Hubert C. Leach (Leach Homes)

Land to the North and East of Ware, Hertfordshire.

Preliminary Risk Assessment

Project no. 27134-01(01)

JULY 2014

RSK

RSK GENERAL NOTES

Project No.: 27134-01(01)

Title: Preliminary Risk Assessment: Land to the North and East of Ware, Hertfordshire

Client: Hubert C. Leach (Leach Homes)
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Date: 7th July 2014

Office: RSK Environment Ltd, Hemel Hempstead

Status: Final

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Date:	7th July 2014	Date:	7th July 2014

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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1 INTRODUCTION

1.1 Instructions

On the instructions of Leach Homes (the 'Client'), RSK Environment Ltd (RSK) has carried out a Preliminary Risk Assessment (PRA) of 300ha of agricultural farmland, woodland and associated roads and tracks to the north and east of Ware, in Hertfordshire, hereafter referred to as the 'site'.

The study aims to principally identify and assess the main geological and environmental ground conditions across the land, with a view to identifying the existing baseline conditions and any potential environmental hazards and liabilities associated with proposed development of the site.

This report is subject to the RSK service constraints given in **Appendix A**.

1.2 Background

It is understood that the site has been identified as a 'broad location for development' by East Hertfordshire County Council (the 'Council') on which they are considering allocating the land for development post 2021.

The main components of the development strategy include increased housing, education, transport, other infrastructure and employment and retail. To meet the current demand for housing, a proposal for the development of between 200 to 3000 homes is in place to the North and East of Ware. Associated highways infrastructure is likely to be in the form of a link road between the A10/A110 junction and the Widbury Hill area, around the northern and eastern boundaries.

Further Development Plan Documents (DPDs) are in preparation by East Herts Council in conjunction with Hertfordshire County Council, Ware Town Council, Ware Parish Council and other regulatory bodies to establish the feasibility of the development.

For this desk based assessment, the entire site has been divided into separate study areas or 'Sections' as indicated within the Envirocheck environmental database report (reference 55933228_1_1, dated April 2014). A copy is presented in **Appendix F.**

Each 'Section' will comprise a quadrant of the proposed assessment area, also referred to as the 'site'.

These 'sections', as shown on **Figure 2**, have been determined as:

Section A – South-western quadrant;

Section B – South-eastern quadrant;

Section C – North-western quadrant;

Section D – North-eastern quadrant.

1.3 Objective and aims

The objective of the PRA is to identify the existing ground conditions underlying the site in relation to supporting future planning proposals for development.

The aim of the PRA is to collate information pertaining to the site from which sources of contamination, receptors that may be impacted and pathways between the two are identified. Where all three are present, these are termed potentially complete contaminant linkages. In accordance with UK guidance including CLR11 and BS 10175, these are presented in a conceptual site model where an evaluation of the risk associated with each contaminant linkage is made.

1.4 Scope

The scope of the PRA is in accordance to an agreed brief, as set out in RSK's proposal reference 27134 T01, dated 24th April 2014. The brief included:

- A site walkover inspection, including the identification of surrounding land use and location of any sensitive environmental receptors in the site vicinity;
- A review of the geology and hydrogeology of the site to enable assessments to be made on the migration potential for contaminants that may be present on or adjacent to the site;
- A review of commercially available environmental database, and historical plans; correspondence with regulatory authorities; and a site walkover – this information is used to develop an initial conceptual site model to consider any potentially complete pollutant linkages; and
- Preparation of an interpretative PRA report, including development of an initial conceptual site model and recommendations for further investigation, if necessary.

1.5 Standards and limitations

The study aims principally to identify and assess the potential risks and liabilities associated with contamination of the ground on, and in the vicinity, of the site. While this includes consideration of current operations and housekeeping on the site, the report does not constitute a comprehensive environmental audit of the site, as covered under ISO 14001.

The layout of this report has been designed with consideration of CLR11 (Environment Agency, 2004a) and guidance on land contamination reports issued by the Environment Agency (EA) (2010a). The study was designed generally to meet the objectives of a preliminary (Phase 1) investigation, as defined by BS 10175:2011 "Code of Practice for the Investigation of Potentially Contaminated Sites".

This report should be considered in the light of any changes in legislation, statutory requirement or industry practices that have occurred subsequent to the date of issue.

The "vicinity" of the site for the purposes of this report is defined as locations situated within an approximate 250m distance from the site boundaries, although certain sources and/or sensitive targets further than 250m may also have been considered.

The opinions expressed in this report, and the comments and recommendations given, are based on the information obtained from the desk assessment and the site reconnaissance survey. No intrusive investigations have been undertaken to confirm the actual ground conditions and hence the environmental status of the site

2 THE SITE

2.1 Site Location

The site lies to the north and east of Ware, Hertfordshire and comprises approximately 300 hectares centred about National Grid Reference 536890^{N}, 215590^{E} as shown on **Figure 1**.

2.2 Site Description

The site is currently occupied by open agricultural farmland with multiple footpaths and tracks, farm buildings and equipment, small residential dwellings, areas of woodland and infrastructure. Fanhams Hall, a registered park and hotel, is located in the centre of the site.

