RLRE Consulting Engineers

Low Moor Road,

Sutton-in-Ashfield

Phase 1 Geo-environmental Desk Study

Low Moor Road, Sutton-in-Ashfield

PHASE 1 GEO-ENVIRONMENTAL DESK STUDY

For

Hallam Land Management Ltd

DATE: 08th Feb 2022

REV: 0

P22-070

Document Reference & Control

Project Name:	**Low Moor Road, Sutton-in-Ashfield**
Project Reference:	**P22-070**
Report Title:	**Phase 1 Geo-environmental Desk Study**
Client:	**Hallam Land Management Ltd**
Document Reference:	**22-070-RL-22-XX-RP-O-0001**
Report Status:	**Final**

Approval Status	Name & Position
Prepared by:	Ben Dorrington MSc BSc Graduate Geotechnical Engineer
Reviewed by:	James Bee MSci PDip FGS Principal Geotechnical Engineer
Approved by:	Stewart Friel MSc BSc(Hons) MIEnvSc Director

Revision Status	Date	Summary of Revision

Executive Summary

This summary presents the salient points of the report and should not be referred to in isolation.

Instruction	In February 2022 Hallam Land Ltd commissioned Rodgers Leask (RL) Ltd to compile a Phase One Desk Study (DTS) for a site at Newark Road, Sutton-in-Ashfield, Nottinghamshire.
Site Location and Description	The site is located off Newark Road, Sutton-in-Ashfield, NG17 5LD and is approximately centred on National Grid Reference 451649E, 358215N. The site comprises agricultal land as is bound to the north and east by roads. The south of the site is bound by agricultural fields and the west of the site comprises residential properties.
History	The majority of the Site has mostly comprised greenfield land for most of its life with the exception to the area in the north of the site and a small area in the eastern corner. Earliest mapping shows sand pits in the north and easternmost corner of the site. The sand pit in the north expanded in size throughout history until it was shown as a playing field on mapping between 1959-1960. The smaller pit in the south-eastern portion of the site remained on mapping up until 1991 and may not have been infilled. Greenfield Farmhouse was present adjacent to the northern site boundary and smaller outbuildings in the north-eastern site corner, demolished between 1967 and 1974.
Geology	The site is indicated to be underlain by Glaciofluvial- Sand and gravel and Head- Sand and silt in the southwest of the site. The majority of the site is not shown to be underlain by superficial deposits. The bedrock geology is the Lenton Sandstone Formation. This was confirmed within the RLE Ltd technical note investigation. Made ground associated with the sand pits/ landfill in the north of the site is present at depths of up to ~10m bgl as shown within the RLE Ltd technical note supporting logs.
Hydrogeology	There are no active groundwater abstraction licenses within 2km of the site. The site is located on a Source Protection Zone 3- Total catchment.
Mining	The Site lies within a Coal Mining Reporting area. However, the depth of worked seams below the site means the risk posed by legacy mining is considered very low.
Hydrology	There are no watercourses located on site. The nearest watercourse is located 139m southwest of the site.
Ecology and Wildlife	The site is located on a Nitrate Vulnerable Zone.
Archaeology	A preliminary online search has shown there are no records pertaining the site. A more detailed search by the relevant HER officer may produce more information.

UXB Risk	The risk from UXO is considered low. No further action is considered necessary.
Flood Risk	The risk of flooding is considered low. The site is not located on or within 50m of a Zone 2 or 3 flood zone and the site is not considered at risk of flooding from rivers or seas. This preliminary risk assessment may need to be confirmed by carrying out a Flood Risk Assessment (FRA) for the Site.
Public Register Information	15 No. records on site related to sand pits, cuttings, unspecified pits, refuse heaps and unspecified disused pits. 1 No. EA record on site related to Stamford Waste disposal Ltd which accepted inert waste. 3 No. EA records between 7m- 384m from the site boundary related to Inert, commercial and household waste. 5 No. records of licensed waste sites between 138m- 345m from the site boundary related to household, commercial and industrial waste.
Potential Contamination Issues	The risk to human health where landfilling has taken place presents a moderate risk to human health. As the majority of the site has been greenfield agricultural land the human health risk related to this is considered low. There are no watercourses located on site but the underlying bedrock has a Principal aquifer status. The risk to Controlled Waters is therefore considered low to moderate given the landfill located on site.
Gassing	The CSM has indicated the gas generation potential is generally considered to be very low to low, with potential sources limited to the landfill in the north of the site and adjacent to the northeast boundary of the site. Gas monitoring conducted to date has identified a low risk gas regime, and data from the EA also indicated a low risk from the adjacent domestic landfill. Low level gas protection measures (Amber 1/ CS-2) in accordance with CIRIA C655/ BS8485 have been recommended based on gas monitoring conducted to date. Further gas monitoring may be required prior to confirmation of gas protection measures required.
Foundations and Geotechnical issues	Previous logs by RLE show deep made ground (~10m deep) in the north of the site in the area associated with the former landfill. In areas where made ground was not present the geology mostly comprised medium dense to dense sand or firm to stiff sandy clay. Piled foundations should be allowed for in areas that coincide with the sand pit in the north. Pile lengths are likely to vary dependant upon the depth of made ground. In areas with less than 2.5m made ground or in areas where made ground is not present traditional strip/ trenchfill foundations are likely to be feasible. RLE did not note shallow groundwater or running sand within the trial pits dug for use as soakaways and note all pits were stable during excavation. Groundwater was encountered at 2.5m bgl in WS08 whilst drilling. A tree survey shall be required which extends beyond the site boundaries for use in foundation design, although on the basis of the RLE logs, the majority of the site is likely to be underlain by granular strata which is unlikely to be subject to volume change.
Further Works	A full Phase 2 investigation to include chemical and geotechnical testing shall be required, and further gas monitring is likely to be necessary.

