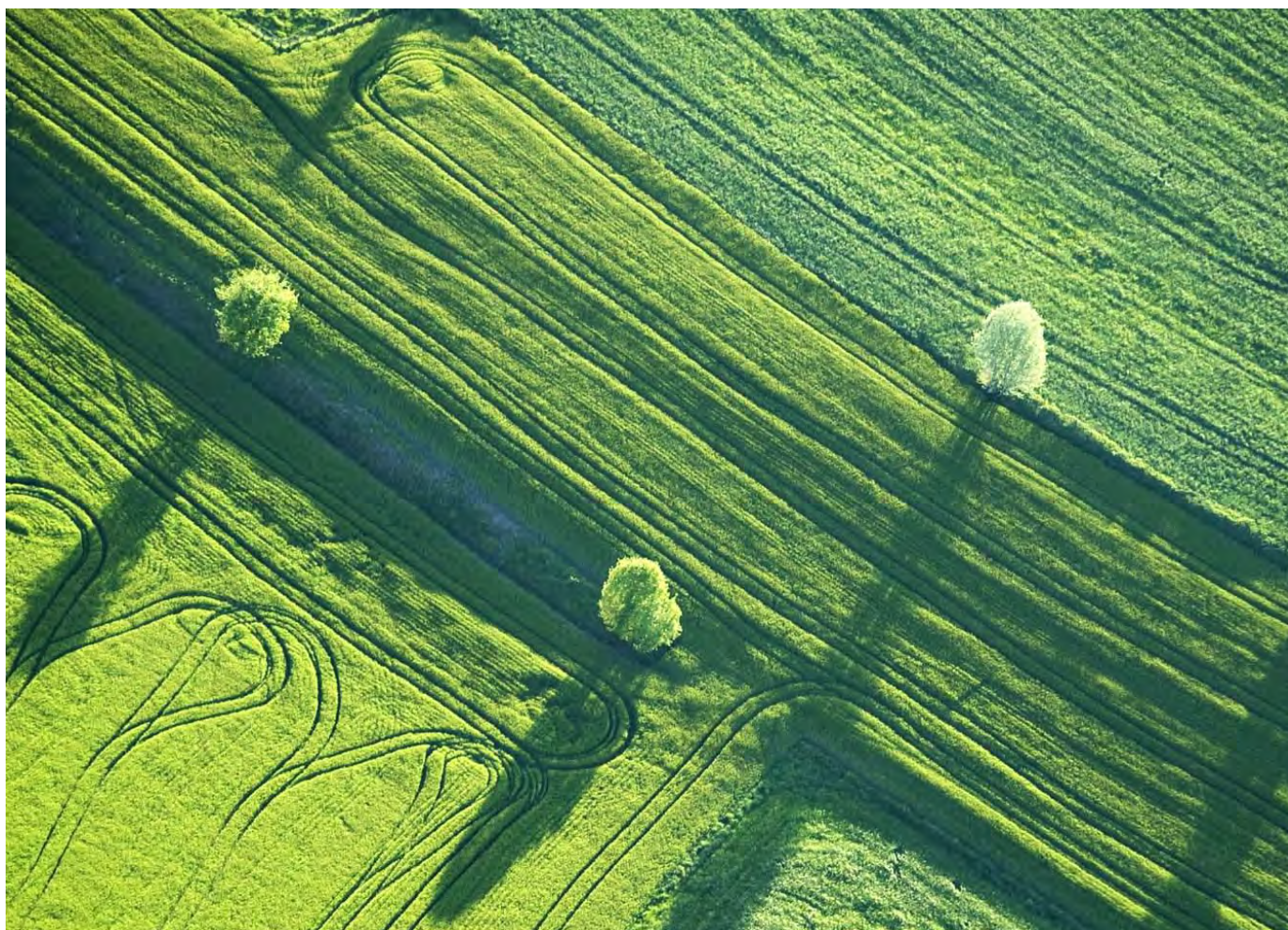




Gallagher Developments Group Ltd.

Highover Farm, Hitchin, SG4 0QW

Phase 2 Geo-environmental and Geotechnical Site
Investigation

340110-R01 (01)

JANUARY 2020





RSK GENERAL NOTES

Project No.: 340110 R01 (01)

Title: Phase 2 Geo-environmental and Geotechnical Site Investigation : Highover Farm, Hitchin, SG4 0QW

Client: Gallagher Developments Group Ltd, Gallagher House, Gallagher Way, Gallagher Business Park, Warwick, CV34 6AF

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Revision control sheet

Revision reference	Date	Reason for revision
Rev 00	3 rd January 2020	First issue. Draft for comment.
Rev 01	9 th January 2020	Second issue based on clients comments.

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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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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by Gallagher Developments Group Ltd to carry out a Geoenvironmental and Geotechnical Site Investigation of the land at Highover Farm, Hitchin. The project was carried out to an agreed brief as set out in RSK's proposal (Ref. 340110-T01 (01), dated 5 July 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 residential use with a primary school and other local amenities. The planned layout of the site is shown in **Appendix B**.

1.3 Objectives

The objective of the work is:

- To identify any land contamination and geotechnical constraints to the proposed development; and
- To identify the need for any additional investigation or remediation 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 C**.

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

Intrusive Investigation

- Exploratory hole locations have been spaced on an approximate 75.0 m by 75.0 m grid, thus equating to a total of 73 exploratory holes across the site which will consist of the following:
 - Drive in sampler (windowless sampling) boreholes with the drilling of up to 24 boreholes, to a depth of 3.0 m to 4.0 m depending on ground conditions, 12 selected shallow boreholes installed with groundwater and ground gas monitoring valves;
 - Excavation of 48 trial pits to a depth of up to 3.0 m, with 18 pits used for soakaway testing in accordance to BRE Digest 365;
 - Advancement of four rotary cored borehole to 20.0 mbgl (metres below ground level), all installed with groundwater monitoring wells
- A 'preliminary' soil gas monitoring programme consisting of 6 gas monitoring rounds has initially been allowed over a 6-week period.
- Interpretation of data to develop a refined conceptual site model (CSM)
- Generic quantitative risk assessment (GQRA) to evaluate potentially complete contaminant linkages identified in the refined CSM
- Identification of the need for further action, e.g. supplementary intrusive investigations/ monitoring, remediation works or other mitigation, if any.
- Interpretation of ground conditions and geotechnical data to provide preliminary recommendations with respect to foundations and infrastructure design;
- Preparation of this factual and interpretative report with recommendations for further works (i.e. undertake a remedial options appraisal to identify appropriate mitigation measures/produce a remedial implementation and verification plan) and/or remediation as necessary.

Factual and interpretative reporting including:

- A review of the previous report;
- The factual information obtained such as the site plans, exploratory hole logs, in situ monitoring results (e.g. soil gas) and laboratory testing certificates;
- Assessment of potential pollutant linkages with the identification of potentially unacceptable risks;
- Generic Quantitative Risk Assessment including an assessment of the chemical data against any published or RSK-derived generic assessment criteria (GAC);
- Recommendations for further assessment works or potential remedial requirements and control measures;
- Initial advice on waste disposal implications;
- A review of geotechnical data and, where appropriate, recommendations on soil parameters for geotechnical design in relation to the proposed development;

- Result of a preliminary assessment on spread foundations;
- A desk-based review of chalk subsidence risk and implications on foundations and ground based infrastructure; and
- A discussion and recommendations on relevant geotechnical matters in relation to the proposed development, including ground floors, sub-grade conditions for road pavements, soakaways, and chemical attack on buried concrete.

1.5 Existing reports

The following reports detailing previous works at the site were made available for review:

- WSP: Highover Farm, Hitchin. Environmental Desk Study Report. Reference 62240435 Dated July 2017;
- WSP/Parsons Brinkerhoff: Land at Hitchin, Utilities Statement dated September 2017. Reference 70032552 Dated September 2017;
- Planit Intelligent Environments LLP. Parameters: Development Area Plan Ref PL1685-VW-005 02 dated 14-09-2017;
- Planit Intelligent Environments LLP. Site Masterplan. Ref PL1685-VW-001 07 dated 23-02-18; and
- Technical Appendix 11.1 – Arboriculture Constraints report table and figures.

Pertinent information from these reports has been summarised in **Section 2 and 3**.

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.

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	Highover Farm, Hitchin
Full site address and postcode	Highover Farm, Hitchin, Hertfordshire, SG4 0QW
National Grid reference (centre of site)	TL 20058 31175
Approximate elevation (mAOD)	60.0 to 80.0 m AOD (Above Ordinance Datum)

2.2 Site description

The Site boundary and current site layout are shown on **Figure 2**. The Site covers an area of c. 40 hectares. It is currently occupied by arable farmland with hedgerows. The site is made up of six parcels of land separated by hedgerows and access tracks. At the time of the site investigation the three northern parcels were cropped barely fields. The south east parcel was covered with cut meadow grass. One parcel (to south of the site) consisted of a pond and overgrown grass land. The parcel next to the farm yard (to the south of the site) was covered by overgrown meadow grass and thistles.

2.3 Surrounding land uses

The Site is located to the north east of Hitchin, within a predominantly residential and rural setting. Immediate surrounding land uses are described in **Table 2**.

Table 2 Surrounding land uses

North	The most northern tip of the site is where Stotfold Road runs beneath the railway line. Beyond this is arable farmland.
East	The site is bordered by Stotfold Road to the east, beyond this is arable farmland with Letchworth Garden City located less than 1.0 km to the east.
South	The site is adjacent to residential properties in the south as well as a school.
West	Along the western boundary of the site runs the railway line. On the other

side of the railway line is an industrial estate.

2.4 Development plans

The proposed layout of the site, at the time of preparing this report, is shown in **Appendix B (Drawing ref: PL1685-VM-001 (07))**. The majority of the proposed layout is made up of c. 700 residential properties with private gardens. The layout also includes a primary school, allotments, wildlife areas, sports pitches, retail facilities and a community hub.

There is currently an active planning application pertaining to the site on the North Hertfordshire District Council planning portal. Its application reference is 18/01154/OP.

3 DESK-BASED ASSESSMENT

3.1 Summary of previous investigation

The previous report prepared by WSP listed below is summarised in this section.

- WSP: Highover Farm, Hitchin. Environmental Desk Study Report. Reference 62240435 Dated July 2017;

A summary of pertinent information from previous investigations is included below in **Table 3**. In addition, relevant information relating to the geology, hydrogeology, hydrology and mining and quarrying from the previous report are presented in **Sections 3.2 to 3.7**.

Table 3 Summary of previous investigation reports

Report Details	WSP: Highover Farm, Hitchin, Environmental Desk Study Report, July 2017
Site coverage	The 2017 report covers the entire footprint of the site this report pertains to.
Summary scope of works	The aim of the PRA was to identify potential environmental & geotechnical liabilities and constraints, associated with the development of the site in support of an outline planning application.
Does the client have reliance upon the report?	Yes
Key factual findings	At the time of writing the report the site is agricultural land with a small pond to the south of the site. UXO online search identified that the site lies within a moderate risk of unexplored ordnance. The PRA indicates that the site poses a low to very low potential environmental risks. There are however, potential moderate/Low risks due to potential made ground associated with the adjacent railways line, former onsite structures and ponds. Environmental constraints are unlikely to exist with respect to the proposed development.

3.2 Site history

Throughout its known history, the site has continued as agricultural use. Based on the information presented in the previous WSP report identifies three small ponds and Highover Farm is present in the south west of the site from 1881. Two unspecified buildings were present on site in the south from 1897 to 1899. The northern most pond was no longer present on site in the early 1980s and the northern most building on site was no longer present around the mid-1980s.

The earliest historical records (i.e.1881) indicates that the land surrounding the site generally comprised of agricultural land along with corn mill and lime works. The River Purwell is located to the west and the village of Walworth is noted to the south of the site.

By the 1890s, gas and iron works were present to the south west of the site and a chalk pit to the west of the site however the Iron works was no longer present in 1940s. By the 1920s, sewage works and a timber yard were noted to the north west as well as allotments on the southern boundary of the site. Mixed industrial and residential developments are present around the vicinity of the site by the 1940s and by 1980s residential housing was up the western and southern boundaries of the site.

It is noted that distances of the above features from the site are not given in the previous report.

3.3 Site geology

3.3.1 Anticipated geological sequence

Based on the information provided within the previous WSP report the anticipated bedrock geology beneath the site is underlain by Zig Zag Chalk Formation to the north east of the site, Hollywell Nodular Chalk Formation and New Pit Chalk Formation (Undifferentiated) to the south west and the Melbourn Rock Member presented in between.

Superficial Head deposits are located to the north east overlying the Zig Zag Chalk Formation and the Lowestoft Formation is noted to the south west, overlying the Hollywell Nodular Chalk Formation and New Pit Chalk Formation (Undifferentiated). The report notes that the central part of the site has no superficial deposits.

No mention has been made of the risk of dissolution features being present on site.

3.4 Radon

In the 2017 WSP report the site is indicated to not be a radon affected area, as less than 1 % of properties are above the action level. No radon protective measures are deemed necessary.

3.5 Mining and quarrying

Evidence from the environmental database report within WSP's previous investigation identifies That the site lies in an area with a known history of quarrying of Chalk. The nearest Chalk pit is 240.0 m to the north west of the site called 'The Cadwell Chalk Pit'. It is noted that this pit is now stated as inactive. However, where Chalk deposits are present at or close to surface, historical mining activities may have resulted in unrecorded mines.

Three sinkholes were recorded within a 1.0 km radius of the site, the closest being 800.0 m to the west of the site.

3.6 Hydrogeology

A summary of the hydrogeological setting of the site, with respect to the anticipated geological sequence set out in **Section 3.2** is presented below in **Table 4**.

Table 4 Summary of hydrogeological setting

Condition	Description
Aquifer characteristics	The site is underlain by a principal aquifer relating to the Zig Zag Chalk Formation, Melbourn Rock Member, Hollywell and New Pit Chalk Formations. The Head Deposits and Lowestoft Formation are both classified as secondary (undifferentiated) aquifers.
Licensed groundwater abstractions	The 2017 WSP report indicates that there are no groundwater abstractions within a 250.0 m radius of the site.
Source protection zones	The previous report indicates that the site does not lie within a currently designated groundwater Source Protection Zone (SPZ).

3.7 Hydrology

A summary of the hydrology within the site area is summarised in **Table 5**.

Table 5 Summary of hydrology in site area

Condition	Description
Surface watercourse s/features	Information from the previous WSP report confirms that there are no surface water features or courses on site, however, it is stated in the report that a pond was present on site during a previous walkover. Its location however is not detailed within the report.
Surface water abstractions	There are no surface water abstractions identified by the 2017 WSP report, within a 250.0 m radius of the site.
Preliminary flood risk assessment	The previous report classifies the site to be at a very low risk from flooding with a potential for Clearwater flooding from groundwater.

4 RSK ADDITIONS TO THE DESK-BASED REVIEW

Based on the above pertinent information from the previous report, RSK have included the additional information and included this within the following subsections.

4.1 Site history

Historical maps publicly available online confirms that only two out of the three mentions ponds are located on site. One pond is adjacent to the Highover farm outside the footprint of the site and is located approximately 60.0 m to the south of the site. The two ponds on site are encountered towards the southern part of the site.

Additional information regarding the history of the surround features is summarised within **Table 6**.

Table 6 Historical features surround the site

Historical feature	Approximate distance and direction from site	Date		Notes
		From	To	
Corn mill and lime works	500.0 m to the south west	1881	1980s	Renamed to works. This area and to the west of the site is now occupied by various large light industrial units which span 500.0 m to the south west of the site and up to 50.0 m to the west of the site
Iron works	750.0 m to the south	1897	1948	Significant residential development to south and south west from 1940s to 1980s.
Gas works	650.0 m to the south	1897	Present day	Renamed to works. Significant residential development to south and south west from 1940s to 1980s.
Chalk pit	500.0 m to the south west	1897	1980s	Chalk pit is replaced with light industrial units
Sewage works	750.0 m to the south west	1921	Present day	Renamed as works in 1958
Timber yard	750.0 m to the south west	1921	Present day	Renamed at depot in 1959

Historical feature	Approximate distance and direction from site	Date		Notes
		From	To	
Allotments	Adjacent to the site in the south	1921	1980s-2002	Partly replaced with residential properties in the 1980s. the remainder of the allotments were replaced with residential properties by 2002.

Given the significant distance, age and increased residential properties in the area, the above features around the vicinity of the site are unlikely to be risk to the proposed development and therefore not investigated further.

4.2 Geology

Published records (British Geological Survey, Hitchin, Sheet No. 221, 1995 and online map 2019) for the area and available historical borehole logs indicate the geology of the site to be characterised by the succession recorded in **Table 7**.

There is one publicly available BGS historical borehole (Ref: TL13SE16) located on site in the south. This is shown in **Appendix D**.

Table 7 Site geology

Strata	Description	Estimated thickness (m)	Permeability
Head deposits (Formerly known as Dry Valley Deposits)	Poorly sorted gravely sandy clay	Up to 5	Variable permeability
Lowestoft Formation (also noted as Till)	Chalky till with outwash sands and gravels, silts and clays. Carbonate content of about 30%.	Up to 10	Low permeability
Hollywell Nodular and New Pit Chalk Formations (undifferentiated) (white Chalk Subgroup)	Hard nodular chalk with thin falser marls and significant proportions of shell debris in part.	75 - 85	Highly permeable
Melbourn Rock Member (White Chalk Subgroup)	Hard to very hard off-white, blocky fractured chalk with numerous nodular chalk beds and thin anastomosing marls. No presence of shells.	2 - 7	
Zig Zag Chalk Formation (Grey Subgroup Chalk)	Mostly firm, pale grey to off-white blocky chalk with a lower part characterised by rhythmic alternations of marls and marly chalks with firm white chalk.	35 to 50	

The above succession appears to confirm the anticipated succession within the previous report.

4.3 Hydrogeology and hydrology

It is estimated that the piezometric surface in the Chalk aquifer is at approximately 45.0 m Above Ordinance Datum (AOD), (some 17.0 to 36.0 mbgl). The regional direction of groundwater flow is towards the north west in line with local topography and in the direction of flow of the River Oughton.

The public available BGS historical borehole (Ref: TL13SE16) located on site in the south did not encounter any shallow groundwater within the superficial soils.

The presence of localised and potential low permeability clay at relatively shallow depths beneath the site (i.e. the superficial Head Deposits to the north east and the Lowestoft Formation to the south west), while restricting downwards migration, may increase the potential for lateral migration of shallow groundwater (and therefore mobile contamination, if present).

A pond is present on site located in the south. In September 2019 the pond in the southern part of the site was dry for only the third time in 50 years according to local knowledge, however this information is to be taken as an indication not fact.

The site is likely to drain directly into the ground given that the majority of the site surfacing comprising of soft landscaping.

4.4 Unexploded ordnance

A detailed unexploded ordnance (UXO) risk assessment (1st Line Defence, Highover Farm, Hitchin, ref: DA9080-00, dated September 2019) was commissioned for this site. It found that there is an overall medium risk from German and anti-aircraft unexploded ordnance. There is low risk from allied ordnance. As such, any intrusive works have to follow a UXO risk management plan, UXO specialist onsite support and intrusive magnetometer survey of all borehole locations. A Copy of the UXO report is presented in **Appendix D**.

4.5 Planning records

Planning records held by the Local Authority Planning Department pertaining to the site and relevant to the current assessment are summarised in **Table 8**.

Table 8 Planning information

Year	Details and application reference no.	Part of site
2018	Outline Application - for the provision of up to 700 residential dwellings and associated works along with, commercial premises, a primary school and public open space Ref: 18/01154/OP	Entire site

4.6 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.

4.6.1 Potential soil, soil vapour and groundwater linkages

4.6.1.1 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 9**. Ground gas sources are addressed in the next section.

Table 9 Potential sources of soil and groundwater contamination

Potential sources	Contaminants of concern	Current or historical?
On-site		
Made ground from previous development on site (access track, former onsite structures and ponds), likely to be limited and localised.	Unknown fill material but potentially including brick, ash and clinker and containing toxic and phytotoxic metals, inorganics, polycyclic aromatic hydrocarbons (PAHs), asbestos	Current
Agricultural activities	Pesticides and herbicides	Current and historical
Compost/ manure stockpiles	Effluent	Current
Off-site		
Railway, Adjacent to west of site	Petroleum hydrocarbons, toxic and phytotoxic metals, inorganics, PAHs, asbestos, herbicides	Current
Farm yard, adjacent to the south	PAHs, herbicides, pesticides, petroleum hydrocarbons, asbestos, herbicides, kerosene, clinker	Current
Nursery and garden centre, 180.0 m east	PAHs, herbicides, pesticides	Current
Notes: The Nursery and garden centre located 180.0 m to the east of the site is unlikely to be a risk to site given its significant distance from site and therefore, this potential off-site source is not investigated further.		

4.6.1.2 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];
- Adjacent site users – residential, commercial [migration of contamination via dust/fibre deposition, vapour or groundwater migration combined with inhalation];
- Future buildings and services [direct contact with contaminated soils or groundwater and chemical attack];
- Future vegetation [direct contact with contaminated soils or groundwater and root uptake leading to phytotoxicity];
- Groundwater in secondary undifferentiated aquifer within Lowestoft formation and Head deposits [leaching from soils/ percolation to aquifer/ lateral migration of dissolved phase]; and
- Groundwater in principal aquifer within the chalk bedrock deposits [percolation through permeable strata to aquifer/ lateral migration of dissolved phase].

Potential linking pathways are shown 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.

Ecological receptors are only considered within the conceptual model in the context of statutory protected sites.

4.6.2 Potential ground gas linkages

4.6.2.1 Ground gas generation potential

Potential ground gas sources identified for the site and surrounding are shown in **Table 10**.

Table 10 Potential ground gas sources

Potential sources	Indicative ground gas generation potential (CIEH, 2008)		
	Generation potential	Risk of lateral migration	Risk to development
On-site			
Made ground with low degradable organic content (if encountered) (e.g. up to 5% organic material and no easily degradable waste).	Very low	Negligible	Very low
Natural carbonate soil and strata such as chalk and limestone	Very low	Negligible	Negligible
Off-site			
Farm yard	Very low	Negligible	Negligible
Source: CIEH, 2008			

Given the anticipated ground conditions set out above, significant potential sources of ground gas generation have not been identified. Therefore, risks relating to ground gases are not included within the CSM.

4.6.2.2 *Preferential pathways for ground gas migration*

Credible preferential pathways potentially connecting the source and receptor through vertical and lateral migration are:

- Geology of the Chalk Formations which are likely to be permeable and contain natural fractures;
- Building foundations, piled foundations and vibro-stone columns;
- Construction joints and cracks within building structure; and
- Utility routes and service penetrations into buildings.

4.6.2.3 *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, commercial [migration and ingress of ground gases into buildings, build-up in confined spaces and explosion/ asphyxiation];
- Adjacent site users – residential users, commercial [migration and ingress of ground gases into buildings, build-up in confined spaces and explosion/ asphyxiation]; and
- 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.

4.6.3 **Preliminary risk assessment**

The preliminary risk assessment findings and potentially complete contaminant linkages are shown in **Table 11** 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 E**.

Table 11 Risk estimation for potentially complete contaminant linkages

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
On site						
Made ground from previous development on site (access track, former onsite structures and ponds)	Future site users - residential	Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce	Low likelihood	Medium	Moderate/ low	There is little evidence to suggest that significant Made Ground will be present at the site base on previous localised developments on site. If present, the extent of any Made Ground is likely to be limited however, there is the potential for the linkage to be complete with proposed soft landscaping areas.
	Adjacent site users - residential	Migration of contamination via dust/fibre deposition, vapour or groundwater migration combined with inhalation	Unlikely	Medium	Moderate/ low	Extent of any Made Ground is likely to be limited. Land is covered with grass with some trees. Vegetation will limit dust/fibre generation. Groundwater migration is likely to flow in a north-westerly direction away from adjacent site users.
	Future buildings and services	Direct contact with contaminated soils or groundwater and chemical attack	Low likelihood	Mild	Low	There is little evidence to suggest that significant Made Ground will be present at the site base on previous localised developments on site. If present It is considered likely that building materials may come in contact with any Made Ground soils. It is considered possible that degradation of concrete materials could occur, however Made ground is likely to be limited.
	Future vegetation	Direct contact with contaminated soils or groundwater and root uptake leading to phytotoxicity	Low likelihood	Mild	Low	There is little evidence to suggest that significant Made Ground will be present at the site base on previous localised developments on site. If present, the extent of any Made Ground is likely to be limited however, there is the potential for the linkage to be complete with proposed soft landscaping areas. During the walkover from the previous investigation, vegetation on site appears healthy.
	Groundwater within Principal aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Medium	Low	Any Made Ground will be in direct contact within the Principal aquifer in the central part of the site, however, concentrations of determinands are likely to be low, the extent of Made Ground is likely to be limited and determinands are unlikely to percolated to groundwater given the significant depth to the water table (approximately 17.0 to 36.0 mbgl)
	Groundwater within Secondary (undifferentiated) aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Low likelihood	Mild	Low	Any Made Ground will be in direct contact within the Secondary (undifferentiated) aquifer to the northeast and southwest of the site, however, concentrations of determinands are likely to be low and extent of made ground likely to be limited
Agricultural activities	Future site users - residential	Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce	Low likelihood	Medium	Moderate/ low	Due to the persistent nature of some herbicides and pesticides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields there is a potential for them to be present., therefore the potential pollutant linkage is complete within proposed soft landscaping areas.
	Future buildings and services	Direct contact with contaminated soils or groundwater and chemical attack	Low likelihood	Mild	Low	Due to the persistent nature of some herbicides and pesticides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields there is a potential for them to be present., therefore the potential pollutant linkage is complete as future buildings and services will be in direct contact with the potentially impacted soils.
	Future vegetation	Direct contact with contaminated soils or groundwater and root uptake leading to phytotoxicity	Low likelihood	Mild	Low	Due to the persistent nature of some herbicides and pesticides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields there is a potential for them to be present., therefore the potential pollutant linkage is complete within proposed soft landscaping areas.
	Groundwater within Principal aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Medium	Low	Due to the persistent nature of some herbicides and pesticides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields there is a potential for them to be present. Although the site is in direct continuity with principal aquifer, determinands are unlikely to percolated to groundwater given the significant depth to the water table (approximately 17.0 to 36.0 mbgl).

Potential source	Potential receptor	Possible pathway	Likelihood	Severity	Potential risk	Justification
	Groundwater within Secondary (undifferentiated) aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Likely	Mild	Moderate/Low	Due to the persistent nature of some herbicides and pesticides there is a potential for residual concentrations to remain within soils over a long period of time. If applied on fields there is a potential for them to be present. The site is in direct continuity with Secondary aquifer.
Compost/ manure stockpiles	Future site users - residential	Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust/fibres, ingestion of home-grown produce	Unlikely	Medium	Low	Unlikely to be a risk to sensitive receptors as stockpile will be removed prior to propose development thus breaking the potential complete pollutant linkages.
	Adjacent site users - residential	Migration of contamination via dust/fibre deposition, vapour or groundwater migration combined with inhalation	Unlikely	Medium	Low	
	Future buildings and services	Direct contact with contaminated soils or groundwater and chemical attack	Unlikely	Mild	Very low	
	Future vegetation	Direct contact with contaminated soils or groundwater and root uptake leading to phytotoxicity	Unlikely	Mild	Very low	
	Groundwater within Principal aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Medium	Low	
	Groundwater within Secondary (undifferentiated) aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Mild	Very low	
Railway land, adjacent to west of site	Future site users - residential	Migration of contamination via dust deposition (i.e. asbestos)	Low likelihood	Medium	Moderate/Low	Potential contamination could migrate to site if airborne given the close proximity to site.
	Groundwater within Principal aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Medium	Low	Groundwater flow is anticipated to be in a north westerly direction, therefore any potential contamination is unlikely to migrate in the aquifers beneath the site as the site is located adjacent to railway land in the east.
	Groundwater within Secondary (undifferentiated) aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Mild	Very low	
Farm yard, adjacent to the south	Future site users - residential	Migration of contamination via dust deposition (i.e. asbestos)	Low likelihood	Medium	Moderate/Low	Farm yard is to remain in close proximity with development. Dusty operations are carried out in farm yard and potential asbestos containing material in buildings.
	Groundwater within Principal aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Unlikely	Medium	Low	Potential contaminates such as hydrocarbons from machinery could have leak/spilled and migrate through to the underlying aquifers beneath the adjacent farm (i.e. Secondary aquifer). Given the anticipated groundwater flow to be in a north westerly direction, this pollutant linkage has the potential to be complete but locally in the to the southern part of the site. The operations at the adjacent farm are unknown. Given the cohesive nature of the superficial deposits (i.e. the Secondary aquifer) within the southern part of the site and no recorded groundwater depth within these soils it is likely that impermeable soils may stop the migration of potential contaminates through to the more sensitive underlying Principal.
	Groundwater within Secondary (undifferentiated) aquifer	Leaching from soils/ percolation to aquifer/ lateral migration	Low likelihood	Mild	Low	

Potentially complete contaminant linkages with a potential risk of moderate to low or higher identified in **Table 10** comprise:

- The impact of potential Made Ground on site, and adjacent off-site sources (i.e. railway land and farm yard) on future residents of the site

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.

It may be prudent to investigate the following in order to confirm their absence or presence given that to date no intrusive works have been undertaken on site.

- Ground gas concentration beneath the site
- Leaching potential of any made ground present at the site
- Potential for soils to impact proposed buildings, services and vegetation.

4.7 Preliminary geotechnical constraints

4.7.1 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; and
- 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 2 has been assumed for the purposes of designing the geotechnical investigation. This should be reviewed at all stages of the investigation and revised where necessary.

4.7.2 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 12** together with an assessment of whether the site may be affected by each of the stated hazards.

Table 12 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
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 4.7.2.1
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

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	
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
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.			

4.7.2.1 Chalk

In view of the prevailing ground conditions, with Chalk at shallow depth beneath the site, it is normal practice to consider the potential risk of ground subsidence related to the presence of swallow holes and other natural chalk solution features or man-made cavities (Chalk Mines).

