

Persimmon Homes East Midlands

Land North of High Road, Weston, Spalding

Phase 1 Desk Study

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RSK GENERAL NOTES

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

This work has been undertaken in accordance with the quality management system of RSK Environment Ltd.

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EXECUTIVE SUMMARY

Commissioning and purpose of assessment	RSK Environment Limited (RSK) was commissioned by Persimmon Homes East Midlands to carry out a Phase 1 Desk Study of the land north of High Road, Weston, Spalding at grid reference 528852,324944. The overall aim of the project was to assess potential contaminative sources and their linkages and to outline any preliminary geotechnical constraints which may affect the proposed development.
Site description and proposed development	The site currently comprises an agricultural field surrounded by various drainage ditches connected to the River Welland. The site occupies an area of 6.2 hectares and is being considered for development of a residential-led scheme with associated access roads and private gardens.
History of site and surrounding area	The site has historically been used as agricultural farm land, which previously had a drainage network running across the site. It has since been limited to a drainage network around the perimeter of the site.
Previous site investigation (SI) reports	There are no previous SI reports available pertaining to the site.
Geology and environmental setting	The site is underlain by Tidal Flat Deposits over West Walton Formation to the south and Oxford Clay Formation to the north of the site, both of which comprise mudstone according to published geological data. The site is not located within a radon affected area, nor within a coal mining area. Environmental receptors identified comprise: surface water within the River Welland located to the west of the site but connected via the drainage ditches present around site.
Site reconnaissance findings	No potentially significant contaminative sources were noted within the site walkover.
Geotechnical constraints assessment	Based on the published geology for the area, it is likely that the following key geotechnical hazards are likely to affect the site; Significant thickness of highly compressible and low bearing capacity strata (soft clays, silts, organic deposits and peat layers); Shallow groundwater; Shrinkable clays; Blowing sand conditions associated with basal granular layers of the Tidal Flats.
Initial conceptual site model (CSM) and preliminary risk assessment (PRA)	Potentially complete contaminant linkages identified with a risk estimate of moderate to low or above include: risks from potential ground gas production and migration from naturally occurring organic or peat deposits, risks from potential ground gas production and migration from made ground associated with the off-site infilled pond, and risks from residual contamination associated with historical pesticide and herbicide use.
The information given in this summary is necessarily incomplete and is provided for initial briefing purposes only. The summary must not be used as a substitute for the full text of the report.	

1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Persimmon Homes East Midlands to carry out a Phase 1 Desk Study of the land north of High Road, Weston, Spalding, PE12 6RQ. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. 252234-T01 (00), dated 21st August 2019).

This report is subject to the RSK service constraints given in Appendix A and limitations that may be described through this document.

1.2 Proposed development

The site in question is being considered for development for primarily residential use. The planned layout of the site is shown as Figure 3.

1.3 Objectives

The objective of the work is:

- to identify any land contamination and/or geotechnical constraints to the proposed development and to support discharge of relevant planning conditions and relevant building control requirements
- to identify the need for any additional investigation works to demonstrate that the site is suitable for its proposed use

1.4 Scope of works

The scope of this assessment has been developed in accordance with relevant British Standards and authoritative technical guidance as referenced through the report. The assessment of the contamination status of the site is in line with the technical approach presented in CLR 11 Model Procedures for the Management of Land Contamination (Environment Agency, 2004) and in general accordance with BS 10175: 2011 + A2 2017 (BSI, 2017). It is also compliant with relevant planning policy and guidance.

The scope of the intrusive investigation has been designed in line with the recommendations of BS5930: 2015 Code of practice for ground investigations (BSi, 2016), which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. It has also been developed in general accordance with BS 10175: 2011 + A2 2017. Ground gas assessment has been undertaken in general accordance with BS8756: 2013 and BS 8485:2015+A1:2019.

A brief summary of relevant legislation and policy relating to contaminated land is given in Appendix B.