Contents

Appendices

1.0 Introduction

1.1. Terms of Reference

In February 2022 Hallam Land Ltd commissioned Rodgers Leask (RL) Ltd to compile a Phase One Desk Study (DTS) for a site at Low Moor Road, Sutton-in-Ashfield.

1.2. Proposed Development

It is understood that the site is at the time of writing in the pre-application phase and is proposed to be redeveloped for residential purposes.

1.3. Objectives

The objectives of the investigation were to:

- Obtain desktop study information to assist in the assessment of potential environmental and ground related issues that may have implications for proposed development.
- Review previous works carried out by RLE and include information pertinent to the site.
- Produce a conceptual model for the site using the findings of the desktop study.

1.4. Scope

In order to achieve the outlined objectives, the scope of the study encompassed:

- A study of historical maps.
- Review of geological and mining information.
- An examination of regulatory authority information.
- Review past reports written by RLE which are pertinent to the site
- A screen for unexploded bombs (UXB).
- Production of a conceptual model.

1.5. Previous Reports

The following reports containing information pertaining to the site have been referred to where relevant within this report:

- Rodgers Leask Environmental Ltd (RLE), 'Phase 1 desk study, Low Moor Road, Sutton-in-Ashfield, for Hallam Land Management Ltd, rev A, dated 20th September 2017.
- Rodgers Leask Environmental Ltd (RLE), Technical Note – Permeability Testing and Ground Gas Monitoring, Low Moor Road, Sutton-in-Ashfield, for Hallam Land Management Ltd, Rev A, dated 20th September 2017.
- Rodgers Leask Environmental Ltd (RLE), 'Technical Note – Ground Gas Risk Assessment', Sutton-in-Ashfield, for Hallam Land Management Ltd, Rev A, dated 18th May 2018.

The site extents within the above reports may differ to the Site being assessed within this report.

1.6. Pernicious Plants

No assessment has been made for the presence of pernicious plant species e.g., Japanese Knotweed, Giant Hogweed, within the remit of this investigation.

1.7. Limitations and Confidentiality

All conclusions and recommendations made within this report are based upon and limited to the factual information obtained as part of this investigation. No responsibility can be taken by RL Ltd for information obtained by third parties and it has been assumed that all third-party information provided is true and correct.

RL Ltd has undertaken the work in accordance with our understanding of current best practice at the time of undertaking the report. Further assessment and revision of the report may be required should new information come to light or legislation/changes to best practice be introduced after the date of issue of the report.

RL Ltd has prepared the report for the sole use and reliance of the Client. The report may not be used or relied upon by any unauthorised third party without the explicit written agreement of RL Ltd.

2.0 Site Location and Description

2.1. Site Location

The site is located off Newark Road, Sutton-in-Ashfield, NG17 5LD and is approximately centred on National Grid Reference 451649E, 358215N.

A concept Masterplan is presented in Appendix A. The boundary of the site is indicated by the red line.

The site can be accessed via Newark Road which forms the northern boundary.

The land within the red line boundary will henceforth be referred to as the "site".

2.2. Site Description

A site walkover was undertaken by RL as part of the previous investigation and has not changed in use since. The purpose of the site walkover was to provide a general description of the site. Detailed surveys such as wildlife or trees surveys were outside the scope of this report.

The site has an 'L' shaped outline and covers an area of approximately 21 hectares (ha) and slopes approximately northeast to southwest, with the slope noticeable steeper in the south-eastern corner of the parcel.

The site largely comprises two arable fields, divided and bounded by hedgerows. An overgrown area is present in the southeastern corner of the parcel understood to be an old quarry.

2.3. Site Boundaries

The boundaries of the site comprise:

- Newark Road is located to the north of the site with an industrial estate beyond.
- Coxmoor Road is located adjacent to the eastern boundary of the site with fields beyond.
- Agricultural fields are located to the south of the site.
- The western boundary of the site comprises residential properties and fields.

2.4. Site Access

Vehicular access to the site is gained from Newark Road.

Pedestrian access is gained from Newark Road to the north and Coxmoor Road to the east.

3.0 Historical Review

3.1. Ordnance Survey Maps

Historical Ordnance Survey Maps at various scales have been obtained via an Emapsite MapInsight Report in order to review the historical land use on the site. These maps are presented within Appendix B.

