Gate Burton Energy Park

Volume 3, Appendix 15-C: Phase 1 Desk Study & Preliminary Risk Assessment

June 2022

Gate Burton Energy Park Limited

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Quality information

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1. Introduction

1.1 Background

1.1.1 Gate Burton Energy Park Limited (hereafter referred to as 'the Applicant') has commissioned this Phase 1 Desktop Study for the Gate Burton Energy Park (hereafter referred to as the 'Scheme'). The Scheme comprises the installation of solar photovoltaic (PV) generating panels and on-site energy storage facilities across a proposed site in Lincolnshire (hereafter referred to as the 'Solar and Energy Storage Park') and grid connection infrastructure (hereafter referred to as the 'Grid Connection Route). The entire scheme, including both the Solar and Energy Storage Park and Grid Connection Route is referred to as the 'DCO Site'. Further information on the Scheme is provided in **PEI Report Volume 1, Chapter 2: The Scheme**.

1.1.2 The Site is located approximately 4 kilometres (km) south of Gainsborough with the Solar and Energy Storage Park, and the potential Grid Connection Route shown on **PEI Report Volume 2, Figure 1-1** and **Figure 1-2**.

1.1.3 It is important to note that at this stage, **PEI Report Volume 2, Figure 1-2** shows the expected maximum extent of land that would be included within the application for a Development Consent Order (DCO), which includes all land being considered for the purposes of the Scheme. It should also be noted, **PEI Report Volume 2, Figure 1-2** represents the likely maximum extent of the Site boundary based on all the options for Scheme elements that have been, and will be, the subject of consultation.

1.1.4 This Phase 1 Desk Study Report provides a Stage 1, Tier 1 level of assessment, as defined by the Environment Agency's Land Contamination Risk Management (LCRM) (2020) guidance for the Solar and Energy Storage Park only. This Phase 1 Desk Study will be updated to include the Grid Connection Route and will be submitted with the Environmental Statement (ES).

1.2 Description of the Scheme

Overview of Solar and Battery Storage Infrastructure

1.2.1 The principal infrastructure will be as follows:

- Solar PV modules;
- PV module mounting structures;
- Inverters;
- Transformers;
- An On-Site Substation);
- Onsite cabling;
- An energy storage system;

- Onsite electrical compounds comprising of substations and control buildings;
- A circa 6km electrical connection route to connect with the National Grid at Cottam Substation;
- An off-site electrical compound comprising of a substation and control building;
- A spare parts storage building or enclosure;
- Fencing and security measures;
- Access tracks; and
- Landscaping and biodiversity enhancement.

1.2.2 During the construction phase, one or more temporary construction compound(s) will be required as well as temporary roadways to facilitate access to all land within the Solar and Energy Storage Park.

1.2.3 In areas around the PV arrays and on other land within the Solar and Energy Storage Park, opportunities for landscaping, biodiversity enhancements and habitat management will be explored.

1.2.4 Further information on the Scheme is provided in **PEI Report Volume 1, Chapter 2: The Scheme**.

1.3 Report Objectives

1.3.1 The Scheme is defined as a Nationally Significant Infrastructure Project (NSIP) under Sections 14(1)(a) and 15(2) of the Planning Act 2008 [1] as an onshore generating station in England, exceeding 50MW.

1.3.2 This Phase 1 Desk Study report is under the requirements of NSIP, via Planning Act 2008, the National Planning Policy Framework (2021) and also considers the potential implications of Part 2A of the Environmental Protection Act 1990 (Part 2A) and the associated Contaminated Land (England) Regulations 2006 and Contaminated Land Statutory Guidance (2012).

1.3.3 This report has been prepared in general accordance with the technical guidance and procedures described in LCRM. This report is the equivalent to a Stage 1, Tier 1 level of assessment (preliminary assessment).

1.3.4 The report will include the following:

- A review of the site's geological, hydrological and hydrogeological setting, and public domain geo-environmental information to build up an accurate understanding of the site and surrounding environmental setting/sensitivity;
- Detail on mineral designations and current/historical mineral extraction activities; the report will not provide a formal assessment of minerals though as is required for an Environmental Impact Assessment (EIA);
- Summary of findings from a site walkover inspection;

- Review of historical land uses for the site and surrounds with a particular emphasis on identifying potential on-site and off-site contamination sources;
- A site conceptual model with a view to identifying any significant source-pathway-receptor linkages followed by a qualitative preliminary risk assessment;
- Review of the potential for geotechnical hazards and constraints; and
- Conclusions and recommendations based on the findings.

1.3.5 The report does not include for an assessment of agricultural land or soils within the context of EIA.

1.4 Sources of Information

1.4.1 This report has been prepared using a combination of published records, information provided by the Client statutory records and historical mapping supplied within a Landmark Envirocheck Report, published geological and hydrogeological mapping, historical borehole records and observations made during the site inspection. There are no previous investigation reports available for the Site. The sources used are:

- Historical maps as part of a standard Envirocheck Report provided by the Landmark Information Group (Ref. 286968913_1_1, dated 28 October 2021);
- Standard Envirocheck data sheets and site sensitivity maps provided by the Landmark Information Group (Ref. 286968913_1_1, dated 28 October 2021);
- 1:100,000 scale Groundwater Vulnerability Map;
- British Geological Survey (BGS) Geological Map and Memoir [2] [3];
- Environment Agency website;
- BGS website;
- DEFRA Magic website [4];
- Zetica website for information on unexploded ordnance [5]; and
- Local Authority Enquiries (where required).

1.4.2 Specific information sources are referenced throughout the document and a bibliography is included in Section 11 of the report.

2. Site Setting

2.1 Location

2.1.1 The Site is located approximately 4 kilometres (km) south of Gainsborough between the villages of Gate Burton and Willingham by Stow. It is approximately centred on approximate National Grid Reference 484942, 383809. A site location plan is provided as **PEI Report Volume 2: Figure 1-1**.

2.2 Description and Setting

2.2.1 The Solar and Energy Storage Park covers an area of approximately 700 hectares and is defined by the red line boundary shown in **PEI Report Volume 2: Figure 1-1**.

2.2.2 The Site use is predominantly agricultural, comprising large arable fields delineated by hedgerows and drainage ditches. Woodlands are also present, including Burton Wood in the southwest of the Site. Buildings within the site boundary comprise farm buildings and associated housing.

2.2.3 The Site is crossed northwest-southeast by a railway line, connecting Lincoln and Doncaster.

2.2.4 The topography of the Site is generally flat, ranging from approximately 10m above ordnance datum (AOD) to >30m AOD. The topographical heights are mostly found in the north-eastern and eastern portion of the Site.

2.2.5 Relevant features immediately surrounding the Site are summarised in Table 2-1.

Table 2-1 Site Surroundings

Direction	Summary
North	Mostly agricultural land and associated farms. The village of Knaith is located approximately less than 100 m from the site boundary. Knaith Park and the Knaith Park Plantation are adjacent to the Site. A crematorium, Woodland (Norbury Hills and Thurlby Wood) and Lea Marshes Main Drain are located to the northwest.
South	The site is bounded by Willingham Road, with agricultural land and farms beyond. a gas pumping station is located to the southwest beyond the Road. Residential and commercial properties (nurseries and farm) are located adjacent to the site boundary, on Willingham Road.
East	Mostly agricultural land. Central Park farm is located adjacent to the Site boundary. The village of Willingham by Stow is located approximately 370 m east.
West	Mostly agricultural land. The A156 runs adjacent for a portion of the Site boundary; the villages of Gate Burton and Marton are located to the southwest.

2.3 Site Reconnaissance

2.3.1 An external inspection of the Site was completed by qualified and experienced AECOM Staff on the 21 and 22 October 2021. The aim of the visit was to identify the range of activities carried out on the Site and any obvious potential sources of ground contamination or ground related constraints.

2.3.2 A summary of the findings of the site walkover is provided below. A photographic record of the visit is included as **Annex A**. The site walkover was limited to safely accessible areas of the Site via public rights of way. Areas immediately west of the Site, north of Gate Burton village are marked as private land and therefore were not accessed. Similarly, the access road to Park Farm was also not possible via public rights of way (PRoW), therefore the surroundings of Park Farm were observed from a distance. In addition, the area of the Site crossed by Kexby Lane to the northwest was not accessible safely on foot.

2.3.3 The Site occupies a large area between the villages of Willingham by Stow, Normanby by Stow, Knaith, Knaith Park, Marton and Gate Burton. The Site is generally flat, with some occasional hills. It is predominantly used for agricultural use and covered with crops and sporadic woodlands. No cattle were observed on Site.

2.3.4 The Railway (SPD3 line, Greetwell Junction to Gainsborough Trent Junction) crosses through the central area of the Site from northwest-southeast. It is built via embankments, cuttings earthworks and is also at grade in parts. It is crossed by flyovers and underpasses [Photo 1, Photo 15].

2.3.5 Numerous small drains [Photo 3, Photo 18, Photo 31] were observed on Site, generally crossing it along the existing crop edges/field boundaries or adjacent to roads. The flow of these were generally very low.

2.3.6 Vegetation mainly comprises woodlands (not accessed) and bushes/hedgerows delineating the crops. No sign of vegetation dieback was noticed during the site walkover.