The scope of works for the assessment has included the following:

Desk Study:

- review of the history of development on the site and surroundings, including a study of historical ordnance Survey mapping and other sources of historical information via an environmental database report
- assessment of local geology, hydrogeology and surface water setting, including the identification of potential geological hazards including mining etc.
- review of relevant information held by appropriate statutory authorities, e.g. local authority Environmental Health Departments and Environment Agency/ NRW/ SEPA, obtained from the environmental database report and/ or consultations
- completion of a site reconnaissance survey to assess the visual condition of the site
- development of an initial conceptual site model (CSM) identifying potential contaminant linkages for potential contaminants, completion of a preliminary risk assessment (PRA) and identification of key uncertainties and assumptions in the CSM
- preliminary consideration of geotechnical constraints and hazards
- identification of the need for further action, e.g. intrusive investigations, if any.

1.5 Existing reports

No existing reports relevant to the site assessment have been provided to RSK.

1.6 Limitations

The comments given in this report and the opinions expressed are based on the ground conditions encountered during the site work and on the results of tests made in the field and in the laboratory. However, there may be conditions pertaining to the site that have not been disclosed by the investigation and therefore could not be taken into account. In particular, it should be noted that there may be areas of made ground not detected due to the limited nature of the investigation or the thickness and quality of made ground across the site may be variable. In addition, groundwater levels and ground gas concentrations and flows may vary from those reported due to seasonal, or other, effects and the limitations stated in the data should be recognised.

Asbestos is often present in soils in discrete areas. Whilst asbestos-containing materials may have been locally encountered during the fieldworks or supporting laboratory analysis, the history of the site indicates that asbestos may be present in soils and could be encountered during more extensive ground works.

Preliminary geotechnical recommendations are presented, and these should be verified in a Geotechnical Design Report once proposed construction and structural design proposals are confirmed.

2 SITE DETAILS

2.1 Site location

Site location details are presented in Table 1 and a site location plan is provided on Figure 1.

Table 1 Site location details

Site name	Land north of High Road
Full site address and postcode	High Road, Weston, Spalding, PE12 6RQ
National Grid reference (centre of site)	528852,324944

2.2 Site description

The site boundary and current site layout are shown on Figure 2. The site covers an area of approximately 6.2 hectares and is currently used as agricultural farm land.

2.3 Surrounding land uses

The site is located in Weston, within a predominantly residential setting. Immediate surrounding land uses are described in Table 2.

Table 2 Surrounding land uses

North	Drainage ditches, further agricultural fields and the A151
East	Drainage ditch and residential dwellings
South	High Road with residential dwellings beyond
West	Residential dwelling with agricultural fields beyond

2.4 Development plans

The proposed layout of the site, at the time of preparing this report, is shown as Figure 3.

The current proposed development comprises of approximately 150 low-rise residential dwellings with associated private gardens and parking. In addition, a play area is proposed to be constructed at the centre of the site and a pond within the north western corner of the site.

3 DESK-BASED ASSESSMENT

3.1 Site history

3.1.1 Historical development record

The development history of the site and surrounding area based upon assessment of historical plans and records is detailed in Table 3. The historical maps reviewed are shown within the environmental database report in Appendix C.

Table 3 Summary of historical development

Date from	Date to	Historical Land Use (on-site)	Area of site
Historically used as agricultural land with drainage networks			
Date from	**Date to**	**Historical Land Use (off-site)**	**Distance (m) and orientation**
1903	1967	Pond (potentially infilled)	9m SE
1987	Present	Gas governor	14m SE
1987	-	Electricity substation	202m E
1887	Present	Graveyard associated with St Mary's Church	241m NE
1987	1955	Various nurseries	299m W, 322m NE & 346m NE
1989	-	Unspecified commercial / industrial	324m N
1929	1987	Various unspecified tanks	365m SW, 402m SW, 426m NE & 480m SW
1973	-	Packing shed	439m NE
1971	1975	Sewage works	475m E
Relevant information sources: Historical OS maps ☒ Town plans ☐ Information from the Local Planning Authority ☐ Aerial photography ☒ Previous reports ☐			
Note: Reference to published historical maps provides invaluable information regarding the land use history of the site, but historical evidence may be incomplete for the period pre-dating the first edition and between successive maps.			