A summary of the historical features is as follows:

Map Date	Site Feature	Adjacent Features
1878 (1:10,560)	Site comprises predominantly fields with sand pits in the north-western corner, adjacent to the north-eastern boundary and south-easternmost corner of the site. A residential dwelling 'Redhouse' is located adjacent to the northern boundary of the site, with some smaller structures adjacen to the north-eastern corner..	Sand pits are located adjacent to the north-eastern boundary of the site. The Site is surroudned by fields with roads along the northern, eastern and western boundary. A bone mill is located 50m north of the site.
1886 (1:10,560)	No significant change.	No significant change.
1898 (1:10,560)	The sand pit in the southeast corner shown as an 'Old Sand Pit'. The sand pit in the north has expanded in size. Redhouse has been renamed 'Greenhill Farm'.	The sand pit adjacent to the northeast corner of the site has expanded in size. The bone mill has also expanded in size and now includes filter beds.
1914 (1:10,560)	Sand pit in the north has increased in size.	The Bone Mill now shows tanks.
1921 (1:10,560)	No significant change.	No significant change.
1938 (1:2,500)	No significant change.	The Bone Mill is no longer shown. Steel works are shown 250m north of site.
1959-1960 (1:2,500)	The sand pit in the north is now labelled as playing field and a Disused Sand Pit.	The sand pit adjacent to the eastern boundary of the site is now shown as dis-used. Residential properties had been constructed adjacent to the northwestern boundary of the site. Works are shown on the location of the former Bone Mill.

Map Date	Site Feature	Adjacent Features
1967 (1:10,000)	The former northern sand pit is no labelled as a Playing Field and a Pavillion had been constructed.	Residential development had occurred to the west around Roundhill Farm.
1974 (1:10,000)	No significant change. The Farmhouse and outbuildings adjacent to the northern site boundary of the site are no longer shown.	No significant change.
1991 (1:10,000)	No significant change.	No significant change.
2001 (1:10,000)	No significant change.	Two further buildings had been constructed on the location of the former bone mill.

3.2. Summary

The majority of the Site has comprised greenfield land for most of its history with the exception to the area in the north of the site and a small area in the eastern corner.

Earliest mapping shows sand pits in the north and easternmost corner of the site. The sand pit in the north expanded in size throughout history until it was shown as a playing field on mapping between 1959-1960. The smaller pit in the south-eastern portion of the site remained on mapping up until 1991 and may not have been infilled. Greenfield Farmhouse was present adjacent to the northern site boundary and smaller outbuildings in the north-eastern site corner, demolished between 1967 and 1974.

The surrounding area has predominantly comprised fields to the south of the site. The land adjacent to the northeast of the site was shown as a sand pit from between 1878- 1960 when it was shown to be disused. A bone mill was shown 50m north of the site from the earliest mapping up until 1938. Between 1959-1960 the land where the former bone mill was located had been redeveloped and shown as 'Works'. This was added to with two further 'Works' buildings and remains the same to this day. Between 1959-1967 a residential development was constructed adjacent to the western boundary of the site.

4.0 Geology, Hydrology, Hydrogeology and Mining

Information regarding the geological conditions of the Site has been obtained via a GroundSure Enviro+Geo Insight report, a copy of which is included in Appendix C as well as RLE Technical Note 'Permeability Testing and Ground Gas Monitoring' dated 13th September 2017 (Appendix D) and 'Ground Gas Risk Assessment' dated 18th May 2018 (Appendix E).

4.1. Geology and Hydrogeology

Information considered pertinent to the Site is presented below.

	Geological Unit	Permeability	Aquifer status (descriptions below table)
Made Ground	Infilled ground is mapped on BGS records in the north of the site. RLE Ltd noted made ground in the north of the site at depths between 0.6m- 10m BGL.	N/A	N/A
Superficial Deposits	BGS mapping shows Glaciofluvial deposits- Sand and gravel are located in the southwest corner of the site.	Very high to high permeability with an intergranular flow type.	Secondary A Aquifer- Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.
	BGS mapping shows Head- Sand and silt deposits in a small area of the southern half of the site.	High to low permeability with a mixed flow type.	Secondary Undifferentiated - Assigned where it is not possible to attribute either category A or B to a rock type. In general, these layers have previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock.

	Geological Unit	Permeability	Aquifer status (descriptions below table)
Bedrock Geology	Lenton Sandstone Formation comprising Sandstone. This was confirmed during the RLE Ltd investigation.	High to moderate permeability with a mixed flow type.	Principal- Geology of high intergranular and/or fracture permeability, usually providing a high level of water storage and may support water supply/river base flow on a strategic scale. Generally principal aquifers were previously major aquifers.
	Nottingham Castle Sandstone Formation slightly encroaches the northeastern boundary of the site.	High to moderate permeability with an intergranular flow type.	Principal aquifer

4.1.1. Structure

A normal inferred fault runs across the site in a northwest-southeast trend.

4.1.2. BGS Borehole Records

There are no BGS borehole records on site. There are 3 No. borehole records between 32m-222m from the site boundary. The poor detail of the logs means they are not considered useful to this report.

4.1.3. Groundwater Abstractions

There are 4 No. groundwater abstraction licenses between 1413m- 1686m from the site boundary relating to pollution remediation and spray irrigation, all of which are historical licenses.

There are no potable water abstraction licenses within 2km of the site boundary.

