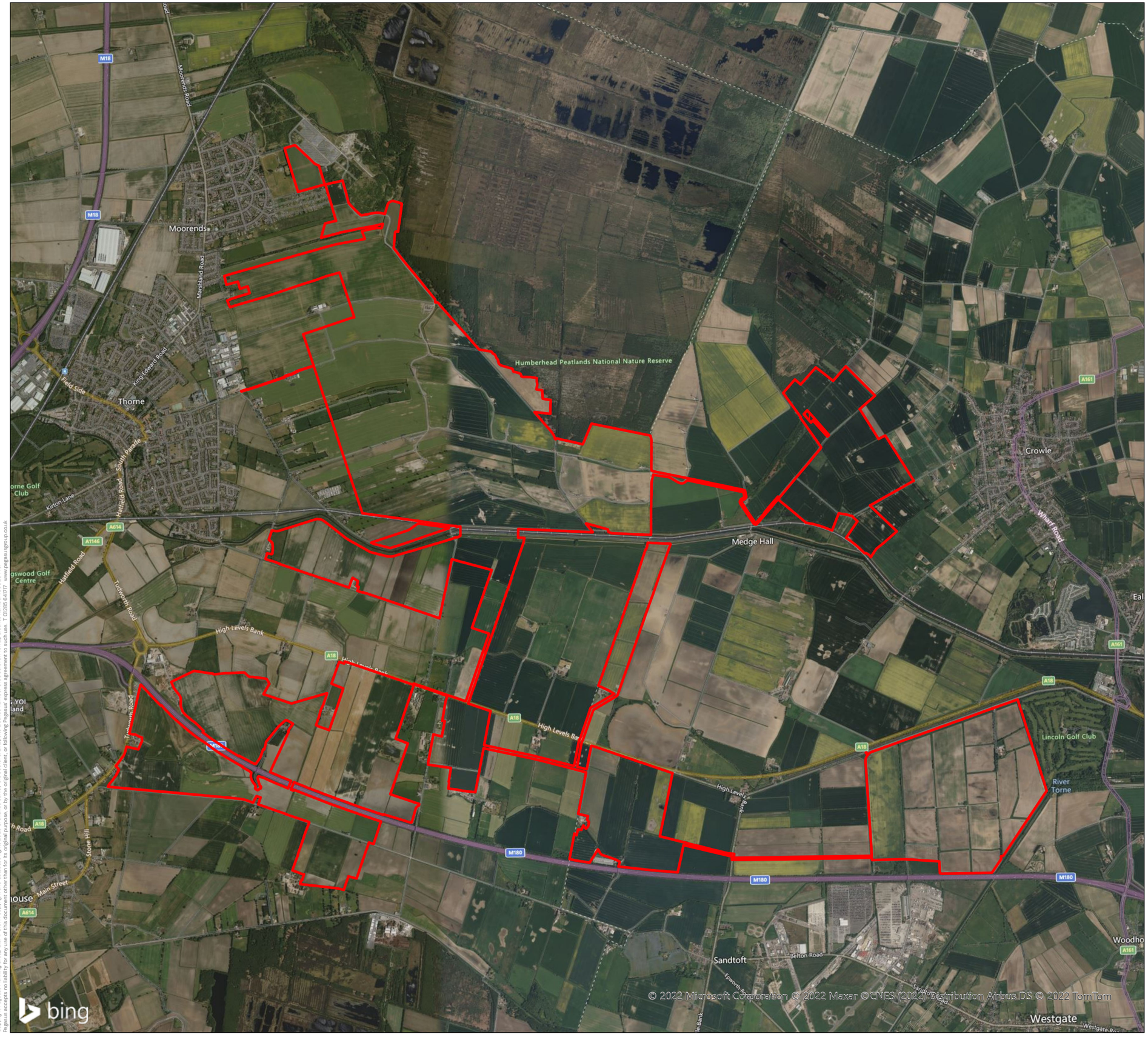
5.4 Directional Drilling

The current scheme proposals necessitate cable ducting beneath the canal and road / rail infrastructure at three locations. Major issues are not anticipated, but site specific boreholes information will be required, guided by the requirements of specialist installers.

5.5 Targetted Ground Investigations

It is critical that adequate **preliminary ground investigation** is completed to:

- Develop a ground model in areas of anticipated variable ground conditions, particularly alluvial soils with river channel complexity. This may be by probing along traverses at select locations to capture the ground conditions highlighted by this desk study.
- A few control boreholes to enable the above probing exercise to be correctly interpreted.
- Additional boreholes at directional drilling locations. It may be better to delay these boreholes until those locations have been frozen.
- Perhaps simple foundation trials to optimise the shallow foundations for solar arrays. The foundations cost for this element alone will be more important than for sites on more predictable, better quality soils.



KEY

AREA EXCLUDED FROM DRAFT ORDER LIMITS

DRAFT ORDER LIMITS

NOTES:
REVISIONS:
21/09/22 - ADDED EASEMENTS
29/09/22 - ADDED EASEMENTS & PARCELS
11/10/22 - REMOVED PARCEL
21/10/22 - ADDED PARCELS
25/10/22 - ADDED AND REMOVED PARCELS
29/11/22 - REMOVED PARCEL
19/12/22 - ADDED ACCESS TRACK & AMMENDED BOUNDARY

SITE BOUNDARY PLAN

TWEEN BRIDGE SOLAR

CLIENT
RWE

DATE	DRAWN	APPROVED	SCALE
20/12/2023	RL	HS	1:36,000@A3

SHEET	REVISION	DRAWING NUMBER
-	G	P21-3484_06_G

N

0 1.5 km

PEGASUS GROUP

Appendix A

Study Area Location & Proposed Solar Areas

Integrale Limited, Suite 7, Westway Farm Business Park, Wick Road, Bishop Sutton, Somerset, BS39 5XP United Kingdom
Tel: 01275 333 036 www.integrale.uk.com

Registered Office: The Granary, Chewton Fields, Ston Easton, Somerset, BA3 4BX United Kingdom VAT Reg. No. 609 7402 37

Appendix A

Study Area Locations

Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

January 2023

Intégrale
Understanding Ground Conditions

Scale = 1:25,000 (approx.) @ A3

Key:

Site Boundary

Area 10
Tween Bridge Moors

Thorne Moor

Humberhead Peatlands National Nature Reserve

Area 9
Tween Bridge
Wind Farm

Area 1
Old River Don

Crowle

Area 11
Moorends

Railway

Medge Hall

Wharf Road

Area 8
Clay Bank

Area 4
Bletchers Drain

High Levels Bank

Area 6
Hatfield Chase

Canal

Tudworth Road

A18

Lincoln Golf Club

Area 5
Elder Gates
High Levels

River
Torne

Area 7
Ferne Carrs
Low Levels

Stone Hill

M180

Area 3
Plains Lane

Area 2
North Engine Drain
to River Torne

Adapted from Pegasus Group drawings:
P21-3484_06_G Rev.G , December 2022 &
P21-3483_05_G Rev. G, October 2022.
Google Earth Images.