The site is bound to the west by the A10 dual carriageway, with the B1004 present to the south and bisected by the Farnhams Hall Road.

Elevation is variable across the site however; in general, the north of the site is approximately 70m to 75m above Ordnance Datum (AOD) with areas in the south ranging between approximately 55m to 65m AOD.

A site plan is included in **Figure 2** with notes and photographs taken during a site walkover included in **Appendices D** and **C,** respectively.

2.2.1 Topography

The majority of the site comprises large-scale arable farmland, bisected by a number of drainage ditches and tributaries. The land is undulating, although overall gently sloping towards the southwest. There is a ridge of elevated land that extends in a northeast to southwest orientation across the centre of the site associated with Fanhams Hall.

Ground level across the site appears to vary by as much as 10 to 15 meters.

On the western boundary of the site, ground level remains relatively flat at approximately 74mOD at Moles Farm before gradually falling to 53mOD at its lowest point, as it reaches a small unnamed tributary to west of Fanhams Hall. Ground levels then begin to rise to a peak of approximately 71m along the ridge at Fanhams Hall, Home Farm and Noah's Ark. To the southeast of this ridge, the land again gradually falls to a low point of approximately 55mOD along Fanhams Tributaries.

2.2.2 Watercourses

There are multiple drainage ditches and river tributaries across the site, most of which drain towards the south with the natural topography of the land and in the direction of the River Lee. In the west of the site the ditches and tributaries some associated with

'Issues' i.e. springs are predominantly orientated northeast-southwest and drain away from the central ridge in a south-westerly direction. Fanhams Tributaries are located in the east of the site and drain in a southerly direction.

Other surface water features present within the site boundaries include multiple small ponds associated with Moles Farm, Fanhams Hall, Great Cozens and Noah's Ark. Issues (i.e. springs) including 'sinks' are identified to the north of Farnham Hall.

2.2.3 Infrastructure

The site is bisected by Fanhams Hall Road which runs in a northeast-southwest orientation. There is a small network of service roads off Fanhams Hall Road that provide vehicular access to Fanhams Hall, Fanhams Gardens, Home Farm, Fanhams Grange and Noah's Ark. The A1170, Wadesmill Road and associated roundabout also cross the site boundary in the west of the site. In addition to the service roads, there are multiple tracks and paths across the agricultural land.

There are a few small buildings associated with nearby farms across the study area. Fanhams Hall is a large hotel and park located in the centre of the site close to Home Farm and further residential dwellings at Fanhams Grange.

There is a communication mast and associated electrical sub-station located to the south of Moles Farm (Section C) and multiple overhead power lines (OHPs) that bisect the open agricultural land.

2.3 Site walkover

A site walkover was undertaken by RSK on 8th and 9th May 2014. A photograph record and a site walkover checklist are provided in **Appendices C** and **D,** respectively.

Given the size, the site has been split into four sections designated Sections A to D. These relate to a south-western (Section A), south-eastern (Section B), north-western (Section C) and north-eastern (Section D) areas as shown in **Figure 2**.

Potentially significant environmental and geotechnical issues arising from the survey are summarised below.

The majority of the site is characterised by arable farmland and associated farm buildings, small isolated residential developments, small drainage ditches and tributaries and paths and tracks. Potentially contaminative issues carried out on the site were identified in the form of made ground deposits in paths/tracks and areas where there has been construction of farm buildings and residential dwellings, one electricity substation and the potential use of herbicides and pesticides owing to the arable nature of the farmland across the site.

There was some evidence of minor fly tipping occurring on site.

A number of small surface water feature were identified just south of Fanhams Hall Road.

Localised desiccation along the edge of the crop fields was also noted and is likely to be the result of high clay content of the underlying soils. This was noted during an extended period of sunshine on 9th May and following prolonged rainfall on 8th May.

Japanese knotweed is a non-native, highly invasive species and spreads via rhizomes (underground 'stems') rather than seeds in the UK. It is found in a range of habitats across the UK including roadsides, riverbanks and derelict land.

Japanese knotweed was not identified during the site visit however its absence cannot be discounted. Suspected Giant Hogweed was noted on the banks of a small surface water feature just off Fanhams Hall Road (Section B).

This report is not intended to replace a full ecological study and it is recommended that a full ecological survey of the site be conducted to confirm the presence or otherwise of invasive plant species.

2.4 Information from Environmental Searches

2.4.1 Environmental Database Report and Environment Agency (EA) Information

Details on the presence of industries with pollution-related licences, landfill sites and pollution incidents have been obtained from the Envirocheck report and from a search of information publicly available on the EA website.

The Envirocheck report has been selected to cover the subject 'site' as detailed in Section 2.2 above (i.e. the 300ha of land to the north and east of Ware). A 250m-search buffer has been applied to the site's surroundings and, as such, has also identified any licence or features of note contained within the wider 'red line' extent of works as shown in **Figure 2** along with delineation of Sections A to D.

A copy of the Envirocheck report is included in **Appendix F** with salient information summarised for each of the individual sections below.