2.3.7 The following were also observed within the Site boundary:

- Clay Farm: located at the end of Clay Lane, in proximity of the railway line, in the southwestern portion of the Site [Photo 15];
- Telecommunications antenna, with associated facilities and delineated by a fence was observed on Clay Lane. It is understood the antenna is operated by Three and EE [Photo 19];
- Overhead lines crossing the site both east-west and north-south. [Photo 8]; and
- No other settlements were visible or accessible.

2.3.8 Several commercial and residential properties were observed in the immediate proximity of the Site, adjacent to the Site boundaries. These included:

- “Nursery house” and “Gate Burton Nursery”: A nursery with associated residential house and static caravan. It is located immediately off-site, adjacent to the southern boundary, on Willingham Road [Photo 5];
- Sandebus Farm and Sandy Barr cottage: farm and residential property. They are located immediately off-site, on Willingham Road, along the southern boundary. Sandebus Farm comprises two warehouses, one of which used for storage of hay. A tank, possibly for water storage, was also visible on one of the buildings [Photo 6];

- Gas pumping station located 130 m southeast of the southern boundary of the Site, beyond Willingham Road. It is understood the station serves a gas pipeline to Cottam Power Station [Photo 11];
- Park Farm, in proximity of the Site boundary to the east, comprising of large storage buildings and hay stacking areas [Photo 32];
- Sort Hills Farm, located approximately 160 m from the southern boundary of the Site; it comprised several buildings, including what appears to be a warehouse [Photo 2];
- Stephenson's Hill House and Central Park Farm; located to the northwest of the Site, immediately adjacent to the Site boundary [Photo 28, Photo 30];
- Lea Fields Crematorium, located approximately 370 m northwest of the Site boundary;
- Additional residential properties on Knaith Hill (northwest, adjacent to the Site boundary), Station Road (in proximity of the northern boundary), and Kexby Lane (in proximity of the northwestern boundary of the Site);
- Gate Burton village, located immediately southeast of the Site boundary, comprising residential properties and a farm; additional buildings are located within a gated private property [Photo 21]; and
- Several warehouses and storage areas were observed to be located on-site and associated with farming. No chemical storage was noticed on Site, except for a small tanker in proximity of Clay Farm [Photo 16].

2.3.9 No evidence of contamination was observed during the site inspection. Sporadic manure stockpiles and a bonfire were noted in the southern portion of the Site [Photo 4].

3. Geological and Environmental Setting

3.1 Introduction

3.1.1 The environmental setting including the topography, geology, hydrogeology and hydrology are the key factors that influence the way in which contaminants in the soil or groundwater can be transported on or off site, and also the way in which contamination can affect applicable receptors including controlled waters and users of the Site.

3.1.2 The environmental setting of the Site has been assessed by making reference to the information sources detailed in Sectionn 1.4.

3.2 Geology and Soils

Published Geology & Exploratory Hole Records

3.2.1 The published 1:50,000 scale geological map of the area produced by the BGS (Sheet 102, “Market Rasen”, 1999 [2] and Sheet 101, “East Retford”, 1998 [3] and the Geoindex Viewer [6] indicates that superficial deposits are absent over approximately 70% of the Site. The mapped geological succession underlying the Site is summarised in Table 3-1. Extracts of the superficial deposits and bedrock maps are included in the Envirocheck Report (Ref. 286968913_1_1). A schematic of the superficial deposits present at the Site is presented as Figure 1-1.

Table 3-1 Geological Succession from Published Mapping

Group	Description	Anticipated Thickness (m)	Distribution
Superficial Geology			
Glaciofluvial deposits -	Sand and gravel. locally with lenses of silt, clay or organic material.	-	Northwest portion of the Site (Knaith) and localised isolated small areas, in the central west portion of the Site (northeast of Burton Wood) and in the southwestern portion of the Site (south of Burton Wood).
Alluvium -	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel.	-	Locally, isolated area in proximity of Clay Farm.
Till - diamicton	Predominately stiff clays with varying thickness and quantities of sand lenses/bands.*	-	Locally, in proximity of the southern boundary, across the railway, south of the alluvium deposits.
Holme Pierrepont Sand And	Sand and gravel. Generally pinkish, poorly sorted , sandy, gravels. Gravel dominated by rounded pebbles of	Typically, 0 to c.12m; typically up to	These deposits are associated with the River Trent to the west of the Site. Mapping indicates

Group	Description	Anticipated Thickness (m)	Distribution
Gravel Member	"Bunter" quartz/quartzite (typically c.80%), plus flint, sandstone, cherts, etc, and other "exotic" lithologies.	c.8m in the middle Trent Valley.	these marginally encroach on to the site in the southwestern tip of the Site at Gate Burton.
Bedrock Geology			
Scunthorpe mudstone formation	Mudstone and limestone, interbedded: grey, variably calcareous and silty, blocky or fissile mudstone with thin beds of argillaceous limestone (bioclastic or micritic) and calcareous siltstone, particularly near base and in upper part, which is ferruginous in the area.	To c.128m.	Majority of the site.
Penarth Group	Mudstone. Grey to black mudstones with subordinate limestones and sandstones; predominantly marine in origin.	0 - >12m.	Along the western and north western boundaries.
Mercia Mudstone Group	Dominantly red, less commonly green-grey, mudstones and subordinate siltstones with thick halite-bearing units in some basinal areas. Thin beds of gypsum/anhydrite widespread; sandstones are also present.	1350m+	Westernmost and north western most tips of the Site, in proximity of Knaith village.

Source: Geoindex Viewer [6] and British Geological Survey Lexicon of Named Rock Units [7].
**General description*

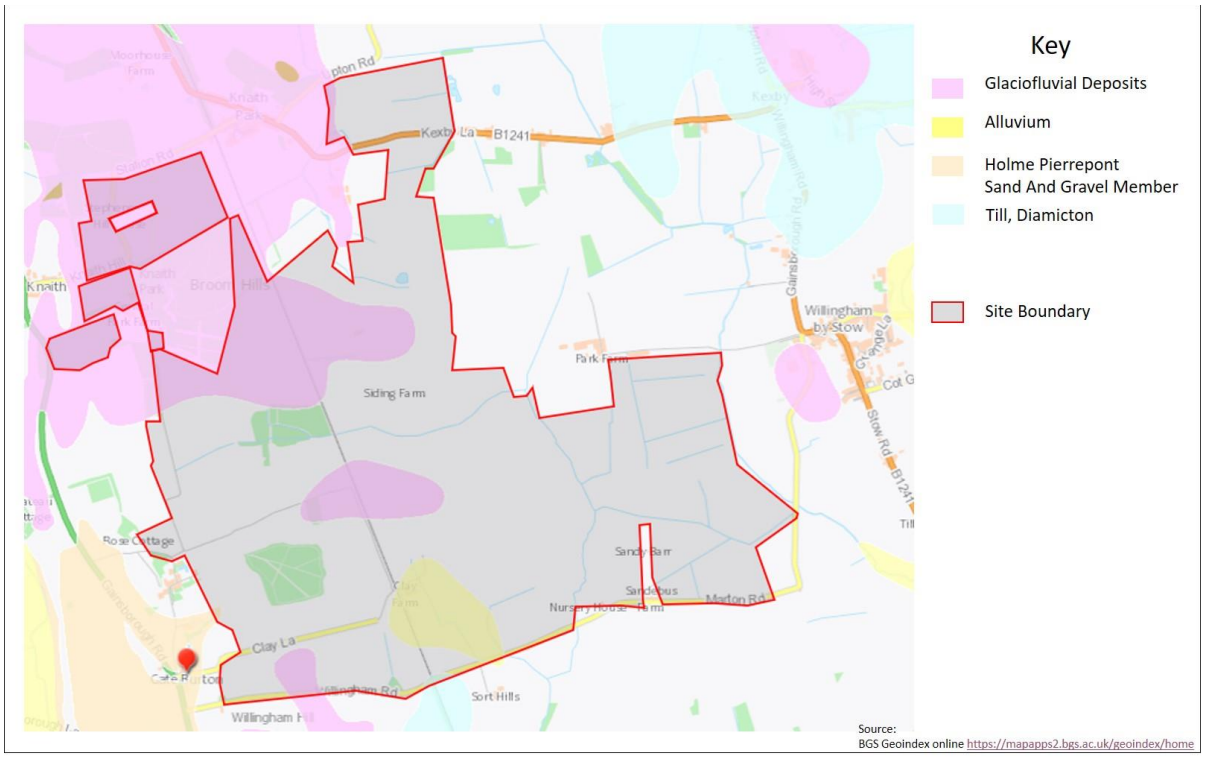

Figure 1-1 Geology -Superficial Deposits

3.2.2 A selection of publicly available borehole scans from the BGS were available to review [6]. Those which are considered to provide useful information on the ground profile at the Site are presented in Table 3-2 below.