1 km
0.5 mi

Appendix B

Topography & Photographs

Integrale Limited, Suite 7, Westway Farm Business Park, Wick Road, Bishop Sutton, Somerset, BS39 5XP United Kingdom
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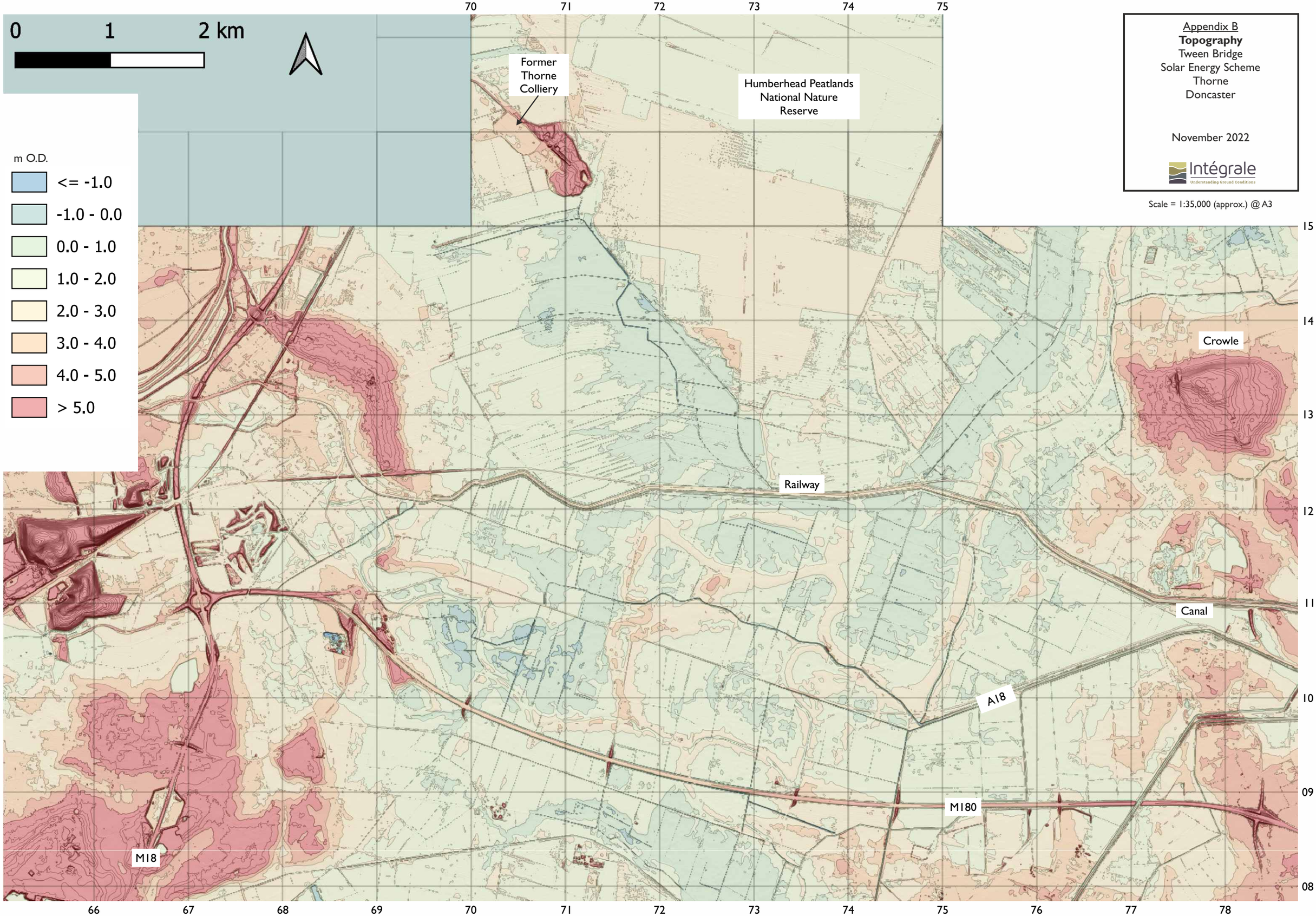

Appendix B
Topography
Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

November 2022

Intégrale
Understanding Ground Conditions

Scale = 1:35,000 (approx.) @ A3

Plate 1 – Area 3 Plains Lane Link Corridor from North Idle Drain East towards Area 2. Peat Deposits

Plate 2 – Area 3 North Idle Drain looking North from Plains Drain junction bridge. Peat Deposits

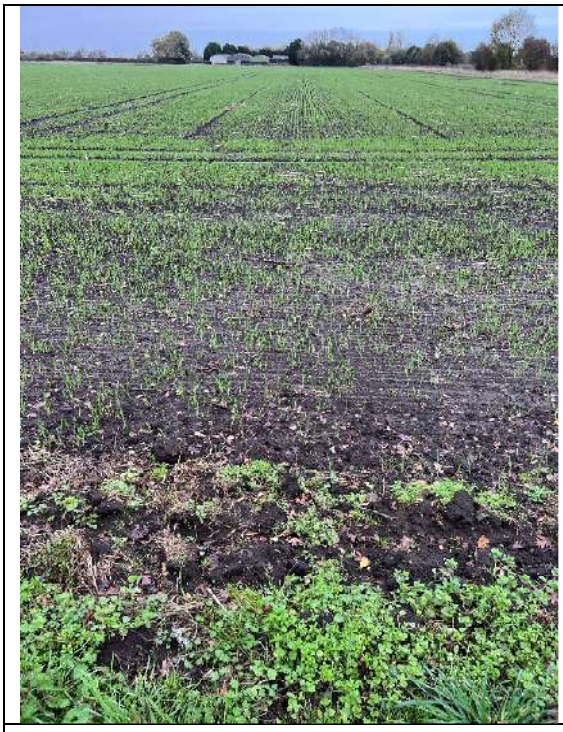

Plate 3 – Plains Lane Track North – Field 106 surface soils. Alluvium.