2.4.1.1 Section A.

Environment Agency and Hydrological Information

There are four records of licensed discharge consents within Section A of the site, which are shown to be active. All of the consents relate to the discharge of 'final / treated sewage', and are operated by:

- Albion Ltd for a domestic property at Great Cozens to discharge into land;
- Trustees of Wenham 1980 Settlement for a domestic property at Great Cozens to discharge into land;
- Bartons Limited for a domestic property at Great Cozens to discharge into land/soakaway; and
- Mrs Jeannie Crawley for multiple domestic properties at Great Cozens to discharge into a freshwater stream/river.

There are no current Integrated Pollution Controls, Pollution Prevention and Controls or associated Enforcements.

There are no records of prosecutions relating to authorised processes or controlled waters.

There is one record of a pollution incident that had occurred to controlled waters on 11th February 1993, from a spill of unknown sewage into an unspecified receiving water, located 14m northwest of the site. The incident was categorised as being a Minor Incident.

There are no groundwater abstractions.

There are no identified radioactive sources.

Waste Sites

There are no records of registered landfill sites (historic or current), waste transfer, treatment or disposal site within the vicinity of the site. However, there is one record of a licensed waste management facility, Westmill 2 Landfill Site, operated by Biffa Waste Services Ltd, 51m northwest of Section A. The facility accepts household, commercial and industrial waste.

Hazardous Substances

There are no records of Control of Major Accident Hazard (COMAH) or Explosive Sites in the vicinity of the site. In addition, there are no records of Notifications Handling Hazardous Substances, Planning Hazardous Substance Consents or Enforcements.

Industrial Land Use

There are no records of active contemporary Trade Directory Entries in the site's surroundings. There are two records of fuel stations within 500m of Section A, one active 319m southeast and one obsolete 443m south.

Sensitive Land Use

Section A is located within an Area of Adopted Green Belt and within a Nitrate Vulnerable Zone.

2.4.1.2 *Section B.*

Environment Agency and Hydrological Information

There are no records of licensed discharge consents which are shown to be active.

There are no current Integrated Pollution Controls, Pollution Prevention and Controls or associated Enforcements.

There are no records of prosecutions relating to authorised processes, controlled waters or pollution incidents relating to controlled waters.

There are no identified groundwater abstractions.

There are no identified radioactive sources.

Waste Sites

There are no records of registered landfill sites (historic or current), waste management facilities or waste transfer, treatment or disposal site.

There are no records of Control of Major Accident Hazard (COMAH) or Explosive Sites. In addition, there are no records of Notifications Handling Hazardous Substances, Planning Hazardous Substance Consents or Enforcements.

Industrial Land Use

There are no records of fuel stations within a 500m of the site.

There are three Contemporary Trade Directory entries present, two of which are inactive. They relate to:

- Cross Autos, located at Wildbury Hall in Ware (approximately 6m to the southwest) for garage services (inactive);
- Alexander Dennis Ltd, located at Wildbury Hall in Ware (approximately 16m to the southwest) for commercial vehicle bodybuilders and repairers (inactive); and
- Get A Grip, located on Elms Road in Ware (approximately 30m to the west) as a tyre dealers (active).

Sensitive Land Use

Section B is located within an Area of Adopted Green Belt and within a Nitrate Vulnerable Zone.

2.4.1.3 Section C.

Environment Agency and Hydrological Information

There are three records of licensed discharge consents which are shown to be active. The nearest of these is located approximately 44m to the southwest, operated by Brian Oakley Limited for the discharge of 'final / treated sewage' from Ermine Point Business Park into a tributary of the River Lee.

There are no current Integrated Pollution Controls, Pollution Prevention and Controls or associated Enforcements.

There are no records of prosecutions relating to authorised processes or controlled waters. However there are two records of pollution incidents relating to controlled waters. One incident occurred on 21st July 1997, from a spill of storm sewage into unspecified receiving water. The incident was categorised as a 'Significant Incident'.

Two groundwater abstractions are located, with a further two abstractions within 500m. The abstractions are both related to a borehole at Moles Farm for general farming and domestic usage. The other two abstractions are located 185m west and 211m west at Hanbury Manor for spray irrigation – storage purposes.

There are no identified radioactive sources.

Waste Sites

There are no records of registered landfill sites (historic or current), waste transfer, treatment or disposal site within the vicinity of the site. However, there is one record of a licensed waste management facility, Westmill 2 Landfill Site, operated by Biffa Waste Services Ltd, 51m southwest. The facility accepts household, commercial and industrial waste.

Hazardous Substances

There are no records of Control of Major Accident Hazard (COMAH) or Explosive Sites in the vicinity of the site. In addition, there are no records of Notifications Handling Hazardous Substances, Planning Hazardous Substance Consents or Enforcements.

Industrial Land Use

There are no records of contemporary Trade Directory Entries in the site's surroundings, or fuel stations within a 500m distance.

Sensitive Land Use

Section C is located within an Area of Adopted Green Belt and within a Nitrate Vulnerable Zone.

2.4.1.4 Section D.

Environment Agency and Hydrological Information

There are two records of licensed discharge consents, which are shown to be active. The consents relate to the discharge of 'final / treated sewage', and are operated by:

- Fanhams Grange Property Management Co. Ltd for multiple domestic properties at Home Farm Development to discharge into a freshwater stream/river; and
- Exclusive Hotels for a wholesale distributors at Fanhams Hall Business Trading Centre to discharge into a freshwater stream/river.