Table 3-2 BGS Boreholes and Location

BGS Borehole	BGS Borehole – Easting and Northing	General Location
SK88SW18	483290, 384400	North and northwest of the Site
SK88SW19	484040, 384330	
SK88NW62	483601, 385413	
SK88SW45	483055, 384006	
SK88SE9	486321, 384362	Northeast (Park Farm) of the Site
SK88SE27	487444, 384567	East (off site (Willingham by Stow))
SK88SE28	487447, 384598	
SK88SW1	483857, 382191	Southwest (off site northwest Marton))

3.2.3 The geology described within these borehole scans is summarised within Table 3-3.

Table 3-3. Geological Succession from Selection of Relevant BGS Boreholes

BGS Borehole	Group	Description	Top Depth (mbgl) (Thickness) (m)
North and northwest of the Site (On-site)			
SK88SW19 SK88SW18 SK88NW62	-	Topsoil	0.0 (0.4)
SK88SW18	Glaciofluvial Deposits	Sand and Gravel - Silty Sand. ‘clayey’ pebbly sand. Gravel; fine, well rounded quartz. Sand: medium well rounded quartz.	0.4 (0.8)
SK88NW62		Sand and Gravel: Silty Sand. Medium grained, some fine and coarse well rounded quartz and less rounded rock fragments, very silty res-brown silt.	0.4 (1.6)
SK88SW45		Sand and gravel.	0.0 (3.05)
SK88SW19	Till, Diamicton	Reddish-brown and grey; some sandy pockets and pebbles of limestone, sandstone, flint and quartz with mudstone towards base.	0.4 (2.6)
SK88SW18		Pale brown and grey, ochreous sandy pockets and a few pebbles of flint and sandstone and clay with greenish brown areas, appears reworked, some pebbles of clack shale and limestone.	1.2 (2.8)
SK88NW62		Grey and brown, weathered appearance, some sandy patches, becomes greyer towards base.	2.0 (1.0)
SK88SW19	Scunthorpe Mudstone	Clay and limestone, dark grey, fossiliferous.	3.0 (>6.0)
SK88NW62	Penarth Group	Dark grey, laminated, unfossiliferous, some harder mudstone and limestone pebbles.	3.0 (>4.5)

BGS Borehole	Group	Description	Top Depth (mbgl) (Thickness) (m)
SK88SW18		Shale, black with pyrite cubes and bivalves.	4.0 (>0.2)
SK88SW45	Mercia Mudstone Group	Keuper Marl	3.05 (250)
Northeast (Park Farm) of the Site (on-site)			
SK88SE9	Scunthorpe Mudstone	Mudstone, grey highly calcareous, several thin gypsums, limestones.	0.0 (45.6)
	Penarth Group	Mudstones, sandstone band.	45.6 (9.2)
	Mercia Mudstone Group	Mudstone, red, chocolate brown various shades of grey, occasionally several thin anhydrites and gypsums.	56.8 (252.5)
East (off site, Willingham by Stow)			
SK88SE27 SK88SE28	Glaciofluvial Deposits	Dense to medium dense dark brown, slightly clayey sand and loose to medium dense light brown slightly clayey fine to coarse sand with some rounded gravel.	0.0 (>1.6)
Southwest (off site, northwest Marton)			
SK88SW1	Holme Pierrepont Sand and Gravel Member	Soil, dry sand, running sand, red clay, sand and quartz.	0.0 (3.05)
	Mercia Mudstone Group	Red clay, shales, stone, marl gypsum.	3.05 (>30)

Soils and Soil Chemistry

3.2.4 Information obtained from Soilscapes [8] describes the soils within the Site as:

- Slowly permeable, seasonally wet slightly acid but base-rich loamy and clayey soils, in the vast majority of the Site;
- Naturally wet very acid sandy and loamy soils, in the north and north-western portion of the Site; and
- Slightly acid loamy and clayey soils with impeded drainage, localised, in the westernmost tips of the site.

3.2.5 The BGS Soil Chemistry datasets provide indicative information on regional concentrations of five potentially harmful elements: arsenic, cadmium, chromium, nickel and lead in soil. Elevated concentrations can exist due to natural geological conditions or possible anthropogenic contamination. The following BGS estimated soil chemistry levels are attributed to the area of the Site based on the geometric mean concentrations of available data (presented in Table 3-4).

Table 3-4. Estimated Soil Chemistry based on BGS background concentrations

Potentially Harmful Element	Estimated geometric mean concentration (mg/kg)
Arsenic	6.78 to 14.1
Cadmium	<0.33 to 1.2
Lead	33.2 to 242
Nickel	10.9 to 31.9
Copper	10.7 to 35

3.2.6 Soil samples were collected for the National Soil Inventory (NSI) by the Soil Survey of England and Wales (now the National Soil Resources Institute, Cranfield University) as part of the Advanced Soil Geochemical Atlas of England and Wales. The maps are based on 5700 surface soil samples (0–15 cm), collected across England and Wales, that have been analysed for 50 major and trace elements. Those determinands considered applicable to the Site and their concentrations are presented in Table 3-5 below.

Table 3-5. Estimated Soil Chemistry based on UK Soil Observatory background concentrations

Determinand	Concentration (mg/kg)
Arsenic	10.38 – 16.81
Cadmium	0.25 – 0.57
Chromium	55 - 67
Copper	16.28 – 27.89
Iron	1.64 – 3.13 (%)
Lead	40 - 83
Nickel	17.93 - 28.8
Selenium	0.29 – 0.48
Vanadium	65 - 95
Zinc	58 - 109

Ground Stability Records

3.2.7 Table 3-6 provides a summary of the variable risk of ground stability hazards across the Site as provided within the Envirocheck report:

Table 3-6 Ground Stability records

Hazard Type	Hazard Potential
Collapsible Ground Stability	No hazard to very low
Compressible Ground Stability	No hazard to moderate
Ground Dissolution Stability	No hazard
Landslide Ground Stability	Very low to moderate
Running Sand Ground Stability	No hazard to low

Hazard Type	Hazard Potential
Shrinking or Swelling Clay Ground Stability	No hazard to low

Mining and Mineral Extraction

3.2.8 The NPPF for England requires minerals planning authorities to promote sustainable use of mineral resources in their Local Plans. This includes defining mineral safeguard zones to ensure that specific mineral resources of local or national importance are not sterilised by non-mineral development (but not assuming that the identified minerals will be worked). If it is necessary for non-mineral development to take place then the local planning authority should set out policies to encourage the prior extraction of minerals, where practicable and environmentally feasible.

3.2.9 When determining planning applications local planning authorities must ensure that, amongst other matters, that there are no unacceptable impacts on the natural and historic environment, human health or aviation safety (taking into account cumulative effects from multiple sites); unavoidable noise, dust and particle emissions, and vibrations are controlled, mitigated or removed at source; and to not normally permit other developments in mineral safeguard zones.

3.2.10 The NPPF makes particular reference to the extraction of peat and coal. It stipulates that in their identification of mineral resources, authorities should not identify new sites or extensions to existing sites for peat extraction, and planning permission for such use should not be granted. Permission should also not be given for the extraction of coal unless the proposal is environmentally acceptable (or it can be made so), or if not, it provides national, local or community benefits which are far greater than the likely impacts.

3.2.11 The Core Strategy & Development Management Policies Plan, adopted in June 2016 [9], indicates that a limited portion of the Site to the southwest and north are located within a Mineral Safeguarding Area (MSA) for Sand and Gravel, which identifies areas where sand and gravel are of current, or future, economic importance. As reported in Policy M11, applications of non-mineral developments within MSAs must include a Minerals Assessment and it will be granted if the development would not sterilise mineral resources or prevent future minerals extractions. If this is not the case, planning permission will be granted when:

- *"the applicant can demonstrate to the Mineral Planning Authority that prior extraction of the mineral would be impracticable, and that the development could not reasonably be sited elsewhere; or*
- *the incompatible development is of a temporary nature and can be completed and the site restored to a condition that does not inhibit extraction within the timescale that the mineral is likely to be needed; or*
- *there is an overriding need for the development to meet local economic needs, and the development could not reasonably be sited elsewhere; or*
- *the development is of a minor nature which would have a negligible impact with respect to sterilising the mineral resource; or*

- *the development is, or forms part of, an allocation in the Development Plan".*

3.2.12 The Site is located within a Sand and Gravel Area of Search[1].

3.2.13 The Coal Authority Interactive Map [9] reports that the Site is located within a Surface Coal Resource Area. The site is not located within a Coal Mining Reporting Area or in a Development High Risk Area. No records of coal mining activities are reported by the Coal Authority Interactive Map nor the Envirocheck Report.

3.2.14 Table 3-7 presents the available information on mining and quarrying operations, that have taken place within 250m of the Site. All identified operations have now ceased; operators are unknown.