Plate 4 – Field 113 Looking Southwest from Plains Lane track (to right of photo). Alluvium and Peat Deposits

	
Plate 5 – Area 2 Cataline Ditch looking south from Northwest corner Field 135. Peat Deposits and Sutton Sand Formation (Blown Sand)	Plate 6 – Area 2 Field 135 Looking southwest from access bridge (area of former WWII decoy site)
	
Plate 7– Area 2 Field 135 Field surface soils. Peat Deposits	Plate 8 – Area 2 Field 135 Field surface soils. Peat Deposits

	
Plate 9 – Area 2 looking Southwest to Field 124 across Woodcarr Drain by Belton Grange pumping station. Peat Deposits	Plate 10 – Area 7A Field 151 looking northeast from Tudworth Green Farm to Tudworth Hill & M180. River Terrace Deposits
	
Plate 11 – Area 7A Field 151 looking East to Tudworth Hill with M180 beyond	Plate 12 –Soils heaps and potential landfilling stockpiles to West of A18 At Tudworth Green
	
Plate 13 – Area 7A Field 151 from Sandtoft Road looking Northeast to Tudworth Hill and Field 153, with M180 beyond. Breighton Sand Formation.	Plate 14 – Area 7A Field 149 soil surface, looking North to Field 153 (Former sand/gravel pit) with Tudworth Hill beyond. Breighton Sand Formation.

	
Plate 15 – Area 7A Field 149 soil surface, Sandtoft Road to right beyond drainage ditch. Breighton Sand Formation	Plate 16 – Area 7B Field 146 north to M180 from Askerns Drain. Alluvium.
	
Plate 17 – Area 6 Field 110 from Crow Tree Bank bridge. Alluvium	Plate 18 - Area 6 Field 110 from Crow Tree Bank bridge. Alluvium
	
Plate 19 – Area 6 Field 110 ploughed Alluvial soil detail.	Plate 20 - Area 5 Field 137 northwest corner looking southeast.

	
Plate 21 -Area 8 Link Corridor to southeast corner of Area 8 looking north from High Levels Bank. Alluvium.	Plate 22 -Area 4 Link Corridor from High Levels Bank looking north. Alluvium.
	
Plate 23 -Area 6 Fields looking south from High Levels Bank. Alluvium.	Plate 24 -Area 6 Fields looking south from High Levels Bank
	
Plate 25 -Area 8 Field 85 looking north from Clay Bank Road.	Plate 26 -Area 8 Field 85 north to wind farm. Hemingbrough Glaciolacustrine Formation.

	
Plate 27 -Area 8 looking north to canal and wind farm.	Plate 28 -Area 8 Drainage ditch between Fields 93/95 looking north. Alluvium.
	
Plate 29 -Area 8 ditch showing Alluvium south of Clay Bank Road	Plate 30 -Area 8 Mauds Bridge over Canal looking east
	
Plate 31 - Area 8 Mauds Bridge over Canal looking west	Plate 32 - Beyond Area 11 northeastern boundary Thorne Solar Farm

	
Plate 33 - Area 11 Substation adjacent east boundary	Plate 34 - Area 11 Fields 1-3 looking southwest from pylon next to electricity substation. Warp soils.
	
Plate 35 - Area 11 Thorne Colliery revegetated spoil heaps north of Field 4	Plate 36 - Area 11 Fields 4 & 5 looking south – Warp soils
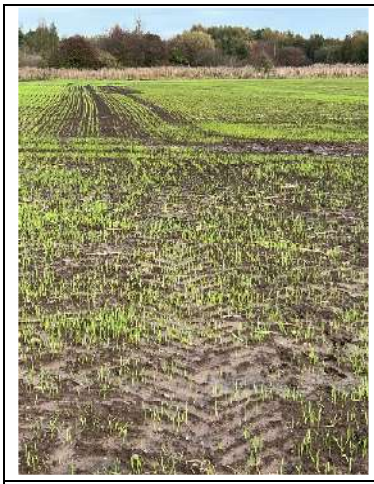	
Plate 37 – Area 11 Field 6 looking east to woods. Clayey Warp soils	Plate 38 Area 10 East end of Leonards Drain looking southeast to woods, Fields 7 & 9. Substation in distance. Hemingbrough Glaciolacustrine Formation.

	
Plate 40 – Area 10 Ditch at Fields 9/15 junction. Hemingbrough Glaciolacustrine Formation.	Plate 41 - Area 10 looking south Fields 16 & 17 to fertiliser storage silos
	
Plate 42 – Area 10 Top Boating Dyke looking north. Field 15 to right, Turbine WTG 01 in Field 165 to left. Hemingbrough Glaciolacustrine Formation	Plate 43 Area 10 Junction of Thorne Waste Drain and Boating Dyke looking north to woods. Field 27 to left Hemingbrough Glaciolacustrine Formation clays & silts. Field 28 to right Peat

	
Plate 44 - Area 9/10 Looking south along Thorne Waste Drain. Field 38 to right on Hemingbrough Glaciolacustrine Formation clays & silts. Field 45 to left on Peat	Plate 45 – Area 9/10 Track alongside Thorne Waste Drain to railway. Field 80 to left on Peat
	
Plate 46 – Area 10 looking west along North Soak Drain. Field 75 on right on Peat	Plate 47 – Area 10 Field 75 peaty soils

	
Plate 48 – Area 9/10 Thorne Waste Drain looking north Field 63 on left, Field 69 to right. Peat Deposits	Plate 49 – Area 9/1 Link Corridor. East beyond existing track & Turbine WTG 20 on Warp area

	
Plate 50 – Area 9/1 Link Corridor. West along existing track to Turbine WTG 20 on Warp area	Plate 51 – Area 10 Turbine WTG 06, Field 43. Looking South southeast to Mauds Bridge

	
Plate 52 – Area 10 Field 43 trafficing of surface by harvesting. Hemingbrough Glaciolacustrine Formation mapped, but suspect thin peaty soils overlie?	Plate 53 – Area 10 Field 43. Blown Sand covering surface south of Turbine WTG 06.