There are no current Integrated Pollution Controls, Pollution Prevention and Controls or associated Enforcements.

There are no records of prosecutions relating to authorised processes or controlled waters. However there is one record of a minor pollution incident relating to controlled waters. The incident occurred at Fanhams Hall on an unspecified date from a spill of unknown oils into an unspecified receiving water.

There are no identified groundwater abstractions.

There are no identified radioactive sources.

Waste Sites

There are no records of registered landfill sites (historic or current), waste management facilities or waste transfer, treatment or disposal site.

Hazardous Substances

There are no records of Control of Major Accident Hazard (COMAH) or Explosive Sites. In addition, there are no records of Notifications Handling Hazardous Substances, Planning Hazardous Substance Consents or Enforcements.

Industrial Land Use

There are no records of contemporary Trade Directory Entries in the site's surroundings, or fuel stations within 500m distance.

Sensitive Land Use

Section D is located within an Area of Adopted Green Belt and within a Nitrate Vulnerable Zone.

2.4.2 Information from Local Authority

An enquiry has been made to the Council to obtain information pertaining to the site with respect to derelict and despoiled land, contaminated and remediated land, mineral workings, local water abstractions and pollution incidents, on and in the vicinity of the site. Their response is included in **Appendix G**.

Information from the Council indicates that four private water supplies are located on site and two are located within 250m distance of the site. All of the water supplies are from deep boreholes. No further details are provided on these private supplies.

Details from the local authority also highlight the industrial/commercial use of the land within 250m of the site, which includes a landfill (former gravel pit), golf course, quarry, car garage, vehicle repair centre, college and public house. There are no details of industrial/commercial land use on site and no records of historical or current registered landfills.

3 DEVELOPMENT HISTORY

3.1 Sources of Information

The history of the site's land-use and development from Victorian times onwards has been researched from:

- Early Ordnance Survey (OS) maps obtained from Envirocheck; and
- Pre-Ordnance Survey (County Series) maps.

Due to the extent of the subject site, historical maps have been produced over a number of segments with eighteen sets of maps at a scale of 1:2,500 and four sets at a scale of 1:10,560.

Following division of the site into four sections (designated sections A to D) as seen in the previous Chapter (2.4.1) and on **Figure 2**, the history of the site and surrounding area is discussed below.

Copies of OS and County Series maps are included in the Envirocheck report in **Appendix F.**

Reference to 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.

3.2 Summary of Development History

The development history of the site and surrounding area is summarised below.

3.2.1 Land comprising the north and east of Ware

The earliest available map records, dating to the mid 1880's show the site to be similar to that of the present day configuration, comprising arable farmland bisected by a number of open drains, tributaries, farm tracks and roads servicing the buildings/structures on site. An unnamed road (later renamed the A1170) cuts across the western boundary of the site on the earliest historical records.

Multiple small developments are present from the mid 1880s to the present day; High Oak (later renamed Round House), Little Fanhams and Great Cozens in the southeast, Fanhams Hall and Fanhams Lodge in the southwest, Moles Farm in the northwest and Noah's Ark in the northeast.

Fanhams Hall Road is present from 1923 and bisects the site in a northeast – southwest orientation. Fanhams Grange and Home Farm also appear on the historical mapping in 1923.

There is little or no further development across the site to the present day.

3.2.2 Surrounding Area

During the mid 1880's, the surrounding areas comprised widespread arable farmland with a number of woods, farm buildings and a few minor roads. Trinity Farm and associated buildings is located approximately 10m beyond the south-western edge of the site. There is also a reservoir and water works 250m south, an unnamed work house (later renamed as the P.A. Institute) and a sand pit 400m south with multiple malthouses 500m south of the site boundary. The town of Ware is also located further afield, with associated industrial land uses, residential properties and road networks.

The parcel of land to the southeast of the site illustrated similar characteristics to the land to the southwest with widespread arable farmland, farm buildings, woodland and minor roads. Priorswood Farm and cottages are situated 5m east, with Widbury Hill Farm 50m south and Swades Farm and Newholes Farm approximately 350m east.

The dominant land use to the northwest of the site is open agricultural land, large areas of woodland and a road network linking the small town of Wadesmill to Ware. A small gravel pit and old chalk pit are present approximately 450m and 500m north of the site, respectively.

Land to the northeast is characterised by open arable farmland and small parcels of woodland, collectively named Ashridge Common. This land remains completely undeveloped to the present day and will not be discussed further.

In the late 1800s a further small gravel pit is noted on the eastern boundary of the site, with a slight increase in the development of Ware, predominantly due to an increase in housing.

Aside from a gradual rise in the size of Ware there was no further significant development of the surrounding area until the 1970s, with multiple schools, residential dwellings and playing fields appearing in the southwest and northwest, including development around the town of Thundridge approximately 300m north of the site. Initial construction of the A10 along the north-western boundary also appears at this time.

The aforementioned workhouse to the south becomes a hospital in the 1980s and aside from the continued growth of Ware, there has been little significant change in the area surrounding the site from this period to the present day.