Table 3-7 Former Quarrying activities within 250m of the Site

National Grid Reference	On site / Off site	Distance and Direction	Name	Material
483145, 384356	On site	South of Knaith and west of Knaith Park.	Knaith Sand Pit	Sand
483457, 385311		In proximity of Stephenson's hill house, northwestern portion of the Site.	Stephenson's Hill Farm	Sand
485135, 383198		In proximity of Clay Farm, central portion of the Site.	Clay Farm	Common clay and shale
483645, 384603	Off site	Within Park Plantation, adjacent to Site boundary.	Central Park Farm Sand Pit	Sand
483808, 384656		Within Park Plantation, adjacent to Site boundary.	Broom Hills Pits	Sand
484618, 385997		Immediately north of Upton Road, east of Knaith Park – approximately. 70 m north of the Site boundary.	Thurlby Farm Sand Pit	Sand
485361, 385788		East of the Site boundary, north of Kexby Lane– approximately. 90 m north of the Site boundary. – now a pond	Kexby Brick Yard	Common clay and shale

Source: Envirocheck Report Ref: 286968913_1_1

3.3 Hydrogeology

3.3.1 The Environment Agency's Combined Groundwater Vulnerability Map of the area shows that:

- the superficial glaciofluvial, alluvium, Holme Pierremont Member deposits, where present at the site are classified as a Secondary A

[1] Defined in [9] as 'an extensive area of land believed to contain significant, but generally unproven mineral resources within which the Mineral Planning Authority would have no objection in principle to mineral working, on at least part of the site subject to satisfactory proposals to protect the range of interests of acknowledged importance within and adjoining the area'.

aquifer. The Till aquifer is classified as a Secondary undifferentiated aquifer.

- the bedrock deposits of the Scunthorpe and Mercia Mudstone groups are classified as Secondary B aquifers; the Penarth group is classified as a Secondary undifferentiated aquifer.

3.3.2 The Environment Agency's Combined Groundwater Vulnerability Map of the area shows that groundwater vulnerability on site varies from medium to high.

3.3.3 Limited information is available from BGS borehole records regarding groundwater levels within the area. Generally, water was not struck within 6 mbgl. However, occasionally water was observed within 1 mgl. Water is likely to be present within the superficial glaciofluvial, alluvium, Holme Pierremont Member deposits, where these are located on the Site

3.3.4 In terms of identifying the risk of contamination from potential polluting activities in a given area to groundwater sources (wells, boreholes and springs) used for supplying public drinking water, the Environment Agency identifies Source Protection Zones (SPZ). These show the extent of a groundwater source catchment and are divided into three zones, which can be found on the Environment Agency section of the gov.uk website. The site does not lie within a SPZ.

3.3.5 No known licensed groundwater abstractions have been identified within 1km of the site.

Risk of Flooding from Groundwater

3.3.6 The BGS Groundwater Flooding Susceptibility map included in the Envirocheck Report indicates that most of the Site has a limited potential for groundwater flooding to occur.

3.3.7 However, the following areas have a potential for groundwater flooding; these are located in the western and northern, southern portion of the Site:

- potential for groundwater flooding of property situated below ground level: some areas in proximity of Clay Farm (southern portion of the Site) and along Kexby Lane (northern portion of the Site); and
- potential for groundwater flooding to occur at surface exists in Gate Burton village (adjacent to the southwestern boundary of the Site), in localised areas surrounding Park Plantation (northwestern portion of the site), along the railway route and along Kexby Lane.

3.4 Hydrology

3.4.1 The nearest Water Framework Directive surface watercourse/feature to the site is the Tributary of the River Till located along the eastern boundary of the Site, flowing in a southerly direction towards the River Till. The River Till is approximately 1.1 km east of the Site.

3.4.2 The River Trent is located approximately 300 to 350m to the west of the Site at its closest point.

3.4.3 Several other drains and ditches are present on the Site, mostly along existing boundaries between agricultural parcels. The drain network is particularly dense in the south eastern and northern portions of the Site.

3.4.4 No significant ponds or lakes are present on Site; however, small ponds can be observed in the immediate proximity of the Site boundary, associated with farms or other settlements.

3.4.5 Table 3-8 summarises the pertinent surface water quality information available associated with the Site.

Table 3-8 Surface Water Quality

Surface Water Feature	General Quality Assessment (GQA)	Distance (m)	Direction	Upstream / Downstream of Site
Tributary of Till	Chemical: Fail Ecological: Poor	On-site, along the eastern boundary	North-South	N/A
Trent from Carlton-on-Trent to Laughton Drain Water Body	Chemical: Fail Ecological: Moderate	300 m west of the Site	South-North	N/A

3.4.6 No Licensed Surface Water Abstractions have been identified within 1km of the Site.

3.4.7 Information on private abstractions has been requested and will be included within Chapter 9 Water Environment of the Environmental Statement.

3.5 Risk of Flooding from Surface Water

3.5.1 Flood maps included in the Envirocheck report indicate that there is the potential for flooding from the Tributary of the River Till which flows along the eastern boundary of the Site, and from the drain northwest of the Site, in the vicinity of Kexby Lane.

3.5.2 Another area subject to flooding is located south of the Site, in proximity of Sort Hills farm.

4. Historical & Planned Development

4.1 Historical Ordnance Survey Mapping & Aerial Photographs

4.1.1 Historical Ordnance Survey (OS) maps of the Site and the wider environs were provided in the Envirocheck Report (scales 1:2,500, 1:10,560 and 1:10,000) and from Google Earth Pro and these are reviewed in this section.

4.1.2 The historical Ordnance Survey (OS) maps obtained with the Landmark Envirocheck report date between 1885 and 2021.

4.1.3 The Site has remained mostly undeveloped since prior to 1900. The railway line was constructed prior to 1900, with farm buildings (including Clay Farm) also present. There was a sandpit and an “old sandpit” noted on the Site in

the northwest from 1900 to 1956. This area is now occupied by grassland. The telecommunications antenna along Clay Lane was visible on the mapping by 2003.

4.1.4 Offsite, the main villages surrounding the Site were already established prior to 1900. These included pumps and wells at this time. Sand pits and brickworks were present adjacent to the north of the Site. The brickyard was disused by the 1950s and shown to be replaced by residential properties in the 1970s. A sewage works was present adjacent to the northern boundary in proximity of Upton Road was noted on the mapping dated 1980 to 2003. Various residential properties adjacent to and immediately surrounding the Site, have been built, removed or modified over this period.

4.1.5 Table 4-1 provides a more detailed summary of the main features present on, and within approximately 250m radius of, the Site boundary. AECOM notes that only indicative map scales are provided. Where dates are stated, these refer to the dates of maps on which the features are present, have changed use or are no longer annotated, and do not necessarily refer to the exact dates of existence of a particular feature. Development that may have occurred between map editions is recorded as occurring on the latter published map, hence there are some limitations to the accuracy to the date of development unless supplementary evidence is available:

Table 4-1 Summary of historical mapping

Date and scale	Key Features on-site	Key Features off site (within 250m)
pre-1900, 1:10,560 and 1:2,500	Mostly agricultural land. Railway crossing the Site approximately north to south through the centre of the site. Clay Farm, Siding Farm, High Pasture Farm are present on-site. 'Long Nursery' located in the central portion of the Site. Burton Windmill located along the southwestern boundary. Sand Pit to the northwest of the Site, close to Gainsborough Road and south of Knaith. Thurlby Farm, located in the northeast of the Site.	Mostly agricultural land with sporadic settlements including Gate Burton village, Knaith village, farms (Sort Hills, Park Farm, Park Farm North, including a pump, Park Farm South, including a well, Stephenson's Farm, including a pump, Sandebus Farm and Golddale Planting). Pumps and a well are present in proximity of the Site, near Knaith village. Glebe Farm (now Park Farm) adjacent to the Site boundary, in the eastern portion of the Site. Sand Pit within Park Plantation and an Old Sand Pit approximately 50 m north of the Site boundary. Brick Yard located to the north east of the Site. Lea Railway Station approximately 100 m from the Site boundary, northern portion of the Site.
1900-1922, 1:10,560 and 1:2500	Burton Windmill no longer present. 'Rises' are now visible within the Site.	Windpipe visible approximately 30m from the site boundary, to the northeast. Sandy Barr cottage, adjacent to the southern boundary of the Site. The BrickYard/Brick Works are now labelled as disused.
1947-1956, 1:10,560 and 1:10,000	No major changes.	Brick yard no longer present. Sporadic presumably residential dwellings now visible of the northern boundary of the Site. By 1956, Glebe Farm is labelled "Park Farm" and includes a windpump.

Date and scale	Key Features on-site	Key Features off site (within 250m)
1970-1973, 1:10,000 (northern portion of the Site only) and 1:2,500 1974-1975, 1:2,500	Several drains are now labelled on-site. Thurbly Farm no longer labelled but some buildings are still present. By 1974, the woodland Burton Gorse, located in the central portion of the Site, is no longer present.	A 'Laundry' is visible approximately 300 m west of the Site boundary, within Knaith. By 1970, the Brick Yard is demolished, and new developments are visible in the same area. By 1974-1975, Park Farm has expanded and includes two ponds and Long Nursery has expanded to the northeast. Sewage works are visible by 1980-1982, adjacent to the northern Site boundary, in proximity of Upton Road.
1980-1981, 1:10,560	Several drains are now labelled on-site. The sand pit in the northwestern portion of the Site is no longer present.	Terrace House Farm now visible within Knaith village, northwest of the Site. Prospect Farm is now visible within Gate Burton village. Buildings labelled as "The Cedars" are now visible immediately southwest of the Site beyond Willingham Road. Small buildings are visible within Park Plantation.
2000, 1:10,000	Buildings previously associated with Thurbly Farm are no longer present. High Pasture Farm is no longer present.	A Nursery House is visible along the southern boundary of the Site, west of Sandebus Farm.
2003-2020, Google Earth Pro Aerial Imagery	The telecom antenna along Clay Lane is visible by 2003. The area previously known as 'Long Nursery' is now a woodland. 'Siding Farm' is comprised of an isolated building, possibly disused, in the 2003 aerial photograph.	Park Farm undergoes redevelopment between 2007 and 2015, with existing buildings being demolished and construction of new ones. The Sewage works along Upton Road are no longer visible in the 2003 aerial photograph. Construction works are also visible at the Nursery close to Sandebus Farm between 2007 and 2018. A new building is constructed around 2012 in proximity of Central Park Farm.
2021, 1:10,000	No major changes.	No major changes.