	
Plate 54 - Area 10 Field 48 (or 118?) ponded surface on peaty soil	Plate 55 - Area 10 Field 48 (or 118?) ponded surface on peaty soil

Plate 56 – Area 10 Field 48 Peaty soils at junction of Hemingbrough Glaciolacustrine Formation and Peat


Area 1 Marsh Lane
looking North
Google Earth
© 2022 Google
N
2.19 m


Area 1 Marsh Lane looking North to Field 51/54
Google Earth
© 2022 Google
N
3.38 m

Intégrale

Appendix C

Geological Information

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Appendix C

BGS GeoIndex Mapping & Contours on Base of Flandrian below OD

Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

January 2023

Intégrale
Understanding Ground Conditions

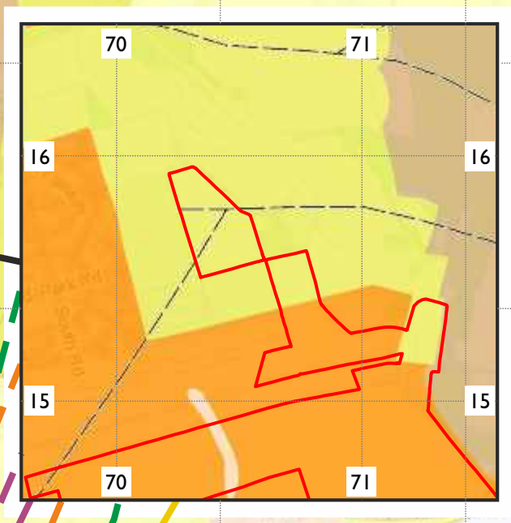
Scale = 1:25,000 (approx.) @ A3

Key:

Site Boundary

69 70 71 72 73 74 75 76 77 78

15 14 13 12 11 10 09



GLACIOFLUVIAL DEPOSITS, DEVENSIAN - SAND AND GRAVEL
SUTTON SAND FORMATION - SAND
ALLUVIUM - CLAY, SILT, SAND AND GRAVEL
BREIGHTON SAND FORMATION - SAND
TIDAL FLAT DEPOSITS - CLAY AND SILT
PEAT - PEAT
WARP - CLAY AND SILT
HEMINGBROUGH GLACIOLACUSTRINE FORMATION - CLAY, SILTY

0 5 10 15

Adapted from Pegasus Group drawings: P21-3484_06_G Rev.G, December 2022 & P21-3483_05_G Rev. G, October 2022. Contains British Geological Survey materials © UKRI 2022. Contains OS data © Crown Copyright and database right 2020. Adapted from BGS Memoir for Sheets 79 and 88 (England &Wales) 1994.

1 km
0.5 mi

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Appendix D

Soils

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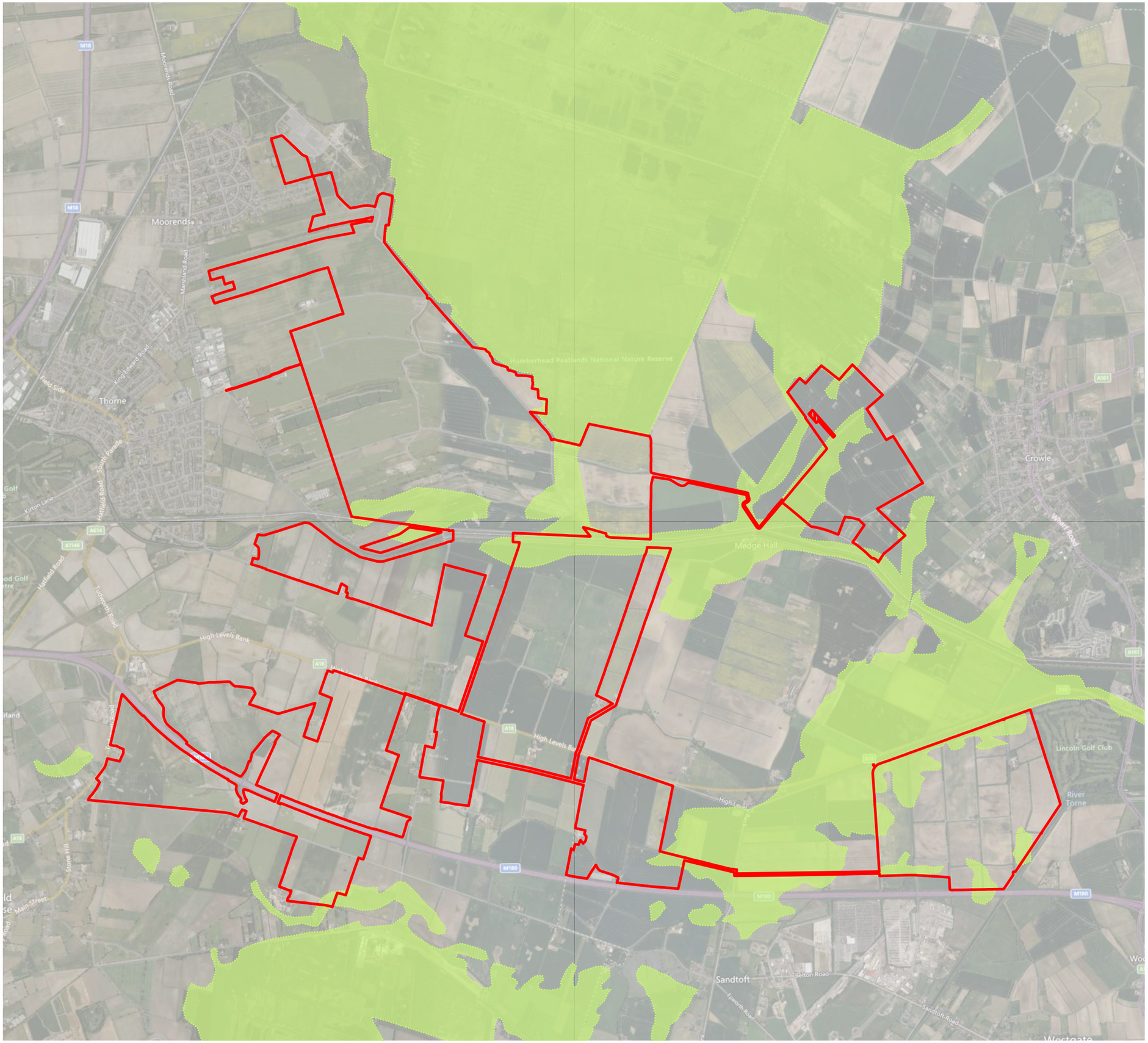

Adapted from Pegasus Group drawings: P21-3484_06_G Rev.G, December 2022 & P21-3483_05_G Rev. G, October 2022. Contains British Geological Survey materials © UKRI 2022. Contains OS data © Crown Copyright and database right 2020. Adapted from BGS Memoir for Sheets 79 and 88 (England &Wales) 1994. Google Earth Images. British Geological Survey Maps.