3.1.2 Unexploded ordnance

A review of publicly available unexploded ordnance (UXO) risk maps indicates that the site is located in an area with low potential for wartime bombs to be present (Zetica, 2019).

3.2 Information from environmental database report

Relevant environmental permits and incidents detailed within the environmental database report (see Appendix C) are summarised below in Table 4.

Table 4 Summary of environmental permits, landfills and incidents

Data type	Entries on-site	Entries <250m from site	Entries >250m from site of relevance	Details
Agency and hydrological				
Environmental permits – incorporating Integrated Pollution Prevention and Control, Integrated Pollution Controls, Local Authority Integrated Pollution Prevention and Control	0	0	0	-
Enforcement and prohibition notices	0	0	0	-
Pollution incidents to controlled waters, Prosecutions relating to controlled waters, Substantiated pollution incident register, Water Industry Act referrals	0	0	0	-
Discharge consents	0	0	3	Closest located 278m north east relating to sewage discharges into the land at St Mary's Churchyard. Permit number: EPRFB3299DV, effective from December 2016
Registered radioactive substances	0	0	0	-
Landfill and waste				
Active landfills	0	0	0	-
Historic / closed landfills	0	0	0	-
Other waste management licences	0	0	0	-

Data type	Entries on-site	Entries <250m from site	Entries >250m from site of relevance	Details
Potentially in-filled land (pit, quarry, pond, marsh, river, stream, dock etc)	0	2	1	Former pond located 9m south east, graveyard associated with St Mary's Church located 241m north east, and a sewage works located 475m east
Hazardous substances/industrial land uses				
Control of Major Accident Hazards (COMAH) sites	0	0	0	-
Explosives sites, Notification of Installations Handling Hazardous Substances (NIHHS), Planning hazardous substance consents/ enforcements	0	0	1	Authorised Substance - pH recorded at Lingarden Flowers Ltd, 475m NE.
Contaminated land Part 2A register entries and notices	0	0	0	-
Contemporary trade directory entries	0	5	0	Closest features are an electricity substation 14m south east, gas governor 16m south east.
Fuel station entries	0	0	0	-
Note: Entries have only been included within the table where they are located within a 250m radius of the site or, where they fall outside of this radius but are considered to comprise a significant entry.				

3.3 Site geology

3.3.1 Anticipated geological sequence

Published records (British Geological Survey, 2019) for the area and available historical borehole logs indicate the geology of the site to be characterised by the succession recorded in Table 5.

There are records of one publicly available BGS historical boreholes located within 250m of the site. The borehole was advanced as part of the Weston Bypass scheme, using cable percussive drilling techniques to advance the borehole to a depth of 13m bgl.

The ground conditions encountered comprised interbedded silts, soft clays, and fine sands, with an occasional organic content. Water strikes were recorded at 2.30 and 8.00m bgl. The results of quick undrained laboratory triaxial testing undertaken on samples of the clays recorded undrained shear strength (c_u) values ranging from 9 to 33kN/m^2.

Table 5 Site geology

Strata	Description	Estimated thickness	Permeability
Tidal Flat Deposits	Clay and Silt	>10m	Low
West Walton Formation (southern half of site)	Mudstone and siltstone	>50m	Low
Oxford Clay Formation (northern half of site)	Mudstone	>50m	Low
Relevant information sources: BGS Geoindex ☒ BGS borehole logs ☒ Previous SI reports ☐			

3.3.2 Radon

The environmental database report indicates that the site is not located within an 'Affected Area'. An 'Affected Area' is one with 1% or more homes above the radon Action Level of 200 Bq m^{-3}, and therefore the risk of significant ingress of radon into structures on-site is considered low and protection measures are not necessary in the construction of non-domestic buildings.

Although the radon data used in production of the ukradon indicative atlas comes from measurements in homes, the maps indicate the likely extent of the local radon hazard in all buildings.