With reference to Edmund's database of known natural and man-made chalk solution features there are no such features in the immediate vicinity of the site. The nearest known feature is over 1.0 km away from site. The nearest known feature is 1,096.0 m away which relates to a natural chalk well.

It is noted however from the previous WSP report that an inactive chalk pit (The Cadwell Chalk Pit) is located 240.0 m to the north west of the site. Three sinkholes were also recorded within the WSP report being 1.0 km radius from the site, the closest being 800.0 m to the west of the site.

Based on the Edmund's risk assessment model for natural dissolution features referred to in CIRIA Report C574 (Lord et al. 2002), the site falls into the following anticipated subsidence risk categories:

- Where Head Deposits overlie the chalk in the north of the site – Moderate risk.



- Where Lowestoft Formation overlies the chalk in the southern third of the site – Low risk.
- Where cover deposits are absent across the remainder of the site – Low risk.

5 SITE INVESTIGATION STRATEGY & METHODOLOGY

5.1 Introduction

RSK carried out intrusive investigation works and subsequent monitoring of boreholes between September 2019 and December 2019.

5.2 Objectives

The specific objectives of the investigation were as follows:

- To establish the ground conditions underlying the site including the extent and thickness of any Made Ground;
- To investigate specific potential sources of contamination identified in initial CSM;
- To determine groundwater depth and flow direction;
- To determine the ground gas regime underlying the site; and
- To assess geotechnical properties of soils.

5.3 Selection of investigation methods

The techniques adopted for the investigation were chosen with consideration of the objectives and site constraints, which are described below.

Rotary drilling was chosen based on the targeted drill depth, requirement for in-situ geotechnical data, the opportunity to collect both disturbed and undisturbed samples and install monitoring wells. This was supplemented by windowless sampling boreholes to obtain shallow geotechnical data and mechanically excavated trial pitting to obtain a number of investigation locations and achieve greater visibility of the Made Ground (if any). Infiltration testing was performed within 18 of trial pits across the site with six of these being targeted within the footprint of proposed attenuation ponds.

Prior to conducting intrusive works, utility service plans were obtained, and buried service clearance undertaken in line with RSK's health and safety procedures.

5.4 Investigation strategy

The ground investigation was carried out using intrusive ground investigation techniques in general accordance with the recommendations of BS5930: 2015 Code of practice for ground investigations, which maintains compliance with BS EN 1997-1 and 1997-2 and their related standards. Whilst every attempt was made to record full details of the strata encountered in the boreholes, techniques of hole formation and sampling will inevitably lead to disturbance, mixing or loss of material in some soils and rocks.

The investigation strategy involved non-targeted boreholes and trial pits.

The constraints to the investigation were as follows:

- Limited investigation of farm track due to being in use and being a network rail emergency access route
- Overhead power lines in the southern part of the site

Details of the investigation locations, installations and rationale are presented in **Table 13**. 48 machine excavated trial pits were dug to a maximum depth of 3.0 mbgl, 18 of these were selected to be used for soakaway testing, before being backfilled with arisings. 4 rotary cored boreholes were drilled to a maximum depth of 20.0 mbgl, each was installed with a combined gas and groundwater monitoring well. 24 drive in sampler (windowless) boreholes were advanced to a maximum depth of 6.0 m with 12 installed with a combined gas and groundwater monitoring well.

Table 13 Exploratory hole and monitoring well location rationale

Investigation type	Number	Designation	Monitoring well installation	Rationale examples below
Boreholes by rotary cored methods	4	BH1a, BH1 to BH3	Three locations installed with gas and groundwater monitoring wells	Advanced to a maximum depth of 20.3 mbgl. To prove the geological succession beneath the site and obtain geotechnical data
Boreholes by dynamic sampling methods	24	WS1 to WS24	12 locations* installed with as and groundwater monitoring wells	Advanced to a maximum depth of 6.0 mbgl. To determine the contamination status of the ground beneath the site and to install additional dual-purpose groundwater and gas monitoring wells
Trial-pits excavated by mechanical excavator	30	TP1 to TP30	n/a	Excavated to a maximum depth of 2.5 mbgl. To accurately log the upper strata beneath the site. Collect samples from shallow and deeper soils.
Soakaway test trial-pits excavated by mechanical excavator	6	SA1 to SA6	Installed with filling and observation pipework then backfilled with gravel	Excavated to a maximum depth of 3.0 mbgl. To perform infiltration testing on targeted locations within the footprint of proposed attenuation ponds.
	12	SA7 to SA18		Excavated to a maximum depth of 2.5 mbgl. To perform infiltration testing on non-targeted locations across the site.

Investigation type	Number	Designation	Monitoring well installation	Rationale examples below
*Installed wells are: BH01, BH02, BH03, WS2, WS3, WS6, WS7, WS8, WS12, WS14, WS16, WS20, WS22, WS23, WS24				

5.4.1 Implementation of investigation works

The exploratory holes were logged by an engineer in general accordance with the recommendations of BS 5930:2015 (which incorporates the requirements of BS EN ISO 14688-1, 14688-2 and 14689-1) and CIRIA C574 for Chalk.

The monitoring well construction and associated response zones are detailed on the exploratory hole records in **Appendix F**. The response zones were installed to target identified gas generation sources detailed in the initial preliminary CSM. The wells were constructed using plain pipe sealed using bentonite and slotted pipe surrounded by a gravel filter.

The soil sampling and analysis strategy was designed to characterise each encountered soil strata, permit an assessment of the potential contaminant linkages identified and investigate the geotechnical characteristics. In addition, samples were taken to allow for geo-environmental and geotechnical testing to be undertaken.

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite required. They were dispatched to the laboratory in cool boxes under chain of custody documentation. Samples were stored in accordance with the RSK quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination.

5.5 Monitoring programme

5.5.1 Ground gas monitoring

In line with the initial CSM, response zones were installed to target the sources or pathways as detailed in **Section 4**.

Six monitoring rounds have been undertaken to provide data to support refining of the CSM. The number of monitoring rounds undertaken is in general accordance with the decision matrix presented as Figure 6 of BS8576.

An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume, while hydrogen sulphide (H₂S) and carbon monoxide (CO) were recorded in parts per million.

Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter. The first round of results produced an unexpectedly high PID reading, this is thought to be caused by the particular bungs used. Bung have been replaced and the PID readings are discounted.

The atmospheric pressure before and during monitoring, together with the weather conditions, were recorded. The monitoring included periods of low atmospheric pressures and after/during rainfall.

All ground gas monitoring results together with the temporal conditions are contained within **Appendix G**. Equipment calibration certificates are available on request.

5.5.2 Groundwater monitoring

Six rounds of groundwater monitoring have been undertaken on a weekly basis. The monitoring records, including dates, are shown in **Appendix G**.

Depths to groundwater were recorded using an electronic dip meter on each of the return monitoring visits.

5.6 Infiltration testing

Infiltration tests were carried out in 18 locations (designated SA1 to SA18) to establish the infiltration rate of geology across the site. The tests were carried out generally in accordance with the method described in BRE Digest 365 (BRE, 2016). This involved filling the pits with water from a tanker and recording the drop-in water level with time as the water soaked into the ground.

Copies of the testing records are included in **Appendix H**.

5.7 Laboratory testing

Laboratory testing was undertaken at a UKAS accredited laboratory with ISO17025 and MCERTS accredited test methods were specified where applicable for contamination testing and as shown in the laboratory test certificates appended.

5.7.1 Chemical analysis of soil samples

The soil sampling strategy was designed to characterise topsoil and natural strata typically within the upper 1.0 m of the ground profile whilst also characterising deeper strata and the potential for contaminant migration from relevant sources of identified within the preliminary CSM.

The programme of chemical tests undertaken on soil samples obtained from the intrusive investigation is presented in **Table 14** with the laboratory testing results contained in **Appendix I**.

Table 14 Summary of chemical testing of soil samples

Stratum	Tests undertaken	No. of tests
Agricultural topsoil	Asbestos screening, metals, pH, Polycyclic Aromatic Hydrocarbons (PAH), Total Petroleum Hydrocarbon (TPH) and Soil Organic Matter (SOM)	26
	Herbicides, pesticides and water-soluble sulphate	10

Stratum	Tests undertaken	No. of tests
	Leachate testing	10
Natural soils (Lowestoft Formation)	Asbestos screening, metals, pH, PAH, TPH and SOM	3
Natural soils (Zig Zag, Melbourn Rock Member, Hollywell Nodular and New Pit Chalk Formations)	Asbestos screening, metals, pH, PAH, TPH and SOM	6

5.7.2 Geotechnical analysis of soils

Where appropriate disturbed, bulk and undisturbed soil samples were taken for geotechnical classification testing with the depth and nature of samples detailed within the exploratory hole records.

Where appropriate, testing was undertaken in accordance with BS 1377:1990 Method of Tests for Soils for Civil Engineering Purposes or, where superseded, by the relevant part of BS EN ISO 17892:2014 Geotechnical investigation and testing - Laboratory Testing of Soil. Tests carried out in order to classify the concrete class required on-site have been undertaken following the procedures within BRE SD1:2005.

The programme of geotechnical tests undertaken on samples obtained from the intrusive investigation is presented in **Table 15**. The results and UKAS accreditation of tests methods are shown in **Appendix J**.

Table 15 Summary of geotechnical testing undertaken

Strata	Tests undertaken	No. of tests
Lowestoft Formation	Moisture content %	25
	Liquid/ plastic limits	25
	Particle Size Distribution (PSD)	3
	pH and water-soluble sulphate	13
Chalk (Zig Zag, Melbourn Rock Member, Hollywell Nodular and New Pit Chalk Formations)	Saturated moisture content of chalk including dry density	42
	Point load test	17
	pH and water-soluble sulphate	10
Soils were unsuitable for laboratory CBR and compaction testing.		

6 SITE INVESTIGATION FACTUAL FINDINGS

The results of the intrusive investigation and subsequent geo-environmental and geotechnical laboratory analysis undertaken are detailed below.

6.1 Ground conditions encountered

The descriptions of the strata encountered, notes regarding visual or olfactory evidence of contamination, list of samples taken, field observations of soil and groundwater, in-situ testing and details of monitoring well installations are included on the exploratory hole records presented in **Appendix F**.

The exploratory holes revealed that the majority of the site is underlain by a variable thickness of topsoil over the Hollywell Nodular and New Pit Chalk Formation, Melbourn Rock Member and the Zig Zag Chalk Formation. In the southern quarter of the site, the Hollywell Nodular and New Pit Chalk Formation is overlain by the Lowestoft Formation. There is a small portion of the northern tip where the Zig Zag Formation is overlain by Head Deposit. This appears to confirm the stratigraphical succession described within the preliminary CSM. For purposes of this report, the different chalk formations have been grouped together.

For the purpose of discussion, the ground conditions encountered during the fieldworks are summarised in **Table 16** with the strata discussed in subsequent subsections.

Table 16 General succession of strata encountered

Stratum	Exploratory holes encountered	Depth to top of stratum m bgl	Proven thickness (m)
Made Ground	WS21	Ground level	0.4
Agricultural topsoil	All exploratory holes apart from WS21	Ground level	0.2 to 0.8
Head Deposits	SA1, SA2, TP1	0.27 – 0.3	0.7 to 2.23
Lowestoft Formation	SA16-SA18, TP17, TP20, TP22, TP23, TP26-TP30, WS10, WS14, WS17, WS18, WS20, WS21, WS23 and WS24	0.2 to 0.58 mbgl	0.2 to 3.5 (confirmed to depths between 2.5 mbgl and 6.45 mbgl)
Chalk (Hollywell Nodular and New Pit Formation, Melbourn Rock Member and Zig Zag Chalk Formation)	All exploratory holes except SA16, SA17, SA18, TP20, TP22, TP26, TP27, TP28, TP30, WS14, WS18, WS20, WS21, WS23 and WS24	0.2 to 3.9 mbgl	Confirmed to 20.34 mbgl

6.1.1 Made Ground

Made Ground was locally encountered within WS21 from ground level to 0.4 mbgl and was described as dark brown to black grading to orangish brown gravelly sandy clay with occasional fragments of brick and concrete associated with the makeup of the current access track.

6.1.2 Agricultural topsoil

The topsoil was encountered within all of the exploratory holes apart from WS21 from ground level to depths ranging between 0.2 mbgl and 0.8 mbgl.

This stratum generally comprised of dark brown gravelly sand or gravelly sandy clay. Rare fragments of brick are noted within this stratum which is potentially due to previous agricultural activities (i.e. ploughing).

6.1.3 Head Deposit

This stratum was encountered from beneath the agricultural topsoil and comprised clayey gravelly sands with inclusions flint and chalk. This stratum was only encountered towards the north eastern corner of the site within TP1, SA1 and SA2 to depths ranging between 1.0 mbgl and 2.5 mbgl (0.7 m to 2.32 m in thickness).

6.1.4 Lowestoft Formation

The Lowestoft Formation was encountered within the south and southwestern part of the site within SA16-SA18, TP17, TP20, TP22, TP23, TP26-TP30, WS10, WS14, WS17 WS18, WS20, WS21, WS23 and WS24 directly below the agricultural topsoil and/or Made Ground from variable depths of 0.2 mbgl and 0.58 mbgl. This stratum progressed to depths ranging between 0.5 mbgl and 3.9 mbgl within TP17, TP23, TP29, WS10 and WS17. However, the Lowestoft Formation was confirmed to the full depth of the investigation (i.e. to maximum depths of 2.5 mbgl and 6.45 mbgl) within SA16-SA18, TP20, TP22, TP26-TP28, TP30, WS14, WS18, WS20, WS21, WS23 and WS24.

Based on the site descriptions and laboratory and in-situ tests carried out this layer can be described as a firm to stiff, locally becoming very stiff, cohesive soil.

Lenses of orangish brown clayey gravelly sand with inclusions of flint and chalk fragments were noted within TP20, TP23 and TP27 from depths ranging between 0.3 mbgl and 1.2 mbgl (0.75 m to 2.2 m in thickness).

A summary of the in-situ and laboratory test results recorded in the stratum are presented in **Table 17** with the full testing results contained in **Appendix F** and **J**.

Table 17 Summary of in-situ and laboratory test results for Lowestoft Formation

Soil parameters	Min. Value	Max. Value	Reference
Moisture content (%)	14	22	Appendix J
Modified moisture content (%)	14	65	-
Liquid limit (%)	30	59	Appendix J
Plasticity limit (%)	17	24	Appendix J

Soil parameters	Min. Value	Max. Value	Reference
Plasticity index (%)	13	35	Appendix J
Modified plasticity index (%)	5.06	25.55	-
Plasticity term	Low	High	-
Volume change potential	Low	Medium	-
SPT 'N' values	9	32	Appendix F
Undrained shear strength inferred from SPT 'N' values (kN/m ²)*	39.5	140.5	-
Consistency term from field description	Firm	Very stiff	Appendix F
Particle density (Mg/m ³) (Granular)	2.70	2.72	Appendix J
Particle density (Mg/m ³) (Cohesive)	2.71		Appendix J
Notes: *derived using a Stroud Factor of 4.39			

6.1.5 Chalk Formations

This stratum was encountered within all exploratory holes apart from SA16, SA17, SA18, TP20, TP22, TP26, TP27, TP28, TP30, WS14, WS18, WS20, WS21, WS23 and WS24 either directly beneath the agricultural topsoil/Made Ground, Head Deposits or Lowestoft Formation and confirmed to the full depth of the investigation (i.e. 20.34 mbgl).

The Chalk Formations generally comprised of a structured chalk with a weathered profile towards the top of the stratum.

The majority of the exploratory holes were terminated prior to the provisional basal depths due to the density of the chalk. .

Zones of core loss were encountered during the drilling of BH1 to BH3 are various depths which is summarised in **Table 18**. It is possible that core loss may be a result of increased fracturing of the chalk either occurring naturally or by the drilling techniques adopted.

Table 18 Summary of zone core loss

Exploratory hole ID	Zone core loss depth		
	From (mbgl)	To (mbgl)	Thickness (m)
BH1	3.74	3.94	0.20
BH1a	1.50	2.00	0.50
BH1a	3.00	3.14	0.14
BH1a	4.5	4.67	0.17
BH1a	9.00	9.26	0.26
BH2	3.70	3.86	0.16
BH3	1.20	1.67	0.47
BH3	4.00	4.20	0.20

Exploratory hole ID	Zone core loss depth		
	From (mbgl)	To (mbgl)	Thickness (m)
BH3	6.96	7.11	0.15
BH3	8.50	8.62	0.12
BH3	14.50	14.79	0.29
BH3	17.50	17.60	0.10
BH3	19.00	19.11	0.11

A summary of the in-situ and laboratory test results recorded in the stratum are presented in **Table 19** with the full testing results contained in **Appendix F** and **J**.

Table 19 Summary of in-situ and laboratory test results for chalk formation

Soil parameters	Min. Value	Max. Value	Reference
Saturated moisture content (%)	13	30	Appendix J
Bulk density	1.94	2.24	Appendix J
Dry density	1.49	2.01	Appendix J
Point load strength Is_{50} (MPa)	0.01	0.26	Appendix J
Unconfirmed Compressive Strength (MPa)	0.67	5.09	-
SPT 'N' values	14	50 for 20 mm (SPT inferred N:750)	Appendix F
Density term	Low	Very high	CIRIA 547

6.1.6 Visual/olfactory evidence of soil contamination

No obvious evidence of soil contamination or asbestos was identified during the site investigation apart from rare brick fragments within SA16, TP3-TP6, TP10-TP13, TP15-TP21 and TP27-TP30.

Occasional fragments of brick and concrete were noted within WS21 to 1.0 mbgl which is likely associated with makeup of the current access track on site.

The above are unlikely to be cause for concern for the proposed development.

6.2 Groundwater

6.2.1 Groundwater encountered during intrusive works

During intrusive works groundwater seepage was noted only in WS24 at 4.0 mbgl within the Lowestoft which is detailed on the logs in **Appendix I**.

6.2.2 Groundwater encountered during monitoring

Resting groundwater levels recorded during the monitoring programme completed are summarised in **Table 20** based on the data provided in **Appendix G**.

Table 20 Summary of groundwater monitoring results

Monitoring well	Response zone stratum	TOC* elevation (m AOD)	Depth to water (mb TOC*)	Product thickness (m)	Groundwater elevation (m AOD) – min.	Groundwater elevation (m AOD) – max.
BH01	Chalk	68.54	16.25 to 16.86	None encountered	51.68	52.29
BH02	Chalk	73.58	Dry		-	-
BH03	Chalk	80.26	Dry		-	-
WS02	Chalk		Dry		-	-
WS03	Chalk		Dry		-	-
WS06	Chalk	74.92	Dry		-	-
WS07	Chalk	72.59	Dry		-	-
WS08	Chalk	74.56	Dry		-	-
WS12	Chalk	75.65	Dry		-	-
WS14	Lowestoft	73.51	Dry		-	-
WS16	Chalk	77.92	Dry		-	-
WS20	Lowestoft	71.50	Dry		-	-
WS22	Lowestoft	76.32	Dry		-	-
WS23	Lowestoft	72.00	Dry to 0.83**		-	-
WS24	Lowestoft	77.37	0.89 to 1.83		75.54	76.48
* TOC – Top of Cover						
** during the last visit WS23 was flooded due to recent fall therefore is discounted as resting groundwater level						

The findings reflect the groundwater table in the Chalk, which is at an elevation locally of 51.68 to 52.29 mAOD, however this is unlikely to represent the true groundwater gradient across the site. It is noted that perched groundwater was encountered within the Lowestoft Formation within WS23 from 0.89 m to 1.83 mbgl.

It should be noted that groundwater levels might fluctuate for a number of reasons including seasonal variations. On-going monitoring would be required to establish both the full range of conditions and any trends in groundwater levels.

6.2.3 Visual/olfactory evidence of groundwater and surface water contamination

No visual or olfactory evidence of groundwater or surface water contamination was noted during site work and monitoring.

6.3 Chemical laboratory results

The soil testing results are presented in **Appendix I**. No asbestos was identified within the samples collected.

6.4 Geotechnical laboratory results

The results of the geotechnical testing are discussed in **Section 9** and presented in **Appendix J**.

6.5 Ground gas monitoring

The results of the ground gas monitoring and testing carried out are given in **Appendix G** and discussed in **section 7**.

7 GEO-ENVIRONMENTAL ASSESSMENT

7.1 Refinement of initial CSM

The ground conditions encountered during the intrusive investigation generally confirm those predicted within the initial conceptual model. Therefore, refinement of the initial conceptual site model is not considered necessary.

7.2 Linkages for assessment

In line with CLR11 (Environment Agency, 2004), there are two stages of quantitative risk assessment, generic (GQRA) and detailed (DQRA). The GQRA comprises the comparison of soil, groundwater, soil gas and ground gas results with generic assessment criteria (GAC) that are appropriate to the linkage being assessed. This comparison can be undertaken directly against the laboratory results or following statistical analysis depending upon the sampling procedure that was adopted.

Following the refinement of the initial CSM, the potentially complete contaminant linkages that require further assessment and the methodology of assessment are presented in **Table 21**.

Table 21 Linkages for GQRA

Potentially relevant contaminant linkage	Assessment method
Soil	
1. Oral, dermal and inhalation exposure with impacted soil, soil vapour and dust by future residents	Human health GAC in Appendix K for a proposed residential end use with home-grown produce since the proposed end use includes residential gardens. Consideration given to the applicability of the use of Statistical Assessment. Methodology for statistical assessment presented in Appendix E .
2. Inhalation exposure of future residents to asbestos fibres	Qualitative assessment based on the asbestos minerals present, their form, concentration, location and the nature of the proposed development.
3. Uptake of contaminants by vegetation potentially impacting plant growth (phytotoxicity)	Comparison of soil data to GAC in Appendix L for phytotoxicity.
4. Contaminants permeating potable water supply pipes	Comparison of soil data to GAC in Appendix M for plastic water supply pipes using UKWIR (2010) guidance.
5. Leaching of soil contaminants and dissolved phase migration	Comparison of leachate data to the relevant GAC in Table 1 of Appendix N .

Potentially relevant contaminant linkage	Assessment method
Ground Gas	
6. Concentrations of methane and carbon dioxide in ground gas entering and accumulating in enclosed spaces or small rooms in new buildings, which could affect future site users. For methane this could create a potentially explosive atmosphere, while death by asphyxiation could result from carbon dioxide.	Gas screening values (GSV) have been calculated using maximum methane and carbon dioxide concentrations with maximum flow rates recorded at the site. The GSV have been compared with the revised Wilson and Card classification presented in BS8485.

7.3 Methodology and assessment of soil results

The analysis of laboratory results relating to soil samples submitted for testing, including leachate analysis, is included in the following sections. It should be noted that given the historically undeveloped nature of the site, only a reconnaissance level of sampling and testing has been undertaken for contamination purposes.

7.3.1 Oral, dermal and inhalation exposure with impacted soil by future occupants/site users

In order to assess the soil results against the appropriate GAC, the soil results have been split into appropriate data sets relevant to the oral, dermal and inhalation linkage.

The datasets being considered in the assessment are:

- Dataset 1 Agricultural topsoil
- Dataset 2 Lowestoft Formation
- Dataset 3 Chalk Formations

As an initial assessment of each dataset, all soil results in each dataset have been directly compared against the GAC for residential with home-grown produce end use.

All Agricultural topsoil results (dataset 1) have been compared with the appropriate GAC. A soil organic matter (SOM) of 2.5 % has been selected since laboratory results within the Made Ground range from 1.3 % and 8.7 %.

Dataset 2 – Lowestoft Formation results have been compared with the appropriate GAC. A soil organic matter (SOM) of 1 % has been selected since laboratory results within the Lowestoft Formation range from 1.2 % and 1.9 %.

Dataset 3 – Chalk Formation results have been compared with the appropriate GAC. A soil organic matter (SOM) of 1 % has been selected since laboratory results within the Lowestoft Formation range from 1.3 % and 6.3 %.

The soil screening output spreadsheets for each dataset is presented as **Appendix O**.

Assessment of the results indicates there are no exceedances of the GAC for any contaminants. However, there is a number of tier 1 exceedances as shown in **Error!**

Reference source not found.. These are highlighted in orange on the screening output spreadsheet in **Appendix O**.

Table 22 Data summary table for human health

Determinand	No. of samples tested	GAC (mg/kg)	No of GAC exceedances	Maximum concentration (mg/kg)	
				Value	Location/depth (m bgl)
Dataset 1 – Agricultural topsoil					
Chromium – tier 1 screen (Hexavalent chromium)	26	910 (21)	0 (9)	32	SA16 at 0.2 m
				30	TP17 at 0.15 m
				34	TP28 at 0.2 m
				29	TP30 at 0.2 m
				22	SA13 at 0.2 m
				41	SA18 at 0.2 m
				22	TP22 at 0.2 m
				21	TP23 at 0.2 m
				21	TP24 at 0.15 m
Inorganic mercury – tier 1 screen (Elemental mercury)	26	39 (0.6)	0 (17)	1.02	TP3 at 0.2 m
				1.17	TP5 at 0.15 m
				1.09	TP6 at 0.2 m
				0.83	SA10 at 0.15 m
				0.78	SA11 at 0.15 m
				0.93	SA15 at 0.15 m
				0.87	SA15 at 0.4 m
				0.98	SA6 at 0.2 m
				0.83	SA8 at 0.2 m
				0.84	SA9 at 0.15 m
				0.87	TP1 at 0.15 m
				0.62	TP14 at 0.2 m
				1.08	TP15 at 0.2 m
				0.92	TP2 at 0.2 m
				0.6	TP22 at 0.2 m
				0.77	TP24 at 0.15 m
				0.73	TP8 at 0.15 m
Dataset 2 – Lowestoft Formation					
Chromium – tier 1 screen (Hexavalent chromium)	3	910 (21)	0 (2)	33	SA16 at 0.5 m
				35	SA18 at 0.5 m
Inorganic mercury – tier 1 screen (Elemental mercury)	3	39 (0.2)	0 (2)	0.41	SA16 at 0.5 m
				1.08	TP23 at 0.5 m

Determinand	No. of samples tested	GAC (mg/kg)	No of GAC exceedances	Maximum concentration (mg/kg)	
				Value	Location/depth (m bgl)
Dataset 3 – Chalk Formations					
Inorganic mercury – tier 1 screen (Elemental mercury)	6	39 (0.2)	0 (6)	0.88	TP8 at 0.4 m
				1.29	TP6 at 0.5 m
				1.56	TP2 at 0.45 m
				0.99	TP16 at 0.5 m
				1.41	TP15 at 0.5 m
				1.26	TP14 at 0.5 m

Due to there being no sources of hexavalent chromium or elemental mercury on site and the results falling below the GAC for total chromium and inorganic mercury, it is unlikely that the potential pollutant linkage is complete for these determinands.

It is noted that deeper Made Ground was encountered from WS21 which is associated with the access track on site. Based on the current proposed development plan, the track is to remain present and comprise of hardstanding for local resident access and network rail access to the adjacent railway land. This hardstanding road will break the potential complete pollutant linkage and so no remedial action is considered necessary.

The results of the chemical analysis undertaken on all datasets indicates the shallow soils at the site are suitable for the proposed end use.

7.3.2 Inhalation exposure of future occupants/site users to asbestos fibres

The visual inspection at the laboratory identified no materials suspected of potentially containing asbestos and the scheduled laboratory screening for asbestos found no detectable asbestos fibres within the samples.

7.3.3 Uptake of contaminants by vegetation potentially inhibiting plant growth (phytotoxicity)

The results have been compared directly with the GAC presented in **Appendix L** for this linkage.

Assessment of the results indicates exceedances of the GAC for the contaminants shown in **Table 23**. Exceedances in the table below have been separated with regards to their appropriate datasets as mentioned within **Section 7.3.1**.

Table 23 Data summary table for phytotoxicity

Determinand	No. of	GAC	No of GAC	Maximum concentration (mg/kg)
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	samples tested	(mg/kg)	exceedances	Value	Location/depth (m bgl)
Dataset 1 – Agricultural topsoil					
Mercury	26	1	4	1.02 1.17 1.09 1.08	TP3 at 0.2 m TP5 at 0.15 m TP6 at 0.2 m TP15 at 0.2 m
Dataset 2 – Lowestoft Formation					
Mercury	3	1	1	1.08	TP23 at 0.5 m
Dataset 3 – Chalk Formations					
Mercury	6	1	4	1.29 1.56 1.41 1.26	TP6 at 0.5 m TP2 at 0.45 m TP15 at 0.5 m TP14 at 1.26 m

The results indicate that a relevant contaminant linkage may exist associated with phytotoxic effects within all datasets.

Following the review of exceedances of the GAC for phytotoxicity, it is considered that statistical data assessment for Mercury should be undertaken to identify the true mean or Upper Confidence Level (UCL) of all the datasets.

Statistical assessment for non-targeted samples

Statistical analysis of the results has been conducted in accordance with Guidance on Comparing Soil Contamination Data with a Critical Concentration (CIEH and CL:AIRE, 2008). The methodology is presented within **Appendix E**.

The following datasets are only appropriate to apply for statistical assessment due to the number of tested samples in the datasets.

- Dataset 1 Agricultural topsoil
- Dataset 3 Chalk Formations

Dataset 2 – Lowestoft Formation has insufficient number of samples to perform statistical analysis and therefore a direct comparison can only be undertaken on this dataset.

With regards to the treatment of non-detects (samples that are reported as less than the laboratory method detection limit (LMDL)), these are treated within the statistics as a concentration half of the LMDL.

No outliers were detected. the normality of the statistical distribution of the datasets has been tested and appropriate statistical tests carried out as shown in **Table 24**.

Table 24 Summary of statistical assessment – Mercury

No of samples in dataset	Number of non-detect	Normality / Test used	Mean mg/kg	Cc* mg/kg	UCL mg/kg	Reject H ₀ ? (% confidence level)
Dataset 1 – Agricultural topsoil						
26	3	Normal / one sample t-test	0.67	1.00	0.71	Yes (100% confidence)
Dataset 3 – Chalk Formations						
6	0	Normal / one sample t-test	1.23	1.00	1.44	No (4% confidence – UCL > Cc)
* Critical concentration (GAC)						

The results of the statistical assessment have revealed that the recorded concentrations of mercury within the Agricultural topsoil (Datasets 1) have returned an upper confidence limits (95th percentile concentration) that pass the corresponding Generic Assessment Criteria (GAC). Based on the above assessment the results indicate that a relevant contaminant linkage is unlikely to exist within the Agricultural topsoil.