Key:

Site Boundary

Approximate areas of Peaty Soil (from British Geological Survey maps)

Scale = 1:35,000 (approx.) @ A3

Appendix D
Geological Sheets 79 & 88
Mapped Peat Deposits
Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

January 2023

Intégrale
Understanding Ground Conditions

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Appendix E

Mining, Quarrying & Minerals

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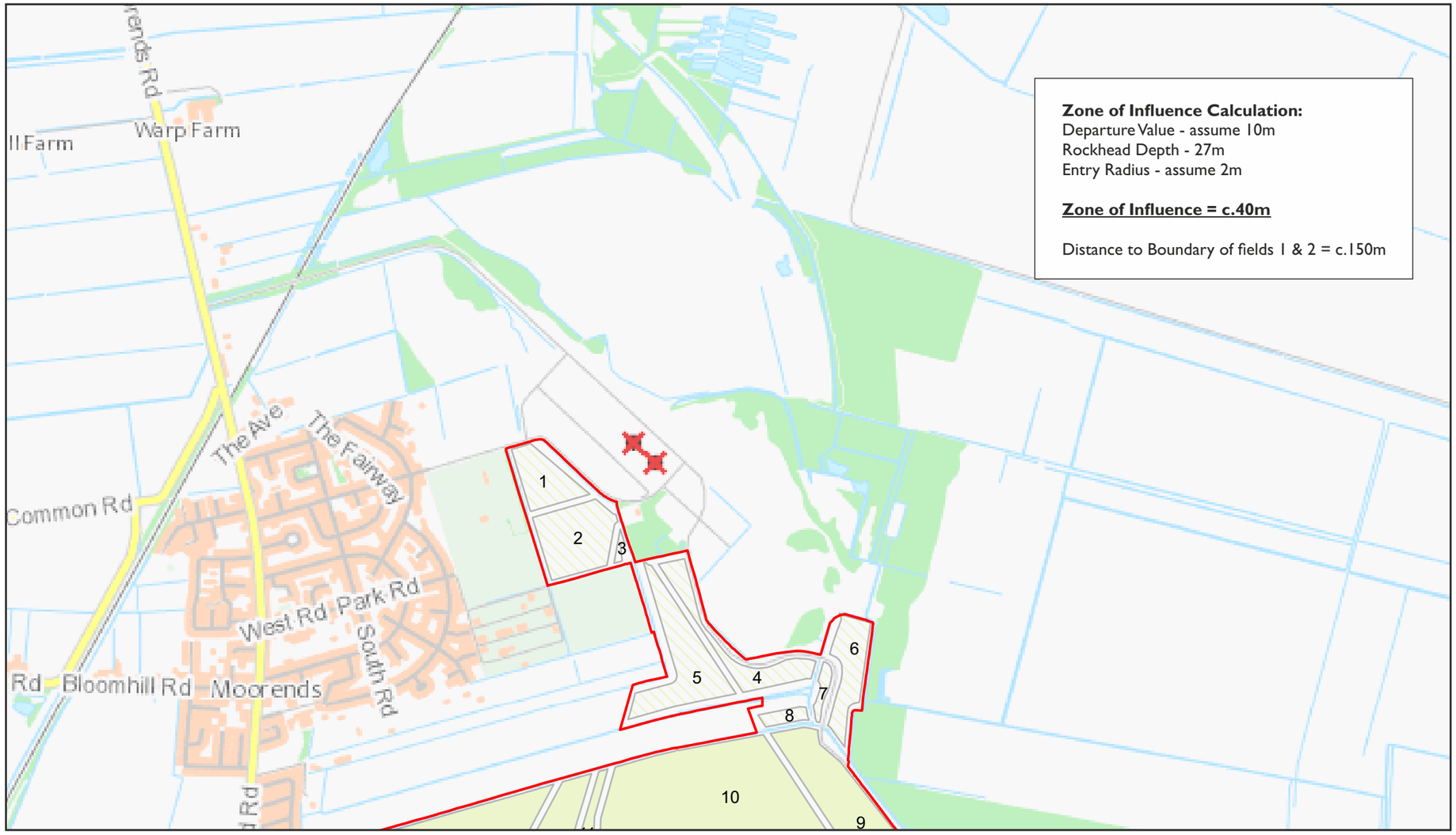
Notts Coal Mining Reporting Area:
470415-001 and 470415-002 Shafts = Development High Risk Area
Rockhead depths 20.4m and 27.1m
Base of Trias/Top of Carboniferous Strata at 279m depth.



Zone of Influence Calculation:
Departure Value - assume 10m
Rockhead Depth - 27m
Entry Radius - assume 2m