4.2 Planning Authority Records

4.2.1 The West Lindsey District Council website [10] has been searched for significant planning applications from 2018 onwards which could significantly impact the Site. No major works are planned within the Site or in the immediate surroundings, except for overhead line alterations along Kexby Lane, in proximity of the northern boundary of the Site.

4.3 Unexploded Ordnance Risk

4.3.1 Based on a review of historical maps dated 1907-1947, the Site was not located near any wartime sites of interest such as military bases, ports or industrial centres.

4.3.2 An analysis of the post war historical map (1947-1956) does not show significant redevelopment within the area. Due to the rural area and the low

level of redevelopment throughout the years, there is the possibility that Unexploded Ordnance (UXO) could have gone unnoticed.

4.3.3 The regional UXO mapping published by Zetica [5] shows the Site lies within a zone of low bomb risk.

4.3.4 Based on the findings of the above assessments it is considered that no further action is required with regard to potential unexploded ordnance at the Site.

5. Regulated Activities and Statutory Consultation

5.1 Introduction

5.1.1 The key relevant features that characterise the Site and surrounding area are summarised in this section, along with an indication of the risk to the land quality of the Site.

5.1.2 Information on groundwater and surface water abstractions is detailed in Section 3 and is not repeated here.

5.1.3 Generally, any regulated activities within 250m of the site could, depending upon their nature, represent potential off-site sources of contamination. Whilst a 1km search area is included as part of the Envirocheck data this section places emphasis on those activities present within 250m.

5.2 Regulated Processes

5.2.1 Table 5-1 summarises the pertinent information on regulated processes contained in the Landmark Envirocheck report (Appendix B).

5.2.2 There are no Control of Major Accident Hazards Sites (COMAH), Explosive Sites, Notification of Installations Handling Hazardous Substances (NIHHS), Planning Hazardous Substance Consents, Planning Hazardous Substance Enforcements, Fuel Station Entries, Gas Pipelines, Underground Electrical Cables, within the Site or in a 250m radius from the Site.

Table 5-1 Summary of Regulatory Information

Subject	Number Present		Details
	On site	0-250m	
Discharge Consents	-	6	Six discharge consents are listed within 250 m of the site. Registered to C Aitchison & M Douce, Sewage Discharges - Final/Treated Effluent - Not Water Company; 10 m west; discharge into Freshwater Stream/River. Status: Revoked Registered to D Fenwick, Agriculture - Livestock Farming- 50 m from the Site boundary, in proximity of Central Park Farm; discharge onto land Status: Deemed Groundwater Regulations Authorisation Registered to Mr Martin Robert Lake, Sewage Discharges - Final/Treated Effluent - Not Water Company- 240 m west; discharge into Freshwater Stream/River. Status: New Consent

Subject	Number Present		Details
	On site	0-250m	
			2 entries Registered to Anglian Water Services Limited, Public Sewage: Storm Sewage Overflow and Sewage Discharges - Stw Storm Overflow/Storm Tank - Water Company, 70 m east; discharge into Freshwater Stream/River. Status: New Consent. Registered to Anglian Water Services Limited, Public Sewage: Storm Sewage Overflow; 90 m east; discharge into Freshwater Stream/River. Status: Revoked: New Consent Issued.
Pollution Incidents to Controlled Waters	2	1	Two Pollution Incidents to Controlled Waters on-site: August 1993: Category 2 – significant incident; receiving waters: Freshwater Stream/River; pollutant: unknown; located in the central portion of the Site. July 1996: Category 3 – minor Incident; receiving waters: Freshwater Stream/River; pollutant: Organic Wastes: Cattle slurry; located along Kexby Lane, northwestern portion of the site. One Pollution Incident to Controlled Waters off-site: June 1992: Category 3 – Minor Incident; receiving waters: Padmoor Drain; pollutant: unknown; located 110 m east.
Substantiated Pollution Incident Register		1	August 2009 – Water impact: Category 2 – Significant Incident; no Land Impact; pollutant: Agricultural Materials and Wastes, Soil Conditioners; located in proximity of Park Farm.

Source: Envirocheck Report Ref. 286968913_1_1

5.3 Licensed Waste Management Facilities

5.3.1 There are no BGS Recorded Landfill Sites, Historical Landfill Sites, Integrated Pollution Control Registered Waste Sites, Licensed Waste Management Facilities (Landfill Boundaries), Local Authority Recorded Landfill Sites, Registered Landfill Sites, Registered Waste Transfer Sites, Registered Waste Treatment or Disposal Sites within the Site or in a 250m radius from the Site.

5.3.2 A licensed waste management facility is present 50m from the boundary of the Site, associated with Park Farm. It is recorded as a household, commercial and industrial transfer station registered to G H By Products Ltd. Current status of the licence is unknown, however it is noted that it was last modified in November 2020.

5.4 Industrial Land Use

5.4.1 There is one active contemporary trade directory entry, located approximately 20m from the southwestern tip of the Site, in Gate Burton. It is associated with horse boxes and transporting.

5.5 Sensitive Land Uses

5.5.1 The Envirocheck Report indicates that Burton Wood, located in the central portion of the Site, is associated with two Ancient Woodland entries as Ancient and Semi-Natural Woodland and as a Plantation on Ancient Woodland.

5.5.2 The Site, or portions of it, are located within four Nitrate Vulnerable Zones (Nvz) for surface water:

- R Trent From Carlton-On-Trent To Laughton Drain Nvz;
- Marton Drain Catchment (Trib Of R Trent) Nvz;
- Seymour Drain Catchment (Trib Of River Trent) Nvz; and
- Lower Witham Nvz.

5.5.3 There are no Areas of Adopted Green Belt, Areas of Unadopted Green Belt, Areas of Outstanding Natural Beauty, Environmentally Sensitive Areas, Forest Parks, Local Nature Reserves, Marine Nature Reserves, National Nature Reserves, National Parks, Nitrate Sensitive Areas, Ramsar Sites, Sites of Special Scientific Interest, Special Areas of Conservation, Special Protection Areas, World Heritage Sites within the Site or in a 250m radius from the Site.

6. Preliminary Ground Model

6.1.1 Based on the review of published geological and hydrogeological information and a selection of historical borehole records, the ground conditions within the Site are considered to comprise the following sequence presented in Table 6-1.

Table 6-1 Preliminary Ground Model

Geology	Typical Description and anticipated thickness	Location and extent	Aquifer	Depth to Groundwater	Ground Gas Potential
Made Ground /Topsoil	Made Ground – thickness unknown Topsoil – 0.4m	Limited potential for Made Ground. Key areas associated with Railways, farm building areas, antennae, infilled pit Topsoil recorded in the north and northwest of the Site.	-	Limited information is available from BGS borehole records regarding groundwater levels within the area. Generally, water was not struck within 6 mbgl. However, occasionally water was observed within 1 mbgl. Water is likely to be present within the superficial glaciofluvial, alluvium, Holme Pierremont Member deposits, where these are located on the Site.	Low (potential infilled pits – unknown fil material)
Superficial Deposits - Glaciofluvial deposits	Sand and Gravel – silty sand. 'clayey' pebbly sand. Gravel; fine, well rounded quartz. Sand: medium well rounded quartz; Medium grained, some fine and coarse well rounded quartz and less rounded rock fragments, very silty res-brown silt; sand and gravel, silty sand ; dense to medium dense dark brown, slightly clayey sand and loose to medium dense light brown slightly clayey fine to coarse sand with some rounded gravel - 0.8 – 3.05m	Recorded in the northwest of the Site, and off-site (west and east of the Site)	Secondary A		Very Low
Superficial Deposits - Alluvium	Normally soft to firm consolidated, compressible silty clay, but can contain layers of silt, sand, peat and basal gravel[2] - thickness unknown.	Mapped in an isolated area in proximity of Clay Farm but not recorded within reviewed boreholes	Secondary A		Low. Possible if organic material present. However, isolated area and limited extent.
Superficial Deposits - Till - diamicton	Reddish-brown and grey; some sandy pockets and pebbles of limestone, sandstone, flint and quartz with mudstone towards base; ale brown and grey, ochreous sandy pockets and a few pebbles of flint and sandstone and clay with greenish brown areas, appears reworked, some pebbles of clack shale and limestone; grey and brown,	Recorded in the northwest of the Site	Secondary undifferentiated		Very Low

[2] BGS description.