It is noted that four out of the six tested samples within the Chalk Formations (Dataset 3) and one out of three tested samples within the Lowestoft Formation (Dataset 2) exceed the corresponding GAC for Mercury. However, this material is unlikely to be used as a growing medium and is not been considered further.

7.3.4 Impact of organic contaminants on potable water supply pipes

It should be noted that at the time of this investigation the future routes of water supply pipes had not been established, hence the investigation and sampling strategy may not be fully compliant with UKWIR recommendations. Consequently, a targeted investigation and specific sampling/analytical strategy may be required at a later date once the route(s) of the supply pipe(s) is/are known. In addition, it is recommended that the relevant water supply company be contacted at an early stage to confirm its requirements for assessment, which may not necessarily be the same as those recommended by UKWIR.

For initial assessment purposes, the results of the investigation have been compared with the GAC presented in **Appendix M** for this linkage, which are reproduced from *UKWIR Report 10/WM/03/21. Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites* (UKWIR, 2010).

The results indicate that a relevant linkage is unlikely to exist associated with organic contaminants and therefore pollutant polyethylene (PE) and/or polyvinyl chloride (PVC) water supply pipes are expected to be suitable for use on the development.

7.3.5 Leaching of contaminants and dissolved phase migration

The soil leachate results found to exceed the GAC presented in **Appendix P** are summarised in **Table 25**.

Table 25 Summary of soil leachate GQRA results with respect to controlled waters

Determinand	GAC (µg/l)	Exceedances	
		Value (µg/l)	Location/depth (m bgl)
Copper	1	7	SA8 at 0.2
		6	SA10 at 0.15
		6	SA11 at 0.15
		6	TP1 at 0.15
		5	TP2 at 0.2
		6	TP6 at 0.2
		7	TP8 at 0.15
		6	TP10 at 0.15
		4	TP14 at 0.2
		6	TP24 at 0.15
Lead	1.2	2	SA10 at 0.2
		2	SA11 at 0.15

The above table indicates exceedances of the GAC in soil leachate samples are present for copper in all samples and lead at 2 locations suggesting that leaching of contaminants may be occurring.

However, further review of the soil results indicate that concentrations of copper and lead are significantly lower in the Head Deposits and Chalk Formations at shallow depth compared to the concentrations measured in topsoil, indicating that these determinands are not leaching in significant concentrations. Further, the concentrations of copper and lead detected in leachate are in the same order of magnitude of the relevant GAC and given the depth to the groundwater table is some 16 mbgl and that portions of the site are underlain by cohesive deposits, elevated concentrations are unlikely to leach into groundwater.

7.4 Ground gas risk assessment

7.4.1 Appropriate guidance

The risks to development from ground gases have been assessed in accordance with BS8485:2015, which provides guidance on ground gas (methane and carbon dioxide) characterisation and hazard assessment, as well as a framework for the prescription of protection measures within new buildings.

The process involves characterising the gas hazard from combining the qualitative assessment of risk (using the conceptual site model) with ground investigation data so that a 'characteristic situation' (CS) can be derived for the site. Characteristic situations range from CS1 to CS6, the higher the CS the higher the hazard potential. Protection measures within new buildings can be prescribed using a point scoring system, taking in to consideration the CS and the proposed building type.

BS8485 indicates that the gas hazard can be characterised using the following methods:

- An empirical semi-quantitative approach using gas monitoring data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (Wilson and Card approach);
- An empirical semi-quantitative approach using TOC data to determine the 'characteristic situation' of the site (or zones of the site) and subsequent protective measures (CL:AIRE RB17 approach), or
- Detailed quantitative assessment methodologies.

For the purpose of this assessment, the first approach listed above has been used to characterise the gas hazard and provide advice on the protective measures likely to be required within new buildings at the site.

7.4.2 Summary of the refined conceptual site model for ground gas

In the assessment of risks and selection of appropriate mitigation measures, BS8485 highlights the importance of the conceptual model. In summary, potential sources of ground gas within influencing distance of the site identified comprise:

- Made ground with low degradable organic content (e.g. up to 5 % organic material and no easily degradable waste); and
- Natural carbonate soil and strata

Pathways and receptors for ground gas were identified in **Section 4.5.2**.

This assessment has been undertaken to assess risks to building structures and proposed end users. The assessment has not taken into consideration the health and safety of construction workers. 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 safe systems of work.

The risk assessment has been undertaken based on the current understanding of the CSM.

7.4.3 Empirical semi-quantitative approach using borehole monitoring data (Wilson and Card approach)

7.4.3.1 Permanent gases – methane and carbon dioxide

The empirical semi quantitative approach using gas monitoring data is based on calculations of the gas screening value (GSV). BS8485 defines the GSV as the '*flow rate (l/hr) of a specific hazardous gas representative of a site or zone, derived from assessment of borehole concentration and flow rate measurements and taking account of all other influencing factors, in accordance with a conceptual site model*'.

Once derived for both methane and carbon dioxide the GSVs are compared to the thresholds presented in Table 2 of BS8485, so that a CS can be determined for the site, or a zone. It is important to note that the GSV thresholds are guideline values and not absolute. The GSV thresholds may be exceeded in certain circumstances, if the site conceptual model indicates it is safe to do so. Similarly, consideration of additional

factors such as very high concentrations of methane, should lead to consideration of the need to adopt a higher risk classification than the GSV threshold indicates.

The results of the ground gas monitoring and testing undertaken at the site are given in **Appendix G**.

The maximum results recorded are presented in **Table 26**.

The range of atmospheric pressure over the six monitoring rounds completed was 969 to 1008 mbar and this was recorded to be falling/fluctuation during the monitoring programme.

Table 26 Summary of ground gas monitoring results

Borehole	Response zone/ stratum	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)	Water level (m bgl)	Atmospheric pressure (mbar)
BH01	Chalk	6	<0.1	0.1 - 1.0	18.7 - 20.9	<0.1 - 0.2	16.25 - 16.86	969 - 1008
BH02	Chalk	6	<0.1	0.1 - 1.5	20.2 - 20.9	<0.1 - 0.1	Dry	
BH03	Chalk	6	<0.1	0.1 - 0.9	18.9 - 20.9	<0.1	Dry	
WS02	Chalk	6	<0.1	0.1 - 0.9	20.0 - 20.9	<0.1 - 0.3	Dry	
WS03	Chalk	6	<0.1	0.1 - 1.2	20.3 - 21.4	<0.1 - 0.3	Dry	
WS06	Chalk	6	<0.1	0.1 - 0.8	20.1 - 20.9	<0.1	Dry	
WS07	Chalk	6	<0.1	0.1 - 0.8	20.4 - 21.0	<0.1 - 0.1	Dry	
WS08	Chalk	6	<0.1	0.1 - 0.8	20.0 - 20.9	<0.1	Dry	
WS12	Chalk	6	<0.1	0.1 - 1.5	18.9 - 20.9	<0.1	Dry	
WS14	Lowes toft	6	<0.1	0.1 - 1.1	18.9 - 20.9	<0.1 - 0.1	Dry	
WS16	Chalk	6	<0.1	0.1 - 1.0	19.8 - 21.0	<0.1	Dry	
WS20	Lowes toft	6	<0.1 - 0.1	0.1 - 2.2	18.2 - 20.9	<0.1 - 0.1	Dry	
WS22	Lowes toft	6	<0.1	0.1 - 0.5	20.8 - 21.4	<0.1	Dry	

Borehole	Response zone/ stratum	Number of monitoring visits	Methane (%)	Carbon dioxide (%)	Oxygen (%)	Flow rate (l/hr)	Water level (m bgl)	Atmospheric pressure (mbar)
WS23	Lowes toft	6	<0.1 - 0.2	0.1 - 1.6	18.7 - 20.9	<0.1	Dry - 0.83	
WS24	Lowes toft	6	<0.1	0.1 - 0.7	19.8 - 21.1	<0.1	0.89 - 1.83	
Note: Minimum to maximum concentration and flows are presented in this table								

BS8485 suggests that the GSV should be derived by multiplying the worse credible (worst case) recorded flow value in any standpipe in that strata or zone with the maximum gas concentration in any other standpipe in that strata or zone. Further guidance is given in BS8485 section 6.3.

Considering the assessment of the gas monitoring results the following maximum GSVs have been derived for the site.

- Methane GSV (0.006 l/hr) = methane concentration (0.2 % v/v)/100 x flow rate (0.3 l/hr)
- Carbon Dioxide GSV (0.0048 l/hr) = carbon dioxide concentration (1.6 % v/v)/100 x flow rate (0.3 l/hr).

Based on the GSVs derived and the method for determining the CS presented within Table 2 of BS8485, the site has been characterised as CS1.

7.4.4 Implications

Based on the current understanding of the conceptual site model and the assessment undertaken, the site has been classified as CS1. Considering the foregoing and in accordance with BS8485, ground gas protective measures are not considered necessary within proposed buildings.

7.5 Uncertainties and implications in refined CSM and GQRA

In accordance with good practice, data gaps and uncertainties in the refined CSM have been identified at this stage. These are summarised in **Table 27** along with the likely implications.

Table 27 Data gaps and uncertainties

Data gap/ uncertainty	Details	Implications
Asbestos not found in any samples tested	Although not encountered to date, asbestos containing material (ACM) could still be present in discrete locations	Vigilance should be maintained for any potential ACM or fibrous material during below ground works

8 PRELIMINARY WASTE ASSESSMENT

In accordance with the definition provided in the Waste Framework Directive (WFD), materials are only considered waste if 'they are discarded, intended to be discarded or required to be discarded, by the holder'. Naturally occurring soils are not considered waste if reused on the site of origin for the purposes of development. Soils such as made ground that are not of clean and natural origin (irrespective of whether they are contaminated or not) and other materials such as recycled aggregate, do not become waste until the criteria above are met. Further background information is provided in **Appendix E**.

Excavation arisings from the development may therefore be classified as waste if surplus to requirements or unsuitable for reuse. The following assessments assume the material tested is classified subsequently as waste.

RSK recommends that a Sampling Plan be prepared to support any waste classifications and hazardous waste assessments, prior to any material being excavated. Given the level of data obtained, scale of the development and heterogeneity of the site soils, the following assessment should be considered indicative and further assessment should be undertaken following the preparation of a waste sampling plan.

8.1 Hazardous waste assessment

Technical Guidance WM3 (EA, 2018) sets out in Appendix D requirements for waste sampling. It is a legal requirement to correctly assess and classify waste. The level of sampling should be proportionate to the volume of waste and its heterogeneity. The preliminary assessment provided below is based only upon the available sample results and may not be sufficient to adequately classify the waste.

8.1.1 Chemical contaminants

EnviroLab, an RSK company, has developed a waste soils characterisation assessment tool (HASWASTE), which follows the guidance within Technical Guidance WM3. The analytical results have been assessed using this tool to assess the hazardous properties to support potential off-site disposal of materials in the future. Note that it is ultimately for landfills to confirm what wastes they are able to accept within the constraints of their permit. The HASWASTE assessment is presented in **Appendix Q**.

No samples were found to have hazardous properties based on this assessment. This suggests that if applicable the waste would require disposal at a suitably permitted inert or non-hazardous waste landfill.

8.1.2 Asbestos within waste soils

Technical Guidance WM3 requires that within a mixed waste the separately identifiable wastes be assessed separately.

For instance, where waste soil contains identifiable pieces of asbestos (visible to the naked eye) the asbestos should, where feasible, be separated from the soil and

classified separately. This should be disposed of within a hazardous, stable non-reactive hazardous waste landfill or a special cell in a non-hazardous waste landfill.

Samples of potential asbestos containing material were collected from site and analysed for the presence of asbestos, the results of which are presented in **Appendix I**. Analysis confirmed that asbestos is not present within the tested samples. Visible asbestos containing material was not identified on-site.

8.2 WAC assessment

8.2.1 Summary of hazardous waste assessment

Based on the hazardous waste assessment it is considered that laboratory tested soils are unlikely to be classified as a hazardous waste.

Analysis confirmed that asbestos is not present within tested samples.

8.2.2 WAC assessment

To determine if waste soils (if any) could be disposed within an inert or non-hazardous waste landfill, WAC testing will be required.

8.2.3 Natural soils

It is noted that samples of 'uncontaminated' natural soil that may be encountered during excavation works should be exempt from WAC testing and classified under the European Waste Category (EWC) Code 17 05 04. These soils are considered suitable for disposal at an inert landfill or a site that has a valid exemption from the Environmental Permitting (England and Wales) Regulations 2010 registered with the EA.

It is recommended that all the laboratory results should be forwarded to the receiving landfill; as such classifications are often at their own discretion.

9 GEOTECHNICAL ASSESSMENT

9.1 Proposed development

It is understood that the proposed development is to involve the construction of residential properties and associated infrastructure. At this stage no specific information relating to building loads has been provided and therefore a wall loading of approximately 100 kN/m has been considered. It has been assumed the ground-bearing floor slabs will not be required and that beam and block flooring will be utilised.

The proposed development layout plan shown in **Appendix B** indicates that the housing development is to be located over the central and southern parts of the site, with approximately the northern quarter of the site to be utilised for landscaped areas.

9.2 Key geotechnical hazards/development constraints

The key risks identified from the available ground investigation data are discussed below:

- Lowestoft Formation cohesive soils of medium volume change potential;
- Moderate risk of chalk dissolution features where the Head Deposits overlie the chalk in the north of the site, where landscaped areas are proposed; and
- Low risk of chalk dissolution features where the Head Deposits are absent across the remainder of the site, where the housing development is proposed.

9.3 Foundations

9.3.1 Development

Based on the proposed development layout, this report has been prepared to provide a preliminary indication of possible foundation solutions and options. This will need review and refinement to prepare detailed foundation solutions when development proposals, layouts, loads and settlement tolerances are understood.

9.3.2 Site Conditions

The southern third of the site is topographically higher than the northern part of the site and appears to be directly underlain by the Lowestoft Formation which overlies the Chalk at depth.

The remainder of the housing development area appears to be directly underlain by chalk immediately beneath nominal deposits of topsoil and localised thin deposits of made ground.

Tracts of Head deposits overlie the chalk in the northern extent of the site outside of the proposed housing development area.

9.3.3 Foundation options

Given the presence of competent natural soils at a relatively shallow depth away from the tracts of Head Deposits in the northern extent of the site, it is considered that traditional spread footings or localised over deepened foundations will be suitable for a proposed residential development.

Given the change in ground conditions across the site it is suggested that foundations within the southern third of the development area will need to be formed into the shallow firm to stiff Lowestoft Formation at a minimum depth of 0.9 mbgl whilst in the remainder of the development area the foundations may be formed into the chalk at a depth of no less than 600.0 mm and most likely at depths of around 1.0 mbgl.

It is considered very unlikely that piled foundations or ground improvement will be required unless loads or settlement tolerances are significantly high or onerous and above the norm for traditional housing, levels are raised significantly locally, or any direct evidence of chalk dissolution is encountered.

No apparent direct evidence of chalk dissolution has been encountered during the investigation and a risk assessment has identified a low risk of chalk dissolution in the development area of the site. In the northern extent of the site a risk assessment has identified a moderate risk of chalk dissolution features to be present where the Head Deposits overlie the chalk, but the risks are considered acceptable for the proposed landscaping end use in this area.

Where sand is encountered at foundation formation level it should be confirmed to be competent, i.e. medium-dense or better, by a geotechnical engineer. Similarly, where chalk is encountered at foundation formation level the materials should be confirmed to be competent, i.e. Grade Dc or better, by a geotechnical engineer. Where differing ground conditions are encountered at foundation formation level across a structure it would be advisable reinforce strip foundations to minimise the risk of future differential foundation movements.

9.3.4 Spread foundations – Lowestoft Formation (southern third of development area)

The recommendations for the design and construction of spread foundations in relation to the southern third of the development area are set out in **Table 28**.

Table 28 Design and construction of spread foundations

Design/construction considerations	Design/construction recommendations
Founding stratum	Firm to Stiff Clay ($C_u \geq 75 \text{ kN/m}^2$) or medium-dense sand (Lowestoft Formation)
Depth	Foundations should be taken to a minimum depth of 0.9 m below the final or existing ground level, whichever is lower, and at least 0.2 m into the founding stratum below any overlying made ground or to any greater depth required in respect of the special design considerations given below.
Special design considerations	

Design/construction considerations	Design/construction recommendations
Shrinkable soils	Owing to the presence of shrinkable clay soils, foundations should be designed taking into account all the normal precautions, including minimum founding depths, to minimise the risk of future foundation movements in accordance with NHBC standards or similar. The findings of the ground investigation indicate that foundations should be designed for shrinkable soils of medium volume change potential.
Variable founding soils	Owing to the potential lateral and vertical variability of the founding strata and the low dissolution risk associated with underlying chalk, where differing ground conditions are encountered at formation level consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements. Where sand is encountered at foundation formation level it should be confirmed to be competent, i.e. medium-dense or better, by a geotechnical engineer.
Presumed bearing capacity	Strip/trench fill foundations with a width of up to 0.75 m and constructed on the firm to stiff glacial till with a minimum shear strength of 75 kN/m², or sand confirmed as medium-dense or better, at a minimum depth of 0.9 m may be designed using a presumed bearing capacity of 170 kN/m² or 130 kN/m run. The presumed bearing capacity includes a partial factor on bearing resistance of 3 against bearing capacity failure. Total settlements associated with the presumed bearing pressure are anticipated to be less than 25 mm.
Construction considerations	All foundation excavations should be inspected, and any made ground and soft, organic or otherwise unsuitable materials removed down to suitable bearing strata and replaced with mass concrete. It is recommended that all foundation excavations should immediately be blinded with concrete or the full foundation constructed as soon as practicable to avoid weathering, instability and potential softening and collapse.

9.3.5 Spread foundations – Chalk (northern two thirds of development area)

The recommendations for the design and construction of spread foundations in relation to the northern two thirds of the development area are set out in **Table 2829**.

Table 29 Design and construction of spread foundations

Design/construction considerations	Design/construction recommendations
Founding stratum	Chalk – Grade Dc or better
Depth	Foundations should be taken to a minimum depth of 0.6 m below the final or existing ground level, whichever is lower, and at least 0.2 m into the founding stratum below any overlying made ground to avoid frost damage or to any greater depth required in respect of the special design considerations given below

Design/construction considerations	Design/construction recommendations
Special design considerations	
Variable founding soils	Owing to the potential lateral and vertical variability of the chalk, where significantly differing grades of chalk are encountered at formation level consideration should be given to incorporating appropriate reinforcement into the strip foundations to minimise the risk of future differential foundation movements.
Frost Protection	The NHBC Technical Guidance 4.3/03 January 2016 suggests that foundations on chalk should extend to depths of no less than 450.0 mm to avoid frost. However, CIRIA C574 2002 Section 7 Shallow Foundations suggests that extreme frosts can impact depths as deep as 600.0 mm causing heave. Therefore, as a precautionary measure it is suggested that foundations should not be constructed to depths any less than 600.0 mm into the chalk below existing or final ground levels, whichever is greatest.
Presumed bearing capacity	Based upon the recommendations of CIRIA C574 Strip/trench fill foundations constructed on Grade Dc Chalk or better at a minimum depth of 0.6 m may be designed using a presumed bearing capacity of 225kN/m ² .
Construction considerations	All foundation excavations should be inspected, and any made ground and soft, organic or otherwise unsuitable materials including Grade Dm chalk and non-chalk materials must be removed down to suitable bearing strata and replaced with mass concrete. It is recommended that all foundation excavations should immediately be blinded with concrete or the full foundation constructed as soon as practicable to avoid weathering, instability and potential softening and collapse.

9.3.6 Foundation works risk assessment

It is anticipated that a foundation works risk assessment report will not be required for the development because:

- The type of foundation proposed does not have the potential to create preferential pathways for migration of ground gas to surface or groundwater to depth;
- There are no identified ground gas sources present at depth that could be affected by the type of foundation method proposed; and
- There is little or no Made Ground present that has been proven to be impacted by potentially leachable contamination.

9.4 Roads and hardstanding

In the 1.0 m to 1.5 m below the proposed finished ground level, the exploratory holes have revealed a soil profile comprising Chalk and the Lowestoft Formation, occasionally overlain by made ground. The Head Deposits encountered in the north of the site are outside of the proposed road and hardstanding locations.

In pavement design terms, the site can be zoned into two areas based on the underlying ground conditions. In the south and southwest part for the site within areas where the Lowestoft Formation is present the groundwater conditions are anticipated to comprise a potentially high water table (i.e. within 300mm of pavement formation level). Across the remainder of the site, the groundwater conditions are anticipated to comprise low water table (i.e. at least 1.0 m below pavement formation level).

The estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the Lowestoft Formation and groundwater conditions described above under a completed pavement is 3 to 4 %, based upon Table C1 in TRRL (1984) Report LR1132.

The estimated minimum, equilibrium soil-suction, California bearing ratio (CBR) value for the weathered surface of the Chalk Formation and groundwater conditions described above under a completed pavement is 5 %, based upon CIRIA C574.

The recommended sub-grade soil CBR value for road pavement design is therefore 3 % for the Lowestoft Formation and 5 % for the chalk. This value assumes that during construction the formation level will be carefully compacted, and any soft spots removed and replaced with well-compacted granular fill.

The sub-grade condition at the time of construction should be confirmed by testing at the final formation level by in situ CBR testing.

The sub-grade soils can be regarded as frost-susceptible, based upon the criteria given in Appendix 1 of TRRL (1970) Report Road Note 29 and CIRIA C574. When the sub-grade is frost-susceptible the thickness of sub-base must be sufficient to give a total thickness of non-frost-susceptible pavement construction over the soil of not less than 450.0 mm.

9.5 Excavations for foundations and services

Generally, the trial pits remained stable during excavation which indicates that foundation excavations should also remain stable in the short term. In the event that excavations are to remain open for longer periods, consideration should be given to the use of trench support systems or the battering back of the excavations to safe and stable angles.

Man entry into any excavations should not be undertaken without provision of suitable shoring and support and dewatering or suitable regrading and battering of side slopes to safe angles. Confined spaces protocols for the Health and Safety of personnel should always be used where man entry into excavations is to be undertaken as low oxygen conditions may be present.

Resting groundwater was encountered within BH1 at 16.25 to 16.86 mbgl. Therefore, significant dewatering is not anticipated to be required to facilitate foundation excavation.

It is noted that a seepage was encountered in exploratory hole WS24 with monitoring rounds recording groundwater resting at 0.89 m to 1.83 mbgl. It is likely that this is a localised area of perched water within the Lowestoft Formation and could require localised dewatering.

Excavation should be possible using conventional site plant.

9.6 Chemical attack on buried concrete

This assessment of the potential for chemical attack on buried concrete at the site is based on BRE Special Digest 1: Concrete in aggressive ground, which represents the most up-to-date guidance on this topic currently available in the UK.

The desk study and site reconnaissance indicate that, for the purposes of assessing the aggressive chemical environment of the site, the site should be considered as comprising natural ground unlikely to contain pyrite.

Based on testing results, **Table 30** gives the characteristic pH, water-soluble and total sulphate content values for soils from each of the geological units encountered on-site.

Table 30 Characteristic pH, water soluble sulphate and total sulphate values

Stratum	pH	Water Soluble Sulphate (mg/l)	Total Potential Sulphate (mg/l)
Agricultural topsoil	7.57 to 8.2	<10 to 250	N/a. Geology encountered beneath the site is unlikely to contain pyrite
Lowestoft Formation	7.85 to 8.98	<10 to 406	
Chalk	8.17 to 9.0	<10 to 15	

Based on the results above and following the steps outlined in the BRE guidance, the Design Sulphate Classes and Aggressive Chemical Environment for Concrete classifications are summarised in **Table 31**, on the basis of water soluble sulphate.

Table 31 Concrete design class

Stratum	Groundwater	Water Soluble Sulphate	
		DS Class	AC Class
Agricultural topsoil	Static	DS-1	AC-1s
Lowestoft Formation	Mobile	DS-1	AC-1d
Chalk	Mobile	DS-1	AC-1d

Therefore, the recommended ACEC Classification is therefore AC-1 with a Design Sulphate Class of DS-1.

9.7 Infiltration drainage

The results of soakaway testing are summarised in **Table 32**.

Table 32 Infiltration test results

Trial pit	Geological unit	Test result (m/s)
SA1	Chalk	Test 1: 5.38×10^{-3}
SA2	Chalk	Test 1: 9.76×10^{-4}
SA3	Chalk	Test 1: 4.60×10^{-4}
SA4	Chalk	Test 1: 1.28×10^{-5} Test 2: 1.10×10^{-5} Test 3: 1.12×10^{-5}
SA5	Chalk	Test 1: 1.77×10^{-5} Test 2: 1.51×10^{-5} Test 3: 1.48×10^{-5}
SA6	Chalk	Test 1: 3.94×10^{-5} Test 2: 2.91×10^{-5} Test 3: 2.48×10^{-5}
SA7	Chalk	Test 1: 1.41×10^{-4} Test 2: 1.48×10^{-4} Test 3: 1.44×10^{-4}
SA8	Chalk	Test 1: 5.00×10^{-6} Test 2: 5.04×10^{-6} Test 3: 5.48×10^{-6}
SA9	Chalk	Test 1: 4.94×10^{-6} Test 2: 4.16×10^{-6} Test 3: 3.76×10^{-6}
SA10	Chalk	Test 1: 1.71×10^{-4} Test 2: 1.49×10^{-4} Test 3: 1.49×10^{-4}
SA11	Chalk	Test 1: 1.31×10^{-6} Test 2: 4.55×10^{-6} Test 3: 3.20×10^{-6}
SA12	Chalk	Test 1: 2.25×10^{-4} Test 2: 1.99×10^{-4} Test 3: 1.71×10^{-4}
SA13	Chalk	Test 1: 2.63×10^{-5} Test 2: 2.27×10^{-5} Test 3: 1.85×10^{-5}
SA14	Lowestoft Formation	Test 1: 9.18×10^{-6} Test 2: 6.83×10^{-6} Test 3: 6.00×10^{-6}

Trial pit	Geological unit	Test result (m/s)
SA15	Chalk	Test 1: 6.19×10^{-5} Test 2: 5.62×10^{-5} Test 3: 5.48×10^{-5}
SA16	Lowestoft Formation	Test 1: Insufficient permeability to calculate
SA17	Lowestoft Formation	Test 1: 2.69×10^{-8}
SA18	Lowestoft Formation	Test 1: Insufficient permeability to calculate
Notes: SA1 to SA3 only one test due to infiltration rate exceeding input SA17 only one test due to non-confirming test		

Based upon the results of the soakaway tests presented in **Table 32** above, the ground conditions appear suitable from a geotechnical viewpoint for the use of pit soakaways to discharge surface run-off water into the Chalk. However, this will need to be the subject of detailed drainage design and agreement with the regulators must be sought to allow discharge to an aquifer.

For environmental reasons, careful consideration will have to be given to selecting the location and design of any soakaways.

The EA should be contacted at the design stage in order to obtain a 'consent to discharge'. This may not be forthcoming where soakage will be into groundwater protection zones. In addition, planning approval will have to be sought for their use.

Owing to the risk of soakaways triggering instability in infilled chalk dissolution features or causing new dissolution, no soakaway should be located within ideally 10.0 m of any building, structure or highway, and certainly no closer than 5.0 m.

10 CONCLUSIONS

10.1 Geo-environmental assessment

The results of the site investigation and GQRA indicate that relevant contaminant linkages are absent based on the data available and therefore the site is suitable for the proposed end use. Although not encountered to date, localised sources of contamination could still be present, although they are unlikely to be widespread. Data gaps and uncertainties have been considered and no further assessment is required.

Should unforeseen contamination be encountered during the development then specialist advice should be sought to determine the appropriate course of action. Imported material (e.g. topsoil, subsoil) should be validated before use on-site to confirm its suitability.

10.2 Waste assessment

Based on the hazardous waste assessment it is considered that laboratory tested soils are unlikely to be classified as a hazardous waste.

Analysis confirmed that asbestos is not present within tested samples.

To determine if waste soils (if any) could be disposed within an inert or non-hazardous waste landfill, WAC testing will be required.

It is noted that samples of 'uncontaminated' natural soil that may be encountered during excavation works should be exempt from WAC testing and classified under the European Waste Category (EWC) Code 17 05 04. These soils are considered suitable for disposal at an inert landfill or a site that has a valid exemption from the Environmental Permitting (England and Wales) Regulations 2010 registered with the EA.

It is recommended that all the laboratory results should be forwarded to the receiving landfill; as such classifications are often at their own discretion.

10.3 Geotechnical assessment

The southern third of the site is topographically higher than the northern part of the site and appears to be directly underlain by the Lowestoft Formation which overlies the Chalk at depth.

The remainder of the housing development area appears to be directly underlain by chalk immediately beneath nominal deposits of topsoil and localised thin deposits of made ground.

Tracts of Head deposits overlie the chalk in the northern extent of the site outside of the proposed housing development area.

10.3.1 Foundation options

The key risks identified from the available ground investigation data are discussed below:

- Lowestoft Formation cohesive soils of medium volume change potential;
- Moderate risk of chalk dissolution features where the Head Deposits overlie the chalk in the north of the site, where landscaped areas are proposed; and
- Low risk of chalk dissolution features where the Head Deposits are absent across the remainder of the site, where the housing development is proposed.

Given the presence of competent natural soils at a relatively shallow depth away from the tracts of Head Deposits in the northern extent of the site, it is considered that traditional spread footings or localised over deepened foundations will be suitable for a proposed residential development.

Given the change in ground conditions across the site it is suggested that foundations within the southern third of the development area will need to be formed into the shallow firm to stiff Lowestoft Formation at a minimum depth of 0.9 mbgl whilst in the remainder of the development area the foundations may be formed into the chalk at a depth of no less than 600.0 mm and most likely at depths of around 1.0 mbgl.