Zone of Influence = c.40m

Distance to Boundary of fields 1 & 2 = c.150m

N
W E
S

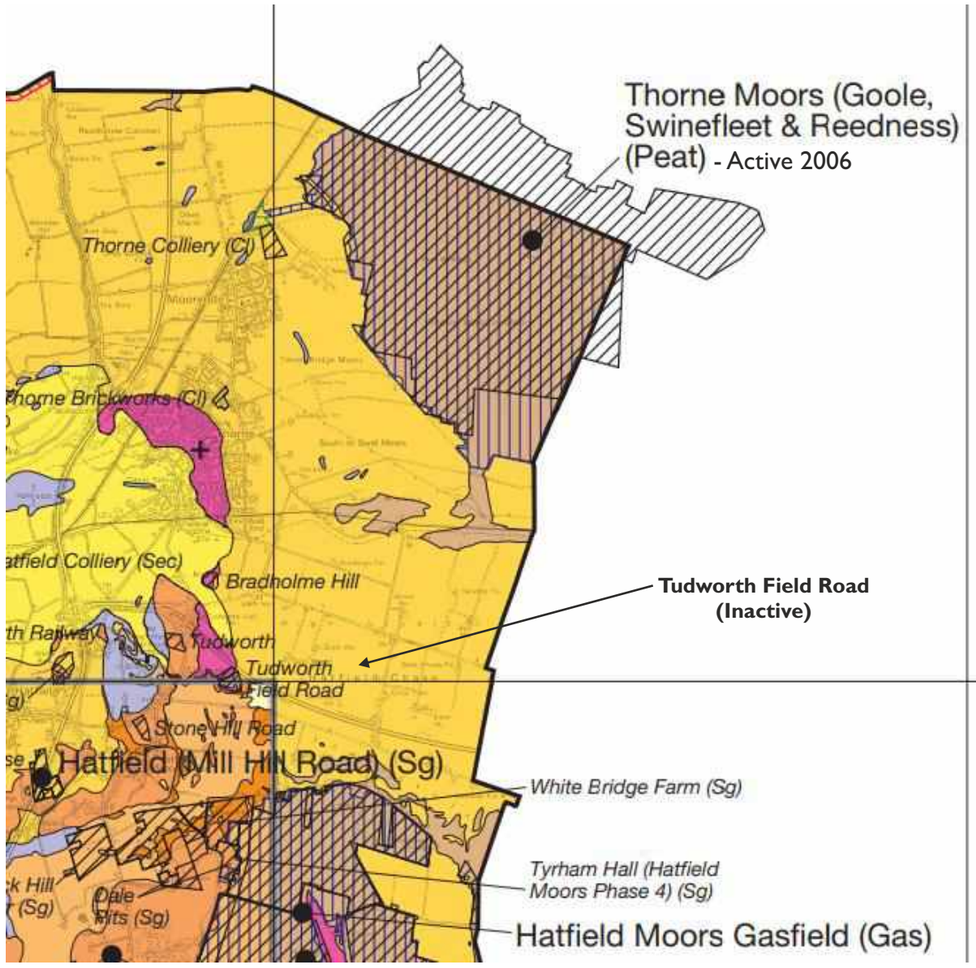
Scale = 1:15,000 (approx.) @ A3

Appendix E
Location of Development High Risk Area at Former Thorne Colliery
Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

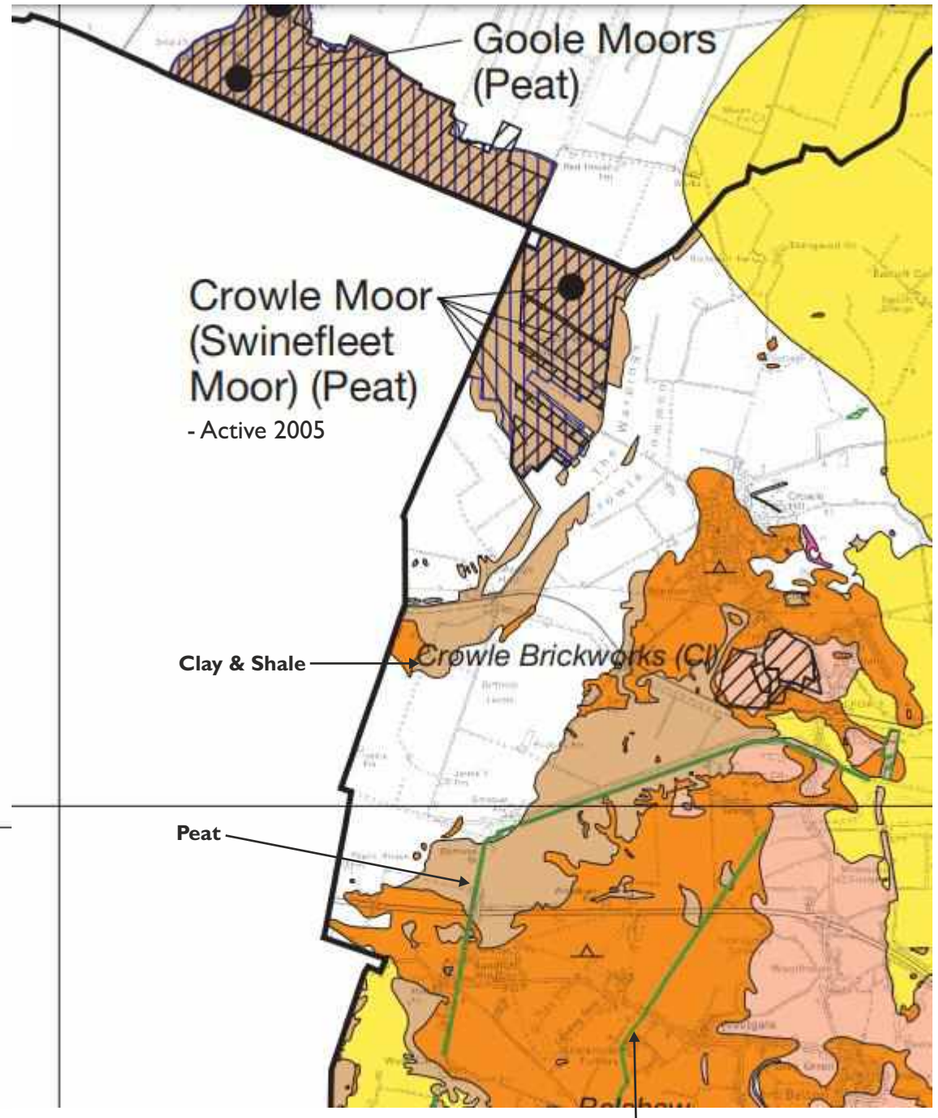
November 2022

Intégrale
Understanding Ground Conditions

EXTRACT OF SOUTH YORKSHIRE MINERAL RESOURCE MAP (2006)



EXTRACT OF HUMBERSIDE MINERALS RESOURCE MAP (2005)



Not to scale.