4 GEOLOGY, HYDROGEOLOGY AND HYDROLOGY

4.1 Geology

4.1.1 General Characteristics

The published 1:50,000 scale geological map of the area (Sheet No. 239, Hertford) and information from the Envirocheck report, indicates that the majority of the site is underlain by superficial deposits of the Lowestoft Formation (previously referred to as 'Boulder Clay' or 'Till') over the Lewes Chalk Formation (White Chalk Subgroup).

In a small section of the southwest and to the south of the site, the geology indicates superficial deposits of the Kesgrave Catchment Subgroup over the White Chalk.

A thin section of the site in the east indicates that the White Chalk outcrops at the surface, with other eastern sections of the site indicating Glaciofluvial superficial deposits over the White Chalk.

Where available on site and within the surroundings of the site, British Geological Society (BGS) boreholes have been reviewed.

Across the central portion of the site, the BGS boreholes indicate that the local geology comprises a variable thickness of between approximately 4m to 20m of Lowestoft Formation (including yellow and brown clay) and sandy gravel, overlying the White Chalk.

Close to the south and south-western boundary, the BGS borehole records indicate that the superficial Kesgrave Deposits are up to 12m in thickness and BGS records in the east of the site illustrate thicknesses of approximately 12m for the Glaciofluvial deposits. All of the BGS boreholes indicate that the local superficial geology overlies the Chalk, proven to 91mbgl.

Copies of the BGS boreholes are presented in **Appendix G.**

On the basis of the published geological maps of the area and available BGS borehole records, the likely composition of natural strata in the vicinity of the site is described in **Table 1**.

Table 1: Conjectural Geological Succession beneath the Site

Geological unit	Brief description	Anticipated thickness (m)
Superficial soils/drift		
Lowestoft Formation	Brown and yellow chalky clay with flint and beds of sand, gravel and silt.	Up to 20m
Glaciofluvial Deposits	Sands and gravels	Up to 12m
Kesgrave Catchment Subgroup	Sands and gravels	Up to 12m
Solid geology deposits		
White Chalk Sub-group (Lewes Chalk Formation)	Chalk with flints. With discrete marl seams, nodular chalk, sponge-rich and flint seams throughout. Typology of flints and incidence of marl seams is important for correlation	Proven 66m thickness, and to a depth of 91mbgl.

The existing topography and history of development of the site suggests that, in addition to these natural strata, localised areas of made ground are likely to be present beneath the site in areas of previous construction and manmade paths/tracks/roads and infilled pits and quarries.

4.2 Hydrogeology

4.2.1 General Characteristics

The superficial deposits of Lowestoft Formation underlying the majority of the site are designated as an 'Unproductive Strata' by the EA, defined as having a low permeability that have negligible significance for water supply or river base flow. Where the Kesgrave Subgroup and Glacialfluvial deposits are present underlying the site, the strata have been designated as Secondary 'A' aquifers. These are defined as permeable layers capable of supporting local levels of water supply and base flow to surface water courses.

The underlying bedrock comprising the Lewes Chalk Formation is designated by the EA as a Principal Aquifer. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale.

The Groundwater Vulnerability Classification across the majority of the site is indicated as 'Intermediate', however there are some sections of the site, predominantly on the western boundary, that are classified as having a 'High' leaching potential.

Information contained within the BGS boreholes, indicates that groundwater is generally present within the Lewes Chalk Formation at approximately 70mbgl. However, lenses

and pockets of sand and gravel within the Lowestoft Formation are also likely to be water bearing, with perched water.

Groundwater flow in the area is likely to be limited and locally complicated owing to the number of man-made drainage ditches and channels located through the wider area. However, general flow of groundwater is likely to be in a southerly direction and ultimately in the direction of the flow of River Lee located to the south of the site boundary.

4.2.2 Groundwater Sensitivity

The Envirocheck report indicates that there are two groundwater abstractions located within Section C of the site, with a further two abstractions within 500m of Section C. The abstractions on site are both related to a borehole at Moles Farm for general farming and domestic usage. The other two abstractions are located 185m west and 211m west of Section C at Hanbury Manor for spray irrigation – storage purposes.

Information available on the EA website indicates that the majority of the site lies within 'Zone 2' of the groundwater Source Protection Zone, or 'Outer Protection Zone', defined by a 400 day travel time to the source. However, there is a thin section in the west of the site that lies within 'Zone 3' of the groundwater Source Protection Zone, defined as the area around a source within which all groundwater recharge is presumed to be discharged at the source.

4.3 Hydrology

4.3.1 Nearest Watercourse

The nearest identified watercourse is the River Lee, located approximately 1.2km to the south of the site. The EA website has information from 2009 with regard to the quality of the water within the stretch of the River Lee nearest the site. A summary of the information is shown in **Table 2**.

Table 2: River Quality in the River Lee (2009)

Chemistry[1]	Biology[1]	Nitrates[2]	Phosphates[2]
A	B	5	4
Notes: [1]Chemistry and Biology – A to F (very good to bad) [2]Nitrates and phosphates – 1 to 6 (very low levels to very high levels)			

There are multiple unnamed surface water features, drains and tributaries that bisect the site in a variety of orientations. Most of the surface water features are associated with issues i.e. springs which drain towards the south with the natural topography of the land and in the direction of the flow of the River Lee. In the west of the site the drains and tributaries are predominantly orientated northeast-southwest and drain away from the central ridge in a south-westerly direction. Fanhams Tributaries are located in the east of the site and drain in a southerly direction.