4.1.4. Source Protection Zone

The Site is located on a Source Protection Zone 3 - total catchment area.

4.1.5. Groundwater Vulnerability and Soil Leaching Potential

The underlying strata are classified as a High Leaching Potential, and a Soil Vulnerability Category of High described as:

'Soils Areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits.'

4.2. Hydrology and Flooding

	Summary
Surface Water features	**On-Site:** There are no records on site. **Off-Site:** There are 3 No. further surface water features recorded between 139m-230m from the site boundary.
Biological & Chemical Data	The River Maun located 628m from the site boundary received a moderate ecological rating and failed the chemical rating in 2019.
Surface Water Abstractions	There are 3 No. active records between 280m- 1018m from the site boundary related to spray irrigation. There is 1 No. record of a historical record 598m from the site boundary related to process water.
Flood Risk	The site is not located on or within 50m of an area that is at risk of flooding from rivers and seas. The site is not located on or within 50m of a zone 2 or 3 flood zone. The highest risk of surface water flooding from extreme rainfall events on site is a 1 in 30-year event with flood depths between 0.3m-1.0m The risk of flooding from unusually high groundwater flooding is considered low.

4.3. Radon

The Site is not in a radon affected area, as less than 1% of properties are above the action level. Therefore, radon protective measures are not required for new developments.

4.4. Mining and Ground Workings

	Summary
Ground Workings map	***Historical:*** ***On-site*** 22 No. records on site related to sand pits, ponds, unspecified disused pits, refuse heaps, old sand pits and cuttings. ***Off-site*** There are 44 No. records between 6m- 243m from the site boundary related to sand pits, unspecified ground workings, unspecified workings, filter beds and unspecified heaps.
Underground workings	There are 3 No. records 891m-994m from the site boundary related to collieries and an unspecified mine.

Mineral Planning Areas	There are 2 No. records between 5m-226m from the site boundary related to sand and gravel. The record 5m northeast has a valid planning status.
Coal Mining	The site lies within a 'Coal Mining Report Area' as defined by the Coal Authority. Further information has been included within section 4.8.
Non-Coal Mining / Mineral Extraction	3 No. records on site related to ceased sand extraction. There are a further 7 No. records between 31m- 330m from the site boundary related to sand and sandstone extraction, all of which have ceased.
Non-Coal Mining Cavities / Natural Cavities	No records.
Brine / Gypsum Extraction	No records.
Clay Mining	No records.

4.5. Potential for Natural Ground Subsidence

Hazard	Hazard Rating	Comments
Shrink -Swell Clays	Low risk in the south of the site. Majority of site is negligible risk.	Low risk associated with Head deposits. Low risk defined as- 'Ground conditions predominantly medium plasticity'. Negligible risk defined as 'Ground conditions predominantly non-plastic'.
Landslides	Very low	Slope instability problems are not likely to occur but consideration to potential problems of adjacent areas impacting on the site should always be considered
Ground Dissolution of Soluble Rocks	Negligible	Dissolution features are unlikely to be present.
Compressible Deposits	Moderate to negligible	Moderate risk associated with the infilled land in the north defined as 'Compressibility and uneven settlement hazards are probably present. Land use should consider specifically the compressibility and variability of the site.' Negligible risk for the majority of the site defined as 'Compressible strata are not thought to occur.'
Collapsible Deposits	Very Low	Deposits with potential to collapse when loaded and saturated are unlikely to be present.

Hazard	Hazard Rating	Comments
Running Sands	Low - Negligible risk	Low risk in the southeast corner and in a small area along the eastern boundary defined as 'Running sand conditions may be present. Constraints may apply to land uses involving excavation or the addition or removal of water.' Very low risk in the north of the site associated with the sand pit and in the south associated with the Head deposits and Glaciofluvial Deposits. Negligible for the majority of the site defined as 'Running sand conditions are not thought to occur whatever the position of the water table. No identified constraints on lands use due to running conditions.'

4.6. Estimated background soil chemistry

The following estimates are provided for the site based upon Rural soil:

Arsenic mg/kg	Cadmium mg/kg	Chromium mg/kg	Nickel mg/kg	Lead mg/kg
7	0.8	76.4	17.3	131.1

4.7. Railways and Tunnels

4.7.1. Tunnels

No records of tunnels are identified within or within 250m of, the Site boundary.

4.7.2. Historical Railways

No records of historical railway or tunnels are identified within the site. There are 27 No. records between 85m- 245m from the site boundary related to railway sidings and mineral railway sidings.

4.7.3. Active Railways

No records of active railways are identified within the site boundary, or within 250m of the site.

4.7.4. HS2

The site does not lie within 500m of HS2.

4.8. Coal Authority records

The Site lies within a Coal Authority reporting area.

A Consultants Coal Mining Report has been obtained for the Site and is included within Appendix F.