Appendix E
Mineral Resources

Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

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Understanding Ground Conditions

Appendix F

Historical Maps
(to be completed in full Phase 1 study)

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Appendix G

LIDAR Imagery
(to be completed in full Phase 1 study)

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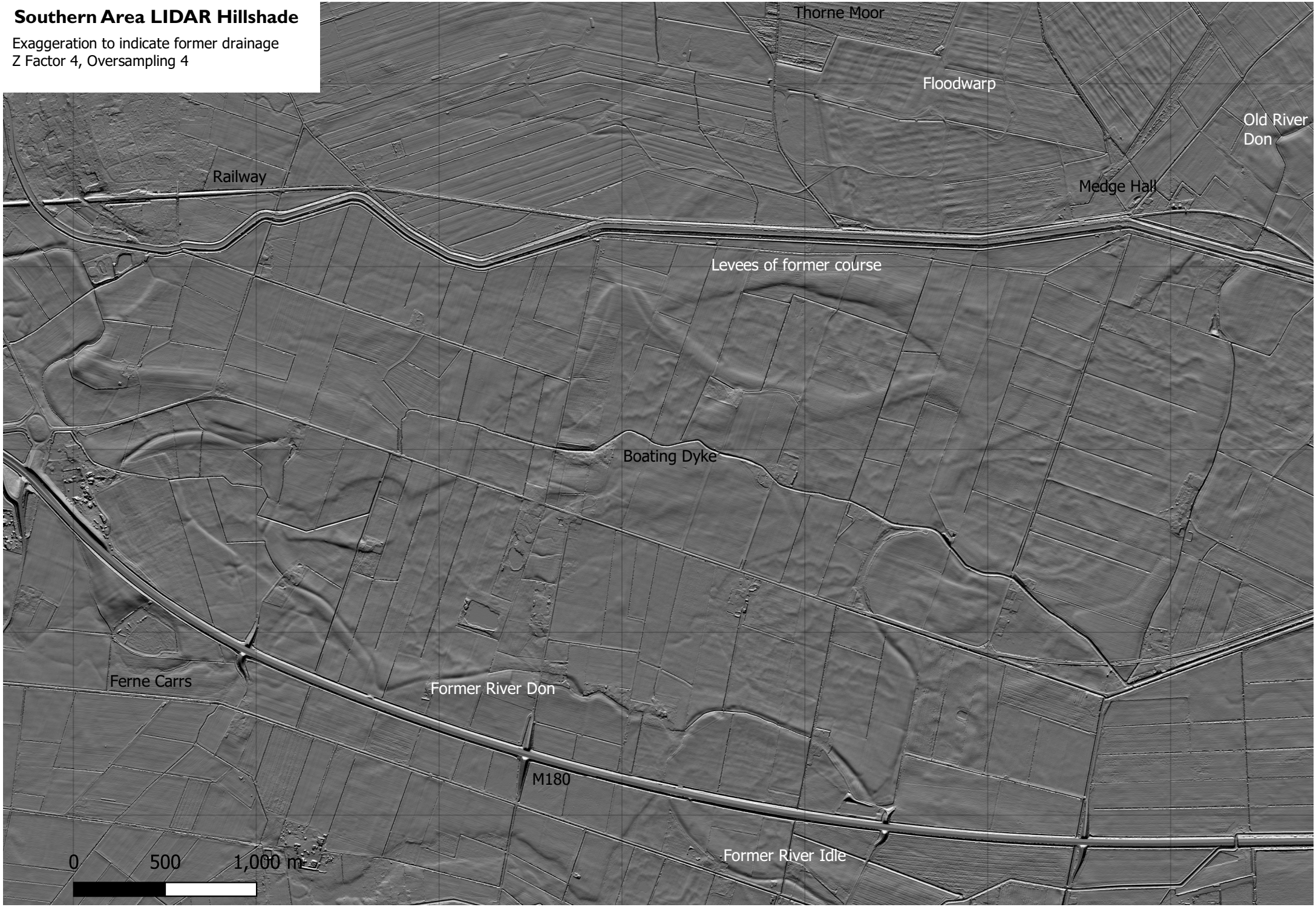
Southern Area LIDAR Hillshade

Exaggeration to indicate former drainage
Z Factor 4, Oversampling 4



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Appendix H

Hydrogeology

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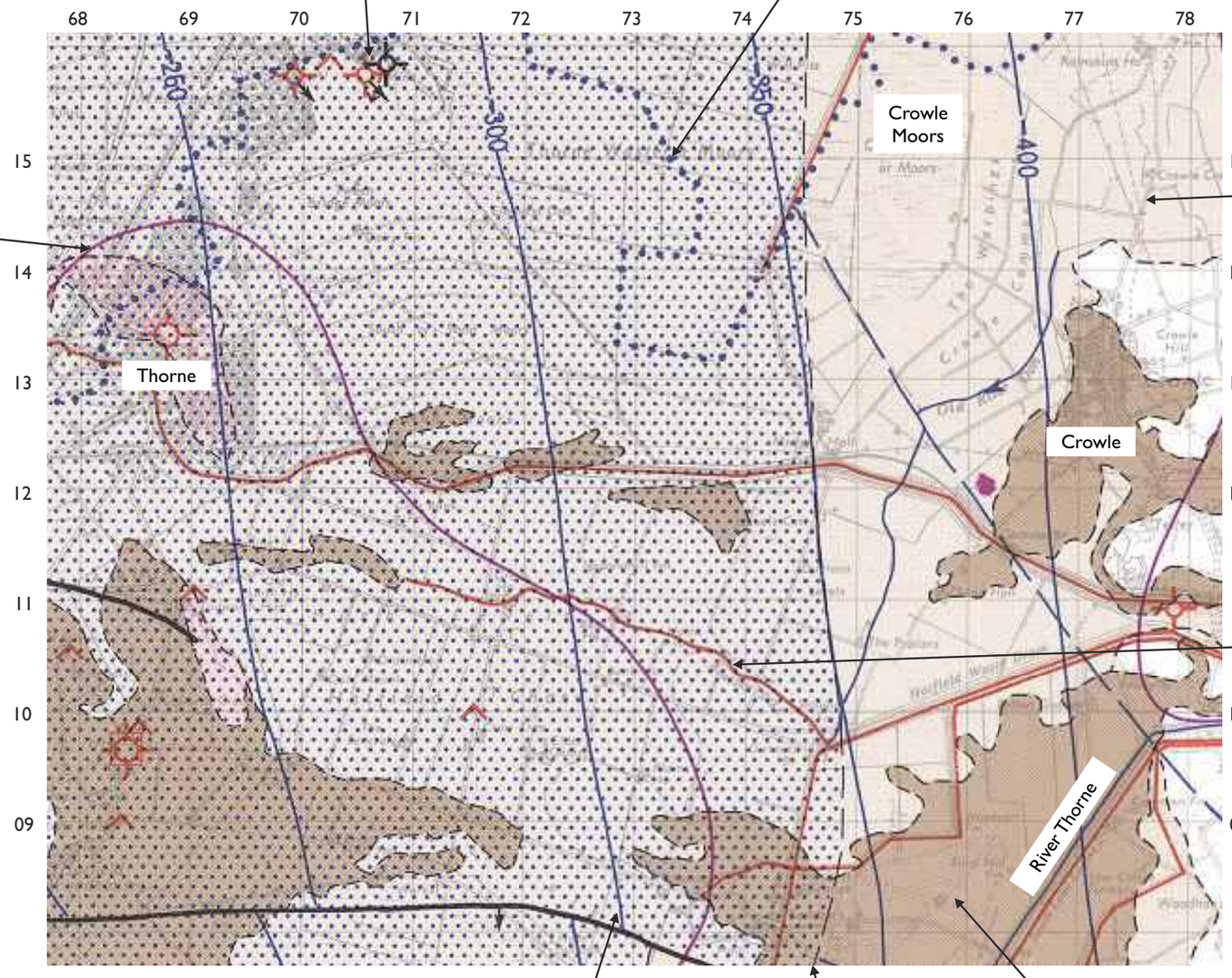