3.4 Mining and quarrying

Evidence has been sought to identify any mining, quarrying, landfilling and land reclamation operations, past and present, which have taken place within 500m of the site.

This indicates the site lies outside the Coal Authority Consultation Area and is not located within a coalfield area.

The key findings from review of the datasets from the Coal Authority Interactive Viewer are summarised in Table 6.

Table 6 Summary of key coal mining information

Item	Applicable to site?	Comment
Development High Risk Area on-site	No	-

Item	Applicable to site?	Comment
Coal mine entries	No	-
Past shallow workings (recorded)	No	-
Probable shallow workings	No	-
Coal seam outcrops	No	-
Surface mining (opencast)	No	-

3.5 Hydrogeology

A summary of the hydrogeological setting of the site, with respect to the anticipated geological sequence set out in Section 3.5 is presented below in Table 7.

Table 7 Summary of hydrogeological setting

Condition	Description
Aquifer characteristics	The site is underlain by a unproductive strata associated with both the superficial Tidal Flat Deposits and the underlying bedrock (West Walton Formation and Oxford Clay Formation). The presence of low permeability clay at relatively shallow depths beneath the site, while restricting downwards migration, may increase the potential for lateral migration of shallow groundwater (and therefore mobile contamination, if present). Groundwater quality beneath the site may be affected by saline intrusion.
Depth to groundwater and flow	The anticipated depth to the groundwater table is in the order of less than 1-2m below ground level estimated from BGS logs. Shallow groundwater in the site area is anticipated to flow in a north westerly direction, i.e. towards the Lord's Drain and River Welland.
Rising groundwater levels	Not applicable
Groundwater recharge/ attenuation	Most of the site is currently unsurfaced and will therefore drain to ground, there is also a series of drainage ditches surrounding the site.
Licensed groundwater abstractions	The environmental database report indicates that there are no groundwater abstractions within a 2km radius of the site.
Source protection zones	Information available in the Envirocheck report indicates that the site does not lie within a currently designated groundwater Source Protection Zone (SPZ).

3.6 Hydrology

A summary of the hydrology within the site area is summarised in Table 8.

Table 8 Summary of hydrology in site area

Condition	Description
Surface watercourses/ features	The site is surrounded by a series of drainage ditches which connect to the Lord's Drain and inland River Welland, to the north west of the site. The site is underlain by Tidal Flat Deposits and is located within approximately 15 miles of the North Sea, although the River Welland is not tidal.
Surface water abstractions	The environmental database report indicates that there are three currently licensed surface water abstractions within a 2km radius of the site. All three are located 1874m NW and are used for general farming and domestic purposes or spray irrigation at Lincolnshire Field Products Ltd.
Site drainage	Surface drainage from the site appears to be discharged either to surface or via the drainage ditches located around the site, which connect to the inland River Welland.
Preliminary flood risk assessment	The indicative floodplain map for the area, shows that the site lies within the designated floodplain of the River Welland. The south of the site is not within a flood risk zone, the centre of the site is listed as a Zone 3 Floodplain and the north of the site is Zone 2 Floodplain. A flood risk assessment (FRA) is outside the scope of this report.

3.7 Sensitive land uses

Table 9 provides a summary of any environmentally sensitive areas identified within 500 m of the site based on the environmental database report.

Table 9 Environmentally sensitive areas

Feature	Present within 500m of site?	Details	Likely pathways from site?
International designations – Ramsar wetland, Special Area of Conservation (SAC), Special Protection Area (SPA)	No	-	-
National designations – Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR), ancient woodland	No	-	-
Local designations – Local Nature Reserve, Site of Importance for Nature Conservation (SINC)	No	-	-
Nearest high sensitivity development, e.g. residential	n/a	n/a	n/a

4 SITE RECONNAISSANCE FINDINGS

A site reconnaissance survey was completed by RSK. The characteristics of the site observed during the walkover and from current ordnance Survey maps are summarised in Table 10.

A site layout plan is provided in Figure 2 with the main features identified below.

Whilst the walkover summary includes consideration of current operations and housekeeping on the site as potential sources of contamination, it does not constitute a comprehensive environmental audit of the site, as covered under ISO 14001.