The key items reported are as follows:

- The property is in a surface area that could be affected by underground mining. There are 20 No. of records of past underground mining within the vicinity of the site, 6 No. records of which are directly beneath the site ranging from depths between 201m-569m below ground level.
- The site intersects 4 No. abandoned mine plan catalogues which intersect the enquiry boundary, these are EM607, EM944, EM945 and EM468.
- There are no recorded coal mine entries known to the Coal Authority within, or within 100 metres, of the boundary of the property.
- There is 1 No. claim of coal mining subsidence within 50m of the site boundary which is shown on the enquiry plan map.
- The property is not within the boundary of an opencast site from which coal has been removed by opencast methods.
- The Coal Authority has no record of a mine gas emission requiring action.

5.0 Environmental Database records and UXO

5.1. Regulatory data

Data regarding Environment Agency and Local Authority regulatory information has been obtained via a GroundSure Enviro+Geo Insight report, a copy of which is included in Appendix C.

Information considered pertinent to the Site is presented below.

Category		Summary
Historical Industrial Sites from 1:10,000 mapping	*Potentially contaminative use within 500m*	***On-site*** 15 No. records on site related to sand pits, cuttings, unspecified pits, refuse heaps and unspecified disused pits. ***Off-site*** There are 119 No. records between 6m- 497m from the site boundary related to sand pits, refuse heaps, unspecified mills, unspecified works, sand pits, unspecified quarries, filter beds, bone mills, cuttings, railway sidings, steel works, industrial parks, flock mills, brick yards, railway stations, and unspecified factories.
	Historical Tank Database	***On-site*** There are no records on site. ***Off-site*** 33 No. records between 15m- 498m from the site boundary related to tanks and unspecified tanks.
	Historical Energy Features	11 No. records of electricity substations between 91m- 484m from the site boundary.
	Historical Garages	There are 4 No. records between 372m -393m from the site boundary related to garages.
Environmental Permits, Incidents and Authorisations	*Part IIA EPA 1990*	The Site is not determined as Contaminated Land.
	Records of List 2 Dangerous Substance Inventory Sites	There are no records within 500m of the site boundary.
	Licensed pollutant release part A(2)B	There are 7 No. records between 227m- 486m from the site boundary related to coating processes, bulk cement, waste oil burning, hot dip galvanizing and surface cleaning.

Category		Summary
	Licensed Discharge Consents	There are 7 No. records between 275m- 279m from the site boundary related to sewer storm overflow.
	Pollution Incidents	There are 2 No. records 347m and 354m from the site boundary related to crude sewage. These had minor impacts on water and land quality.
Landfills and other Waste Disposal Sites	*EA registered, BGS survey, Local Authority and Historical Mapping*	1 No. record of an active or recent landfill site registered 8m northeast of the site related to household, commercial and industrial waste. 1 No. Historical Landfill (EA/NRW records) on site related to Stamford Waste Disposal Ltd which accepted inert waste, licensed surrendered 22/10/1992. 3 No. EA records between 7m- 384m from the site boundary related to inert, commercial and household waste. 5 No. records of licensed waste sites between 138m- 345m to the east of the site boundary related to household, commercial and industrial waste.
Current land Use	*Current Industrial Sites*	1 No. record on site related to electricity poles.
Designated Environmentally Sensitive Sites	SSSI's, NNR's, AONB's	The site is not located on a SSSI. The site is located on a Nitrate Vulnerable Zone.

5.2. Unexploded Bombs (UXB)

Regional Unexploded Bomb Risk maps obtained from Zetica indicates that the Site is in a Low-risk area for Unexploded Bombs (UXB). A copy of the risk map is included in Appendix G.

Zetica state that low-risk regions are those with a bombing density of up to 15 bombs per 1000 acres or less. These areas are considered to have significant but low UXB risk. In general, further action to mitigate the risk is considered prudent, although not essential. Care is required when assessing the risk for specific sites where the risk may be higher because of local wartime activity.

The Zetica Risk Map shows an area of 'industry' adjacent to the eastern boundary of the site although historical mapping of the area does not highlight what this could relate to.

Given that the Site has historically remained fields for the most part and that the historical maps do not show any obvious signs of wartime activity within the Site locality, the risk of encountering UXB is therefore considered low. No further risk assessment is therefore considered to be required in this regard.

5.3. Archaeology

A preliminary search of the Heritage Gateway archaeological database (www.heritagegateway.org.uk, accessed February 2022) shows no records are on site.

Local Historic Environment Records (HER) databases may contain more detailed information on the archaeology of the site.

6.0 Conceptual Site Model (CSM)

This section provides a qualitative risk assessment of the risk posed from potential on and off-site contamination sources, identified by the information presented in the previous sections.

The conceptual model below has been developed based on the commonly adopted source-pathway-receptor model as recommended within Land Contamination Risk Management (LCRM).

6.1. Proposed Development

It is understood that the site is proposed to be redeveloped for residential purposes.

6.2. Potential Sources of Soil Contamination related to the sites past and current use

6.3. On-site

The site has mostly been occupied for most of its history by agricultural fields. Agricultural land use is not listed within the Department of Industry (DOE) industry profile. However, localised contamination such as made ground where farm buildings were located may be present.

There are multiple records of infilled ground on-site associated with the sand pits which coincide with the location of the historic landfill in the northern portion of the site. This landfill is listed as accepting inert waste. A summary table of the potential contaminants related to the past land uses on site has been included below.