It is considered very unlikely that piled foundations or ground improvement will be required unless loads or settlement tolerances are significantly high or onerous and above the norm for traditional housing, levels are raised significantly locally, or any direct evidence of chalk dissolution is encountered.

No apparent direct evidence of chalk dissolution has been encountered during the investigation and a risk assessment has identified a low risk of chalk dissolution in the development area of the site. In the northern extent of the site a risk assessment has identified a moderate risk of chalk dissolution features to be present where the Head Deposits overlie the chalk, but the risks are considered acceptable for the proposed landscaping end use in this area.

Where sand is encountered at foundation formation level it should be confirmed to be competent, i.e. medium-dense or better, by a geotechnical engineer. Similarly, where chalk is encountered at foundation formation level the materials should be confirmed to be competent, i.e. Grade Dc or better, by a geotechnical engineer. Where differing ground conditions are encountered at foundation formation level across a structure it would be advisable reinforce strip foundations to minimise the risk of future differential foundation movements.

The recommended sub-grade soil CBR value for road pavement design is 3 % for the Lowestoft Formation and 5 % for the chalk. This value assumes that during construction the formation level will be carefully compacted, and any soft spots removed and replaced with well-compacted granular fill. The sub-grade condition at the time of construction should be confirmed by testing at the final formation level by in situ CBR testing.

The recommended ACEC Classification is AC-1 with a Design Sulphate Class of DS-1.

Ground conditions appear suitable from a geotechnical viewpoint for the use of pit soakaways to discharge surface run-off water into the Chalk. However, this will need to be the subject of detailed drainage design and agreement with the regulators must be sought to allow discharge to an aquifer. For environmental reasons, careful consideration will have to be given to selecting the location and design of any soakaways.

The EA should be contacted at the design stage in order to obtain a 'consent to discharge'. This may not be forthcoming where soakage will be into groundwater protection zones. In addition, planning approval will have to be sought for their use.

Owing to the risk of soakaways triggering instability in infilled chalk dissolution features or causing new dissolution, no soakaway should be located within ideally 10.0 m of any building, structure or highway, and certainly no closer than 5.0 m.

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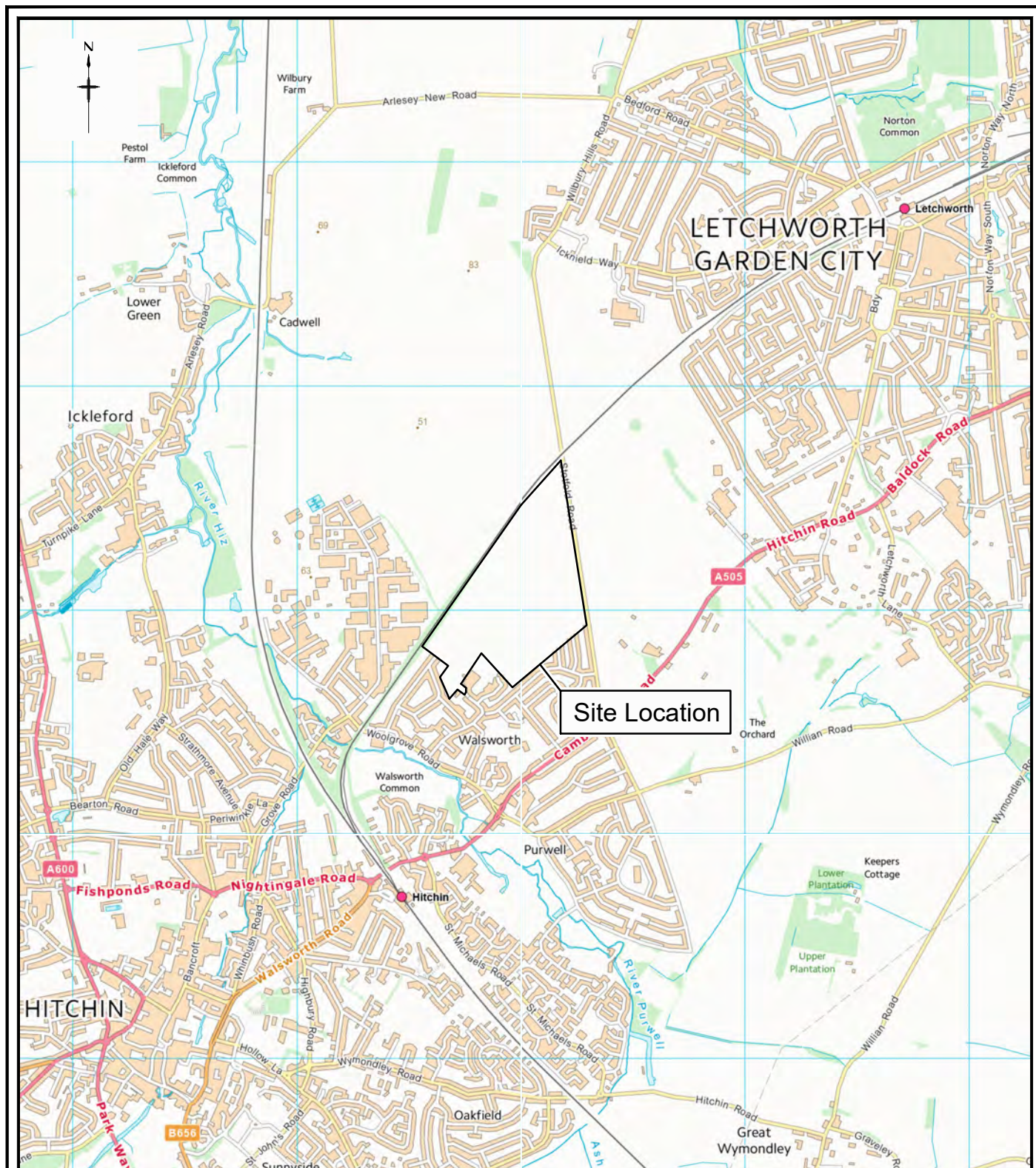
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FIGURES



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GALLAGHER DEVELOPMENTS GROUP LTD

Project Title

HIGHOVER FARM, HITCHIN

Drawing Title

SITE LOCATION PLAN

Rev	Drawn	Date	Checked	Date	Approved	Date
01	LN	29.11.19	SY	29.11.19	CW	29.11.19
Dimensions		Scale		Original Size		
m		1:25,000		A4		

Project Number

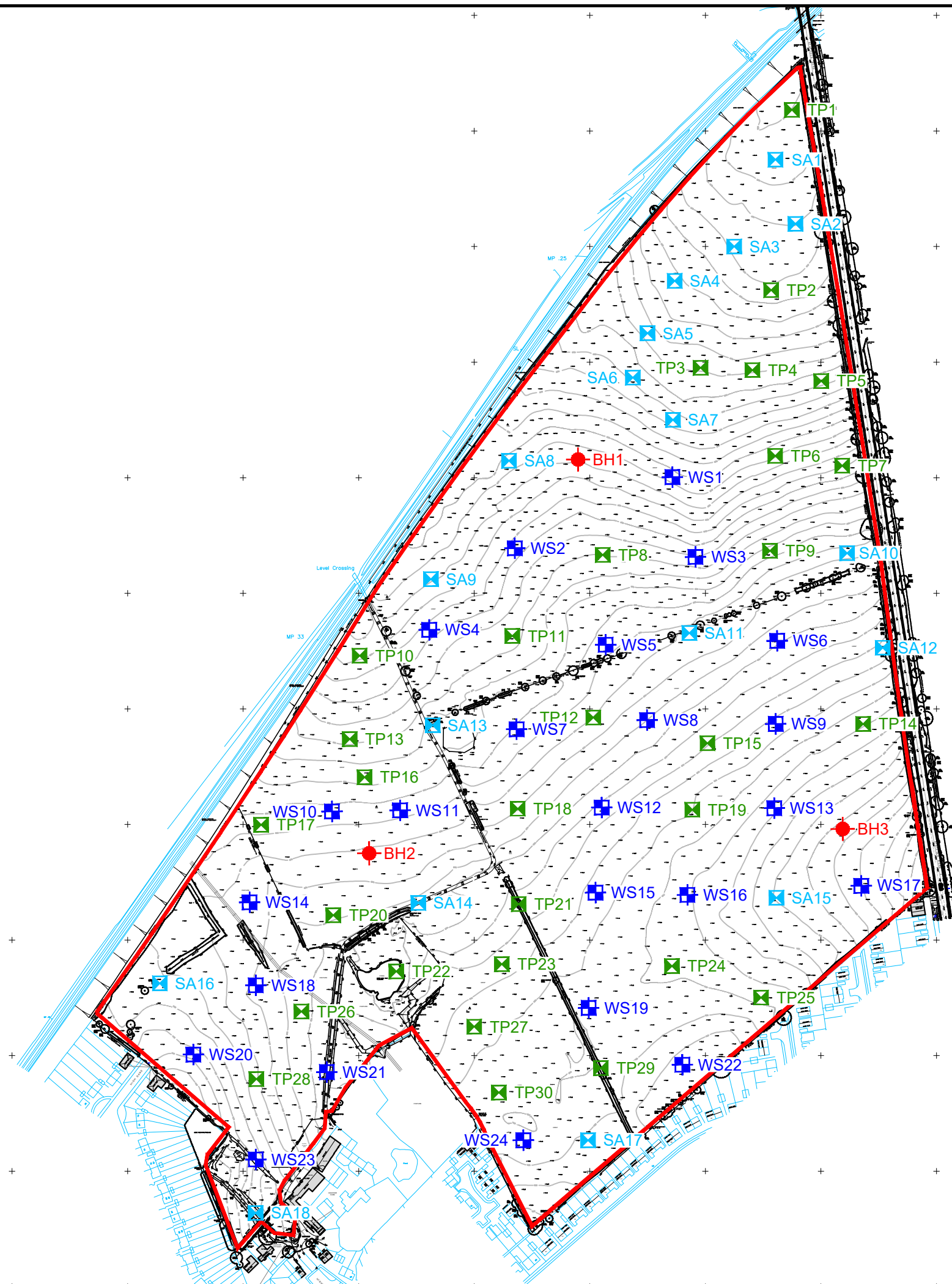
340110- R01 (00)

Drawing File

340110 (R01-00) Figure 1.dwg

Drawing Number

FIGURE 1



LEGEND

- Site Boundary
- Borehole Location
- Window Sample Location
- Trial Pit Location
- Soakaway Test

P2	06.01.20	Removed background colour and grid, and changed TP's colour from green to purple.	LN	VM	VM
P1	29.11.19	First Issue	LN	SY	GW
Rev.	Date	Amendment	Drawn	Chkd.	Appd.

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Project Title

HIGHOVER FARM,
HITCHIN

Drawing Title

EXPLORATORY HOLE
LOCATION PLAN

Drawn	Date	Checked	Date	Approved	Date
LN	06.01.20	VM	06.01.20	VM	06.01.20

Scale	Orig Size	Dimensions
1:4000	A3	M

Project No.	Drawing File
340110 - R01 (01)	340110 (R01-01) Figure 3.dwg

Drawing No.	Rev.
FIGURE 2	P2

Scale 1 : 4,000

APPENDIX A

SERVICE CONSTRAINTS

1. This report and the site investigation carried out in connection with the report (together the "Services") were compiled and carried out by RSK Environment Limited (RSK) for Gallagher Developments Group Ltd (the "Client") in accordance with the terms of a contract [RSK Environment Limited Standard Terms and Conditions] between RSK and the Client, dated 15th August 2019. The Services were performed by RSK with the reasonable skill and care ordinarily exercised by an environmental consultant at the time the Services were performed. Further, and in particular, the Services were performed by RSK taking into account the limits of the scope of works required by the client, the time scale involved and the resources, including financial and manpower resources, agreed between RSK and the Client.
2. Other than that, expressly contained in paragraph 1 above, RSK provides no other representation or warranty whether express or implied, in relation to the Services.
3. Unless otherwise agreed in writing, the Services were performed by RSK exclusively for the purposes of the Client. RSK is not aware of any interest of or reliance by any party other than the Client in or on the Services. Unless expressly provided in writing, RSK does not authorise, consent or condone any party other than the client relying upon the Services. Should this report or any part of this report, or otherwise details of the Services or any part of the Services be made known to any such party, and such party relies thereon that party does so wholly at its own and sole risk and RSK disclaims any liability to such parties. **Any such party would be well advised to seek independent advice from a competent environmental consultant and/or lawyer.**
4. It is RSK's understanding that this report is to be used for the purpose described in the introduction to the report. That purpose was a significant factor in determining the scope and level of the Services. Should the purpose for which the report is used, or the proposed use of the site change, this report may no longer be valid and any further use of or reliance upon the report in those circumstances by the client without RSK's review and advice shall be at the client's sole and own risk. Should RSK be requested to review the report after the date of this report, RSK shall be entitled to additional payment at the then existing rates or such other terms as agreed between RSK and the client.
5. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should not be relied upon in the future without the written advice of RSK. In the absence of such written advice of RSK, reliance on the report in the future shall be at the Client's own and sole risk. Should RSK be requested to review the report in the future, RSK shall be entitled to additional payment at the then existing rate or such other terms as may be agreed between RSK and the client.
6. The observations and conclusions described in this report are based solely upon the Services which were provided pursuant to the agreement between the Client and RSK. RSK has not performed any observations, investigations, studies or testing not specifically set out or required by the contract between the client and RSK. RSK is not liable for the existence of any condition, the discovery of which would require performance of services not otherwise contained in the Services. For the avoidance of doubt, unless otherwise expressly referred to in the introduction to this report, RSK did not seek to evaluate the presence on or off the site of asbestos, invasive plants, electromagnetic fields, lead paint, heavy metals, radon gas or other radioactive or hazardous materials, unless specifically identified in the Services.
7. The Services are based upon RSK's observations of existing physical conditions at the Site gained from a visual inspection of the site together with RSK's interpretation of information, including documentation, obtained from third parties and from the Client on the history and usage of the site, unless specifically identified in the Services or accreditation system (such as UKAS ISO 17020:2012 clause 7.1.6):

- a. The Services were based on information and/or analysis provided by independent testing and information services or laboratories upon which RSK was reasonably entitled to rely.
- b. The Services were limited by the accuracy of the information, including documentation, reviewed by RSK and the observations possible at the time of the visual inspection.
- c. The Services did not attempt to independently verify the accuracy or completeness of information, documentation or materials received from the client or third parties, including laboratories and information services, during the performance of the Services.

RSK is not liable for any inaccurate information or conclusions, the discovery of which inaccuracies required the doing of any act including the gathering of any information which was not reasonably available to RSK and including the doing of any independent investigation of the information provided to RSK save as otherwise provided in the terms of the contract between the Client and RSK.

8. The intrusive environmental site investigation aspects of the Services are a limited sampling of the site at pre-determined locations based on the known historic / operational configuration of the site. The conclusions given in this report are based on information gathered at the specific test locations and can only be extrapolated to an undefined limited area around those locations. The extent of the limited area depends on the properties of the materials adjacent and local conditions, together with the position of any current structures and underground utilities and facilities, and natural and other activities on site. In addition, chemical analysis was carried out for a limited number of parameters (as stipulated in the scope between the client and RSK, based on an understanding of the available operational and historical information) and it should not be inferred that other chemical species are not present.
9. Any site drawing(s) provided in this report is (are) not meant to be an accurate base plan but is (are) used to present the general relative locations of features on, and surrounding, the site. Features (intrusive and sample locations etc) annotated on site plans are not drawn to scale but are centred over the approximate location. Such features should not be used for setting out and should be considered indicative only.
10. 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.
11. Asbestos is often observed to be 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 brownfield and demolition sites indicates that asbestos fibres may be present more widely in soils and aggregates, which could be encountered during more extensive ground works.
12. Unless stated otherwise, only preliminary geotechnical recommendations are presented in this report and these should be verified in a Geotechnical Design Report, once proposed construction and structural design proposals are confirmed.



APPENDIX B

DEVELOPMENT DRAWINGS

KEY

n vehicle access off Stotfold Road.
ited vehicular access via High Dane to serve c. 137 dwellings.
ghbourhood Equipped Area of Play (NEAP).
al Equipped Area of Play (LEAP).
al square provides setting for existing farm buildings.
ghbourhood green incorporates existing pond.
ting track to be retained and enhanced to provide a green
or.
ting hedgerow to be retained.
dscape buffer provides screening to railway.
rmal tree lined avenue is aligned with topography.
mmunity squares provide pedestrian friendly spaces and
ct the central hub and school to the neighbourhood green.
hicular turning area
ormal landscaped parking incorporated, for trips to the
l hub or for school drop off.
rkland provides enhanced wildlife area and recreation areas,
l as a gradual green transition to the wider countryside.
orts pitches.
mary School is strategically located adjacent to retail and
ver Green to form a community hub within the development.
ategic community hub comprising retail/community uses (Use
s A1-A5, D1-D2) and residential element (Use Classes C3/C2)
sting hedgerow along Stotfold Road is retained and
ced.
tential for shared surface areas located at key junctions. +
enuation pond and swales form part of the wider parkland.
iltration basin.
rmland bird habitat.
e planting strategically placed along contour lines to mitigate
impact of development on the slope and ridgeline.
otments.
derground crated storage for drainage of adjacent units.



LEGEND

- Site Boundary
- Borehole Location
- Window Sample Location
- Trial Pit Location
- Soakaway Test

P1	06.01.20	First Issue	LN	VM	VM
Rev.	Date	Amendment	Drawn	Chkd.	Appd.

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Client
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Project Title
**HIGHOVER FARM,
HITCHEN**

Drawing Title
**EXPLORATORY HOLE
LOCATION PLAN**

Drawn LN	Date 06.01.20	Checked VM	Date 06.01.20	Approved VM	Date 06.01.20
Scale 1:4000	Orig Size A3	Dimensions M	Project No. 340110 - R01 (00)	Drawing File Appendix B.dwg	Rev. P1

Scale 1 : 4,000
0 40 80 120 160 200m

APPENDIX C

SUMMARY OF LEGISLATION AND POLICY RELATING TO CONTAMINATED LAND

Part IIA of the Environmental Protection Act 1990

Part IIA of the Environmental Protection Act 1990 (Part IIA) and its associated Contaminated Land Regulations 2000 (SI 2000/227), which came into force in England on 1 April 2000, formed the basis for the current regulatory framework and the statutory regime for the identification and remediation of contaminated land. Part IIA of the EPA 1990 defines contaminated land as 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused, or that there is significant possibility of significant harm being caused, or that pollution of controlled waters is being or is likely to be caused'. Controlled waters are considered to include all groundwater, inland waters and estuaries.

In August 2006, the Contaminated Land (England) Regulations 2006 (SI 2006/1380) were implemented, which extended the statutory regime to include Part IIA of the EPA as originally introduced on 1 April 2000, together with changes intended chiefly to address land that is contaminated by virtue of radioactivity. These have been replaced subsequently by the Contaminated Land (England) (Amendment) Regulations 2012, which now exclude land that is contaminated by virtue of radioactivity.

The intention of Part IIA is to deal with contaminated land issues that are considered to cause significant harm on land that is not undergoing development (see Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, April 2012). This document replaces Annex III of Defra Circular 01/2006, published in September 2006 (the remainder of this document is now obsolete).

Planning Policy

Contaminated land is often dealt with through planning because of land redevelopment. This approach was documented in Planning Policy Statement: Planning and Pollution Control PPS23, which states that it remains the responsibility of the landowner and developer to identify land affected by contamination and carry out sufficient remediation to render the land suitable for use. PPS23 was withdrawn early in 2012 and has been replaced by much reduced guidance within the National Planning Policy Framework (NPPF), reference ISBN: 978-1-5286-1033-9, February 2019.

The new framework has only limited guidance on contaminated land, as follows:

Chapter 11. Making effective use of land

- 117 Planning policies and decisions should promote an effective use of land in meeting the need for homes and other uses, while safeguarding and improving the environment and ensuring safe and healthy living conditions. Strategic policies should set out a clear strategy for accommodating objectively assessed needs, in a way that makes as much use as possible of previously-developed or 'brownfield' land.

118. Planning policies and decisions should:

- c) give substantial weight to the value of using suitable brownfield land within settlements for homes and other identified needs, and support appropriate opportunities to remediate despoiled, degraded, derelict, contaminated or unstable land.

Chapter 15. Conserving and enhancing the natural environment

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

- e) preventing new and existing development from contributing to, being put at unacceptable risk from, or being adversely affected by, unacceptable levels of soil, air, water or noise pollution or land instability. Development should, wherever possible, help to improve local environmental conditions such as air and water quality, taking into account relevant information such as river basin management plans; and
- f) remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate.

Ground conditions and pollution

178. Planning policies and decisions should ensure that:

- a) a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation);
- b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990; and
- c) adequate site investigation information, prepared by a competent person, is available to inform these assessments.

179. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner.

Water Resources Act (WRA)

The Water Resources Act 1991 (Amendment) (England and Wales) Regulations 2009 updated the Water Resources Act 1991, which introduced the offence of causing or knowingly permitting pollution of controlled waters. The Act provides the Environment Agency with powers to implement remediation necessary to protect controlled waters and recover all reasonable costs of doing so.

Water Framework Directive (WFD)

The Water Framework Directive 2000/60/EC is designed to:

- enhance the status and prevent further deterioration of aquatic ecosystems and associated wetlands that depend on the aquatic ecosystems
- promote the sustainable use of water

- reduce pollution of water, especially by 'priority' and 'priority hazardous' substances
- ensure progressive reduction of groundwater pollution.

The WFD requires a management plan for each river basin be developed every six years.

Groundwater Directive (GWD)

The 1980 Groundwater Directive 80/68/EEC and the 2006 Groundwater Daughter Directive 2006/118/EC of the WFD are the main European legislation in place to protect groundwater. The 1980 Directive is due to be repealed in December 2013. The European legislation has been transposed into national legislation by regulations and directions to the Environment Agency.

Priority Substances Directive (PSD)

The Priority Substances Directive 2008/105/EC is a 'Daughter' Directive of the WFD, which sets out a priority list of substances posing a threat to or via the aquatic environment. The PSD establishes environmental quality standards for priority substances, which have been set at concentrations that are safe for the aquatic environment and for human health. In addition, there is a further aim of reducing (or eliminating) pollution of surface water (rivers, lakes, estuaries and coastal waters) by pollutants on the list. The WFD requires that countries establish a list of dangerous substances that are being discharged and EQS for them. In England and Wales, this list is provided in the River Basin Districts Typology, Standards and Groundwater threshold values (Water Framework Directive) (England and Wales) Directions 2010. In order to achieve the objectives of the WFD, classification schemes are used to describe where the water environment is of good quality and where it may require improvement.

Environmental Permitting Regulations (EPR)

The Environmental Permitting (England and Wales) Regulations 2016 (as amended) provide a single regulatory framework that streamlines and integrates waste management licensing, pollution prevention and control, water discharge consenting, groundwater authorisations, and radioactive substances regulation. Schedule 22, paragraph 6 of EPR 2016 states: 'the regulator must, in exercising its relevant functions, take all necessary measures - (a) to prevent the input of any hazardous substance to groundwater; and (b) to limit the input of non-hazardous pollutants to groundwater so as to ensure that such inputs do not cause pollution of groundwater.'

Notes:

1. *The above information is provided for background but does not constitute site-specific advice*
2. *The above summary applies to England only. Variations exist within other countries of the United Kingdom*



APPENDIX D

SUPPORTING DESK STUDY INFORMATION

W.S.B.H. p. 223. Surface c.240. Shaft. Before 1921.

Boulder Clay	...	...	8	8
Sand and Gravel	...	...	8	16

British Geological Survey

British Geological Survey

British Geological Survey

GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

THICKNESS
ft.

DEPTH
ft.

Boulder clay 8'	Clay + loam	8	8
Sand + gravel 8'	Gravel	8	16

British Geological Survey

British Geological Survey

British Geological Survey

pp. L. P. Thomas 8/3/68.

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

Bucks. & Herts.

Page 223

W.S.B.H. p. 223. Surface +c.240. Shaft. Before 1921.

Boulder Clay
Sand and Gravel...
......
...8
88
16

British Geological Survey

British Geological Survey

British Geological Survey

GEOLOGICAL
CLASSIFICATION

NATURE OF STRATA

THICKNESS
ft.DEPTH
ft.

Boulder clay 8'

Clay + loam

8

8

Sand + Gravel 8'

Gravel

8

16

British Geological Survey

British Geological Survey

British Geological Survey

pp. L.P. Thomas 8/3/68.

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

British Geological Survey

T413/48
221

43

British Geological Survey

HITCHIN

British Geological Survey

Boulder Clay
Sand and gravel

4. Highover Farm, north-east of the town, near the barn.
Information given to Mr. JUKES-BROWNE by the foreman.
Dug through clay and loam 8
" gravel to water 8 } 16 ft.

The same water-bearing gravel is intersected in the railway-cutting, into which water often runs.

mgf July '66

L.P.T. 8/3/68.

Visited Highover Farm.

Farmer could ~~not~~ remember a soft water well
on the N.W. side of house which had a handpump.

British Geological Survey

No knowledge of any other well.

British Geological Survey

Is it possible that well known as soft-water well
was once a drinking water well?

Site of well marked by O. on Herts 7 SW/E.

OD + c. 240.

20/9/60 BH.

British Geological Survey

British Geological Survey

British Geological Survey

DATA Bank

British Geological Survey

British Geological Survey

British Geological Survey

Water Supply of
Bucks. & Herts.

British Geological Survey

British Geological Survey

British Geological Survey



1ST LINE DEFENCE



Detailed Unexploded Ordnance (UXO) Risk Assessment

Project Name	Highover Farm, Hitchin
Client	RSK
Site Address	Highover Farm, Hitchin, Hertfordshire
Report Reference	DA9080-00
Date	10 th September 2019
Originator	HAS



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Executive Summary

Site Location and Description

The site is situated in Hitchin, Hertfordshire. The area of works is bordered by Stortford Road to the east, residential properties to the south and a railway line to the west of the site.

The area of works comprise of several open fields with a small track through the southern section of the site. There is a small body of water in the southern section of the site, near Highover Farm.

The site is approximately centred on the OS grid reference: TL 2000431083.

Proposed Works

Proposed works are understood to involve three rotary boreholes to 20m, 24 window samples to 3-4m, and 47 trial pits to 3m. This is understood to be in lieu of the construction of a large residential development.

Geology and Bomb Penetration Depth

The British Geological Survey (BGS) map shows the site to be underlain by three types of bedrock geology. The northern section of the site is underlain by the Zag Chalk Formation – Chalk, the central section of the site is underlain by Melbourn Rock Member – Chalk and the southern section of the site is underlain by Holywell Nodular Chalk Formation.

Site specific geotechnical information was not available to 1st Line Defence at the time of the production of this report. An assessment of maximum bomb penetration depth can be made once such data becomes available, or by a UXO specialist during on-site support.

It should be noted that the maximum depth that a bomb could reach may vary across a site and will be largely dependent on the specific underlying geological strata and its density.

UXO Risk Assessment

1st Line Defence has assessed that there is an overall **Medium Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is an assessed **Low Risk** from Allied ordnance.

The Risk from German Aerial Delivered Ordnance

- At the start of WWII, the proposed site at Highover Farm comprised of open fields, with a small body of water present in the southern section of the site. The area of works was located within the Rural District of Hitchin.
- A range of WWII bombing records, such as Home Office statistics and Hitchin bomb mapping were consulted. These collectively indicate that the Rural District of Hitchin sustained a very low density of bombing with an average of 6.2 items recorded per 1,000 acres. However, the site's local bomb density appears to have been particularly higher. The reason for this high density is unclear – as no obvious Luftwaffe target could be identified within the area.
- Two HE bombs are recorded in the northern section of the site within the Hitchin Incident Map, with a further two plotted immediately outside the boundary. These incidents are likely to have formed a 'stick' of dropped bombs. The concentration of bombs on the site's southern boundary appears to be particularly high, comprising five HE bombs. Written records also indicate that Hitchin sustained several bombing raids. At least one incident record refers to bombing likely on site, with bombing in Walsworth, in the immediate vicinity, referenced on at least two other occasions. An overlay showing the approximate locations of these recorded bomb strikes on WWII-era imagery is presented within **Annex K3**.
- OS mapping and high resolution WWII-era aerial imagery have been consulted and indicate that the majority of the site did not sustain any obvious signs of significant bomb damage or cratering. Although, as the site remained an open area of land with hardly any structures, bomb damage may not necessarily be evident across the entire site. **Annex K2** highlights potential areas of bomb damage in the northern section of the site, which resembles an area of previous bomb cratering and matches the approximate location of the recorded bomb strikes in the Hitchin Incident Map.
- It should be noted that the absence of visible damage throughout the rest of the site is not necessarily indicative of a lack of bombing in these areas. Evidence of UXO can be obscured within areas of open ground. For example, the entry hole for a 50kg UXB can be as small as 20cm in diameter.
- The majority of the wartime footprint of the site was likely subject to low levels of regular access during the war, given its open undeveloped nature. Despite ad hoc agricultural use, access to the majority of the site is likely to have been sporadic. It cannot be confidently stated that this agricultural use was consistent throughout WWII. Evidence of UXO has a greater chance of going unnoticed and unrecorded within undeveloped and infrequently accessed areas.

**UXO Risk Assessment**

- In summary, the site is considered to be of medium risk of UXO contamination due to the open nature of the area, lack of anticipated regular access, poor ground conditions for identifying UXO and the density of bombing both within and immediately bordering the area of works. It has therefore not possible to 'risk map' or lower the risk from UXO within any substantial section of the site on this occasion.

The Risk from Allied Ordnance

- There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. There is an in-house reference to a WWI-era Royal Engineer Camp which was located within the Hitchin area, although, this is not anticipated to have been on site. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.
- The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

Post-War Redevelopment

- The site is not anticipated to have experienced any post-war development, as it still remains occupied by open fields. Land south of the site has experienced significant development with the construction of several residential properties.
- The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

Recommended Risk Mitigation Measures

The following risk mitigation measures are recommended to support the proposed works at the Highover Farm:

All Works

- UXO Risk Management Plan
- Site Specific UXO Awareness Briefings to all personnel conducting intrusive works.