4.3.2 Site Drainage

With the exception of a few road crossings, farm buildings and hotel (with associated registered park), the entirety of the site comprises agricultural farmland. As such, drainage is via natural infiltration, aided by a network of irregular drainage ditches, commonly located along field boundaries which drain into larger channels.

4.3.3 Preliminary Flood Risk Assessment

The indicative floodplain map for the area, published by the EA, shows that the site is not located within an area at risk of flooding.

This report is not intended to replace a full hydrological study and it is recommended that additional specialist studies be conducted to confirm flood risks at the site.

4.4 Mining, Quarrying, Landfilling and Land Reclamation

Evidence has been sought to identify any mining, quarrying and landfilling operations, past and present, which have taken place in the vicinity of the construction corridor. The sources of information referenced in this element of the desk study include:

- Envirocheck report;
- Records held by local authority/EA;
- Old Ordnance Survey maps and plans (see Section 3); and
- Geological maps (see Section 4.1).

With reference to the above data sources, there are five landfill sites (current or historic), within 1km of the site boundary. The closest landfill is located 307m west of the site at Ware Quarry, Watton Road, Ware although no further information is available. Given the direction and distance of the landfill from the site, it is unlikely to be a significant source of contamination.

Historically there may have been some infilling of local land drains and ditches, however from a review of historical maps, it does not appear that there has been any significant infilling within the site area or its boundaries. Farming activities, however, may have resulted in uncontrolled waste disposal including potentially asbestos containing materials.

Historical information gleaned from the Envirocheck report indicates that there are no records of pits or quarries on site, however multiple gravel pits, sand pits and old chalk pits formed during the 1800s have been identified within the surrounding area, the closest of which is located approximately 5m from the eastern boundary of the site.

The gravel pit indicated on the 1880's historical map, measuring approximately 50m by 20m is shown to be infilled by 1923. Given the time of backfilling, un-regulated waste may have been used to infill the former pit, however due to historic and current soft surface covering (crops) it is likely that natural dilution and attenuation of any significant mobile contamination would have occurred. Vegetation within this location is in good

health (see Photo 11,**Appendix C**) and there is no obvious sign of the former pit at the surface.

All other pits were located at least 400m from site and were infilled by the 1960s at the latest. Given the time of backfilling and the distance of the pits from site, they are unlikely to be a significant source of contamination.

5 PRELIMINARY CONCEPTUAL SITE MODEL

5.1 Introduction

A conceptual site model (CSM) is a simplified written and/or visual/schematic description of the environmental conditions on a site and the surrounding area. It is developed from the individual components of the desk-based assessment to provide a depiction of likely contaminants, pathways and receptors, and highlights the key areas of uncertainty.

Fundamental to the CSM is the principle of pollutant linkages, an overview of which is presented in **Appendix B**. This approach is now accepted best practice in the industry but it does not take into account less scientific factors such as perceived risk, which frequently has a significant influence on land values, particularly when dealing with brownfield sites with a history of contamination.

Information obtained during the site walkover (included in **Appendices C** and **D**), the environmental database and historical maps (included in **Appendix F**) together with on-line records held by the BGS and Environment Agency have been used to inform the conceptual site model. The sources, pathways and receptors are presented below together with the potentially complete contaminant linkages.

The preliminary CSM presented below is based on the findings of the Preliminary Risk Assessment (PRA) and therefore contains elements of conjecture and hypothesis.

In the following sections, the individual components of all identified possible pollutant linkages are identified and the risks of potentially complete pollutant linkages are assessed qualitatively in the preliminary CSM.

5.2 Sources of Contamination

The study has identified a few potentially contaminative land uses on and in the vicinity of the site. These are summarised in **Table 3** below, together with the identified contaminants of concern typically associated with those land uses (from CLR8, Industrial Profiles and other sources including the walkover survey).

Table 3: Potential sources and types of contamination

Potential sources	Contaminants of concern
On-site present day	
Made Ground associated with construction of tracks/roads, residential dwellings and farm buildings etc (i.e. fill material)	Unknown fill material (but potentially including heavy metals, ash, clinker, sulphates, PAHs, asbestos etc.)
One electrical substation, located on the north-western boundary (post 1990's to present day)	PCBs, mineral oils and hydrocarbons.
Arable crops	Herbicides and pesticides
Farm machinery and equipment	Fuels, oils, ubiquitous agricultural chemicals
Off-site	
Electrical Substations (predominately to the south).	PCBs, mineral oils, asbestos and hydrocarbons.
Infilled former gravel pit, 5m east (1880's to 1923)	Uncontrolled backfilling of unknown fill material (but potentially including heavy metals, ash, clinker, sulphates, PAHs, asbestos etc.) Ground gas.
MOT Centres, vehicle repair shops, fuel stations (predominately to the south).	Fuel oils, hydrocarbons, lubricants and ubiquitous chemicals

There has been little significant development across the majority of the site. However, within developed areas (existing buildings/farmsteads), sources of contamination are likely to exist, predominantly in the form of Made Ground and other fill material that could potentially comprise heavy metals, ash, clinker, PAHs and asbestos.