Table 10 Site reconnaissance findings

Feature	Description
Physical characteristics	
Access constraints	No areas of the site were inaccessible during the walkover
Site topography	The site is essentially level
Surface cover	The site is entirely covered by soft landscaping
Site drainage	The site drains to surface as covered in soft landscaping. There are also a series of drainage ditches around the perimeter of the site which the site may drain into also.
Surface water	Drainage ditches are present around the perimeter of the site, which are connected to Lord's Drain and the River Welland to the west of the site.
Trees and hedges	Vegetation present on-site comprises agricultural crops, which at the time of the walkover were potato crops.
Invasive species	Based upon the walkover survey obvious evidence of Japanese Knotweed or other invasive species has not been identified on-site. However, it should be noted that a detailed survey of the possible presence or absence of invasive species is outside of the scope of investigation and consideration should be given to commissioning a specialist survey, as necessary.
Existing buildings on-site	No buildings are present on-site
Retaining walls and adjacent buildings on or close to site boundary	There are no such structures on or close to the site boundary
Basements on-site	No evidence of existing or infilled basements was observed
Made ground, earthworks and quarrying	None observed
Potentially unstable slopes on or close to site	None observed

Feature	Description
Buried and overhead services present	None observed
Environmental characteristics	
Underground/ above ground storage tanks and pipework	None observed
Potentially hazardous materials storage and use	None observed
Asbestos-containing materials	None observed
Waste storage	None observed
Fly-tipping	None observed
Electricity sub-stations/ transformers	There is an existing sub-station located approximately 15m of the site within the cul-de-sac.
Evidence of possible land contamination on-site	None observed
Potential off-site sources of ground contamination	The site to the north is bound by High Road (A151) and beyond are further agricultural fields. The rest of the site is surrounded by residential dwellings. No significant sources of potential contamination were noted during the walkover.

5 PRELIMINARY GEOTECHNICAL CONSTRAINTS

5.1 Design class

BS EN 1997-1 defines three different Geotechnical Categories that structures may fall into, which are summarised as follows:

- Category 1: Small and relatively simple structures for which it is possible to ensure that the fundamental requirements will be satisfied on the basis of experience and qualitative geotechnical investigations; with negligible risk
- Category 2: Conventional types of structure and foundation with no exceptional risk or difficult ground or loading conditions
- Category 3: Structures or part of structures, which fall outside limits of Geotechnical Categories 1 and 2. Examples include very large or unusual structures; structures involving abnormal risks, or unusual or exceptionally difficult ground or loading conditions; structures in highly seismic areas; structures in areas of probable site instability or persistent ground movements that require separate investigation or special measures.

Based on the information provided above on the proposed development and in view of the anticipated ground conditions, a Geotechnical Category of 3 has been assumed.

5.2 Preliminary geotechnical hazards assessment

A summary of commonly occurring geotechnical hazards associated with the anticipated geology outlined in Section 3 above is given in Table 11 together with an assessment of whether the site may be affected by each of the stated hazards.

Table 11 Summary of preliminary geotechnical risks that may affect site

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Sudden lateral changes in ground conditions	☐	☒	Likely to affect ground engineering and foundation design and construction
Shrinkable clay soils	☒	☐	Design to NHBC Standards Chapter 4 or similar
Highly compressible and low bearing capacity soils, (including peat and soft clay)	☒	☒	Likely to affect ground engineering and foundation design and construction