Geology	Typical Description and anticipated thickness	Location and extent	Aquifer	Depth to Groundwater	Ground Gas Potential
	weathered appearance, some sandy patches, becomes greyer towards base at 1.0m – 2.8m				
Superficial Deposits - Holme Pierrepont Sand And Gravel Member	Soil, dry sand, running sand, red clay, sand and quartz; red clay, shales, stone, marl gypsum – 3.05m	Recorded mainly off-site, to the southwest of the Site. However, these may marginally encroach on to the Site in the southwestern tip of the Site at Gate Burton.	Secondary A		Low

7. Initial Conceptual Site Model

7.1 Introduction

7.1.1 This section is aimed at identifying possible risks, if any, arising from substances used or deposited on-site, or from other sources of land contamination. Both past and current potentially contaminative land uses have been considered. It is based on the Solar and Energy Storage Park only which will comprise the installation of solar PV generating panels and on-site energy storage facilities. This Phase 1 Desk Study will be updated to include the Grid Connection Route and will be submitted with the Environmental Statement (ES).

7.2 Assessment Framework

7.2.1 Current best practice recommends that the determination of health hazards due to contaminated land is based on the principle of risk assessment, as outlined in the Statutory Guidance to Part 2A (2012) and Land Contamination: Risk Management (LCRM) (2020).

7.2.2 The “suitable for use” approach is adopted for the assessment of contaminated land where remedial measures are undertaken where unacceptable risks to human health or the environment are realised taking into account the use (or proposed use) of the land in question and the environmental setting.

7.2.3 The risk assessment process for environmental contaminants is based on a source-pathway-receptor analysis. These terms can be defined as follows:

- **Source**: hazardous substance that has the potential to cause adverse impacts; and
- **Pathway**: route whereby a hazardous substance may come into contact with the receptor: examples include ingestion of contaminated soil and leaching of contaminants from soil into watercourses; and
- **Receptor: target that may be affected by contamination**: examples include human occupants/ users of site, water resources (surface waters or groundwater), or structures.

7.2.4 For a risk to be present, there must be a relevant/ viable contaminant linkage; i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.

7.2.5 The following sections details the initial Conceptual Site Model (iCSM) which has been developed for the Site with a view to assessing the potential risks/ liabilities and constraints associated with the Site in its current condition prior to any proposed redevelopment. Risks associated with the proposed redevelopment have also been assessed based on a commercial future land use scenario, including any potential sources of contamination, potential receptors and potential contaminant pathways identified during this desk-based assessment.

7.3 Sources of Potential Contamination

7.3.1 Based on the above Table 7-1 lists the potential sources of contamination that may be found at the Site and associated potential contaminants with reference to the DoE Industry Profiles [11] and R&D Publication 66: 2008 [12].

Table 7-1 Potential Sources of Contamination

Source Reference	Location	Potential Sources	Typical Associated Contaminants of Potential Concern (CoPC)
S1	On-site	Agricultural land and associated facilities	Potential for: metals; inorganics, nitrites, nitrates, ammonium pesticides and herbicides; hydrocarbons
S2	On-site	Railway and sidings	Potential for hydrocarbons; Polychlorinated Biphenyls (PCBs); Polycyclic Aromatic Hydrocarbons (PAH) and creosote; Solvents; Benzene, toluene, ethylbenzene; xylene (BTEX) herbicides; metals; asbestos, ash and fill, sulphates
S3	On-site	Potentially infilled land associated with historic quarries and pits	Low potential for ground gas. Subject to the nature of fill materials, potential for a range of inorganic and organic contaminants including but not limited to metals, metalloids, acids, alkalis, organic compounds, inorganic compounds, asbestos, Total Petroleum Hydrocarbons (TPH), PAH, solvents, lubricants, fuel oils, Volatile Organic Compounds (VOC), Semi-Volatile Organic Compounds (SVOC), timber and water treatment chemicals, PCBs, methane, hydrogen sulphide and carbon dioxide.
S4	On-site	Potential Made Ground associated with utilities infrastructure (Antennae, drainage, roadways)	Low potential for ground gas. Potential for a range of inorganic and organic contaminants including but not limited to metals, metalloids, acids, alkalis, organic compounds, inorganic compounds, asbestos, TPH, PAH, solvents, lubricants, fuel oils, VOC, SVOC, timber and water treatment chemicals, PCB, methane, hydrogen sulphide and carbon dioxide.
S5	Off-site Sources	Agricultural land and associated facilities Railway and sidings Potentially infilled land associated with historic quarries and pits Potential Made Ground associated with utilities (gas) infrastructure Former Sewage works Former Brick Yard	Potential for: metals; inorganics, nitrites, nitrates, ammonium pesticides and herbicides; hydrocarbons PCBs, TPH, PAH and VOC, SVOC; BTEX asbestos, ash and fill, sulphates Low potential for ground gas – infilled ground, former sewage works (methane, hydrogen sulphide and carbon dioxide).

Sources: Department of Environment Industry Profiles [11] and R&D Publication 66: 2008 [12].

7.4 Potential Receptors

7.4.1 Potential receptors associated with the Scheme are shown on Table 7-2.

Table 7-2 Potential Receptors

Receptor Reference	Receptor	Description
R1	Human Health (Future users)	Future commercial receptors on-site (workers/maintenance workers at the Main Site – duration anticipated to be three staff per day during operation with an average two visitors per day).
R2	Human Health (off site – commercial/residential properties)	Commercial receptors off-site (adjacent farms and commercial properties during construction works only).
R3	Water Environment: Superficial Aquifers	Groundwater within the Secondary A and Secondary undifferentiated aquifers.
R4	Water Environment: Surface waters	Tributary of the Till, River Trent and multiple drains and ponds on-site and off-site. River Till and River Trent.
R5	Water Environment: Bedrock Aquifers	Groundwater within the Secondary B and Secondary undifferentiated aquifers.
R6	Buildings & Infrastructure: Concrete foundations associated with buildings, solar PV, utilities services.	Infrastructure at risk from ignition of accumulated ground gas in confined space. Below ground infrastructure at risk from aggressive ground conditions.

7.5 Potential Pathways

7.5.1 Potential pathways associated with the Scheme are shown in Table 7-3.

Table 7-3 Potential Pathways

Pathway Reference	Receptor	Description
P1	Human Health	Direct contact, dermal absorption or ingestion of soil/ water.
P2	Human Health	Inhalation of soil particulates or soil vapour derived from soils.
P3	Human Health	Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion).
P4	Water Environment: Surface water	Spillage/loss/run off from surface direct to receiving water.
P5	Water Environment: Surface water	Lateral migration of impacted shallow groundwater towards surface water receptors.
P6	Water Environment: Groundwater	Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater.
P7	Water Environment: Groundwater	Vertical migration of impacted shallow groundwater to the deeper aquifer.
P8	Buildings & Infrastructure: Concrete	Direct contact of buried concrete with contaminated soils (i.e. hydrocarbons) and aggressive ground conditions (pH and sulphate).
P9	Buildings & Infrastructure: Supply pipes	Direct contact of services and supply pipes with contaminated soils.
P10	Buildings & Infrastructure: Structures	Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches.

8. Environmental Risk Assessment

8.1 Risk Assessment Principles

8.1.1 Current best practice recommends that the determination of hazards due to contaminated land is based on the principle of risk assessment, as outlined in the Environment Agency guidance on LCRM.

8.1.2 For a risk to be present, there must be a viable contaminant linkage i.e. a mechanism whereby a source impacts on a sensitive receptor via a pathway.

8.1.3 Assessments of risks associated with each of these contaminant linkages are discussed in the following sections.

8.1.4 Using criteria broadly based on those presented in the National House Building Council/Environment Agency/Chartered Institute of Environmental Health publication R&D 66 (NHBC/EA/CIEH, 2008), the magnitude of the risk associated with potential contamination at the Site has been assessed. To do this an estimate is made of:

- The magnitude of the potential consequence (i.e. severity);
- The magnitude of probability (i.e. likelihood).

8.1.5 The severity of the risk is classified according to the criteria in Table 8-1.

Table 8-1. Description of Severity of Risk

Term	Description
Severe	Highly elevated concentrations likely to result in significant harm to human health. Catastrophic damage to crops, buildings or property (e.g. by explosion). Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects of water quality. Major damage to aquatic or other ecosystems.
Medium	Elevated concentrations which could result in significant harm to human health. Significant damage to crops, buildings or property (e.g. damage to building rendering it unsafe). Equivalent to EA Category 2 pollution incident including significant effect on water quality. Significant damage to aquatic or other ecosystems.
Mild	Exposure to human health unlikely to lead to significant harm. Minor damage to crops, buildings or property (e.g. surface spalling to concrete). Equivalent to EA Category 3 pollution incident including minimal or short-lived effect on water quality. Minor or short-lived damage to aquatic or other ecosystems.
Minor	No measurable effect on humans. Repairable effects of damage to buildings, structures and services. Equivalent to insubstantial pollution incident with no observed effect on water quality of ecosystems.

The probability of the risk occurring is classified according to the criteria in Table 8-2.

Table 8-2 Likelihood of Risk Occurrence

Likelihood	Explanation
High	Contaminant linkage may be present that appears very likely in the short-term and risk is almost certain to occur in the long term, or there is evidence of harm to the receptor.
Likely	Contaminant linkage may be present, and it is probable that the risk will occur over the long term.
Low	Contaminant linkage may be present and there is a possibility of the risk occurring, although there is no certainty that it will do so.
Unlikely	Contaminant linkage may be present but the circumstances under which harm would occur even in the long-term are improbable.