Land Use	Inorganic Contaminants	Organic Contaminants
Landfill	Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Zinc, Sulphate, sulphide, sulphur, asbestos, pH, Free Cyanide, , asbestos.	PAH, Total Petroleum Hydrocarbons (TPH), Volatile Organic Compounds.
Farmland	Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Sulphate, ammonium, nitrates phosphates.	Phenol, PAH; Total Petroleum Hydrocarbons (TPH) pesticides

Asbestos may be present where former above ground or below ground structures have historically been demolished such as the farm building in the north of the site.

Targeted investigation of the made ground should be undertaken to determine the presence of contaminants.

The former sand pit in the southeast corner of the site is not recorded as a landfill and based on the steep topography in this area, is unlikely to have been infilled. Further GI should target this area to confirm the absence of infill materials.

6.4. Off-site

There are 2 No. landfills located 7m and 17m from the site boundary. The closest of which is listed as accepting inert, commercial, and household waste and the other has no information on waste type. The landfill located 7m from site is an EA registered landfill site whose license allowed the deposition of varied wastes including biodegrading wastes but not Difficult Wastes. Wastes with a 'High Polluting Potential' as defined by the EA were allowed. This may act as a source of contamination.

The former Bone Mill to the north of the site which became host to unspecified works thereafter is also a potential source of off-site contamination.

6.5. Ground Gassing

The key sources of ground gassing from on-site and off-site sources are the 2 No. landfills. RLE technical note 'Permeability Testing and Ground Gas Monitoring' dated 13th September 2017' sought to determine the ground gas risk presented by the on-site landfill. The note concluded the following:

Key conclusions from the investigation were that:

- Generally, methane was detected in low concentrations (<5%) in some boreholes at times of low and falling atmospheric pressure.
- The majority of the occurrences of methane were in the deeper CP boreholes, indicating that methane may be generated in the deeper areas of fill onsite.
- Several readings of carbon dioxide were recorded above trigger levels but there was no direct correlation between carbon dioxide and atmospheric pressure.

- The Sutton Quarry landfill was not generating significant concentrations of gas or gas is not migrating onto the Site from the adjacent site.
- According to the CIRIA C665 classification method Amber 1 gas protection measures should be adopted on site. Further monitoring was however recommended.

The coal seams which are located beneath the site are considered to be at a depth where the risk is considered very low in relation to ground gas migration.

The former sand pit in the southeast corner of the site is not recorded as a landfill and is considered unlikely to have been infilled based on current topography. Further investigation will be required to confirm.

Off-site

RLE Technical Note 'Ground gas risk assessment' dated 18th May 2018 aimed to assess the risk of gas migration from the adjacent former household, commercial and industrial waste landfill site to the northeast of the site as well as further, more extensive gas monitoring of the already installed boreholes where the on-site landfill is located. The Environment Agency provided gas monitoring data for the adjacent Sutton Quarry Landfill Site. The data showed any ground gas generated from this landfill was well controlled and does not mitigate to the perimeter of the site.

The note concluded that ground gas monitoring at the Site has identified negligible to low gas regime, and both the area around the former onsite inert landfill and the portion investigated along the northern boundary of the Site adjacent to the off-site domestic waste landfill can be classified as very low to low risk to potential end users. In general, the available data is considered consistent with the recorded and verified inert nature of the waste deposited in the onsite landfill.

Monitoring data received from the EA indicates that the former landfill at Sutton Quarry poses a low risk to the development site. The data suggests that any gas generated within the landfill is well controlled and does not migrate to the perimeter. Generation levels within the former landfill are likely to be low indicated by the quarterly frequency of monitoring.

6.6. Potential Pathways

With regard to the assessment of risk to human health, the following pathways are considered to be potential exposure routes based on residential end-use, in accordance with the CLEA Documentation:

- Dermal contact.
- Direct ingestion of soil.
- Inhalation and ingestion of soil dust.
- Inhalation of gases.
- Ingestion of contaminated water via plastic pipes.

With regard to Controlled Waters, the following pathways are considered applicable:

- Downward infiltration through soils and bedrock
- Lateral migration through soils and bedrock towards the nearest surface feature
- Newly created preferential pathways associated with the redevelopment of the site e.g., deep boreholes/piles/sewers.

6.7. Potential Receptors

The following are considered to be potential receptors for contamination:

Receptor		Additional information
Human Health	Site end users Construction/maintenance workers	A female child will be regarded as the critical receptor.
Controlled Waters	Secondary A Aquifer – superficial. Principal Aquifer – bedrock.	Moderate Sensitivity- Source Protection Zone 3 (Total Catchment) with history of landfill in the area.
	No on site watercourses. Nearest watercourse 139m southwest.	
Other	Neighbouring buildings	Residential properties adjacent to the west of the site.
	Underground structures	
	Flora and fauna	

6.8. Pollutant linkages

Based on the information above, the following potential pollutant linkages are considered applicable to the site. The risk classification has been qualitatively derived in accordance with LCRM. The terminology used is taken from CIRIA C552, and a summary of the principal terms are provided in Appendix G.