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Silt-rich soils susceptible to rapid loss of strength in wet conditions	☒	☐	Likely to affect ground engineering and foundation design and construction
Running sand at and below water table	☒	☐	Likely to affect ground engineering and foundation design and construction
Karstic dissolution features (including 'swallow holes' in Chalk terrain)	☐	☒	May affect ground engineering and foundation design and construction – refer to Section 4.1.2
Evaporite dissolution features and/or subsidence	☐	☒	May affect ground engineering and foundation design and construction
Ground subject to or at risk from landslides	☐	☒	Likely to require special stabilisation measures
Ground subject to peri-glacial valley cambering with gulls possibly present	☐	☒	Likely to affect ground engineering and foundation design and construction
Ground subject to or at risk from coastal or river erosion	☒	☒	Likely to require special protection/stabilisation measures
High groundwater table (including waterlogged ground)	☒	☐	May affect temporary and permanent works
Rising groundwater table due to diminishing abstraction in urban area	☐	☒	May affect deep foundations, basements and tunnels
Underground mining	☐	☒	Likely to require special stabilisation measures
Effects of extreme temperature (e.g. cold stores or brick kilns/furnaces)	☐	☒	Likely to affect ground engineering and foundation design and construction
Existing sub-structures (e.g. tunnels, foundations, basements, and adjacent sub-structures)	☐	☒	Likely to affect ground engineering and foundation design and construction
Filled and made ground (including embankments, infilled ponds and quarries)	☐	☒	Likely to affect ground engineering and foundation design and construction

Hazard category	Hazard status based on desk study findings and proposed development		Engineering considerations if hazard affects site
	Could be present and/or affect site	Unlikely to be present and/or affect site	
Adverse ground chemistry (including expansive slags and weathering of sulphides to sulphates)	☐	☒	May affect ground engineering and foundation design and construction
Site topography	☐	☒	May affect ground engineering and foundation design and construction
Note: Seismicity is not included in the above table as this is not normally a design consideration in the UK.			

On the basis of the published geology, the following key geotechnical hazards are anticipated:

- Significant thickness of highly compressible and low bearing capacity strata (soft clays, silts, organic deposits and peat layers);
- Shallow groundwater;
- Shrinkable clays; and
- Blowing sand conditions associated with basal granular layers of the Tidal Flats.

In terms of ground improvement options, given the anticipated presence of soft clay soils, vibro-compaction techniques are unlikely to achieve an acceptable compaction result.

Whilst cohesive deposits are typically more suited to a vibro-replacement technique; due to the lack of lateral confinement associated with the organic soils, peats and very soft clays; vibro-replacement methods may also prove problematic. In addition, the silt layers within the Tidal Flats have been known to effectively 'liquefy' when compacted in the presence of the shallow groundwater table.

In terms of piling, bored / CFA piles may experience problems with 'flighting' within the aforementioned soft clays and organic deposits; and as such, driven piles may provide a more feasible solution for the proposed development.

It should be appreciated that any surcharge of the site (i.e. increase in ground levels) could lead to significant ongoing settlements within the Tidal Flats; and this would need to be taken into account for both foundations and new infrastructure.

6 INITIAL CONCEPTUAL SITE MODEL

In line with CLR11 (Environment Agency, 2004) and BS 10175: 2011 + A2 2017 (BSI, 2017), RSK has used information in the preceding sections to identify sources of contaminants, receptors that may be impacted and plausible linking pathways. Where all three are present this is termed a potentially complete contaminant linkage and a qualitative risk estimation is made.

6.1 Potential soil, soil vapour and groundwater linkages

6.1.1 Potential sources of contamination

Potential sources of soil and groundwater contamination identified from current activities and the history of the site and surrounding area are presented in Table 12. Ground gas sources are addressed in the next section.

Table 12 Potential sources of soil and groundwater contamination

Potential sources	Contaminants of concern	Current or historical?
On-site		
Agricultural land use	Pesticides and herbicides	Historical and current
Off-site		
Potentially infilled pond 9m SE of site	Unknown fill material but potentially including brick, ash and clinker and containing toxic and phytotoxic metals, inorganics, polycyclic aromatic hydrocarbons (PAHs), asbestos	Historical
Electricity substation (14m SE) and gas governor (16m SE)	Polychlorinated biphenyls (PCBs)	Current

6.1.2 Sensitive receptors and linking exposure/migration pathways

Sensitive receptors identified at or in the vicinity of the site that could be affected by the potential sources identified above comprise:

- future site users – residential users [oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce]
- future buildings and services [direct contact with contaminated soils or groundwater and chemical attack]
- surface waters within the adjacent drains, Lord's Drain and River Welland [lateral migration of dissolved phase / site run-off / drainage]

Potential linking pathways are show in brackets for each item above.