Medium Risk Areas**Open Intrusive Works (trial pits, service pits, open excavations, shallow foundations etc.)**

- Non-Intrusive UXO Magnetometer Survey and Target Investigation.
Where this type of survey is not practical (due to for example terrain or ground conditions), the following is recommended to support shallow intrusive works:
- UXO Specialist On-site Support

Boreholes and Piled Foundations

- Intrusive Magnetometer Survey of all borehole and pile locations/clusters down to maximum bomb penetration depth.



Glossary

Abbreviation	Definition
AA	Anti-Aircraft
AFS	Auxiliary Fire Service
AP	Anti-Personnel
ARP	Air Raid Precautions
DA	Delay-action
EOC	Explosive Ordnance Clearance
EOD	Explosive Ordnance Disposal
FP	Fire Pot
GM	G Mine (Parachute mine)
HAA	Heavy Anti-Aircraft
HE	High Explosive
IB	Incendiary Bomb
JSEODOC	Joint Services Explosive Ordnance Disposal Operation Centre
LAA	Light Anti-Aircraft
LCC	London County Council
LRRB	Long Range Rocket Bomb (V-2)
LSA	Land Service Ammunition
NFF	National Filling Factory
OB	Oil Bomb
PAC	Pilotless Aircraft (V-1)
PB	Phosphorous Bomb
PM	Parachute Mine
POW	Prisoner Of War
RAF	Royal Air Force
RCAF	Royal Canadian Air Force
RFC	Royal Flying Corps
RNAS	Royal Naval Air Service
ROF	Royal Ordnance Factory
SA	Small Arms
SAA	Small Arms Ammunition
SD2	Anti-personnel "Butterfly Bomb"
SIP	Self-Igniting Phosphorous
U/C	Unclassified bomb
UP	Unrotated Projectile (rocket)
USAAF	United States Army Air Force
UX	Unexploded
UXAA	Unexploded Anti-Aircraft
UXB	Unexploded Bomb
UXO	Unexploded Ordnance
V-1	Flying Bomb (Doodlebug)
V-2	Long Range Rocket
WAAF	Women's Auxiliary Air Force
X	Exploded

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1st Line Defence Limited

Detailed Unexploded Ordnance (UXO) Risk Assessment

Site: Highover Farm, Hitchin
Client: RSK

1. Introduction

1.1. Background

1st Line Defence has been commissioned by RSK to conduct a Detailed Unexploded Ordnance (UXO) Risk Assessment for the proposed works at the proposed Highover Farm site.

Buried UXO can present a significant risk to construction works and development projects. The discovery of a suspect device during works can cause considerable disruption to operations as well as cause unwanted delays and expense.

UXO in the UK can originate from three principal sources:

1. Munitions resulting from wartime activities including German bombing in WWI and WWII, long range shelling, and defensive activities.
2. Munitions deposited as a result of military training and exercises.
3. Munitions lost, burnt, buried or otherwise discarded either deliberately, accidentally, or ineffectively.

This report will assess the potential factors that may contribute to the risk of UXO contamination. If an elevated risk is identified at the site, this report will recommend appropriate mitigation measures, in order to reduce the risk to as low as is reasonably practicable. Detailed analysis and evidence will be provided to ensure an understanding of the basis for the assessed risk level and any recommendations.

This report complies with the guidelines outlined in *CIRIA C681*, 'Unexploded Ordnance (UXO) A Guide for the Construction Industry.'

2. Method Statement

2.1. Report Objectives

The aim of this report is to conduct a comprehensive assessment of the potential risk from UXO at Highover Farm. The report will also recommend appropriate site and work-specific risk mitigation measures to reduce the risk from explosive ordnance during the envisaged works to a level that is as low as reasonably practicable.

2.2. Risk Assessment Process

1st Line Defence has undertaken a five-step process for assessing the risk of UXO contamination:

1. The likelihood that the site was contaminated with UXO.
2. The likelihood that UXO remains on the site.
3. The likelihood that UXO may be encountered during the proposed works.
4. The likelihood that UXO may be initiated.
5. The consequences of initiating or encountering UXO.

In order to address the above, 1st Line Defence has taken into consideration the following factors:

- Evidence of WWI and WWII German aerial delivered bombing as well as the legacy of Allied occupation.
- The nature and conditions of the site during WWII.
- The extent of post-war development and UXO clearance operations on site.
- The scope and nature of the proposed works and the maximum assessed bomb penetration depth.
- The nature of ordnance that may have contaminated the proposed site area.

2.3. Sources of Information

Every reasonable effort has been made to ensure that relevant evidence has been consulted and presented in order to produce a thorough and comprehensible report for the client. To achieve this the following, which includes military records and archive material held in the public domain, have been accessed:

- The National Archives and Hertfordshire Archive.
- Historical mapping datasets.
- Historic England National Monuments Record.
- Relevant information supplied by RSK.
- Available material from 33 Engineer Regiment (EOD) Archive (now 28 Regt).
- 1st Line Defence's extensive historical archives, library and UXO geo-datasets.
- Open sources such as published books and internet resources.

Research involved a visit to The National Archives and Hertfordshire Archives.

3. Background to Bombing Records

3.1. General Considerations of Historical Research

This desktop assessment is based largely upon analysis of historical evidence. Every reasonable effort has been made to locate and present significant and pertinent information. 1st Line Defence cannot be held accountable for any changes to the assessed risk level or risk mitigation measures, based on documentation or other data that may come to light at a later date, or which was not available to 1st Line Defence during the production of this report.

It is often problematic and sometimes impossible to verify the completeness and accuracy of WWII-era records. As a consequence, conclusions as to the exact location and nature of a UXO risk can rarely be quantified and are to a degree subjective. To counter this, a range of sources have been consulted, presented and analysed. The same methodology is applied to each report during the risk assessment process. 1st Line Defence cannot be held responsible for any inaccuracies or the incompleteness in available historical information.

3.2. German Bombing Records

During WWII, bombing records were generally gathered locally by the police, Air Raid Precaution (ARP) wardens and military personnel. These records typically contained information such as the date, the location, the amount of damage caused and the types of bombs that had fallen during an air raid. This information was made either through direct observation or post-raid surveys. The Ministry of Home Security Bomb Census Organisation would then receive this information, which was plotted onto maps, charts, and tracing sheets by regional technical officers. The collective record set (regional bomb census mapping and locally gathered incidents records) would then be processed and summarised into reports by the Ministry of Home Security Research and Experiments Branch. The latter were tasked with providing the government ‘a complete picture of air raid patterns, types of weapons used and damage caused- in particular to strategic services and installations such as railways, shipyards, factories and public utilities.’¹

The quality, detail and nature of record keeping could vary considerably between provincial towns, boroughs and cities. No two areas identically collated or recorded data. While some local authorities maintained records with a methodical approach, sources in certain areas can be considerably more vague, dispersed, and narrower in scope. In addition, the immediate priority was mostly focused on assisting casualties and minimising damage at the time. As a result, some records can be incomplete and contradictory. Furthermore, many records were even damaged or destroyed in subsequent air raids. Records of raids that took place on sparsely or uninhabited areas were often based upon third party or hearsay information and are therefore not always reliable. Whereas records of attacks on military or strategic targets were often maintained separately and have not always survived.

3.3. Allied Records

During WWII considerable areas of land were requisitioned by the War Office for the purpose of defence, training, munitions production and the construction of airfields. Records relating to military features vary and some may remain censored. Within urban environments datasets will be consulted detailing the location of munition production as well as wartime air and land defences. In rural locations it may be possible to obtain plans of military establishments, such as airfields, as well as training logs, record books, plans and personal memoirs. As with bombing records, every reasonable effort will be made to access records of, and ascertain any evidence of, military land use. However, there are occasions where such evidence is not available, as records may not be accessible, have been lost/destroyed, or simply were not kept in the first place.

¹ <http://www.nationalarchives.gov.uk/help-with-your-research/research-guides/bomb-census-survey-records-1940-1945/>.

4. UK Regulatory Environment and Guidelines

4.1. General

There is no formal obligation requiring a UXO risk assessment to be undertaken for construction projects in the UK, nor is there any specific legislation stipulating the management or mitigation of UXO risk. However, it is implicit in the legislation outlined below that those responsible for intrusive works (archaeology, site investigation, drilling, piling, excavation etc.) should undertake a comprehensive and robust assessment of the potential risks to employees and that mitigation measures are implemented to address any identified hazards.

4.2. CDM Regulations 2015

The Construction (Design and Management) Regulations 2015 (CDM 2015) define the responsibilities of parties involved in the construction of temporary or permanent structures.

The CDM 2015 establishes a duty of care extending from clients, principle co-ordinators, designers, and contractors to those working on, or affected by, a project. Those responsible for construction projects may therefore be accountable for the personal or proprietary loss of third parties, if correct health and safety procedure has not been applied.

Although the CDM does not specifically reference UXO, the risk presented by such items is both within the scope and purpose of the legislation. It is therefore implied that there is an obligation on parties to:

- Provide an appropriate assessment of potential UXO risks at the site (or ensure such an assessment is completed by others).
- Put in place appropriate risk mitigation measures if necessary.
- Supply all parties with information relevant to the risks presented by the project.
- Ensure the preparation of a suitably robust emergency response plan.

4.3. The 1974 Health and Safety at Work etc. Act

All employers have a responsibility under the Health and Safety at Work etc. Act 1974 and the Management of Health and Safety at Work Regulations 1999, to ensure the health and safety of their employees and third parties, so far as is reasonably practicable and conduct suitable and sufficient risk assessments.

4.4. CIRIA C681

In 2009, the Construction Industry Research and Information Association (CIRIA) produced a guide to UXO for the UK construction industry (CIRIA C681). CIRIA is a neutral, independent and not-for-profit body, linking organisations with common interests and facilitating a range of collaborative activities that help improve the industry.

The publication provides the UK construction industry with a defined process for the management of risks associated with UXO from WWI and WWII aerial bombardment. It is also broadly applicable to the risks from other forms of UXO that might be encountered. It focuses on construction professionals' needs, particularly if there is a suspected item of UXO on site and covers issues such as what to expect from a UXO specialist. The guidance also helps clients to fulfil their legal duty under CDM 2015 to provide designers and contractors with project specific health and safety information needed to identify hazards and risks associated with the design and construction work. This report conforms to this CIRIA guidance and to the various recommendations for good practice referenced therein. It is recommended that this document is acquired and studied where possible to allow a better understanding of the background to both the risk assessment process and the UXO issue in the UK in general.

4.5. Additional Legislation

In the event of a casualty resulting from the failure of an employer/client to address the risks relating to UXO, the organisation may be criminally liable under the Corporate Manslaughter and Corporate Homicide Act 2007.

5. The Role of Commercial UXO Contractors and The Authorities

5.1. Commercial UXO Specialists

The role of a UXO Specialist (often referred to as UXO Consultant or UXO Contractor) such as 1st Line Defence is defined in CIRIA C681 as the provision of expert knowledge and guidance to the client on the most appropriate and cost-effective approach to UXO risk management at a site.

The principal role of UXO Specialists is to provide the client with an appropriate assessment of the risk posed by UXO for a specific project, and identify and carry out suitable methodology for the mitigation of any identified risks to reduce them to an acceptable level.

The requirement for a UXO Specialist should ideally be identified in the initial stages of a project, and it is recommended that this occur prior to the start of any detailed design. This will enable the client to budget for expenditure that may be required to address the risks from UXO, and may enable the project team to identify appropriate techniques to eliminate or reduce potential risks through considered design, without the need for UXO specific mitigation measures. The UXO Specialist should have suitable qualifications, levels of competency and insurances.

Please note 1st Line Defence has the capability to provide a complete range of required UXO risk mitigation services, in order to reduce a risk to as low as reasonably practicable. This can involve the provision of both ground investigation, and where appropriate, UXO clearance services.

5.2. The Authorities

The police have a responsibility to co-ordinate the emergency services in the event of an ordnance-related incident at a construction site. Upon inspection they may impose a safety cordon, order an evacuation, and call the military authorities Joint Services Explosive Ordnance Disposal Operation Centre (JSEODOC) to arrange for investigation and/or disposal. Within the Metropolitan Police Operational Area, SO15 EOD will be tasked to any discovery of suspected UXO. The request for Explosive Officer (Expo) support is well understood and practiced by all Metropolitan Boroughs. The requirement for any additional assets will then be coordinated by the Expo if required.

In the absence of a UXO specialist, police officers will usually employ such precautionary safety measures, thereby causing works to cease, and possibly requiring the evacuation of neighbouring businesses and properties.

The priority given to the police request will depend on the EOD teams judgement of the nature of the UXO risk, the location, people and assets at risk, as well as the availability of resources. The speed of response varies; authorities may respond immediately or in some cases it may take several days for the item of ordnance to be dealt with. Depending on the on-site risk assessment the item of ordnance may be removed from the site and/or destroyed by a controlled explosion.

Following the removal of an item of UXO, the military authorities will only undertake further investigations or clearances in high-risk situations. If there are regular UXO finds on a site the JSEODOC may not treat each occurrence as an emergency and will recommend the construction company puts in place alternative procedures, such as the appointment of a commercial contractor to manage the situation.

6. The Site

6.1. Site Location

The site is situated in Hitchin, Hertfordshire. The area of works is bordered by Stortford Road to the east, residential properties to the south and a railway line to the west of the site.

The site is approximately centred on the OS grid reference: **TL 2000431083**.

Site location maps are presented in **Annex A**.

6.2. Site Description

The area of works comprise of several open fields with a small track through the southern section of the site. There is a small body of water in the southern section of the site, near Highover Farm.

A recent aerial photograph and site plan are presented in **Annex B** and **Annex C** respectively.

7. Scope of the Proposed Works

7.1. General

Proposed works are understood to involve three rotary boreholes to 20m, 24 window samples to 3-4m, and 47 trial pits to 3m. This is understood to be in lieu of the construction of a large residential development.

8. Ground Conditions

8.1. General Geology

The British Geological Survey (BGS) map shows the site to be underlain by three types of bedrock geology. The northern section of the site is underlain by the Zag Chalk Formation – Chalk, the central section of the site is underlain by Melbourn Rock Member – Chalk and the southern section of the site is underlain by Holywell Nodular Chalk Formation.

8.2. Site Specific Geology

Site-specific geotechnical data was not available during the production of this report.

9. Site History

9.1. Introduction

The purpose of this section is to identify the composition of the site pre and post-WWII. It is important to establish the historical use of the site, as this may indicate the site's relation to potential sources of UXO as well as help with determining factors such as the land use, groundcover, likely frequency of access and signs of bomb damage.

9.2. Ordnance Survey Historical Maps

Relevant historical maps were obtained for this report and are presented in **Annex D**. See below for a summary of the site history shown on acquired mapping.

Pre-WWII		
Date	Scale	Description
1921	10,560	The site is comprised of open fields with a railway line bordering the western boundary, a roadway bordering the eastern boundary and Highover Farm and open ground bordering the southern section of the site. There is an 'Old Chalk Pit' on the north western side of the railway and a 'Tumulus' situated to the north east of the site.
1938	10,560	There does not appear to have been any significant change within the site boundary. Adjacent to the south western border of the site, there has been development of a residential area with new roads and structures.

Post-WWII		
Date	Scale	Description
1948	10,560	The site does not appear to have undergone any substantial change when compared with pre-war mapping. The residential area to the south west of the site has been developed further but there has been no other development in the surrounding area.

10. Introduction to German Aerial Delivered Ordnance

10.1. General

During WWI and WWII, the UK was subjected to bombing which often resulted in extensive damage to city centres, docks, rail infrastructure and industrial areas. The poor accuracy of WWII targeting technology and the nature of bombing techniques often resulted in neighbouring areas to targets sustaining collateral damage.

In addition to raids which concentrated on specific targets, indiscriminate bombing of large areas also took place, this occurred most prominently in the London 'Blitz', though affected many other towns and cities. As discussed in the following sections, a proportion of the bombs dropped on the UK did not detonate as designed. Although extensive efforts were made to locate and deal with these UXBs at the time, many still remain buried and can present a potential risk to construction projects.

The main focus of research for this section of the report will concern German aerial delivered ordnance dropped during WWII, although WWI bombing will also be considered.

10.2. Generic Types of WWII German Aerial Delivered Ordnance

To provide an informed assessment of the hazards posed by any items of unexploded ordnance that may remain in situ on site, the table below provides information on the types of German aerial delivered ordnance most commonly used by the Luftwaffe during WWII. Images and brief summaries of the characteristics of these items of ordnance are listed in **Annex E**.

Generic Types of WWII German Aerial Delivered Ordnance		
Type	Frequency	Likelihood of detection
High Explosive (HE) bombs	In terms of weight of ordnance dropped, HE bombs were the most frequently deployed by the Luftwaffe during WWII.	Although efforts were made to identify the presence of unexploded ordnance following an air raid, often the damage and destruction caused by detonated bombs made observation of UXB entry holes impossible. The entry hole of an unexploded bomb can be as little as 20cm in diameter and was easily overlooked in certain ground conditions (see Annex F). Furthermore, ARP documents describe the danger of assuming that damage, actually caused by a large UXB, was due to an exploded smaller bomb. UXBs therefore present the greatest risk to present-day intrusive works.
1kg Incendiary bombs (IB)	In terms of the number of weapons dropped, small IBs were the most numerous. Millions of these were dropped throughout WWII.	IBs had very limited penetration capability and in urban areas would often have been located in post-raid surveys. If they failed to initiate and fell in water, on soft vegetated ground, or bombed rubble, they could easily go unnoticed.
Large Incendiary bombs (IB)	These were not as common as the 1kg IBs, although they were more frequently deployed than PMs and AP bomblets.	If large IBs did penetrate the ground, complete combustion did not always occur and in such cases they could remain a risk to intrusive works.
Aerial or Parachute mines (PM)	These were deployed less frequently than HE and IBs due to size, cost and the difficulty of deployment.	If functioning correctly, PMs generally would have had a slow rate of descent and were very unlikely to have penetrated the ground. Where the parachute failed, mines would have simply shattered on impact if the main charge failed to explode. There have been extreme cases when these items have been found unexploded. However, in these scenarios, the ground was either extremely soft or the munition fell into water.
Anti-personnel (AP) bomblets	These were not commonly used and are generally considered to pose a low risk to most works in the UK.	SD2 bomblets were packed into containers holding between 6 and 108 submunitions. They had little ground penetration ability and should have been located by the post-raid survey unless they fell into water, dense vegetation or bomb rubble.

10.3. Failure Rate of German Aerial Delivered Ordnance

It has been estimated that 10% of WWII German aerial delivered HE bombs failed to explode as designed. Reasons for why such weapons might have failed to function as designed include:

- Malfunction of the fuze or gain mechanism (manufacturing fault, sabotage by forced labour or faulty installation).
- Many were fitted with a clockwork mechanism that could become immobilised on impact.
- Failure of the bomber aircraft to arm the bombs due to human error or an equipment defect.
- Jettisoning the bomb before it was armed or from a very low altitude. This most likely occurred if the bomber aircraft was under attack or crashing.

From 1940 to 1945 bomb disposal teams reportedly dealt with a total of 50,000 explosive items of 50kg and over, 7,000 anti-aircraft projectiles and 300,000 beach mines. Unexploded ordnance is still regularly encountered across the UK, see press articles in **Annex G**.

10.4. UXB Ground Penetration

An important consideration when assessing the risk from a UXB is the likely maximum depth of burial. There are several factors which determine the depth that an unexploded bomb will penetrate:

- Mass and shape of bomb.
- Height of release.
- Velocity and angle of bomb.
- Nature of the ground cover.
- Underlying geology.

Geology is perhaps the most important variable. If the ground is soft, there is a greater potential of deeper penetration. For example, peat and alluvium are easier to penetrate than gravel and sand, whereas layers of hard strata will significantly retard and may stop the trajectory of a UXB.

10.4.1. The J-Curve Effect

J-curve is the term used to describe the characteristic curve commonly followed by an aerial delivered bomb dropped from height after it penetrates the ground. Typically, as the bomb is slowed by its passage through underlying soils, its trajectory curves towards the surface. Many UXBs are found with their nose cone pointing upwards as a result of this effect. More importantly however is the resulting horizontal offset from the point of entry. This is typically a distance of about one third of the bomb's penetration depth, but can be higher in certain conditions (see **Annex F**).

10.4.2. WWII UXB Ground Penetration Studies

During WWII the Ministry of Home Security undertook a major study on actual bomb penetration depths, carrying out statistical analysis on the measured depths of 1,328 bombs as reported by bomb disposal (BD) teams. Conclusions were made as to the likely average and maximum depths of penetration of different sized bombs in different geological strata.

For example, the largest common German bomb (500kg) had a likely concluded penetration depth of 6m in sand or gravel but 11m in clay. The maximum observed depth for a 500kg bomb was 11.4m and for a 1,000kg bomb 12.8m. Theoretical calculations suggested that significantly greater penetration depths were probable.

10.4.3. Site Specific Bomb Penetration Considerations

When considering an assessment of the bomb penetration at the site of proposed works the following parameters have been used:

- WWII geology – Zag Chalk Formation, Melbourn Rock Member and Holywell Nodular Chalk Formation.
- Impact angle and velocity – 10-15° from vertical and 270 metres per second.
- Bomb mass and configuration – The 500kg SC HE bomb, without retarder units or armour piercing nose (this was the largest of the common bombs used against Britain).

It has not been possible to determine maximum bomb penetration capabilities at this stage due to the lack or limitations of site specific geotechnical information. An assessment can be made once such information becomes available or by an UXO Specialist on-site.

10.5. V-Weapons

Hitler's 'V-weapon' campaign began from mid-1944. It used newly developed unmanned cruise missiles and rockets. The V-1 known as the *flying bomb* or *pilotless aircraft* and the V-2, a long range rocket, were launched from bases in Germany and occupied Europe. A total of 9,251 V-1s and 1,115 V-2s were recorded in the United Kingdom.

Although these weapons caused considerable damage their relatively low numbers allowed accurate records of strikes to be maintained. These records have mostly survived. There is a negligible risk from unexploded V-weapons on land today since even if the 1000kg warhead failed to explode, the weapons are so large that they would have been observed and dealt with at the time. Therefore, V-weapons are referenced in this report not as a viable risk factor, but primarily in order to help account for evidence of damage and clearance reported.

11. The Likelihood of Contamination from German Aerial Delivered UXBs

11.1. World War I

During WWI Britain was targeted and bombed by Zeppelin Airships as well as Gotha and Giant fixed-wing aircraft. A WWI map of air raids and naval bombardments across England is presented in **Annex H**. This source does not record any WWI bombing incidents to have affected the site.

WWI bombs were generally smaller and dropped from a lower altitude than those used in WWII. This resulted in limited UXB penetration depths. Aerial bombing was often such a novelty at the time that it attracted public interest and even spectators to watch the raids in progress. For these reasons there is a limited risk that UXBs passed undiscovered in the urban environment. When combined with the relative infrequency of attacks and an overall low bombing density the risk from WWI UXBs is considered low and will not be further addressed in this report.

11.2. World War II Bombing of the Rural District of Hitchin

The Luftwaffe's main objective for the attacks on Britain was to inhibit the country's economic and military capability. To achieve this they targeted airfields, depots, docks, warehouses, wharves, railway lines, factories, and power stations. As the war progressed the Luftwaffe bombing campaign expanded to include the indiscriminate bombing of civilian areas in an attempt to subvert public morale.

During WWII the site was located within the Rural District of Hitchin, which sustained an overall very low density of bombing, as represented by bomb density data figures. The site area was largely rural

and did not contain many targets of interest to the Luftwaffe. However, Hitchin was bombed on several occasions.

The presence of RAF Henlow, approximately 5.8km north west of the site, may have been a contributing factor. During the Second World War RAF Henlow's main function was acting as one of the Royal Air Forces largest Maintenance Units which assembled aircraft shipped in crates from overseas. Therefore, it was a desirable Luftwaffe target. The railway lines running through Hitchin may have also been a reason for the attacks as they would have been important lines serving London.

Records of bombing incidents in the civilian areas of the district were typically collected by Air Raid Precautions wardens and collated by Civil Defence personnel. Some other organisations, such as port and railway authorities, maintained separate records. Records would be in the form of typed or hand written incident notes, maps and statistics. Bombing data was carefully analysed, not only due to the requirement to identify those parts of the country most needing assistance, but also in an attempt to find patterns in the Germans' bombing strategy in order to predict where future raids might take place.

Records of bombing incidents for the district are presented in the following sections.

11.3. WWII Home Office Bombing Statistics

The following table summarises the quantity of German aerial delivered bombs (excluding 1kg incendiaries and anti-personnel bombs) dropped on the Rural District of Hitchin between 1940 and 1945.

Record of German Ordnance Dropped on the Rural District of Hitchin		
Area Acreage		82,527
Weapons	High Explosive bombs (all types)	460
	Parachute mines	7
	Oil bombs	21
	Phosphorus bombs	6
	Fire pots	0
	Pilotless aircraft (V-1)	11
	Long range rocket bombs (V-2)	5
Total		510
Number of Items per 1,000 acres		6.2

Source: Home Office Statistics

This table does not include UXO found during or after WWII.

Detailed records of the quantity and locations of the 1kg incendiary and anti-personnel bombs were not routinely maintained by the authorities as they were frequently too numerous to record. Although the risk relating to IBs is lesser than that relating to larger HE bombs, they were similarly designed to inflict damage and injury. Anti-personnel bombs were used in much smaller quantities and are rarely found today but are potentially more dangerous. Although Home Office statistics did not record these types of ordnance, both should not be overlooked when assessing the general risk to personnel and equipment.

11.4. Hitchin Incident Map

A local bomb map compiled by the Hitchin Rural District showing HE bombs, parachute mines, oil bombs, fire pots, phosphorous bombs, fly bombs, rockets and enemy planes was obtained from the Hertfordshire Archives. The section showing the area of the site is described in the table below and presented in **Annex I**.

Hitchin Incident Map – Annex I	
Date Range	Comments
1939-1945	Unfortunately the map is not of a high quality but the bomb strikes are still clearly visible and show that there were bomb strikes recorded within the northern section of the site and several bombing incidents were recorded directly north and south of the boundary. Two HE bombs are recorded in the northern section of the site, with a further two plotted immediately outside the boundary. These incidents are likely to have formed a 'stick' of dropped bombs. The concentration of bombs on the site's southern boundary appears to be particularly high, comprising three HE bombs and a potential parachute mine.

11.5. Records of Air Raid Damage

Records of air raid damage for the Rural District of Hitchin were obtained from Hertfordshire Archives and Local Studies. A transcript of the associated written records for bombs which fell within the site area is presented in the table below and in **Annex J**. It should be noted that this register does not record unexploded bombs.

Hitchin Rural District records		
Date Range	Type of bomb	Comments
15 th November 1940	2 HE bombs	2 high explosive bombs fell near railway bridge, Walsworth End, 1 mile H.E. of Hitchin. Damage to bridge no casualties.
6 th August 1941	9 HE bombs	9 high explosive bombs fell at Walsworth, north of Hitchin. 2 houses demolished, approximately 50 houses slightly damaged. 1 woman killed, 2 women seriously injured, 1 woman slightly injured. 1 man slightly injured, 1 child (male) slightly injured, 1 rescue party worker slightly injured.
30 th June 1942	4 HE bombs	4 high explosive bombs fell at Hitchin, north and south of LNER line. Fell on open ground, no damage.

11.6. WWII-Era Aerial Photography

A high-resolution scan of WWII-era aerial photography for the site area was obtained from the National Monuments Record Office (Historic England). This photograph provides a record of the potential composition of the site during the war, as well as its condition immediately following the war (see Annex K).

WWII-Era Aerial Photography – Annex K	
Date	Description
24 th June 1947	The site area comprises of open fields with a small line trees within the southern section of the site. There is a small pond within the southern section of the site and an area of residential properties have been constructed to the south of the site boundary. Annex K2 highlights several small areas which resemble potential bomb damage or cratering. However as this image was taken in 1947 additional bomb damage may have been cleared and craters could have been filled in. The locations of the potential bomb craters in the northern section of the site approximately correlate with position of incidents plotted on the Hitchin Incident Map.

11.7. Abandoned Bombs

A post air-raid survey of buildings, facilities, and installations would have included a search for evidence of bomb entry holes. If evidence of an entry hole was encountered, Bomb Disposal Officer Teams would normally have been requested to attempt to locate, render safe, and dispose of the bomb. Occasionally, evidence of UXBs was discovered but due to a relatively benign position, access problems, or a shortage of resources the UXB could not be exposed and rendered safe. Such an incident may have been recorded and noted as an ‘abandoned bomb’.

Given the inaccuracy of WWII records and the fact that these bombs were ‘abandoned’, their locations cannot be considered definitive or the lists exhaustive. The MoD states that ‘action to make the devices safe would be taken only if it was thought they were unstable’. It should be noted that other than the ‘officially’ abandoned bombs, there will inevitably be UXBs that were never recorded.

1st Line Defence holds no records of officially registered abandoned bombs at or near the site of the proposed works.

11.8. Bomb Disposal Tasks

The information service from the Explosive Ordnance Disposal (EOD) Archive Information Office at 33 Engineer Regiment (EOD) (now 29 Regt) is currently facing considerable delay. It has therefore not been possible to include any updated official information regarding bomb disposal/clearance tasks with regards to this site. A database of known disposal/clearance tasks has been referred to which does not make reference to such instances occurring within the site of proposed works. If any relevant information is received at a later date RSK will be advised.