Pollutant Linkage	Source	Pathway	Receptor	Probability	Consequence	Risk
1	Contaminated Soils	Ingestion of soil, dermal contact, inhalation of dust	Site end users Construction workers; maintenance workers	Low likelihood	Medium	Moderate / Low
2	Contaminated Soils	Inhalation of soil dust	Members of the public adjacent to the site during construction	Low likelihood	Medium	Moderate/ Low
3	Contaminated Water Supplies	Ingestion of water, Migration of organic contaminants via plastic pipes	Humans – Site End Users	Low likelihood	Medium	Moderate/ Low
4	Contaminated Soils and Groundwater	Leaching and groundwater flow to surface water	Unnamed Watercourse 140m southwest.	Low likelihood	Medium	Moderate/ low
5	Contaminated Soils and Groundwater	Downward migration into groundwater.	Secondary A Aquifer. Principal Aquifer	Low likelihood	Medium	Moderate/ low
6	Contaminated Soils and Groundwater	Leaching of sulphate and corrosive contaminants	Buried concrete structures and services	Low likelihood	Mild	Low
7	Ground gasses from inert wastes made ground and natural soils	Migration of asphyxiant and explosive gasses into confined spaces	Site end users, construction/ maintenance workers in trenches;	Low likelihood	Severe	Moderate

7.0 Conclusions and Recommendations

7.1. Site setting and historical development

The majority of the Site has comprised greenfield land with the exception to the area in the north of the site and a small area in the eastern corner. Earliest mapping showed sand pits in the north and easternmost corner of the site. The sand pit in the north expanded in size throughout history until it was shown as a playing field on mapping between 1959-1960. During this period the small farmhouse located along the northern boundary of the site was demolished.

The north of the site is bound by Newark Road and the east of the site is bound by Coxmoor Road. Agricultural fields are located to the south of the site with residential properties located to the west of the site.

As it stands today the site appears to be used for arable farming.

The site is indicated to be underlain by Glaciofluvial- Sand and gravel and Head- Sand and silt in the southwest of the site. The majority of the site is not shown to be underlain by superficial deposits. The bedrock geology is the Lenton Sandstone Formation. This was confirmed within the RLE Ltd technical note investigation.

Made ground associated with the landfill in the north of the site is present at depths of up to ~10m bgl as shown within the RLE Ltd Technical Note and supporting logs.

7.2. Planning/Enabling Works Considerations

Any clearance of existing hedgerows and trees required to facilitate some of the development should be undertaken outside of bird nesting season. A survey should be undertaken prior to removal of any trees/hedges in order to enable foundation design with respect to tree influence should new structures be proposed. The survey should include boundary vegetation and extend beyond the site boundary to cover any trees that may influence the foundations of proposed structures.

Historical mapping shows past structures were once present on site. Grubbing out of foundations may be required prior works starting.

The site is not shown to be affected by the proposed route of HS2.

7.3. Flood Risk

The site is not located on or within 50m of an area that is at risk of flooding from rivers and seas. The site is not located on or within 50m of a Zone 2 or Zone 3 flood plain.

The highest risk of surface water flooding from extreme rainfall events on site is a 1 in 30-year event with flood depths between 0.3m-1.0m and the risk of flooding from unusually high groundwater flooding is considered low.

As such, available information would suggest that the general risk of flooding is considered low. However, this preliminary risk assessment may need to be confirmed by carrying out a Flood Risk Assessment (FRA) for the Site.

7.4. Access

Vehicular access can be gained off Newark Road in the north of the site. Due to the lack of fencing it is likely that the general public can gain pedestrian access to the site from most areas.

7.5. Qualitative contamination risk assessment

At present the site is in operation as arable farmland. The main sources of contamination are likely to be related to the historical landfill located on site and adjacent to the northeast boundary of the site, these are considered to be low to moderate risk due to the waste type accepted.

Asbestos may be present where former above ground or below ground structures have historically been demolished.

It is therefore considered there is a low to moderate risk of contamination existing from the past land use in the north of the site, but this should be confirmed through testing of soils at the ground investigation stage prior to construction. The remainder of the site which has remained undeveloped greenfield land is considered low risk in regard to contamination.

The risk to Controlled Waters from on-site soils and groundwater is considered low to moderate based on current information given the presence of no on site watercourses, the underlying aquifer classifications (Secondary A and Principal) and the lack of surface water abstraction licenses downstream from the site. Should contaminants be present within soils, the risk that they will affect groundwater and subsequent surface waters shall be related to the mobility of the contaminants, the permeability of strata and distance to receptor. The

sensitivity of the site with respect to the identified controlled water receptors is considered low to moderate at this stage.

7.6. Ground Gas

The CSM has indicated the gas generation potential is generally considered to be very low to low, with potential sources limited to the landfill in the north of the site and adjacent to the northeast boundary of the site. Gas monitoring conducted to date has identified a low-risk gas regime, and data from the EA also indicated a low risk from the adjacent domestic landfill.

The sensitivity of the proposed development in accordance with CIRIA C665 is considered to be high given the intended residential end use and would equate to building type 'A' in accordance with British Standard BS8485:2015+A1:2019.

Low level gas protection measures (Amber 1/ CS-2) in accordance with CIRIA C655/ BS8485 have been recommended based on gas monitoring conducted to date. Further gas monitoring may be required prior to confirmation of gas protection measures required.