Scale = 1:50,000 (approx.) @ A3

Appendix H

Extract from Hydrologeological Map of Northern East Midlands at 1:100,000 Scale (1981)

Tween Bridge
Solar Energy Scheme
Thorne
Doncaster

November 2022

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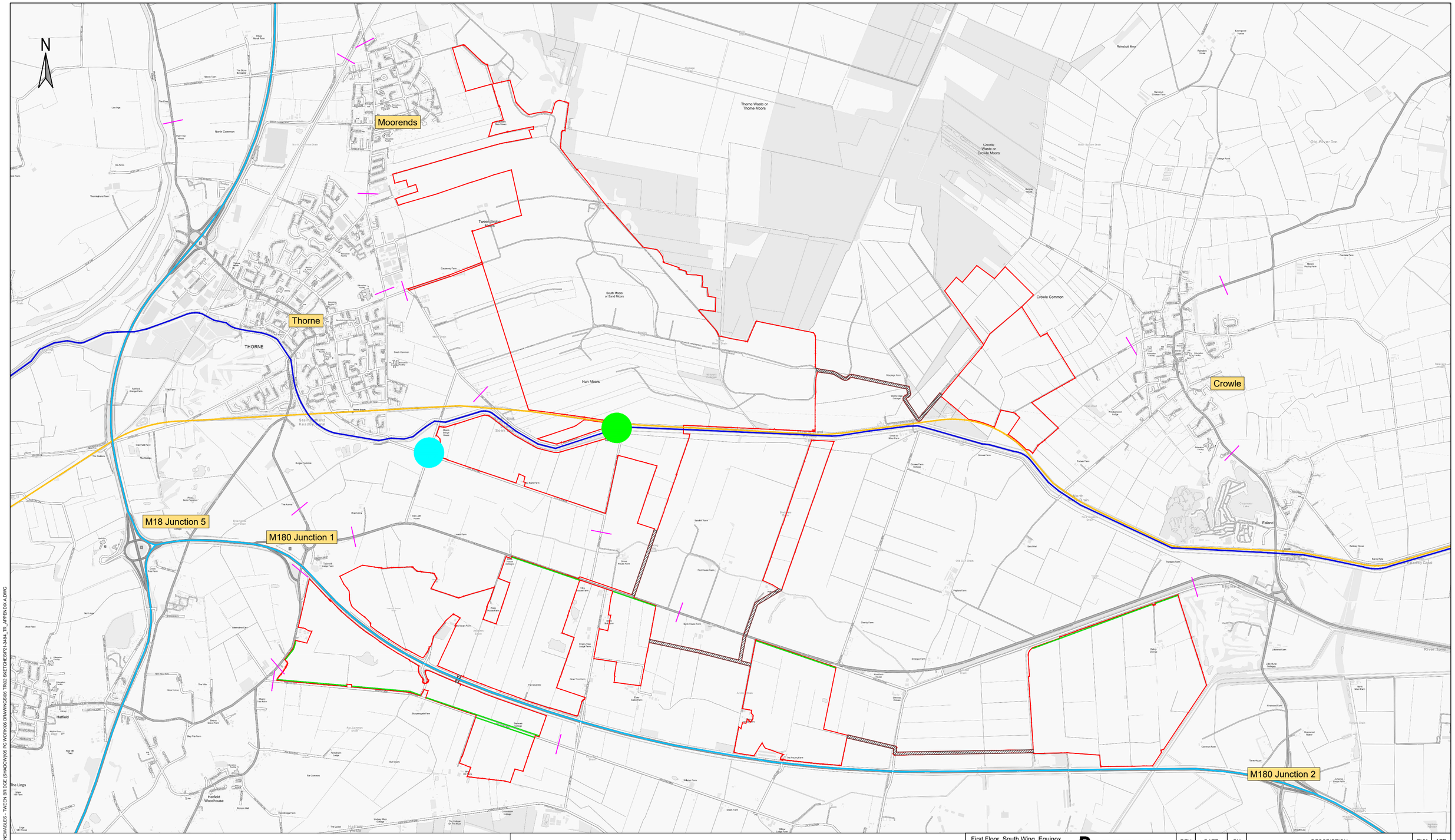
Understanding Ground Conditions

Appendix 10.1 – Transport Indicative Access Strategy



Key:

- Approximate Red Line Boundary
- Approximate Extent of Cable Run between Land Parcels (not available for access)
- Weak Bridge (7.5 tonne)
- Constrained Junction
- Drain/Ditches
- Motorway
- Stainforth and Keadby Canal
- Railway Line
- Indicative locations to place Automatic Traffic Count surveys

First Floor, South Wing, Equinox
North Great Park Road,
Almondsbury, Bristol , BS32 4QL

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REV	DATE	BY	DESCRIPTION	CHK	APD

CLIENT: RWE RENEWABLES	SCALE @ A2: NTS	CHECKED: ADWS	APPROVED: KSS
PROJECT: TWEEN BRIDGE	DATE: 08/11/2022	DESIGN-DRAWN: JAN	DRAWING-STATUS: SK
TITLE: INDICATIVE ACCESS STRATEGY	PROJECT No: P21-3484	DRAWING No: TR - APP A	REV: -

X:\BRISTOL PROJECTS\BRISTOL - LIVE PROJECTS\P21\P21-3401-3500\P21-3484 - RWE RENEWABLES - TWEEN BRIDGE (SHADOW)\05 PG WORK\06 DRAWINGS\06 TR\02 SKETCHES\P21-3484_TR_APPENDIX A.DWG

Town & Country Planning Act 1990 (as amended)
Planning and Compulsory Purchase Act 2004

Expertly Done.

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