11.9. Evaluation of German Aerial Delivered UXO Records

Factors	Conclusion
Density of Bombing <i>It is important to consider the bombing density when assessing the possibility that UXBs remain in an area. High bombing density could allow for error in record keeping due to extreme damage caused to the area.</i>	During WWII, the proposed site was situated within the Rural District of Hitchin. Home Office statistics indicate that this borough sustained a very low density of bombing with an average of 6.2 items recorded per 1,000 acres. Despite this, two HE bombs are recorded in the northern section of the site within a Hitchin Incident Map, with a further two plotted immediately outside the boundary. These incidents are likely to have formed a 'stick' of dropped bombs. The concentration of bombs on the site's southern boundary appears to be particularly high, comprising five HE bombs. Written records also indicate that Hitchin sustained several bombing raids. At least one incident record refers to bombing likely immediately on site, with bombing in the immediate vicinity referenced on at least two other occasions. An overlay showing the approximate locations of bomb strikes recorded within the Hitchin Bomb Map on WWII-era imagery is presented in in Annex K3.
Damage <i>If buildings or structures on a site sustained bomb or fire damage any resulting rubble and debris could have obscured the entry holes of unexploded bombs dropped during the same or later raids. Similarly, a high explosive bomb strike in an area of open agricultural land will have caused soil disturbance, increasing the risk that a UXB entry hole would be overlooked.</i>	Historical OS mapping and pre and post-WWII imagery were consulted in order to assess the wartime condition of the site. There are small areas in the north which resemble potential bomb strikes visible within WWII-era aerial photography, highlighted in Annex K2, which suggests that the site sustained some bomb damage during the war. It should be noted that the absence of visible damage throughout the rest of the site is not necessarily indicative of a lack of bombing in these areas. Evidence of UXO can be obscured within areas of open ground. For example, the entry hole for a 50kg UXB can be as small as 20cm in diameter.
Access Frequency <i>UXO in locations where access was irregular would have a greater chance of passing unnoticed than at those that were regularly occupied. The importance of a site to the war effort is also an important consideration as such sites are likely to have been both frequently visited and subject to post-raid checks for evidence of UXO.</i>	The majority of the wartime footprint of the site was likely subject to low levels of regular access during the war, given its open undeveloped nature. Despite ad hoc agricultural use, access to the majority of the site is likely to have been sporadic. Evidence of UXO has a greater chance of going unnoticed and unrecorded within undeveloped and infrequently accessed areas.
Ground Cover <i>The nature of the ground cover present during WWII would have a substantial influence on any visual indication that may indicate UXO being present.</i>	The ground cover of the site is not likely conducive to evidence of UXO due to its undeveloped, open nature. Evidence of UXO can be obscured within areas of open ground. For example, the entry hole for a 50kg UXB can be as small as 20cm in diameter. As such, the possibility that an item of UXO fell on site unnoticed and unrecorded cannot be confidently discounted, particularly when the particularly high density of bombing in the immediate area is taken into account.
Bomb Failure Rate	There is no evidence to suggest that the bomb failure rate in the locality of the site would have been dissimilar to the 10% normally used.
Abandoned Bombs	1st Line Defence holds no records of abandoned bombs at or within the site vicinity.

Bombing Decoy sites	1 st Line Defence could find no evidence of bombing decoy sites within the site vicinity.
Bomb Disposal Tasks	1 st Line Defence could find no evidence of bomb disposal tasks within the site boundary and immediate area.

12. Introduction to Allied Explosive Ordnance

12.1. General

Many areas across the UK may be at risk from Allied UXO because of both wartime and peacetime military use. Typical military activities and uses that may have led to a legacy of military UXO at a site include former minefields, home guard positions, anti-aircraft emplacements, training and firing ranges, military camps, as well as weapons manufacture and storage areas.

Although land formerly used by the military were usually subject to clearance before they returned to civilian use, items of UXO are sometimes discovered and can present a potential risk to construction projects.

It should be highlighted that there is no evidence that the site formerly had any military occupation or usage that could have led to contamination with such items of Allied ordnance. Despite this, urban areas such as the location of the site, can however be at risk from buried unexploded anti-aircraft projectiles fired during WWII – as addressed below.

12.2. Defending the UK From Aerial Attack

During WWII the War Office employed a number of defence tactics against the Luftwaffe from bombing major towns, cities, manufacturing areas, ports and airfields. These can be divided into passive and active defences (examples are provided in the table below).

Active Defences	Passive Defences
• Anti-aircraft gun emplacements to engage enemy aircraft. • Fighter aircraft to act as interceptors. • Rockets and missiles were used later during WWII.	• Blackouts and camouflaging to hinder the identification of Luftwaffe targets. • Decoy sites were located away from targets and used dummy buildings and lighting to replicate urban, military, or industrial areas. • Barrage balloons forced enemy aircraft to greater altitudes. • Searchlights were often used to track and divert adversary bomber crews during night raids.

Active defences such as anti-aircraft artillery present a greater risk of UXO contamination than passive defences. Unexploded ordnance resulting from dogfights and fighter interceptors is rarely encountered and difficult to accurately qualify.

12.2.1. Anti-Aircraft Artillery (AAA)

During WWII three main types of gun sites existed: heavy anti-aircraft (HAA), light anti-aircraft (LAA) and 'Z' batteries (ZAA). If the projectiles and rockets fired from these guns failed to explode or strike an aircraft they would descend back to land. The table below provides further information on the operation and ordnance associated with these type of weapons.

Anti-Aircraft Artillery				
Item	Description			
HAA	These large calibre guns such as the 3.7" QF (Quick Firing) were used to engage high flying enemy bombers, They often fired large HE projectiles, which were usually initiated by integral fuzes triggered by impact, area, time delay or a combination of aforementioned mechanisms.			
LAA	These mobile guns were intended to engage fast, low flying aircraft. They were typically rotated between locations on the perimeters of towns and strategically important industrial works. As they could be moved to new positions with relative ease when required, records of their locations are limited. The most numerous of these were the 40mm Bofors gun which could fire up to 120 x 40mm HE projectiles per minute to over 1,800m.			
Variations in HAA and LSA Ammunition	Gun type	Calibre	Shell Weight	Shell Dimensions
	3.0 Inch	76mm	7.3kg	76mm x 356mm
	3.7 Inch	94mm	12.7kg	94mm x 438mm
	4.5 Inch	114mm	24.7kg	114mm x 578mm
	40mm	40mm	0.9kg	40mm x 311mm
Z-AA	The three inch unrotated rocket/projectile known as the UP-3 had initially been developed for the Royal Navy. The UP-3 was also used in ground-based single and 128-round launchers known as "Z" batteries. The rocket, containing a high explosive warhead was often propelled by cordite.			

The closest recorded HAA to the site was located approximately 8.5km north of the site, however the range of a projectile can be up to 15km. The site would also have been in range of mobile light anti-aircraft guns.

The conditions in which anti-aircraft projectiles may have fallen unnoticed within a site area are analogous to those regarding aerial delivered ordnance. Unexploded anti-aircraft projectiles could essentially have fallen indiscriminately anywhere within range of the guns. The chance of such items being observed, reported and removed during the war depends on factors such as land use, ground cover, damage and frequency of access – the same factors that govern whether evidence of a UXB is likely to have been noted. More information about these factors with regards to this particular site can be found in the German Aerial Delivered Ordnance section of this report.

Illustrations of Anti-Aircraft artillery, projectiles and rockets are presented at **Annex L**.

13. The Likelihood of Contamination from Allied Ordnance

13.1. Introduction

There are several factors that may serve to either affirm, increase, or decrease the level of risk within a site with a history of military usage. Such factors are typically dependent upon the proximity of the proposed area of works to training activities, munition productions and storage, as well as its function across the years.

This section will examine the history of the proposed site and assess to what degree, if any, the site could have become contaminated as a result of the military use of the surrounding area.

13.2. Evaluation of Contamination Risk from Allied UXO

1st Line Defence has considered the following potential sources of Allied ordnance contamination:

Sources of Allied UXO Contamination	Conclusion
Military Camps <i>Military camps present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training.</i>	1 st Line Defence could find no evidence of a military camp within the site. There is an in-house reference to a WWI-era Royal Engineer Camp (named Hitchin North Army Camp) which was located within the Hitchin area, although this is not anticipated to have been on site.
Anti-Aircraft Defences <i>Anti-Aircraft defences were employed across the country. Proximity to anti-aircraft defences increases the chance of encountering AA projectiles.</i>	1 st Line Defence could find no evidence of Anti-Aircraft defences such as a HAA or LAA gun emplacement occupying or bordering the site. The closest HAA was located approximately 8.5km north of the site, however the range of a projectile can be up to 15km. The conditions in which HAA or LAA projectiles may have fallen unnoticed within a site footprint are analogous to those regarding German aerial delivered ordnance.
Home Guard Activity <i>The Home Guard regularly undertook training and ordnance practice in open areas, as well as burying ordnance as part of anti-invasion defences.</i>	1 st Line Defence has no evidence of any Home Guard activities on the site.
Defensive Positions <i>Defensive positions suggest the presence of military activity, which is often indicative of ordnance storage, usage or disposal.</i>	There is no evidence of any defensive features formerly located on or bordering the site footprint.
Training or firing ranges <i>Areas of ordnance training saw historical ordnance usage in large numbers, often with inadequate disposal of expended and live items. The presence of these ranges significantly impact on the risk of encountering items of ordnance in their vicinity.</i>	There is no evidence of such features affecting the site.
Defensive Minefields <i>Minefields were placed in strategic areas to defend the country in the event of a German invasion. Minefields were not always cleared with an appropriate level of vigilance.</i>	There is no evidence of defensive minefields affecting the site.



Ordnance Manufacture <i>Ordnance manufacture indicates an increased chance that items of ordnance were stored, or disposed of, within a location.</i>	No information of ordnance being stored, produced, or disposed of within the proposed site could be found.
Military Related Airfields <i>Military airfields present an elevated risk from ordnance simply due to the large military presence and likelihood of associated live ordnance training or bombing practice.</i>	The site was not situated within the perimeters or vicinity of a military airfield. RAF Henlow is the nearest recorded military airfield, situated approximately 5.8km north west of the site.

14. The Likelihood of UXO Contamination Summary

The following table assesses the likelihood that the site was contaminated by items of German aerial delivered and Allied ordnance. Factors such as the risk of UXO initiation, remaining, and encountering will be discussed later in the report.

UXO Contamination Summary	
Quality of the Historical Record	The research has evaluated pre- and post-WWII Ordnance Survey maps, Luftwaffe reconnaissance imagery, WWII-era aerial photography, Hertfordshire records of air raid damage and historical anecdotal records. The record is of generally good quality, with incidents record across multiple sources. It should be noted however that due to the open nature of the site, it has not been possible to precisely locate where recorded bomb strikes within the written records landed. Although it has been possible to ascertain the general area affected by bombing.
German Aerial Delivered Ordnance	- At the start of WWII, the proposed site at Highover Farm comprised of open fields, with a small body of water present in the southern section of the site. The area of works was located within the Rural District of Hitchin. - A range of WWII bombing records, such as Home Office statistics and Hitchin bomb mapping were consulted. These collectively indicate that the Rural District of Hitchin sustained a very low density of bombing with an average of 6.2 items recorded per 1,000 acres. However, the site's local bomb density appears to have been particularly higher. The reason for this high density is unclear – as no obvious Luftwaffe target could be identified within the area. - Two HE bombs are recorded in the northern section of the site within the Hitchin Incident Map, with a further two plotted immediately outside the boundary. These incidents are likely to have formed a 'stick' of dropped bombs. The concentration of bombs on the site's southern boundary appears to be particularly high, comprising five HE bombs. Written records also indicate that Hitchin sustained several bombing raids. At least one incident record refers to bombing likely on site, with bombing in Walsworth, in the immediate vicinity, referenced on at least two other occasions. An overlay showing the approximate locations of these recorded bomb strikes on WWII-era imagery is presented within Annex K3. - OS mapping and high resolution WWII-era aerial imagery have been consulted and indicate that the majority of the site did not sustain any obvious signs of significant bomb damage or cratering. Although, as the site remained an open area of land with hardly any structures, bomb damage may not necessarily be evident across the entire site. Annex K2 highlights potential areas of bomb damage in the northern section of the site, which resembles an area of previous bomb cratering and matches the approximate location of the recorded bomb strikes in the Hitchin Incident Map. - It should be noted that the absence of visible damage throughout the rest of the site is not necessarily indicative of a lack of bombing in these areas. Evidence of UXO can be obscured within areas of open ground. For example, the entry hole for a 50kg UXB can be as small as 20cm in diameter. - The majority of the wartime footprint of the site was likely subject to low levels of regular access during the war, given its open undeveloped nature. Despite ad hoc agricultural use, access to the majority of the site is likely to have been sporadic. It cannot be confidently stated that this agricultural use was consistent throughout WWII. Evidence of UXO has a greater chance of going unnoticed and unrecorded within undeveloped and infrequently accessed areas. - In summary, the site is considered to be of medium risk of UXO contamination due to the open nature of the area, lack of anticipated regular access, poor ground conditions for identifying UXO and the density of bombing both within and immediately bordering the area of works. It has therefore not possible to

	'risk map' or lower the risk from UXO within any substantial section of the site on this occasion.
Allied Ordnance	There is no evidence that the site formerly had any military occupation or usage that could have led to contamination with items of Allied ordnance, such as LSA and SAA. There is an in-house reference to a WWI-era Royal Engineer Camp which was located within the Hitchin area, although, this is not anticipated to have been on site. The conditions in which HAA or LAA projectiles may have fallen unnoticed within the site boundary are however analogous to those regarding aerial delivered ordnance.

15. The Likelihood that UXO Remains

15.1. Introduction

It is important to consider the extent to which any explosive ordnance clearance (EOC) activities or extensive ground works have occurred on site. This may indicate previous ordnance contamination or reduce the risk that ordnance remains undiscovered.

15.2. UXO Clearance

1st Line Defence has found no evidence in the public domain or within internal records that any official ordnance clearance operations have taken place on site. Note however that we have not received confirmation of this fact from the 33 EOD Regiment Archive (now part of 29 Regt). It should also be noted that in addition to 29 Regt archival information, 1st Line Defence also do not currently have access to data that may be relevant including 5131(BD)SQN Archive, SD Training Technical Advisory Section (TAS) and MACA Records (bomb disposal callouts).

If such information is available at a later date, it is recommended that it be reviewed as it will assist with understanding both levels and types of contamination likely to be present, and may indicate risk reduction in certain areas.

15.3. Post-war Redevelopment

The site is not anticipated to have experienced any post-war development, as it still remains occupied by open fields. Land south of the site has experienced significant development with the construction of several residential properties.

The risk from deep-buried unexploded bombs is only considered mitigated at locations where post war piling or deep foundations have taken place.

16. The Likelihood of UXO Encounter

16.1. Introduction

For UXO to pose a risk at a site, there should be a means by which any potential UXO might be encountered on that site.

The likelihood of encountering UXO on the site of proposed would depend on various factors, such as the type of UXO that might be present and the intrusive works planned on site. In most cases, UXO is more likely to be present below surface (buried) than on surface.

In general, the greater the extent and depth of intrusive works, the greater the risk of encountering. The most likely scenarios under which items of UXO could be encountered during construction works is during piling, drilling operations or bulk excavations for basement levels. The overall risk will depend on the extent of the works, such as the numbers of boreholes/piles (if required) and the volume of the excavations.

16.2. Encountering Aerial Delivered Ordnance

Since an aerial delivered bomb may come to rest at any depth between just below ground level and its maximum penetration depth, there is a chance that such an item (if present) could be encountered during shallow excavations (for services or site investigations) into the original WWII ground level as well as at depth.

17. The Likelihood of UXO Initiation

17.1. Introduction

UXO does not spontaneously explode. Older UXO devices will require an external event/energy to create the conditions for detonation to occur. The likelihood that a device will function can depend on a number of factors including the type of weaponry, its age and the amount of energy it is struck with.

17.2. Initiating Aerial Delivered Ordnance

Unexploded bombs do not spontaneously explode. All high explosive filling requires significant energy to create the conditions for detonation to occur.

In recent decades, there have been a number of incidents in Europe where Allied UXBs have detonated, and incidents where fatalities have resulted (some examples are presented in **Annex L**). There have been several hypotheses as to the reason why the issue is more prevalent in mainland Europe – reasons could include the significantly greater number of bombs dropped by the Allied forces on occupied Europe, the preferred use by the Allies of mechanical rather than electrical fuzes, and perhaps just good fortune. The risk from UXO in the UK is also being treated very seriously in many sectors of the construction industry, and proactive risk mitigation efforts will also have affected the lack of detonations in the UK.

There are certain construction activities which make initiation more likely, and several potential initiation mechanisms must be considered:

UXB Initiation	
Direct Impact	Unless the fuze or fuze pocket is struck, there needs to be a significant impact e.g. from piling or large and violent mechanical excavation, onto the main body of the weapon to initiate a buried iron bomb. Such violent action can cause the bomb to detonate.
Re- starting the Clock	A small proportion of German WWII bombs employed clockwork fuzes. It is probable that significant corrosion would have taken place within the fuze mechanism over the last 70+ years that would prevent clockwork mechanisms from functioning. Nevertheless, it was reported that the clockwork fuze in a UXB dealt with by 33 EOD Regiment in Surrey in 2002 did re-start.
Friction Impact	The most likely scenario resulting in the detonation of a UXB is friction impact initiating the shock-sensitive fuze explosive. The combined effects of seasonal changes in temperature and general degradation over time can cause explosive compounds to crystallise and extrude out from the main body of the bomb. It may only require a limited amount of energy to initiate the extruded explosive which could detonate the main charge.

18. Consequences of Initiation/Encounter

18.1. Introduction

The repercussions of the inadvertent detonation of UXO during intrusive ground works, or if an item or ordnance is interfered with or disturbed, are potentially profound, both in terms of human and financial cost. A serious risk to life and limb, damage to plant and total site shutdown during follow-up investigations are potential outcomes. However, if appropriate risk mitigation measures are put in place, the chances of initiating an item of UXO during ground works is comparatively low.

The consequences of encountering UXO can be particularly notable in the case of high-profile sites (such as airports and train stations) where it is necessary to evacuate the public from the surrounding area. A site may be closed for anything from a few hours to a week with potentially significant cost in lost time. It should be noted that even the discovery of suspected or possible item of UXO during intrusive works (if handled solely through the authorities), may also involve significant loss of production

18.2. Consequences of Detonation

When considering the potential consequences of a detonation, it is necessary to identify the significant receptors that may be affected. The receptors that may potentially be at risk from a UXO detonation on a construction site will vary depending on the site specific conditions but can be summarised as follows:

- People – site workers, local residents and general public.
- Plant and equipment – construction plant on site.
- Services – subsurface gas, electricity, telecommunications.
- Structures – not only visible damage to above ground buildings, but potentially damage to foundations and the weakening of support structures.
- Environment – introduction of potentially contaminating materials.

19. 1st Line Defence Risk Assessment

19.1. Risk Assessment Stages

Taking into account the quality of the historical evidence, the assessment of the overall risk from unexploded ordnance is based on the following five considerations:

1. That the site was contaminated with unexploded ordnance.
2. That unexploded ordnance remains on site.
3. That such items will be encountered during the proposed works.
4. That ordnance may be initiated by the works operations.
5. The consequences of encountering or initiating ordnance.

19.2. Assessed Risk Level

1st Line Defence has assessed that there is an overall **Medium Risk** from German and anti-aircraft unexploded ordnance at the site of proposed works. There is an assessed **Low Risk** from Allied ordnance.

Ordnance Type	Risk Level			
	Negligible	Low	Medium	High
German Unexploded HE Bombs			✓	
German 1kg Incendiary Bombs			✓	
Allied Anti-Aircraft Artillery Projectiles			✓	
Allied Land Service and Small Arms Ammunition		✓		

This report has been undertaken with due diligence, and all reasonable care has been taken to access and analyse relevant historical information. By necessity, when dealing historical evidence, and when making assessments of UXO risk, various assumptions have to be made which we have discussed and justified throughout this report. Our reports take a common-sense and practical approach to the assessment of risk, and we strive to be reasonable and pragmatic in our conclusions.

It should however be stressed that if any suspect items are encountered during the proposed works, 1st Line Defence should be contacted for advice/assistance, and to re-assess the risk where necessary. The mitigation measures outlined in the next section are recommended as a minimum precaution to alert ground personnel to the history of the site, what to look out for, and what measures to take in the event that a suspect item is encountered. It should also be noted that the conclusions of this report are based on the scope of works outlined in the 'Proposed Works' section of this report. Should the scope of works change or additional works be proposed, 1st Line Defence should be contacted to re-evaluate the risk.

20. Proposed Risk Mitigation Methodology

20.1. General

The following risk mitigation measures are recommended to support the proposed works at Highover Farm:

Type of Work	Recommended Mitigation Measure
All Works	UXO Risk Management Plan It is recommended that a site-specific plan for the management of UXO risk be written for this site. This plan should be kept on site and be referred to in the event that a suspect item of UXO is encountered at any stage of the project. It should detail the steps to be taken in the event of such a discovery, considering elements such as communication, raising the alarm, nominated responsible persons etc. Contact 1st Line Defence for help/more information. Site Specific UXO Awareness Briefings to all personnel conducting intrusive works. As a minimum precaution, all personnel working on the site should be briefed on the basic identification of UXO and what to do in the event of encountering a suspect item. This should in the first instance be undertaken by a UXO Specialist. Posters and information on the risk of UXO can be held in the site office for reference.
Shallow Intrusive Works/Open Excavations	A Non-Intrusive UXO Magnetometer Survey A Non-Intrusive survey is undertaken using a man-portable magnetometer. Data is recorded and then interpreted to map magnetic fields and model discrete magnetic anomalies which may show the characteristics of UXO. The anomalies can then be investigated by a target investigation team. Where this type of survey is not practical (due to for example terrain or ground conditions), on-site UXO specialist support is recommended. Unexploded Ordnance (UXO) Specialist Presence on Site to support shallow intrusive works When on site the role of the UXO Specialist would include: - Monitoring works using visual recognition and instrumentation, including immediate response to reports of suspicious objects or suspected items of ordnance that have been recovered by the ground workers on site. - Providing UXO awareness briefings to any uninformed staff and advise staff of the need to modify working practices to take account of the ordnance risk. - To aid incident management which would involve liaison with the local authorities and police should ordnance be identified and present an explosive hazard.
Borehole/Piles	Intrusive Magnetometer Survey of all borehole and pile locations down to a maximum bomb penetration depth: 1st Line Defence can deploy a range of intrusive magnetometer techniques to clear pile locations. The appropriate technique is influenced by a number of factors, but most importantly the site's ground conditions. The appropriate survey methodology would be confirmed once the enabling works have been completed.

In making this assessment and recommending these risk mitigation measures, if known, the works outlined in the 'Scope of the Proposed Works' section were considered. Should the planned works be modified or additional intrusive engineering works be considered, 1st Line Defence should be consulted to see if a re-assessment of the risk or mitigation recommendations is necessary.

1st Line Defence Limited

10th September 2019

This Report has been produced in compliance with the Construction Industry Research and Information Association (CIRIA) C681 guidelines for the writing of Detailed UXO Risk Assessments.

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Project: **Highover Farm, Hitchin**

Ref: **DA9080-00**

Source: Google Maps

 **Approximate site boundary**





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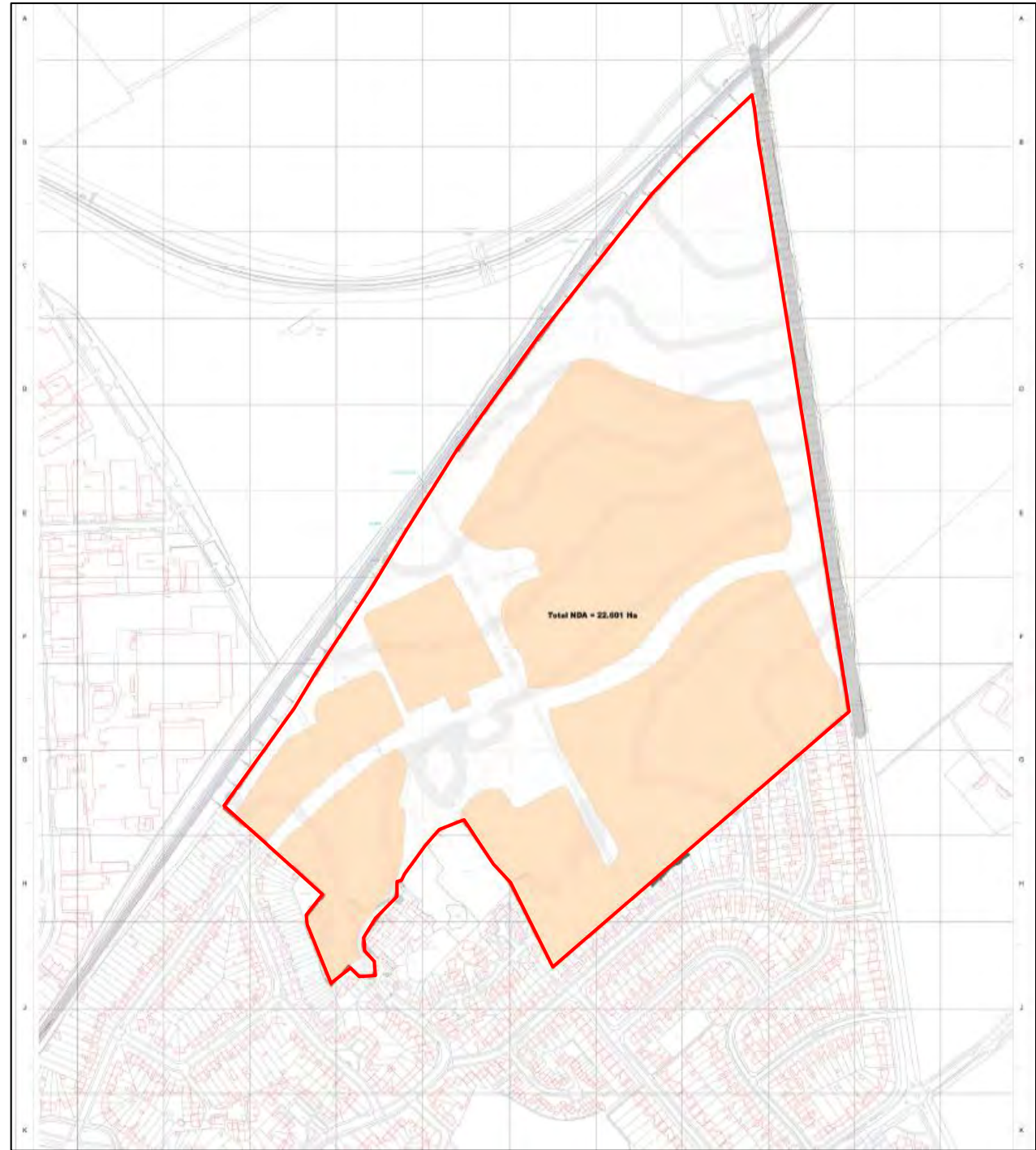
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Ref: **DA9080-00**

Source: Google Earth™ Mapping Services

 **Approximate site boundary**





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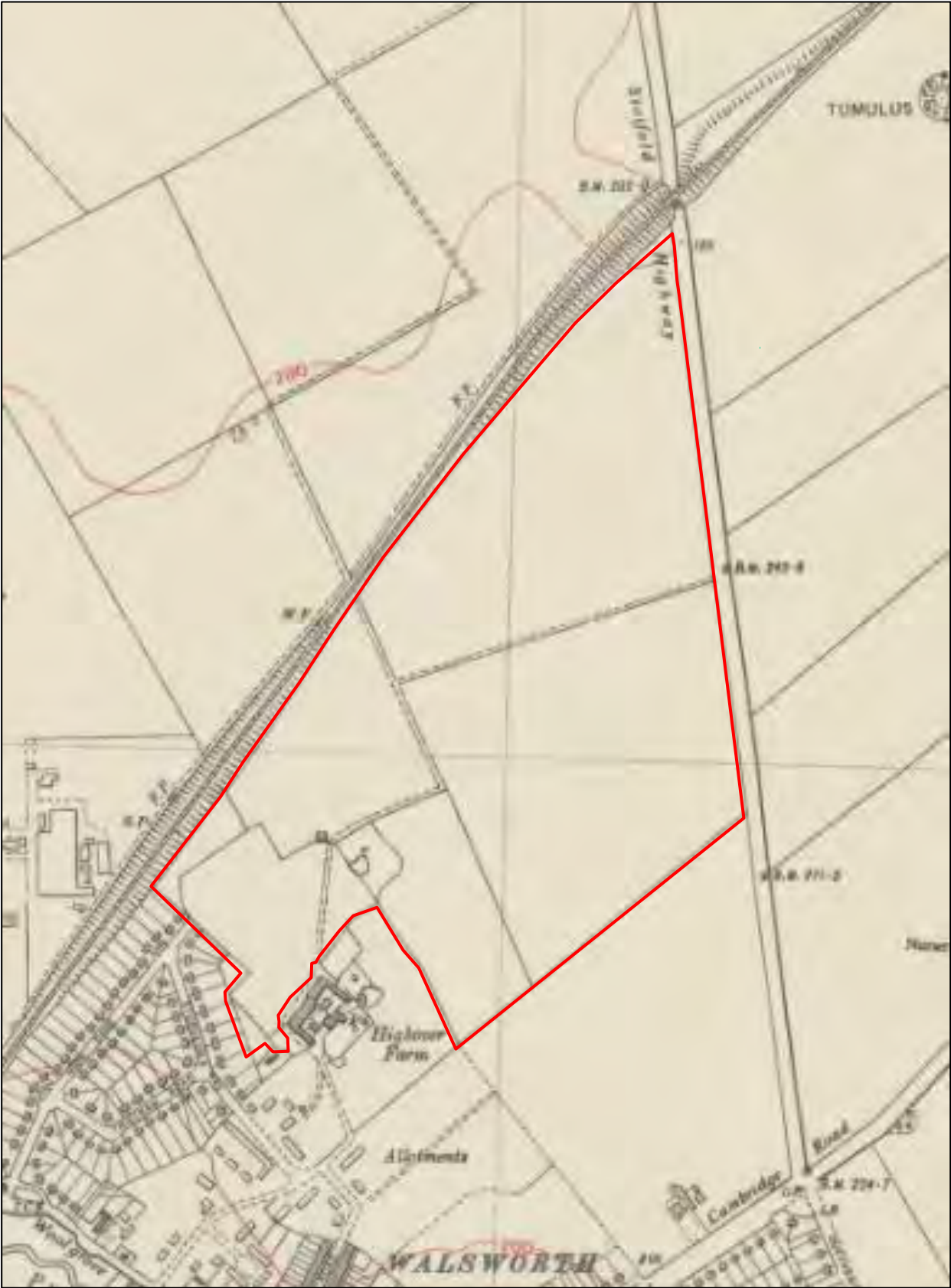
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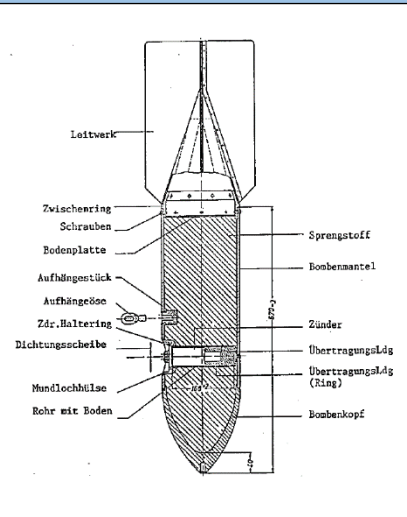
 **Approximate site boundary**



Examples of German Air-Delivered Ordnance

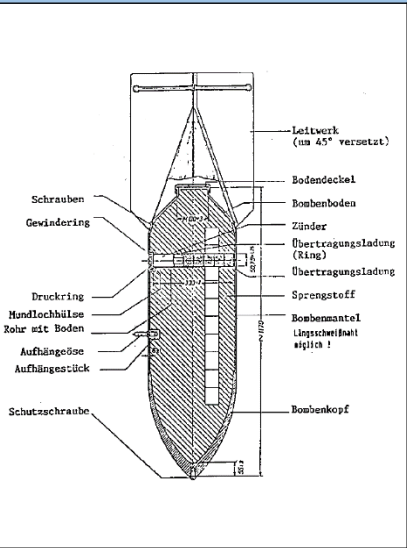
SC 50kg High Explosive Bomb

Bomb Weight	40-54kg (88-119lb)
Explosive Weight	25kg (55lb)
Fuze Type	Impact fuze/electro-mechanical time delay fuze
Bomb Dimensions	1,090 x 280mm (42.9 x 11.0in)
Body Diameter	200mm (7.87in)
Use	Against lightly damageable materials, hangars, railway rolling stock, ammunition depots, light bridges and buildings up to three stories.
Remarks	The smallest and most common conventional German bomb. Nearly 70% of bombs dropped on the UK were 50kg.