8.1.6 An overall evaluation of the level of risk is gained from a comparison of the severity and probability, as shown in Table 8-3.

Table 8-3 Risk based on Comparison of Likelihood and Severity

		Severity			
		SEVERE	**MEDIUM**	**MILD**	**MINOR**
Likelihood	**HIGH**	Very High	High	Moderate	Low
	LIKELY	High	Moderate	Moderate/Low	Low
	LOW	Moderate	Moderate/Low	Low	Very Low
	UNLIKELY	Moderate/Low	Low	Very Low	Very Low

8.2 LCRM Assessment of Risk

8.2.1 Current contaminated land guidance in LCRM [13] categorises risk at Stage 1 Tier 1 (i.e. PRA) as follows:

- Acceptable; and
- Unacceptable.

8.2.2 However, no framework for assessing the risk has been published to accompany the guidance, so the CIEH & NHBC R&D 66 assessment framework constitutes best practice in this regard. To align the risk rankings in Section 9.2 with the LCRM rankings and with the Part 2A definitions, the following matrix has been utilised. This conversion is demonstrated in Table 8-4 below:

Table 8-4 Conversion to LCRM Risk Categories

	Acceptable	Unacceptable
Very Low		
Low		
Moderate/Low		
Moderate*		
High		
Very High		

** This risk category spans both acceptable and unacceptable. This is intentional as it is this risk band that tends to have the greatest level of uncertainty associated with it. Acceptability will dependent on site-specific circumstances and level of confidence in the available evidence.*

For a risk to be unacceptable, the contaminant linkage should be associated with at least a "medium" severity as defined in Table A4.3 in Annex 4 of R&D66 and the probability should (in the majority of cases) be at least "likely" as defined in Table A4.4 of R&D66.

8.2.3 These risk categories represent the level of risk as it is currently understood from the information available at this time.

8.3 Preliminary Risk Assessment

8.3.1 An iCM illustrating plausible contaminant linkages has been formulated for this site. The qualitative preliminary risk assessment of the possible linkages of the above sources (S1 to S5), transport pathways (P1 to P10) and receptors (R1 to R6) is provided in Table 8-5.

8.3.2 The level of risk is determined based on the current condition of the Site (i.e. the effects of mitigation measures are not included).

8.3.3 The preliminary risk assessment undertaken within this section does not consider acute linkages for construction and maintenance workers. AECOM anticipates that these acute linkages will be managed by appropriate health and safety measures.

Table 8-5 Potential Sources, Pathways and Receptors

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
S1 Onsite Agricultural land and associated facilities	P1 Direct contact, dermal absorption or ingestion of soil / water.	R1 Human Health (future users)	Mild	Low	Low	Acceptable	The Site is mostly used as agricultural/undeveloped land. Very limited storage areas were identified However, direct contact and inhalation are possible given the presence of residential and commercial receptors on-site. Exposure is likely to be transient in nature
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Mild	Low	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Mild	Low	Low	Acceptable	
	P1 Direct contact, dermal absorption or ingestion of soil / water.	R2 Human Health (off site – commercial /residential properties)	Mild	Unlikely	Low	Acceptable	Given the presence of a dense drainage network associated with agricultural activities, the risk to surface water is considered to be moderate/low. Groundwater underlying the site was found lying at depths generally > 6m bgl; the presence of superficial deposits was not continuous across the Site therefore the bedrock aquifer may be in direct continuity with shallow soils, potentially impacted by agricultural activities. It is therefore considered that there is a moderate/low risk for contamination to impact the groundwater within the superficial deposits and potentially bedrock. Risk to building infrastructure is considered to be very low/low.
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Mild	Unlikely	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Mild	Unlikely	Low	Acceptable	
	P4 Spillage/loss/run off from surface direct to receiving water	R3 Water Environment: Surface waters	Mild	Likely	Moderate/Low	Acceptable	
	P5 Lateral migration of impacted shallow groundwater towards surface water receptors .		Mild	Likely	Moderate/Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater	R4 Water Environment: Superficial Aquifers	Mild	Likely	Moderate/Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable		Mild	Low	Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	unsaturated strata to shallow and/ or deep groundwater	R5 Water Environment: Bedrock Aquifers					
	P7 Vertical migration of impacted shallow groundwater to the deeper aquifer.		Mild	Low	Low	Acceptable	
	P8 Direct contact of buried concrete with contaminated soils (i.e. hydrocarbons) and aggressive ground conditions (pH and sulphate).	R6 Buildings & Infrastructure: Concrete foundations associated with buildings, solar PV, utilities services.	Minor	Unlikely	Very Low	Acceptable	
	P9 Direct contact of services and supply pipes with contaminated soils.		Minor	Low	Very Low	Acceptable	
	P10 Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches		Medium	Unlikely	Low	Acceptable	
S2 Onsite Railway and sidings	P1 Direct contact, dermal absorption or ingestion of soil / water.	R1 Human Health (future users)	Medium	Unlikely	Low	Acceptable	Access to the railway sidings is generally restricted, therefore direct contact with contaminants is considered unlikely. Residential and commercial receptors may be exposed to vapours and gases although there is no evidence of significant contamination that might cause this from the railway sidings. A minimum distance from the railway sidings is generally assumed due to restrictive access and reduces the risks significantly. Groundwater underlying the Site was
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Medium	Unlikely	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Medium	Unlikely	Low	Acceptable	
	P1 Direct contact, dermal absorption or ingestion of soil / water.	R2 Human Health (off site – commercial/	Medium	Unlikely	Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	P2 Inhalation of soil particulates or soil vapour derived from soils.	residential properties)	Medium	Unlikely	Low	Acceptable	found lying at depths generally > 6 m bgl. The presence of superficial deposits was not continuous across the Site and within the area of the railway, this is likely to only be Till deposits (low permeability). Therefore, the shallow aquifers are unlikely be impacted by soil from the railway. The bedrock aquifer may be in direct continuity with shallow soils, potentially impacted by railway sidings. However, given the limited extent of railway land and the presence of a relatively deep groundwater, the risk to groundwater is considered to be low. Given the presence of a dense drainage network crossing the railway path in multiple points, the risk to surface water is considered to be moderate/low. Risk to building infrastructure is considered to be very low/low.
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Medium	Unlikely	Low	Acceptable	
	P4 Spillage/loss/run off from surface direct to receiving water	R3 Water Environment: Surface waters	Mild	Likely	Moderate/Low	Acceptable	
	P5 Lateral migration of impacted shallow groundwater towards surface water receptors.		Mild	Low	Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater	R4 Water Environment: Superficial Aquifers	Mild	Low	Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater	R5 Water Environment: Bedrock Aquifers	Mild	Low	Low	Acceptable	
	P7 Vertical migration of impacted shallow groundwater to the deeper aquifer.		Mild	Low	Low	Acceptable	
	P8 Direct contact of buried concrete with contaminated soils (i.e. hydrocarbons) and aggressive ground conditions (pH and sulphate).	R6 Buildings & Infrastructure: Concrete foundations associated with buildings, solar PV, utilities services.	Mild	Unlikely	Very Low	Acceptable	
	P9 Direct contact of services and supply pipes with contaminated soils.		Mild	Unlikely	Very Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	P10 Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches		Medium	Unlikely	Low	Acceptable	
S3 On site Potentially infilled land associated with historic quarries and pits	P1 Direct contact, dermal absorption or ingestion of soil / water.	R1 Human Health (future users)	Mild	Low	Low	Acceptable	Direct contact with potentially infilled land is considered unlikely given the historical use of the Site and the limited presence of known infilled areas. Residential and commercial receptors may be exposed to vapours and hazardous gases from potentially infilled land, if present. However, this is likely to be limited therefore the risk is deemed to be low. Migration of contaminants from infilled land towards surface water is possible, given the presence of a drainage network associated with agricultural use, however the risk is considered to be low, given the limited extent of known infilled land across the Site. Leaching of contaminants towards both the superficial aquifer (when present) and deep aquifers is possible, but the risk is considered low, given the likely limited extent of Made Ground across the Site. Risk to building infrastructure is considered to be very low/low.
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Mild	Low	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Mild	Low	Low	Acceptable	
	P1 Direct contact, dermal absorption or ingestion of soil / water.	R2 Human Health (off site – commercial/residential properties)	Medium	Unlikely	Low	Acceptable	
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Medium	Unlikely	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Medium	Unlikely	Low	Acceptable	
	P4 Spillage/loss/run off from surface direct to receiving water	R3 Water Environment: Surface waters	Mild	Low	Low	Acceptable	
	P5 Lateral migration of impacted shallow groundwater towards surface water receptors .		Mild	Low	Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable	R4 Water Environment:	Mild	Low	Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	unsaturated strata to shallow and/ or deep groundwater	Superficial Aquifers					
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater	R5 Water Environment: Bedrock Aquifers	Mild	Low	Low	Acceptable	
	P7 Vertical migration of impacted shallow groundwater to the deeper aquifer.		Mild	Low	Low	Acceptable	
	P8 Direct contact of buried concrete with contaminated soils (i.e. hydrocarbons) and aggressive ground conditions (pH and sulphate).	R6 Buildings & Infrastructure: Concrete foundations associated with buildings, solar PV, utilities services.	Mild	Unlikely	Very Low	Acceptable	
	P9 Direct contact of services and supply pipes with contaminated soils.		Mild	Unlikely	Very Low	Acceptable	
	P10 Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches		Medium	Unlikely	Low	Acceptable	
S4 On site Potential Made Ground associated with utilities infrastructure (Antennae, drainage)	P1 Direct contact, dermal absorption or ingestion of soil / water.	R1 Human Health	Mild	Unlikely	Very Low	Acceptable	Direct contact with potential Made Ground is to be considered unlikely given the historical use of the Site and the likely limited presence of Made Ground. Residential and commercial receptors may be exposed to vapours and hazardous gases from potential Made Ground. However, extent of those is likely to be limited therefore the risk is
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Mild	Unlikely	Very Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion)		Mild	Unlikely	Very Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	P1 Direct contact, dermal absorption or ingestion of soil / water.	R2 Human Health (off site – commercial/residential properties)	Medium	Unlikely	Low	Acceptable	deemed to be low. Migration of contaminants from Made Ground towards surface water is possible, given the presence of a drainage network associated with agricultural use, however the risk is considered to be low, given the presumably limited extent of Made Ground across the Site. Leaching of contaminants towards both the superficial aquifer (when present) and deep aquifers is possible, given the likely limited extent of Made Ground across the Site. Risk to building infrastructure is considered to be very low/low.
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Medium	Unlikely	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion).		Medium	Unlikely	Low	Acceptable	
	P4 Spillage/loss/run off from surface direct to receiving water.	R3 Water Environment: Surface waters	Mild	Low	Low	Acceptable	
	P5 Lateral migration of impacted shallow groundwater towards surface water receptors.		Mild	Low	Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater.	R4 Water Environment: Superficial Aquifers	Mild	Low	Low	Acceptable	
	P6 Leaching of chemicals and vertical migration via permeable unsaturated strata to shallow and/ or deep groundwater.	R5 Water Environment: Bedrock Aquifers	Mild	Low	Low	Acceptable	
	P7 Vertical migration of impacted shallow groundwater to the deeper aquifer.		Mild	Low	Low	Acceptable	
	P8 Direct contact of buried concrete with contaminated soils (i.e. hydrocarbons) and aggressive ground conditions (pH and sulphate).	R6 Buildings & Infrastructure: Concrete foundations associated with	Mild	Unlikely	Very Low	Acceptable	