It is considered that any significant contamination present within the backfill material used in the former gravel pit immediately east of the site boundary is likely to have naturally dispersed from attenuation. However, it cannot be discounted completely as a potential source of contamination from waste and materials (including asbestos fibres) and as a potential source of ground gas if a significant depth of made ground is present.

Undisclosed, small scale infilling of pits and drains may have been undertaken by landowners within the site area, but these are unlikely to be of a significant scale to be a noteworthy source.

One electrical substation was identified on the sites north-western boundary (developed post 1990) and several stations were also noted to the south of the site, however they all appear to be well maintained and in good working condition. Consequently, they are not considered to form a significant source of contamination.

Although considered a potential source of contamination, all adjacent industrial works associated with the town of Ware to the south are considered to be at distance not to impact the site. Also, any mobile contamination present off-site is likely to migrate in a southern direction towards the River Lee.

The farms located on site and within 250m of the site boundary (and other farms beyond this) are not considered to represent significant sources of contamination under standard operation conditions. However, due to the arable nature of the farming it is possible that herbicides and pesticides have been/are still used and consequently form a possible source of contamination. There may be some farming activities that may have/are potential sources of contamination although these are likely to be localised.

The current overhead cables that bisect the site are unlikely to be a potential source of significant contamination.

5.3 Receptors at Risk

With respect to development at the proposed site, the risk assessment identifies four categories of potential receptors:

- **Site end users:** residents or other future users (workers/maintenance personnel) of the site who may have acute exposure to sources of contamination on a regular and predictable basis;
- **Controlled waters:** perched groundwater within the Lowestoft Formation, which underlies the majority of the site, could be impacted by mobile contaminants. It is anticipated that groundwater is likely to flow in a south to south-western direction towards a secondary aquifer comprising granular superficial deposits (Kesgrave Subgroup and Glacialfluvial Deposits), and ultimately in the direction of the River Lee.
- **Buildings and Infrastructure:** including services/utilities placed within the ground and concrete foundations/piles which may be at risk from chemical attack from contaminated soils and groundwater. Also consideration for ingress of ground gas into building structures from infilled former gravel pits; and
- **Other targets:** such as the "environment", including any vegetation (flora and fauna) on or near the site and neighbouring properties and site users located close to the sites boundaries.

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

5.4 Pathways for migration

Based on the current land use across the site and the anticipated ground conditions through the area, the following contaminant pathways are considered potentially viable:

- **Direct contact:** owing to the likely development of residential properties on site, areas of soft landscaping inclusive of private gardens or communal areas give rise to pathways including soil and dust ingestion and inhalation and dermal contact that may cause harm to human health;
- **Groundwater migration**: in areas where granular strata are present, groundwater will provide a transport medium for soil leachate and groundwater contaminates to migrate vertically beneath the site and laterally off-site. Perched water within the Lowestoft Formation could also provide a pathway, however given it's cohesive nature, migration will be hindered;
- **Ground gas migration**: within limited areas on site where a significant quantity of potentially impacted made ground is present from infilling of former gravel pits and quarries;

- **Chemical attack on concrete, foundations and building structures**: chemical attack on concrete and foundations from contact with aggressive/contaminated ground, especially if mobile groundwater is present;
- **Chemical attack on portable water supply pipes:** chemical attack and permeation through plastic water supply pipes from contact with aggressive/contaminated ground; and
- **Root uptake in vegetation**: other ecological targets may be affected by contact with contaminated soils via plant uptake routes.

Pathways for gas migration from off-site sources (i.e. landfill site to the west) are not considered to exist through the predominately cohesive Lowestoft Formation, however in areas where predominately granular deposits are present underlying the site (i.e. Kesgrave Catchment Subgroup and Glaciofluvial Deposits), a potential pathway is present for migration from nearby sources. Due to a lack of potential contaminative gaseous source within predominately granular strata and confined spaces for gas to migrate into this is not considered a significant risk.

Pathways towards construction and maintenance works will relate to acute exposure and as such are outside the scope of chronic risk assessment methodologies.

5.5 Preliminary CSM

Based on the assumptions above, a preliminary CSM of pollutant linkages has been developed and is presented as **Table 4**.

The CSM includes a qualitative estimation of risk for each pollutant linkage, based on a comparison of the consequence of the event against the probability of its occurrence, in line with the risk classification methodology presented in CIRIA Report C552 (2001)[6].