SC 250kg High Explosive Bomb

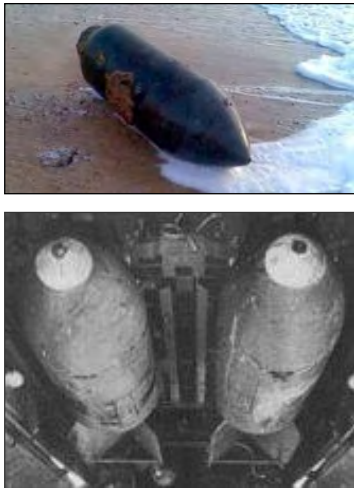
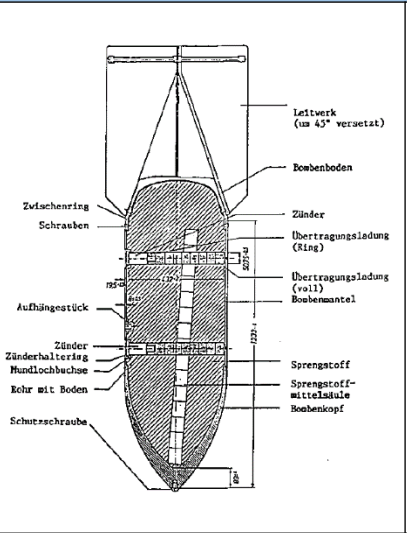
Bomb Weight	245-256kg (540-564lb)
Explosive Weight	125-130kg (276-287lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1640 x 512mm (64.57 x 20.16in)
Body Diameter	368mm (14.5in)
Use	Against railway installations, embankments, flyovers, underpasses, large buildings and below-ground installations.
Remarks	It could be carried by almost all German bomber aircraft, and was used to notable effect by the Junkers Ju-87 Stuka (Sturzkampfflugzeug or dive-bomber).



SC250 bomb being loaded onto German bomber

SC 500kg High Explosive Bomb

Bomb Weight	480-520kg (1,058-1,146lb)
Explosive Weight	250-260kg (551-573lb)
Fuze Type	Electrical impact/mechanical time delay fuze.
Bomb Dimensions	1957 x 640mm (77 x 25.2in)
Body Diameter	470mm (18.5in)
Use	Against fixed airfield installations, hangars, assembly halls, flyovers, underpasses, high-rise buildings and below-ground installations.
Remarks	40/60 or 50/50 Amatol TNT, trialene. Bombs recovered with Trialen filling have cylindrical paper wrapped pellets 1-15/16 in. in length and diameter forming



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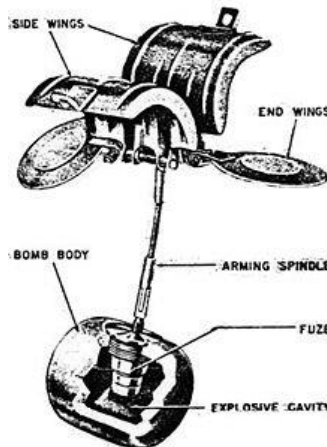
Source: Various sources

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Examples of German Air-Delivered Ordnance

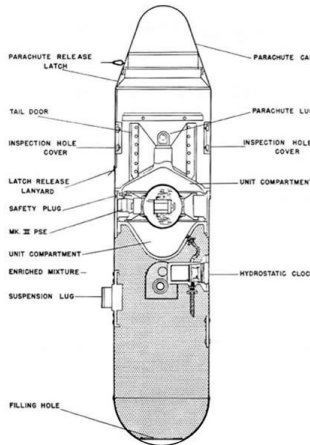
SD2 Anti-Personnel ‘Butterfly Bomb’

Bomb Weight	Approx. 2kg (4.41lb)
Explosive Weight	Approx. 7.5oz (225 grams) of Amatol surrounded by a layer of bituminous composition.
Fuze Type	41 fuze (time) , 67 fuze (clockwork time delay) or 70 fuze (anti-handling device)
Body Diameter	3in (7.62 cm) diameter, 3.1in (7.874) long
Use	Designed as an anti-personnel/ fragmentation weapon. They were delivered by air, being dropped in containers of 23-144 sub-munitions that opened at a predetermined height, thus scattering the bombs.
Remarks	Very rare. First used against Ipswich in 1940, but were also dropped on Kingston upon Hull, Grimsby and Cleethorpes in June 1943, amongst various other targets in UK. As the bombs fell the outer case flicked open by springs which caused four light metal drogues with a protruding 5 inch steel cable to deploy in the form of a parachute & wind vane which armed the device as it span.

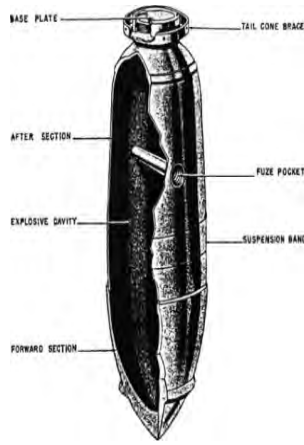




Parachute Mine (Luftmine B / LMB)

Bomb Weight	Approx. 990kg (2176lb)		  
Explosive Weight	Approx. 705kg (1,554lb)		
Fuze Type	Impact/ Time delay / hydrostatic pressure fuze		
Dimensions	2.64m x 0.64m (3.04m with parachute housing)		
Use	Against civilian, military and industrial targets. Used as blast bombs and designed to detonate above ground level to maximise damage to a wider area.		
Remarks	Deployed a parachute when dropped in order to control its descent. Had the potential to cause extensive damage in a 100m radius.		

SC 1000kg

Bomb Weight	Approx. 993-1027kg (2,189-2,264lb)		
Explosive Weight	Approx. 530-620kg (1168-1367lb)		
Fuze Type	Electrical impact/mechanical time delay fuze.		
Filling	Mixture of 40% amatol and 60% TNT, but when used as an anti-shipping bomb it was filled with Trialen 105, a mixture of 15% RDX, 70% TNT and 15% aluminium powder.		
Bomb Dimensions	2800 x 654mm (110 x 25.8in)		
Body Diameter	654mm (18.5in)		
Use	SC type bombs are General Purpose Bombs used primarily for general demolition work. Constructed of parallel walls with comparatively heavy noses. They are usually of three piece welded construction		



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Project: Highover Farm, Hitchin

Ref: DA9080-00

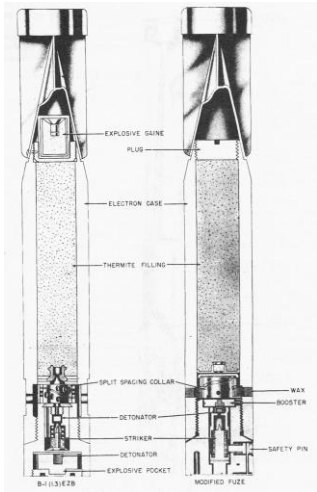
Source: Various sources

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German Incendiary Bombs

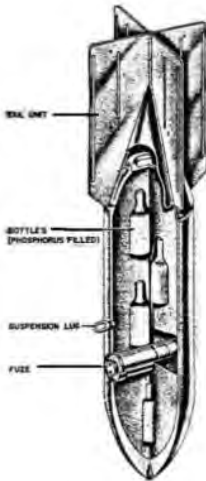
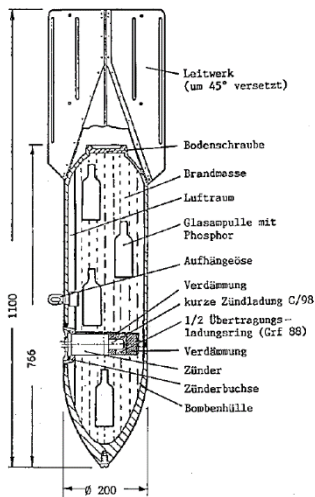
1kg Incendiary Bomb

Bomb Weight	Approx. 1.0 - 1.3kg (2.2 and 2.9lb)
Explosive Weight	Approx. 680g (1.5lb) Thermit 8-15gm Explosive Nitropenta
Fuze Type	Impact fuze
Bomb Dimensions	350 x 50mm (13.8 x 1.97in)
Body Diameter	50mm (1.97in)
Use	As incendiary – dropped in clusters on towns and industrial complexes
Remarks	Magnesium alloy case. Sometimes fitted with high explosive charge. The body is a cylindrical alloy casting threaded internally at the nose to receive the fuze holder and fuze.



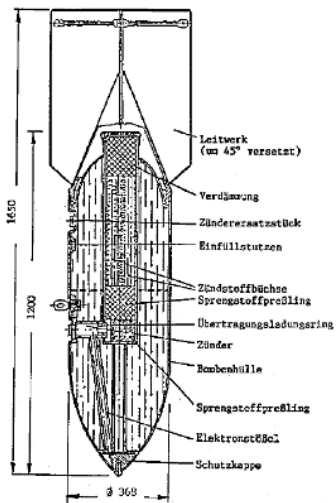
C50 A Incendiary Bomb

Bomb Weight	Approx. 41kg (90.4lb)
Explosive Weight	Approx. 0.03kg (0.066lb)
Incendiary Filling	12kg (25.5lb) liquid filling with phosphor igniters in glass phials. Benzine 85%; Phosphorus 4%; Pure Rubber 10%
Fuze Type	Electrical impact fuze
Bomb Dimensions	1,100 x 280mm (43.2 x 8in)
Use	Against any targets where an incendiary effect is required
Remarks	Early fill was a phosphorous/carbon disulphide incendiary mixture



Flam C-250 Oil Bomb

Bomb Weight	Approx. 125kg (276lb)
Explosive Weight	Approx. 1kg (2.2lb)
Fuze Type	Super-fast electrical impact fuze
Filling	Mixture of 30% petrol and 70% crude oil
Bomb Dimensions	1,650 x 512.2mm (65 x 20.2in)
Body Diameter	368mm (14.5in)
Use	Often used for surprise attacks on ground troops, against troop barracks and industrial installations. Thin casing – not designed for ground penetration



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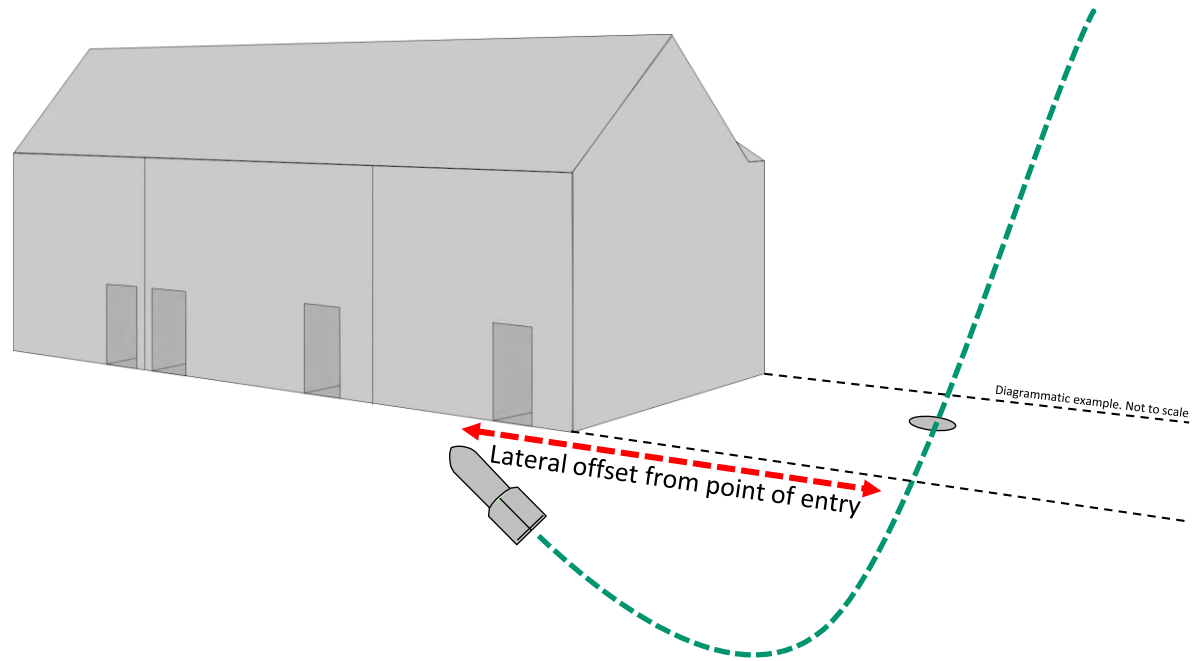
Client: RSK

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Top: J-curve Effect - Due to angle of entry, unexploded bombs would often end their trajectory at a lateral offset from point of entry, often ending up beneath adjacent extant structures/sites. The photograph above shows 250kg bomb found in Bermondsey pointing upwards, demonstrating 'J-curve'



One of the most common scenarios for UXO going unnoticed was when a UXB fell into a 'bomb site' (such as the area shown **Top Left**), the entry hole of the bomb obscured by any debris and rubble present. Note that the entry hole of a 50kg UXB could be as little as 20cm in diameter (**Left**).



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Bermondsey bomb: World War Two device safely removed



An unexploded World War Two bomb found in south London has been driven away safely under police and Army escort.

The 500lb (250kg) device was found on a building site in Grange Walk, Bermondsey on Monday.

March 2015



Bethnal Green WW2 bomb: Experts remove unexploded device



An unexploded World War Two bomb that prompted the evacuation of 700 people in east London has been made safe and removed by the military.

Families spent the night in a school hall after the 500lb bomb was found in the basement of a building site on Temple Street, in Bethnal Green, on Monday afternoon.

A 200m (650ft) exclusion zone was set up around the device.

August 2016



Bath WW2 bomb scare: Device defused, police say



A 500lb World War Two bomb found on the site of a former school in Bath has been defused and made safe.

The discovery of the bomb on Thursday led to the evacuation of hundreds of homes and many road closures in the Lansdown area of the city.

A cordon around the site was lifted on Friday evening, more than 24 hours after residents were asked to leave their homes.

May 2016



London City Airport reopens after WW2 bomb moved



London City Airport has reopened after an unexploded 500kg World War Two bomb was safely moved from the area.

The device was discovered at the King George V Dock on Sunday during planned work at the east London airport.

All flights were cancelled on Monday after an exclusion zone was put in place, with the closure affecting up to 16,000 passengers and nearby residents being evacuated from their homes.

May 2015



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Ref: DA9080-00

Source: BBC News

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BASF has confirmed that an explosive device, most likely a World War II-era bomb, caused the blast that left one person injured Tuesday at a plant construction site in Germany.

The explosion was reported at BASF's Ludwigshafen toluene diisocyanate (TDI) plant, which recently broke ground for a 300,000 metric tons per year TDI production plant and other construction to expand its facilities.



BASF Provides Some Details

Responding to a request from *PaintSquare News* for more information on Wednesday (Feb. 27), BASF's manager of media relations and corporate communications Europe, Ursula von Stetten, wrote in an email, "So here [are] the facts: The detonation took place at 10:00 a.m. One person was injured; the injury is not serious. He will be kept in the hospital for some days.

"Cause of the detonation was an explosive device, presumably a bomb deriving from the Second World War. The device detonated when grounding work was done. No details on [a] delay [are] available. At the moment, the exact circumstances of the incident are [being] evaluated."

1st March 2013

SPIEGEL ONLINE

Blast Kills One
World War II Bomb Explodes on German Motorway

A highway construction worker in Germany accidentally struck an unexploded World War II bomb, causing an explosion which killed him and wrecked several passing cars.



A World War II bomb has exploded during construction work on a German highway, killing one worker and injuring several motorists who were driving past, police said.

The worker had been cutting through the road surface near the south-western town of Aschaffenburg when his machine struck the bomb and triggered it. Police said they weren't sure yet what type of bomb it was. "The explosion seems to have been too small for it to have been an aircraft bomb," a police spokesman said.

23rd October 2006

WWII bomb injures 17 at Hattingen construction site



Seventeen people were injured on Friday when a construction crew unwittingly detonated a buried World War II-era bomb in Hattingen.

An excavator apparently drove over a 250-kilogramme (550 pound) American bomb, damaging surrounding buildings. Most of the injured suffered auditory trauma from the blast, and the excavator operator suffered injuries to his hands, police in the German state of North Rhine-Westphalia said.

"The hole was astoundingly small for such a large bomb full of so many explosives," Armin Gebhard, head of the Arnsberg department for military ordnance removal, told The Local. "But of course it damaged all the surrounding buildings too. We are really happy it wasn't worse."

19th September 2013



World War II bomb kills three in Germany



A special commission is investigating the causes of the explosion, while prosecutors are considering whether the team leader should face charges of manslaughter through culpable negligence, the BBC's Oana Lungescu reports from Berlin.

The blast happened an hour before the defusing operation was due to start.

Officials said the three men who died were experienced sappers, or combat engineers, who over 20 years had defused up to 700 bombs.

More than 7,000 people were immediately evacuated when the 500kg bomb was found. Several schools, a kindergarten and local companies remain closed.

2nd June 2010

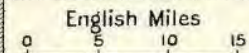


June 2006



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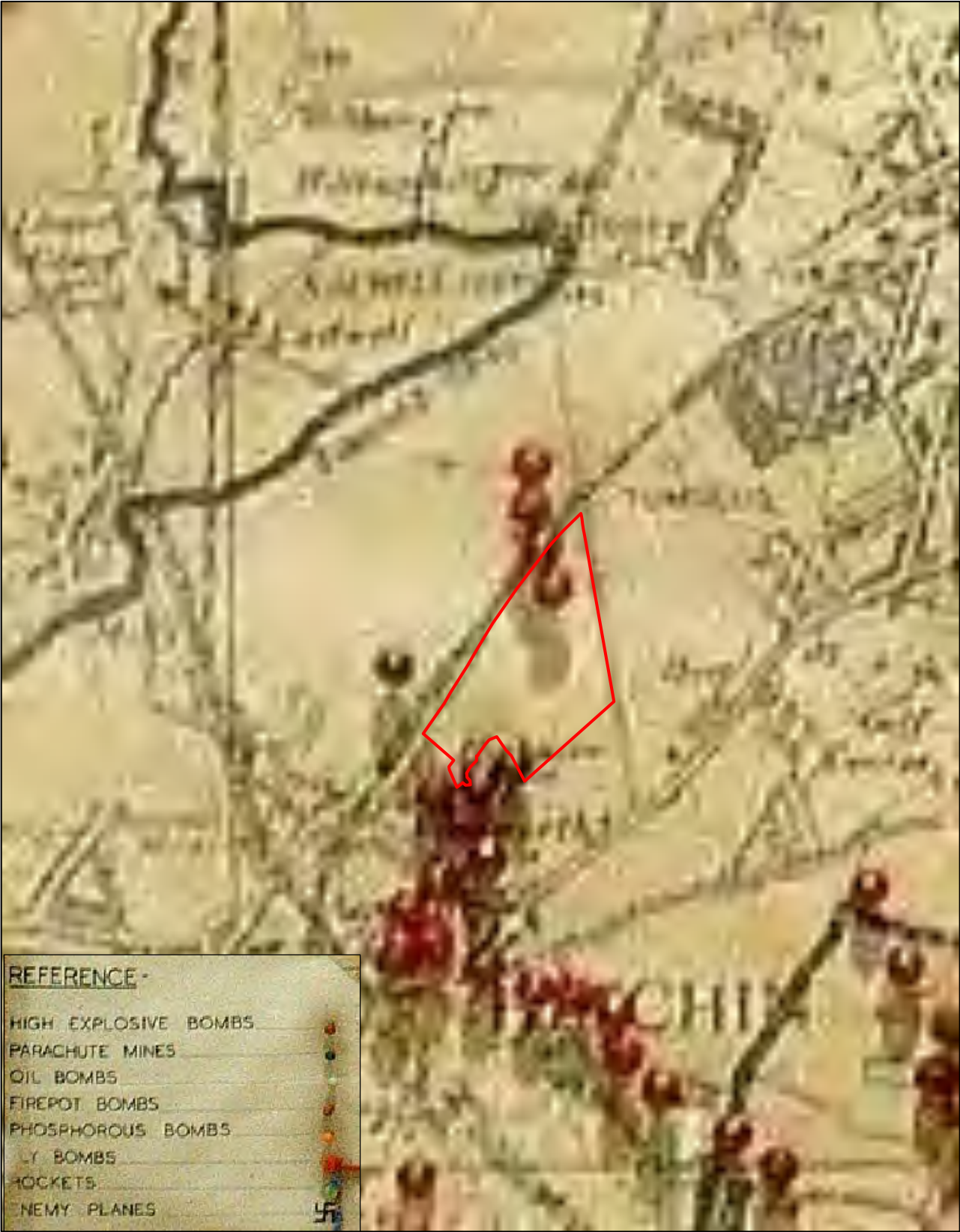
Project: **Highover Farm, Hitchin**

Ref: **DA9080-00**

Source: Hertfordshire Archives

 **Approximate site boundary**





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Source: Hertfordshire Archives

Approximate site boundary



15th November 1940

Card No. 1.

AIR RAID DAMAGE - HITCHIN URBAN DISTRICT.

3rd October, 1940.

4 High Explosive Bombs fell in fields at Gosmore and Charlton, South of Hitchin. No damage, no casualties.

15th October, 1940

12 Incendiary Bombs fell at Hitchin. no damage, no casualties.

16th October, 1940.

1 High Explosive Bomb fell West of Hitchin-Stotfoeld Road, 200 yards North of Cambridge Railway Line Branch. No damage, no casualties.

15th November, 1940.

2 High Explosive Bombs fell near Railway Bridge, Walsworth End, 1 mile N.E. of Hitchin. Damage to bridge, no casualties.

6 High Explosive Bombs fell at Walsworth, Hitchin. No damage, no casualties.

6th August 1941 & 30th June 1942

Card No. 2

AIR RAID DAMAGE - HITCHIN URBAN DISTRICT.

6th August, 1941.

9 High Explosive Bombs fell at Walsworth, North of Hitchin. 2 houses demolished, approximately 50 houses slightly damaged. 1 woman killed, 2 women seriously injured, 1 woman slightly injured. 1 man slightly injured, 1 child (male) slightly injured, 1 rescue party worker slightly injured.

30th June, 1942.

4 High Explosive Bombs fell at Hitchin, North and South of L.N.E.R. line. Fell on open ground, no damage.



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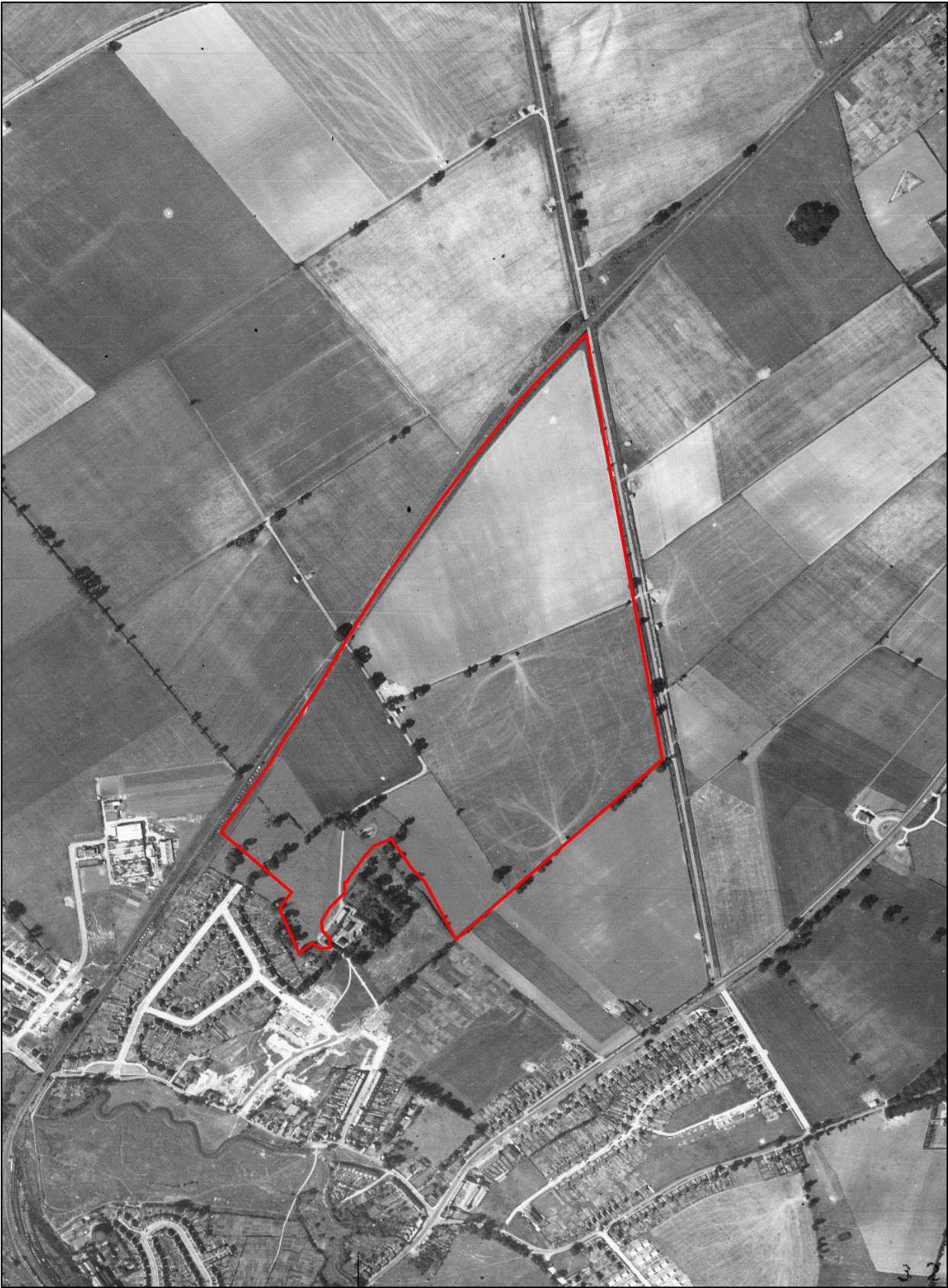
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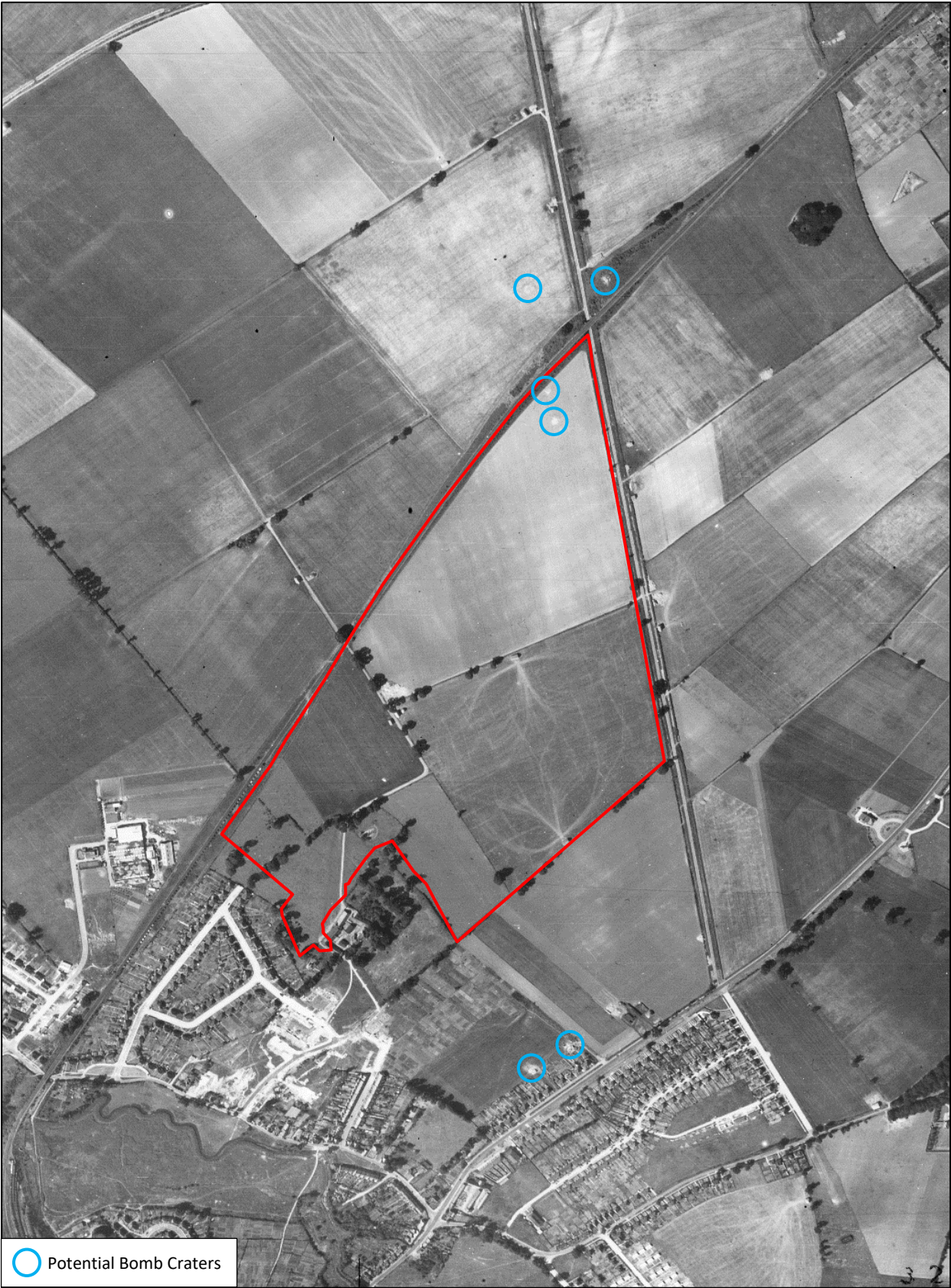
Project: **Higover Farm, Hitchin**