Please note that construction workers and future maintenance workers have not been identified in the conceptual model as receptors because risks are considered to be managed through health and safety procedures according to the CDM Regulations.

6.2 Potential ground gas linkages

6.2.1 Ground gas generation potential

Potential ground gas sources identified for the site and surrounding are shown in Table 13.

Table 13 Potential ground gas sources

Potential sources	Indicative ground gas generation potential (CIEH, 2008)	Additional information
On-site		
Natural soil with a high degradable organic content	Low	Organic deposits and peat layers may be present within the tidal flat deposits
Off-site		
Infilled pond located 9m SE from site	Very Low	Made ground may be present

6.2.2 Sensitive receptors and linking pathways

Sensitive receptors identified at or in the vicinity of the site that could be affected by the potential ground gas sources identified above comprise:

- future site users – residential users [migration and ingress of ground gases into buildings, build-up in confined spaces and explosion/ asphyxiation]
- future buildings and services [migration and ingress of ground gases into buildings, build-up in confined spaces and explosion].

The assessment has identified receptors to include building structures and proposed end-users.

Construction workers have not been identified as receptors for the purposes of this assessment. Risks may still be present to construction workers especially where works include the entry into excavations within the ground. Construction workers should undertake appropriate risk assessments and risks should be managed through health and safety procedures and the use of PPE.

6.3 Preliminary risk assessment

The preliminary risk assessment findings and potentially complete contaminant linkages are shown in **Error! Reference source not found.** overleaf. The risk classification based

on the combination of hazard consequence and probability using a risk matrix from CIRIA C552 (Rudland et al., 2001), a summary of which is included in Appendix H.

Table 14 Risk estimation for potentially complete contaminant linkages

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
Agricultural land use (presence of pesticides and herbicides)	Future site users	Direct contact	Low likelihood	Medium	Moderate / low	Due to the persistent nature of some pesticides and herbicides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields historically there is a potential for them to be present but typically at low concentrations.
	Surface waters	Lateral migration including leaching and subsequent lateral flow in groundwater and surface water runoff	Unlikely	Medium	Low	The potential for persistent compounds to be present as a result of historical pesticide and herbicide use remains, although it is unlikely that significant concentrations would be present that could impact surface water.
Natural soil potentially containing organic deposits and peat	Future site users	Migration and accumulation of ground gas	Unlikely	Severe	Moderate / Low	Natural soils containing organic deposits associated with the Tidal Flat Deposits may present a plausible source of hazardous ground gas; albeit nearby historical borehole logs are not indicative of large quantities of organic material / peat layers. Potential migration pathways may be present if granular material is encountered.
	Future buildings and services					
Possible made ground associated with infilled pond (9m SE)	Future site users	Migration and accumulation of ground gas	Unlikely	Severe	Moderate / Low	The pond was previously shown to be present but was no longer shown on historical maps after 1967. On this basis, the pond may have been infilled, although it should be appreciated that there is no evidence to suggest that this is the case. The area to the south of the site has subsequently been redeveloped with residential housing. As such, the potential for a significant source of ground gas to remain in-situ is considered unlikely.
	Future buildings and services					

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
Electrical substation (14m SE) and gas governor (16m SE)	Future site users	Direct contact, via leaching and lateral migration	Unlikely	Medium	Low	Given the relatively recent age of the substation installation (late 1980s), the generally widespread presence of hardstanding within the vicinity of the substation and governor and the low mobility of the PCB compounds; it is unlikely that the existing substation and gas governor will have detrimentally impacted the underlying soils or groundwater.