Table 4: Preliminary conceptual model of pollutant linkages

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification given history
ON SITE CONTAMINATION					
Potentially contaminated made ground and soils (associated with local development and infilling of former pits and farming activities)	Site end users	Direct contact and Inhalation of indoor/outdoor dust/vapour/fibres	Low Likely	Medium	**Moderate/Low -** unknown fill material on site may potentially be contaminated. Plausible pathways in areas of soft landscaping.
	Controlled waters	Leaching from soils and groundwater migration	Unlikely	Medium	**Low** – impacted groundwater and perched water could migrate into local Secondary Aquifer, however low permeability clay (Lowestoft Formation) will hinder progress off site.
	Buildings and Infrastructure	Chemical attack	Low likely	Medium	**Moderate/Low** – impacted soils/and perched groundwater beneath the site could chemically attack concrete foundations of new buildings and permeate through plastic water supply pipes.
		Ground gas migration	Low likely	Medium	**Moderate/Low** – significant fill materials within former pits may generate ground gases that are able to ingress into buildings and confined spaces developed on site.
	Other Targets - Vegetation	Root uptake	Unlikely	Mild	**Very Low** – proposed areas of vegetation could offer a plausible pathway if contamination is present on site.
	Other Targets – off site buildings and site users	Surface run-off and leaching from soils and groundwater migration	Unlikely	Medium	**Low –** off site targets (buildings and human health) affected by mobile contaminants present on site.
Electrical Substation (NW boundary – Section c)	Controlled waters	Surface run-off and leaching from soils and groundwater migration	Unlikely	Medium	**Low** – one identified on the sites boundary. Potential for localised impact to groundwater and perched water which could migrate into local Secondary Aquifer, however low permeability clay (Lowestoft Formation) will hinder progress off site.
	Site end users	Direct contact (dermal contact and ingestion) with contaminated soils.	Unlikely	Medium	**Low –** localised soil contamination could affect site end users within areas of soft landscaping.

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Risk and justification given history
Herbicides and Pesticides associated with arable farming	Controlled waters	Leaching from soils and groundwater migration	Unlikely	Medium	**Low** – impacted groundwater and perched water could migrate into local Secondary Aquifer, however low permeability clay (Lowestoft Formation) will hinder progress off site.
	Other Targets - Vegetation	Root uptake	Unlikely	Mild	**Low** – proposed areas of vegetation could offer a plausible pathway if herbicides and pesticides are used on site.
OFF SITE CONTAMINATION					
Contaminants associated with historic infilled gravel pits located around the boundaries of the site.	Future site users	Ground Gas migration (on to site)	Unlikely	Medium	**Low: -** Fill materials may generate ground gases that are able to migrate onto site, however intervening land comprising permeable soft covering will allow attenuation.
	Buildings and Infrastructure				
	Controlled waters	Leachate migration (on to site)	Unlikely	Medium	**Low**: - impacted groundwater and perched water could migrate into local Secondary Aquifer, however low permeability clay (Lowestoft Formation) will hinder progress off site. Direction of groundwater is likely to be to the south, away from the site.

Pollutant linkages identified in **Table 4**, with a moderate (or higher) risk that may drive further investigation works include potential contaminants associated with made ground deposits potentially present from the infilling of former gravel pits and 'worked' areas (as identified immediately to the east of the site and from farming activities).

An initial risk may be present to construction workers across sections of the site from sources of contaminated soils and perched groundwater, however adequate measures and the correct use of PPE will protect the health and safety of construction workers and control further any possible pollution caused by the works.

To summarise, the preliminary CSM has identified evidence of possible localised ground contamination existing on site, possible pathways for contamination to migrate and sensitive receptors potentially at risk. Possible pollutant linkages are therefore deemed to exist.

Overall, the site is considered to be at 'low' risk from contamination within the potential for a 'low to moderate' risk to exist locally.

6 CONCLUSIONS AND RECOMMENDATIONS

The Preliminary Risk Assessment has identified the potential for localised historical sources of ground contamination on site associated with general made ground deposits from localised development, including building construction and infilling of former gravel pits and drains that may not have been disclosed.

Potential off site contamination has also been identified within close proximity to the site associated with the infilling of a former gravel pit immediately adjacent to the east of the site.

The most significant risks associated with development of the site are considered to be:

- Direct Contact (including ingestion, inhalation and dermal contact of impacted ground) with future proposed site users (including residents, workers and maintenance personnel of the site);
- Chemical attack to concrete and foundations of future proposed buildings and structures on site;
- Chemical attack to plastic water supply pipes placed in the ground for future proposed buildings and structures on site;
- Localised ground gas migration to ingress into future proposed buildings and structures on site (where infilling of former gravel pits has been identified on site);

It is also considered that within localised areas where deposits of impacted made ground are present a small risk to proposed areas of soft landscaping within private gardens or communal areas may be present.

The preliminary findings suggest that the site is unlikely to be classified by the local authority as 'Contaminated Land' under the current contaminated land regime (Environmental Protection Act 1990: Part IIA).

Therefore, the overall environmental liability associated with the site and the risks associated with proposed development are considered to be **'low'** and **'low to moderate'** in areas of potential localised contamination.

It is recommended that an intrusive investigation be carried out to identify the geotechnical parameters and the possible presence, nature and extent of any contamination, particularly in areas of potential concern (i.e. in filled areas, existing structures). The preliminary investigation, which should comprise a series of shallow boreholes and mechanically excavated trial pits, local to the proposed sources of contamination and a basic suite of testing, should be conducted. This will clarify the geological/hydrogeological constraints on contamination migration and give a more detailed assessment of the potential environmental risks and liabilities with site development. The information will also enable as assessment of ground conditions for the design of foundations and associated works.