Source	Pathway	Receptor	Potential Severity	Likelihood of Occurrence	Potential Risk (R&D 66)	LCRM Risk Category	Justification
	P9 Direct contact of services and supply pipes with contaminated soils.	buildings, solar PV, utilities services.	Mild	Unlikely	Very Low	Acceptable	
	P10 Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches.		Medium	Unlikely	Low	Acceptable	
S5 Off Site Agricultural land and associated facilities Railway and sidings Potentially infilled land associated with historic quarries and pits Potential Made Ground associated with utilities (gas) infrastructure Former Sewage works Former Brick Yard	P1 Direct contact, dermal absorption or ingestion of soil / water.	R1 Human Health (future users)	Medium	Unlikely	Low	Acceptable	The risk from off-site sources to on-site human receptors and infrastructure is considered to be very low to low. Risk to building infrastructure is considered to be very low/low.
	P2 Inhalation of soil particulates or soil vapour derived from soils.		Medium	Unlikely	Low	Acceptable	
	P3 Migration of hazardous gases/vapours via permeable strata into confined spaces (asphyxiation/explosion).		Medium	Unlikely	Low	Acceptable	
	P10 Migration of hazardous gases/vapours via permeable strata into enclosed spaces and service/utility trenches	R6 Buildings & Infrastructure: Concrete foundations associated with buildings, solar PV, utilities services.	Mild	Unlikely	Very Low	Acceptable	

8.4 Discussion of Acute Risk to Future Construction Workers & Off-Site Receptors.

8.4.1 AECOM understands that the Scheme works will be undertaken in compliance with Construction Design and Management (CDM) 2015 regulations.

8.4.2 Prior to work commencing, a health and safety risk assessment should be carried out by the appointed Principal Contractor / developed in accordance with current health and safety regulations. This assessment should cover potential risks to construction staff, permanent site staff and the local population. Based on the findings of this risk assessment, appropriate mitigation measures should be implemented during the construction period.

8.4.3 The greatest potential for generation of dust will be during the Site works and therefore dust generation should be kept to a minimum in accordance with general best practice, as outlined in, for example, 'Environmental Good Practice on Site', CIRIA Publication C692 to reduce this risk.

8.4.4 The risk to construction workers during the excavation and construction phases in terms of potential exposure to high concentrations of contaminants is considered to be low given the historic and current land uses identified at the Site. Should gross contamination be identified during the construction phase, then this may pose a potential acute risk to construction works. It is likely to be able to be effectively managed through good health and safety practices and protocols. Adoption of appropriate dust suppression techniques would also mitigate the degree of potential particulate migration off-site.

9. Conclusions

9.1.1 The following is a summary of the review of the information sources listed in Section 1.3.

9.1.2 The anticipated geology comprises localised Glaciofluvial deposits, Alluvium, Till-diamicton and Holme Pierrepont Sand and Gravel Member superficial deposits on approximately a third of the Site. The bedrock formations, expected to be underlying the Site are the Scunthorpe Mudstone Formation, Penarth and Mercia Mudstone Group.

9.1.3 The glaciofluvial, Alluvium, Holme Pierremont Member deposits, where present at the Site, are classified as a Secondary A aquifer. The Till aquifer is classified as a Secondary undifferentiated aquifer.

9.1.4 The bedrock deposits of the Scunthorpe and Mercia Mudstone groups are classified as Secondary B aquifers; the Penarth group is classified as a Secondary undifferentiated aquifer. The Secondary B aquifer is only occasionally provided cover by superficial deposits; the Secondary undifferentiated aquifer within the Penarth Group is at shallow depth in the southwestern portion of the Site.

9.1.5 Based on the review of historical maps, the Site has had a predominantly agricultural use with the exception of the railway line running through the centre of the Site. Sporadic other potential sources of contamination were identified within the Site boundaries and off-site, including several historical quarries, potentially infilled, potential Made Ground, gas infrastructure, former sewage works and a brick yard.

9.1.6 Given the Scheme, the sources identified and the nature of the likely exposure to existing human health receptors and that of the future users of the Site, the risk to human health is considered to be low. Risks to controlled waters has been identified to be low to moderate/low, considering the presence of numerous drains in the drainage network within the Site, which may also provide potential pathways to the River Till and River Trent.

9.1.7 Overall, the potential risks that have been identified have been assessed by the Preliminary Risk Assessment as being acceptable.

9.1.8 Therefore, the potential risks identified are not considered to pose a significant risk to the Scheme.

10. Recommendations

10.1.1 Although a low to moderate low risk has been identified, it would be prudent to undertake some limited intrusive ground investigation to confirm the findings of this assessment which may be included as part of any geotechnical scope of works. Investigation may be most relevant where there might be some ground disturbance required by the scheme. In undertaking an intrusive ground investigation, an assessment of the ground and groundwater profiles may be carried out and the geo-environmental and geotechnical risks associated with the Site made. This will allow for a quantitative risk assessment to be undertaken and a refined CSM to be developed in accordance with LCRM methodology and the requirements of a Tier 1, Stage 2 level of assessment. The investigation will allow for a more quantitative assessment as to whether any of the potential risks identified in this study are present and are of material concern to the Scheme.

10.1.2 Key objectives to be addressed by the investigation should include:

- Confirmation of the ground (and groundwater) conditions and validation of the CSM;
- Chemical status of Made Ground and natural soils for the purpose of risk assessment to human health, groundwater and for preliminary waste classification (if required);
- Chemical status of surface water and groundwater in order to determine risks to controlled waters as part of the construction works; and
- Potential localised ground gas monitoring where there may be buildings close to known areas of infilled land.

10.1.3 Additional objectives of the investigation, depending on the final development proposals and if required may include:

- Identification of geotechnical design parameters for earthworks and preliminary foundation design (where required); and
- Confirmation of infiltration characteristics for any drainage infrastructure which may be required.

10.1.4 The investigation should be designed with due consideration of the requirements of BS 10175:2011+A2 2017. However, due the size of the Site, consideration should be undertaken with regard to exploratory hole spacing requirements to provide a proportionate investigation for the limited contamination anticipated and the planned development proposed.

10.1.5 If geotechnical considerations are required such as understanding ground conditions for any foundation requirements, infrastructure, access roads etc, this part of the scope of the investigation should be designed with consideration of BS EN 1997-1:2004, BS EN 1997-2:2007 (Eurocode 7: Geotechnical Design – Parts 1 and 2) and BS 5930:2015+A1:2020.

10.1.6 If there is likely to be excavated soils associated with the Scheme construction and a planned re-use of that material within the Scheme design, a Materials Management Plan developed in accordance with the CL:AIRE Definition of Waste Development Industry Code of Practice may be a suitable framework to manage excavated materials for this project.

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Annex A– Photolog

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