Risk matrix		Consequences			
		Severe	Medium	Mild	Minor
Probability	Highly likely	Very high	High	Moderate	Moderate/low
	Likely	High	Moderate	Moderate/low	Low
	Low likelihood	Moderate	Moderate/low	Low	Very low
	Unlikely	Moderate/low	Low	Very low	Very low

Potentially complete contaminant linkages with a potential risk of moderate to low or higher identified in in **Error! Reference source not found.** comprise:

- Ground gas produced by either the naturally occurring organic or peat deposits or from the made ground within the infilled pond off-site, affecting both future occupants of the site and future buildings and services; and
- Direct contact between future residential site users and residual pesticide / herbicide contamination within the shallow soils.

These potentially complete contaminant linkages need to be assessed further through appropriate site investigation to target the identified sources of potential contamination and assess the feasibility of identified pathways.

6.4 Data gaps and uncertainties

Key data gaps and uncertainties identified in the CSM at desk study stage include:

- there are no previous investigations available for the site, therefore no information on actual concentrations of contaminants in soil and groundwater or ground gas at this stage
- groundwater depth and flow direction are conceptual at this stage

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 Geo-environmental assessment

Potentially relevant pollutant linkages have been identified within the initial conceptual site model. The linkages with a risk factor or moderate to low or higher are:

- Potential ground gas production and migration from naturally occurring organic or peat deposits;
- Potential ground gas production and migration from made ground associated with the off-site former pond (potentially infilled); and
- Potential residual pesticide / herbicide contamination within the shallow soils.

7.2 Geotechnical assessment

Based on the geology in the area, the following geotechnical hazards are anticipated:

- Significant thickness of highly compressible and low bearing capacity strata (soft clays, silts, organic deposits and peat layers);
- Shallow groundwater;
- Shrinkable clays;
- Blowing sand conditions associated with basal granular layers of the Tidal Flats.

7.3 Recommendations

In line with the relevant pollutant linkages identified within the initial conceptual site model, a Phase II intrusive investigation is recommended across the site. The investigation should focus on shallow investigation of soils across the site, testing for the contaminants associated with the above and testing of soils for geotechnical purposes. Gas monitoring is recommended across the site and particularly along the southern boundary (to target the infilled pond off-site); however, if areas of significant made ground or contamination are identified during any investigation then further assessment will be required.

In addition, a deeper ground investigation comprising deep boreholes and Cone Penetration Testing (CPT) and use of a piezocone would be beneficial, in order to confirm geotechnical parameters for design purposes.

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FIGURES

Figure 1 – Site location plan
Figure 2 – Site layout plan
Figure 3 – Proposed development plan

527000 528000 529000 530000 531000

326000 325000 324000



Shepherds Farm
Stone Gt
St Lamberts Cottage
Moulton Mere Drain
Wiseman's Gate
Lowgate House
Cross Gate
White House Farm
A151
High Road
Weston
Wool Hall Farm
Small Drove
Fold Lane
River Lane
Bell Lane
Shivean Gate
Church Lane
Sycamore Farm
Holbeach Road
High Road
Moulton
Swindler's Drove
Cobgate Farm
West Cob Gate
East Cob Ga
Broad Lane
Station Road
New England Farm
Lane

Legend:

Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter



Rev	Date	Description	Drn	Chk	App
00	30/10/2019	First Draft	DR	EW	EW

Weston, Spalding

RSK

TITLE:
Figure 1:
Site Location Plan

0 250 500
Metres
SCALE: 1:12,500 @ A3

N W E S

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528600 528700 528800 528900 529000 529100

325200 325100 325000 324900 324800 324700

Legend:

Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter



Rev	Date	Description	Drn	Chk	App
00	31/10/2019	First Draft	DR	EW	EW

Weston, Spalding

RSK

TITLE:
Figure 2:
Site Layout Plan

0 25 50
Metres
SCALE: 1:2,000 @ A3

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528700 528800 528900 529000

325100 325000 324900 324800

Drain

Drain

PINCHBECK LANE

Legend:

Site Boundary

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter



Rev	Date	Description	Drn	Chk	App
00	31/10/2019	First Draft	DR	EW	EW

Weston, Spalding

RSK

TITLE:

Figure 3:
Proposed Development Plan

0 25 50
Metres

SCALE: 1:1,250 @ A3

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