During construction works, entry into deep trenches should be avoided, gas may accumulate within the confined space created. Permit to work systems and personal gas monitors may be required for such works.

No radon protection measures are necessary for new structures.

7.7. Surface water drainage

RLE Technical Note 'Permeability Testing and Ground Gas Monitoring' dated 13th September 2017 undertook 6 No. soakaway tests. The tests had infiltration rates ranging between 1.5 x 10^{-6} m/s and 1.3 x 10^{-5} m/s for the Lenton Sandstone Formation. These results are in the lower end of rates which are considered feasible for the use of soakaways and further consultation with a drainage engineer should be sought. If the rates are not considered feasible an alternative means of surface water drainage should be considered.

7.8. Foundation Design and Geotechnical issues for construction

The two technical notes produced by RLE Ltd included WS, CP and TP logs of the site, mostly located in the north of the site. The logs showed deep made ground (~10m deep) in the north of the site in the area associated with the former landfill.

In areas where made ground was not present the geology mostly comprised medium dense to dense sand or firm to stiff sandy clay.

Piled foundations should be allowed for in areas that coincide with the sand pit in the north. Pile lengths are likely to vary dependent upon the depth of made ground. In areas with less than 2.5m made ground or in areas where made ground is not present traditional strip/ trenchfill foundations may be feasible.

Shallow groundwater or running sand was not noted within the trial pits dug for use as soakaways and note all pits were stable during excavation. Groundwater was encountered at 2.5m bgl in WS08 whilst drilling.

A tree survey shall be required which extends beyond the site boundaries for use in foundation design, although on the basis of the logs, the majority of the site is likely to be underlain by granular strata which is unlikely to be subject to volume change.

7.9. Mining and Geological Issues

The Site lies within a Coal Mining Reporting area. However, the depth of worked seams below the site means the risk posed by legacy mining is considered very low.

7.10. Radon

No radon protection measures are required.

7.11. Ecology and Wildlife Issues

Wildlife surveys are outside the scope of this report. However, there are no designated sensitive sites such as SSSI's on the site, although the Site is indicated to lie on a Nitrate Vulnerable Zone.

7.12. Archaeological Issues

A preliminary archaeological database search suggests there are no features of significance recorded on site. Local HER databases may contain more detailed records and it is recommended that early consultation is made with the Local Authority Planners to confirm the requirement for any further action prior to development.

7.13. UXB

Regional Unexploded Bomb Risk maps obtained from Zetica indicates that the Site is in a Low-risk area for Unexploded Bombs (UXB). Given that the Site has historically remained greenfield land and a sand pit, and that the historical maps do not show any obvious signs of wartime activity within the Site locality, the risk of encountering UXB is therefore considered low. No further risk assessment is therefore considered to be required in that regard.

7.14. Geo-environmental Abnormal Risk Register

The following table presents a summary of the main risks identified by the CSM. The table should be read in conjunction with the main body of the report and not in isolation.

Hazard/ Risk	Cause	Risk Rating	Recommendations
Soil & groundwater contamination	Potential made ground; Use of site as landfill	Moderate/ Low	Intrusive ground investigation with chemical testing required.
Asbestos	Past structures noted on site.	Moderate/ Low	Intrusive ground ivestigation testing in areas of landfill and former building footprints
Soil Gas	Landfill on site	Low	Further gas monitoring may be required. Low level (e.g. CS-2/Amber 1) gas protection anticipated.
Flooding	Site does not lie on Zone 2 or 3 flood plain.	Low	May require Flood Risk Assessment.
Foundation Design / Geotechnical issues	Deep made ground.	Moderate/ Low	Intrusive ground investigation required. Grubbing out of old foundations. Alternative foundations (e.g. piled foundations) required in areas of made ground.
Excavations	Instability in granular deposits. Shallow groundwater	Low	Shoring and dewatering unlikely to be required.
Surplus topsoil	Site is arable land, likely to be abundant in topsoil.	Low	Characterise topsoil. Re-use of topsoil on-site where possible.

Hazard/ Risk	Cause	Risk Rating	Recommendations
Earthworks	N/A	Low	Intrusive investigation required. Importation of material may be required to meet minimum FFLs. Place fill material in accordance with an Engineers Specification.
Drainage	Natural soakaways may potentially be feasible	Low/moderate	Drainage engineer assessment required. Alternative solution may be required.

7.15. Recommended further works

An intrusive Phase 2 site investigation shall be required to confirm ground conditions of the wider site as previous investigation has mostly focused on the north of the site. Chemical testing on the landfill area in the north of the site is also required. Further gas monitoring may be needed subject to regulatory liaison.

References

1. British Standards Institution. BS 5930:2015. Code of practice for ground investigations. 2015.

2. British Standards Institution. BS 10175:2015. Investigation of potentially contaminated sites – Code of practice. 2015.

3. British Standards Institution. BS 8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings.

4. Construction Industry Research and Information Association. 2008. Assessing the risk posed by hazardous gases to buildings. C665.

5. Environment Agency. Land Contamination Risk Management (LCRM). Published 8th October 2020.

Appendices

Appendix A: Site Plan