Ref: **DA9080-00**

Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**





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Source: National Monuments Record Office (Historic England)

 **Approximate site boundary**





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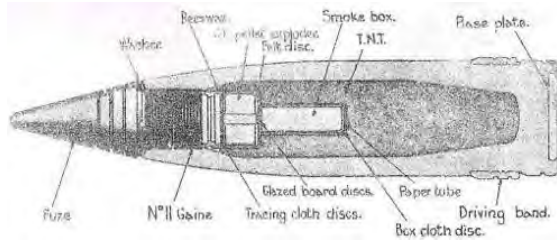
Source: Various Sources

 **Approximate site boundary**



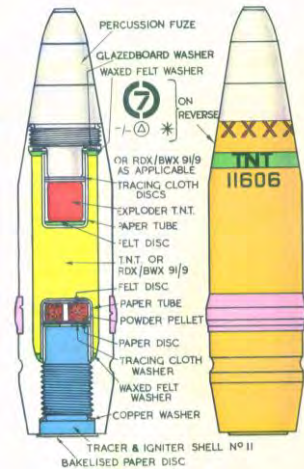
3.7 Inch QF Anti-Aircraft Projectile

Projectile Weight	28lb (12.6 kg)
Explosive Weight	2.52lbs
Fuze Type	Mechanical Time Fuze
Dimensions	3.7in x 14.7in (94mm x 360mm)
Rate of Fire	10 to 20 rounds per minute
Use	The 3.7in AA Mks 1-3 were the standard Heavy Anti-Aircraft guns of the British Army.
Ceiling	30,000ft to 59,000ft



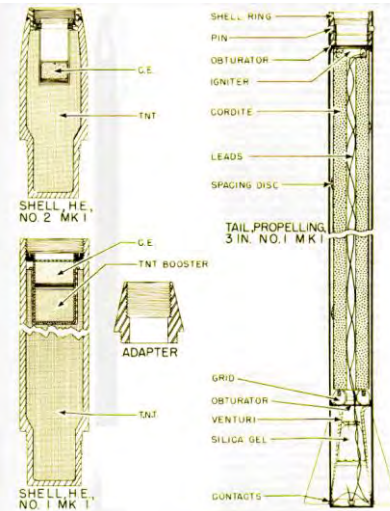
40mm Bofors Projectile

Projectile Weight	1.96lb (0.86kg)
Explosive Weight	300g (0.6lb)
Fuze Type	Impact Fuze
Rate of Fire	120 rounds per minute
Projectile Dimensions	40 x 180mm
Ceiling	23,000ft (7000m)
Remarks	Light quick fire high explosive anti-aircraft projectile. Each projectile fitted with small tracer element. If no target hit, shell would explode when tracer burnt out. Designed to engage aircraft flying below 2,000ft



3in Unrotated Projectile (UP) Anti-Aircraft Rocket ("Z" Battery)

HE Projectile Weight	3.4kg (7.6lb)
Explosive Weight	0.96kg (2.13lb)
Filling	High Explosive – TNT. Fitted with aerial burst fuzing
Dimensions of projectile	236 x 83mm (9.29 x 3.25in)
Remarks	As a short range rocket-firing anti-aircraft weapon developed for the Royal Navy. It was used extensively by British ships during the early days of World War II. The UP was also used in ground-based single and 128-round launchers known as Z Batteries. Shell consists of a steel cylinder reduced in diameter at the base and threaded externally to screw into the shell ring of the rocket motor



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APPENDIX E

TECHNICAL BACKGROUND

E1 Desk Study

Aquifer designation and Source protection zones

Principal aquifer: layers of rock or drift deposit that have high intergranular and/or fracture permeability (usually providing a high level of water storage). They may support water supply and/or river base flow on a strategic scale.

Secondary A aquifer: permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.

Secondary B aquifer: predominantly lower permeability layers that may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering.

Secondary undifferentiated aquifer: it has not been possible to attribute either a category A or B to a rock type. In most cases this means that it was previously designated as both a minor and non-aquifer in different locations owing to the variable characteristics.

Unproductive' strata: low permeability with negligible significance for water supply or river base flow.

The EA generally adopts a three-fold classification of source protection zones (SPZ) surround abstractions for public water supply. The Site is situated in an area defined as follows:

- Zone 1 or the 'inner protection zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time from any point below the water table to the source. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source
- Zone 2 or the 'outer protection zone' is defined by a 400-day travel time from a point below the water table to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants
- Zone 3 or the 'total catchment' is the area around the source within which all groundwater recharge is presumed to be discharged at the source.

Preliminary risk assessment methodology

CLR11 outlines the framework to be followed for risk assessment in the UK. The framework is designed to be consistent with UK legislation and policies including planning. Under CLR11, three stages of risk assessment exist: preliminary, generic quantitative and detailed quantitative. An outline conceptual model should be formed at the preliminary risk assessment stage that collates all the existing information pertaining to a site in text, tabular or diagrammatic form. The outline conceptual model identifies potentially complete (termed possible) contaminant linkages (contaminant–pathway–receptor) and is used as the basis for the design of the site investigation. The outline conceptual model is updated as further information becomes available, for example as a result of the site investigation.

Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, both the likelihood and the consequences of an event must be taken into account when assessing risk. RSK has adopted guidance provided in CIRIA C552 for use in the production of conceptual models.

The likelihood of an event can be classified on a four-point system using the following terms and definitions based on CIRIA C552:

- highly likely: the event appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution
- likely: it is probable that an event will occur or circumstances are such that the event is not inevitable, but possible in the short term and likely over the long term
- low likelihood: circumstances are possible under which an event could occur, but it is not certain even in the long term that an event would occur and it is less likely in the short term
- unlikely: circumstances are such that it is improbable the event would occur even in the long term.

The severity can be classified using a similar system also based on CIRIA C552. The terms and definitions relating to severity are:

- severe: short term (acute) risk to human health likely to result in 'significant harm' as defined by the Environment Protection Act 1990, Part IIA. Short-term risk of pollution of sensitive water resources. Catastrophic damage to buildings or property. Short-term risk to an ecosystem or organism forming part of that ecosystem (note definition of ecosystem in 'Draft Circular on Contaminated Land', DETR 2000)
- medium: chronic damage to human health ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000), pollution of sensitive water resources, significant change in an ecosystem or organism forming part of that ecosystem
- mild: pollution of non-sensitive water resources. Significant damage to crops, buildings, structures and services ('significant harm' as defined in 'Draft Circular on Contaminated Land', DETR 2000). Damage to sensitive buildings, structures or the environment
- minor: harm, not necessarily significant, but that could result in financial loss or expenditure to resolve. Non-permanent human health effects easily prevented by use of personal protective clothing. Easily repairable damage to buildings, structures and services.

Once the probability of an event occurring and its consequences have been classified, a risk category can be assigned according to the table below.

		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

Definitions of these risk categories are as follows together with an assessment of the further work that may be required:

- very high: there is a high probability that severe harm could occur or there is evidence that severe harm is currently happening. This risk, if realised, could result in substantial liability; urgent investigation and remediation are likely to be required
- high: harm is likely to occur. Realisation of the risk is likely to present a substantial liability. Urgent investigation is required. Remedial works may be necessary in the short term and are likely over the long term
- moderate: it is possible that harm could arise, but it is unlikely that the harm would be severe and it is more likely that the harm would be relatively mild. Investigation is normally required to clarify the risk and determine the liability. Some remedial works may be required in the longer term
- low: it is possible that harm could occur, but it is likely that if realised this harm would at worst normally be mild
- very low: there is a low possibility that harm could occur and if realised the harm is unlikely to be severe.

E2 Site Investigation Methodology

Ground gas monitoring

An infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume, while hydrogen sulphide (H₂S) and carbon monoxide (CO) were recorded in parts per million. Initial and steady state concentrations were recorded. In addition, during the first monitoring round, all wells were screened with a PID to establish if there are any interferences and cross-sensitivity of other hydrocarbons with the infrared gas meter.

Low flow groundwater sampling

Groundwater samples were retrieved using a United States Environment Protection Agency (USEPA) approved low-flow purging and sampling methodology.

The low-flow method relies on moving groundwater through the well screen at approximately the same rate as it flows through the geological formation. This results in a significant reduction in the volume of water extracted before sampling and significantly reduces the amount of disturbance of the water in the monitoring well during purging and sampling. Drawdown levels in the monitoring well and water quality indicator parameters (pH, temperature, electrical conductivity, redox potential and dissolved oxygen) are monitored during low-flow purging and sampling, with stabilisation indicating that purging is complete and sampling can begin. As the flow rate used for purging, in most cases, is the same or only slightly higher than the flow rate used for sampling, and because purging and sampling are conducted as one continuous operation in the field, the process is referred to as low-flow purging and sampling.

E3 Site Investigation Methodology

Statistical assessment

Statistical analysis of the results has been conducted in accordance with *Guidance on Comparing Soil Contamination Data with a Critical Concentration* (CIEH and CL:AIRE, 2008) as detailed in Appendix D.

Statistical analysis is utilised to establish whether the land is suitable for the proposed use under the land use planning system by attempting to answer a key question. For a site being developed the key question is: *'can we confidently say that the level of contamination on this land is low relative to some appropriate measure of risk?'* More specifically, this is expressed as *'Is there sufficient evidence that the true mean concentration of the contaminant (μ) is less than the critical concentration (C_c)?'*, where the critical concentration could be the GAC or a site-specific assessment criterion (SSAC). The true mean (μ) is unknown and therefore a conservative estimate, termed the upper confidence limit (UCL), of this value is derived from the data. The UCL is then compared against the GAC.

In statistical terms the question above is handled through the use of a formal hypothesis – the null hypothesis and the alternate hypothesis. The statistical tests are structured to show (with a defined level of confidence, in this case 95%) which of the two hypotheses is most likely to be true, by determining whether the null hypothesis can be rejected.

For consideration under the planning regime, the null (H_0) and alternative (H_1) hypotheses are presented below.

Null and alternative hypotheses

Hypothesis	Equation	Description
Null (H_0)	$\mu \geq C_c$	The true mean concentration is equal to, or greater than, the critical concentration
Alternative (H_1)	$\mu < C_c$	The true mean concentration is less than the critical concentration

Therefore, if the null hypothesis is accepted for a certain contaminant it can be concluded that its concentration is high relative to the critical concentration, which in the case of this assessment is

taken to be the GAC/SSAC and as such the whole site may be classed as being contaminated by a particular substance.

In addition, the statistical guidance provides an outlier test (Grubbs' test) that has been used within this assessment for the identification of 'outliers' or 'hotspots'. The 'outlier' test is conducted before undertaking statistical analysis (and 'outliers' may be removed from the dataset) but **only** where the conceptual model supports this.

The statistical tests applied to the dataset are selected based on whether the data is normally or non-normally distributed. The distribution of the dataset has been assessed using the Shapiro-Wilks normality test. Where the dataset has been found to be normally distributed the one sample t-test is undertaken. Where data has been found to be non-normally distributed Chebyshev's theorem is utilised.

Reuse of suitable materials

The Definition of Waste: Development Industry Code of Practice (CL:AIRE, 2011) (CoP) was developed in consultation with the Environment Agency and development industry to enable the re-use of materials under certain scenarios and subject to demonstrating that specific criteria are met. The current reuse scenarios covered by the CoP comprise

- reuse on the site of origin (with or without treatment)
- direct transfer of clean and natural soils between sites
- use in the development of land other than the site of origin following treatment at an authorised Hub site (including a fixed soil treatment facility).

The importation of made ground soils (irrespective of contamination status) or crushed demolition materials is not permitted currently under the CoP and requires either a standard rules environmental permit or a U1 waste exemption (see below).

In the context of excavated materials used on-sites undergoing development, four factors are considered to be of particular relevance in determining if the material is a waste or when it ceases to be waste:

- the aim of the Waste Framework Directive is not undermined, i.e. if the use of the material will create an unacceptable risk of pollution of the environment or harm to human health it is likely to be waste
- the material is certain to be used
- the material is suitable for use both chemically and geotechnically
- only the required quantity of material will be used.

The CoP requires the preparation of a materials management plan (MMP) that confirms the above factors will be met. This plan needs to be reviewed by a 'Qualified Person' (QP) who will then issue a declaration form to the EA. As the project progresses, data must be collated and on completion a verification report produced that shows the MMP was followed and describes any changes.

The MMP establishes whether specific materials are classified as waste and how excavated materials will be treated and/or reused in line with the CoP. The MMP is likely to form part of the site waste management plan.



APPENDIX F

EXPLORATORY HOLE RECORDS

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH1
Contract Ref: 340110	Start: 30.10.19	Ground Level (m AOD): 68.54	National Grid Co-ordinate: E:519990.0 N:231315.6		Sheet: 1 of 3
End: 31.10.19					

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
1.20-2.20 1.20-1.58	86	28	0	NI 35 70	1	SPT(c)	N:50 for 225mm (SPT inferred = N:66.66)		Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk (AGRICULTURAL TOPSOIL)	0.40	
2.20-3.70 2.20-2.65	93	17	0	NI 30 90	2	SPT(c)	N=50		Upper end of weak medium density light creamy white CHALK. Well fractured, close with black and orange staining. Fine chalk sand around fractures.	(0.80) 1.20 1.40	
3.70-5.20 3.70-4.14	75	50	0	NI 30 90	3	SPT(c)	N:50 for 285mm (SPT inferred = N:52.63)		Upper end of weak medium density light creamy grey CHALK. Due to drilling disturbance, recovered as non intact gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse	(1.30) 2.70	
5.20-6.70 5.20-5.60	91	64	35	NI 80 220	4	SPT(c)	N:50 for 250mm (SPT inferred = N:60)		Upper end of weak to moderately weak medium to high density light creamy grey CHALK. Well fractured vertical and horizontal fractures with black stained faces. Occasional short lengths of core <5 cm of non intact chalk. Rare shell fragments to 3 mm	3.74 3.94	ZCL
6.70-8.20 6.70-6.99	97	45	3	NI 90 180	5	SPT(c)	N:50 for 155mm (SPT inferred = N:96.77)		Upper end of weak medium density light creamy grey CHALK. Due to drilling disturbance, recovered as non intact sub-angular to sub-rounded fine to coarse GRAVEL. Heavily fractured, clean and close horizontally and vertically with black stained faces and orange staining	4.41	
8.20-9.70 8.20-8.43	95	0	0	NI NI NI	6	SPT(c)	N:50 for 105mm (SPT inferred = N:142.86)		Zone of core loss	(3.91) 8.32	
									Upper end of weak medium density light creamy grey CHALK. Clean and close horizontal vertical and sub-vertical fractures with black stained faces and orange staining throughout. Occasional short lengths of core <5 cm of non intact chalk		
									Description on next sheet		

Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth		
						1. Position scanned with a CAT and Genny prior to excavation. 2. UXO checked before and during drilling. 3. Hand pit to 1.2 mbgl. 4. No groundwater encountered.	
Method Used: Rotary coring						All dimensions in metres Scale: 1:50	
Plant Used: Comacchio GEO 205			Drilled By: ???		Logged By: CWright	Checked By:	



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH1
Contract Ref: 340110	Start: 30.10.19	Ground Level (m AOD): 68.54	National Grid Co-ordinate: E:519990.0 N:231315.6		Sheet: 2 of 3

Mechanical Log					Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results					
9.70-11.20 9.70-9.89	95	0	0	NI 90 210	7	SPT(c)	N:50 for 105mm (SPT inferred = N:142.86)			Very weak to upper end of weak low to medium density light creamy grey CHALK. Due to drilling disturbance, recovered as non intact clayey angular to sub-rounded fine to coarse GRAVEL. Black staining on fracture faces and orange staining throughout. (stratum copied from 8.32m from previous sheet)	(1.51) 9.83	
11.20-12.70 11.20-11.39	86	67	38	NI 190 260	8	SPT(c)	N:50 for 75mm (SPT inferred = N:200)			Upper end of weak medium density light creamy grey CHALK. Heavily fractured, clean and close horizontally vertically and sub-vertically with black stained faces and orange staining throughout	(2.11) 11.94	
12.70-14.20 12.70-12.88	91	85	71	50 260 350	9	SPT(c)	N:50 for 70mm (SPT inferred = N:214.29)			Moderately weak medium density light creamy grey CHALK. Clean and close vertical and horizontal fractures with black stained faces. Orange staining throughout. Occasional 1mm black speckles ... @ 13.3 m... 20 mm ironstone	(3.76) 15.70 15.87	
14.20-15.70 14.20-14.41	97	97	94	NI 100 480	10	SPT(c)	N:50 for 115mm (SPT inferred = N:130.43)					
15.70-17.20 15.70-15.92	99	88	61	NI 80 180	11	SPT(c)	N:50 for 115mm (SPT inferred = N:130.43)			Moderately weak high density light creamy grey CHALK. Due to drilling disturbance, recovered as non intact angular to sub-rounded fine to coarse GRAVEL. Black stained fracture faces		
17.20-18.70 17.20-17.49	94	67	45	NI 50 230	12	SPT(c)	N:50 for 170mm (SPT inferred = N:88.24)			Moderately weak high density light creamy grey CHALK. Well fractured with vertical and sub-vertical clean and close fractures with black stained faces. Orange staining throughout. Occasional 1 mm black speckles. Small <6 cm sections of non intact		
	90	66	52									

Drilling Progress and Water Observations						General Remarks						
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth							
All dimensions in metres			Scale:			1:50						
Method Used: Rotary coring			Plant Used: Comacchio GEO 205			Drilled By: ???		Logged By: CWright		Checked By:		



BOREHOLE LOG

Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Borehole: BH1
Contract Ref: 340110	Start: 30.10.19 End: 31.10.19	Ground Level (m AOD): 68.54	National Grid Co-ordinate: E:519990.0 N:231315.6	Sheet: 3 of 3

Mechanical Log					Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results					
18.70-20.20 18.70-18.94	90 ↕	66 ↕	52 ↕	NI 110 460	13	SPT(c)	N:50 for 130mm (SPT inferred = N:115.38)			Moderately weak high density light creamy grey CHALK. Well fractured with vertical and sub-vertical clean and close fractures with black stained faces. Orange staining throughout. Occasional 1 mm black speckles. Small <6 cm sections of non intact (stratum copied from 15.87m from previous sheet)	(4.47)	
20.20-20.34	95 ↕	88 ↕	88 ↕		14	SPT(c)	N:50 for 65mm (SPT inferred = N:230.77)			Borehole terminated at 20.34 m depth.	20.34	

Drilling Progress and Water Observations						General Remarks			
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth				
Method Used: Rotary coring			Plant Used: Comacchio GEO 205		Drilled By: ???	Logged By: CWright	Checked By:	All dimensions in metres Scale: 1:50	



Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH1a
Contract Ref: 340110	Start: 16.09.19	Ground Level (m AOD): 68.54	National Grid Co-ordinate: E:519990.0 N:231315.6		Sheet: 1 of 2
End: 16.09.19					

Mechanical Log				Samples & Testing			Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
1.50-3.00 1.50-1.61	↑	↑	↑	40 100 100	SPT	SPT(c)	N:50 for 60mm (SPT inferred = N:250)		Dark brown gravelly clayey fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse flint and white chalk (AGRICULTURAL TOPSOIL)	0.30	
									Upper end of weak medium density creamy white grey CHALK with black staining. Recovered as non intact sandy angular to sub-rounded fine to coarse GRAVEL.	(1.20)	
									Zone of core loss	1.50	
										(0.50)	ZCL
										2.00	
	7	4	0						Upper end of weak medium density light creamy white CHALK with black speckles on fracture faces. Due to drilling disturbance, recovered as non-intact clayey sub-angular to sub-rounded fine to coarse GRAVEL. Fracture faces stained black	2.31	
										2.64	
3.00-4.50 3.00-3.33	↑	↑	↑	25 75 185	SPT	SPT(c)	N:50 for 245mm (SPT inferred = N:74.69)			3.00	
										3.14	ZCL
										3.56	
	8	6	1						Moderately weak medium density light creamy white CHALK with black staining. Probably structured chalk recovered as non-intact clayey angular to sub-rounded fine to coarse GRAVEL.	(0.94)	
									Upper end of weak medium density light creamy white CHALK with black speckles	4.50	
4.50-6.00 4.50-4.90	↑	↑	↑	40 115 125	SPT	SPT(c)	N:50 for 255mm (SPT inferred = N:58.82)		... @ 2.88 m... 16 mm bivalve fossil	4.67	ZCL
									Zone of core loss	5.12	
	8	7	1						Upper end of weak medium density light creamy white CHALK. Due to drilling disturbance, recovered as non-intact sandy sub-angular to sub-rounded fine to coarse GRAVEL.		
									Upper end of weak medium density light creamy white CHALK with occasional orange staining and black speckles. Clean and close vertical and horizontal fractures with black staining		
6.00-7.50 6.00-6.25	↑	↑	↑	55 200 270	SPT	SPT(c)	N:50 for 160mm (SPT inferred = N:93.75)			(3.62)	
									Zone of core loss		
6.90	10	9	7		1	C			Upper end of weak medium density light creamy white CHALK. Due to drilling disturbance, recovered as non-intact very gravelly CLAY. Gravel is sub-angular to sub-rounded fine to coarse. Black staining throughout fracture faces		
7.50-9.00 7.50-7.75	↑	↑	↑	27 140 335	SPT	SPT(c)	N:50 for 161mm (SPT inferred = N:93.17)		Moderately weak high density light creamy white CHALK with occasional orange staining. Horizontal vertical and sub-horizontal fractures with black staining. lengths of core up to 80 mm were recovered as non-intact clayey angular to	8.74	
	10	9	7							9.00	

Drilling Progress and Water Observations						General Remarks			
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth				
						1. Terminated due to access constraints 2. No groundwater encountered during excavation 3. Backfilled with gravel to chalk rock head and sealed with bentonite to surface 4. All fractures are close with no infill			
						All dimensions in metres	Scale:	1:50	
Method Used: Rotary coring			Plant Used: Comacchio GEO 205			Drilled By: ???	Logged By: CWright	Checked By:	



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH1a
Contract Ref: 340110	Start: 16.09.19	Ground Level (m AOD): 68.54	National Grid Co-ordinate: E:519990.0 N:231315.6		Sheet: 2 of 2

Mechanical Log				Samples & Testing			Backfill	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
9.00-10.50 9.00-9.05	↑	↑	↑	40 140 190	SPT	SPT(c)	N:50 for 40mm (SPT inferred = N:375)		sub-rounded fine to medium GRAVEL.	9.26	ZCL
	8	3	2						Upper end of weak medium density light creamy white CHALK with black and orange staining. Due to drilling disturbance, recovered as non-intact clayey sub-angular to sub-rounded fine to coarse GRAVEL. Black staining throughout.	(1.24)	
10.50-12.00 10.50-10.71	↑	↑	↑	80 95 240	SPT	SPT(c)	N:50 for 125mm (SPT inferred = N:120)		Zone of core loss	10.50 10.62	
	10	8	6						Upper end of weak to moderately weak medium density light creamy white CHALK with orange staining. Close and clean sub-horizontal fractures with black staining		
11.85 12.00-13.50 12.00-12.09	↑	↑	↑	30 250 380	2	C	N:50 for 81mm (SPT inferred = N:185.19)		Moderately weak medium density light creamy white CHALK with orange staining. Heavily fractured with faces stained black. Due to drilling disturbance, recovered as non-intact clayey sub-angular to sub-rounded fine to coarse GRAVEL.	(3.08)	
	9	9	8						Moderately weak high density light creamy white CHALK with orange staining. Clean and close horizontal vertical and sub-vertical fractures with black staining.		
13.25 13.50-13.70	↓	↓	↓		3	C	N:50 for 115mm (SPT inferred = N:130.43)		... @ 11.35 m... 120 mm of non-intact slightly clayey GRAVEL. Gravel is sub-angular to sub-rounded fine to medium	13.70	
									Borehole terminated at 13.70 m depth.		

Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth		
						All dimensions in metres	Scale: 1:50
Method Used: Rotary coring			Plant Used: Comacchio GEO 205		Drilled By: ???	Logged By: CWright	Checked By:



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH2
Contract Ref: 340110	Start: 31.10.19 End: 01.11.19	Ground Level (m AOD): 73.58	National Grid Co-ordinate: E:519809.0 N:230975.1		Sheet: 1 of 3

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
1.20-2.20 1.20-1.64	↑	↑	↑	NI 30 80	1	SPT(c)	N:50 for 285mm (SPT inferred = N:52.63)		Dark brown slightly gravelly clayey SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert (AGRICULTURAL TOPSOIL)	0.40	
									Upper end of weak medium density light creamy grey CHALK. Well fractured, close and clean with black stained faces	(0.80)	
	100	85	0							1.20	
2.20-3.70 2.20-2.58	↑	↑	↑	NI 30 100	2	SPT(c)	N:50 for 230mm (SPT inferred = N:65.22)		Upper end of weak medium density light creamy greyish white CHALK with orange staining. Due to drilling disturbance, recovered as non intact sandy slightly clayey sub-angular to sub-rounded fine to coarse GRAVEL. Black staining on faces	(0.54)	
									Upper end of weak medium density light creamy greyish white CHALK with light orange staining. Clean and close vertical and horizontal fractures with black stained faces	1.74	
	100	29	7							2.20	
3.70-5.20 3.70-4.08	↑	↑	↑	NI 80 100	3	SPT(c)	N:50 for 225mm (SPT inferred = N:66.66)		Upper end of weak medium density light creamy white CHALK with light orange staining. Heavily fractured clean and close horizontally and vertically with black stained faces	(1.50)	
									Zone of core loss	3.70	
	89	66	7							3.86	ZCL
5.20-6.70 5.20-5.60	↑	↑	↑	NI 80 120	4	SPT(c)	N:50 for 245mm (SPT inferred = N:65.22)		Upper end of weak medium density light creamy white CHALK with light orange staining. Clean and close horizontal and vertical fractures with black stained faces	(1.11)	
										4.97	
	85	46	8							5.58	
6.70-8.20 6.70-7.04	↑	↑	↑	NI 100 180	5	SPT(c)	N:50 for 200mm (SPT inferred = N:75)		Upper end of weak medium density light creamy white CHALK with black and orange staining. Due to drilling disturbance, recovered as non intact sandy clayey angular to sub-rounded fine to coarse GRAVEL.	(0.61)	
									Upper end of weak medium density light creamy white CHALK with orange staining. Heavily fractured horizontally and vertically clean and close with black stained faces	8.13	
	96	68	42							8.46	
8.20-9.70 8.20-8.55	↑	↑	↑	NI 50 130	6	SPT(c)	N:50 for 220mm (SPT inferred = N:68.18)		Upper end of weak medium density light creamy white CHALK with black and orange staining. Due to drilling disturbance, recovered as non intact sandy clayey angular to sub-rounded fine to coarse GRAVEL	(2.55)	
	88	24	9								

Drilling Progress and Water Observations						General Remarks				
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth					
						1. Position scanned with a CAT and Genny prior to excavation. 2. UXO checked before and during drilling. 3. Hand pit to 1.2 mbgl. 4. No groundwater encountered.				
						All dimensions in metres		Scale:	1:50	
Method Used: Rotary coring			Plant Used: Comacchio GEO 205			Drilled By: ???		Logged By: CWright	Checked By:	



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH2
Contract Ref: 340110	Start: 31.10.19 End: 01.11.19	Ground Level (m AOD): 73.58	National Grid Co-ordinate: E:519809.0 N:230975.1		Sheet: 2 of 3

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
9.70-11.20 9.70-10.06	88	24	9	NI 50 100	7	SPT(c)	N:50 for 230mm (SPT inferred = N:65.22)		Upper end of weak medium density light creamy white CHALK with black and orange staining. Well fractured with clean and close horizontal and vertical fractures (stratum copied from 8.46m from previous sheet)	(1.24) 9.70 10.04	
11.20-12.70 11.20-11.54	77	43	7	NI 30 170	8	SPT(c)	N:50 for 215mm (SPT inferred = N:69.77)		Upper end of weak medium density light creamy white CHALK. Due to drilling disturbance, recovered as non intact sandy sub-angular to sub-rounded fine to coarse GRAVEL. Fracture faces stained black		
12.70-14.20 12.70-13.02	91	47	19	NI 50 140	9	SPT(c)	N:50 for 220mm (SPT inferred = N:68.18)		Upper end of weak medium density light creamy white CHALK. Clean and close horizontal and vertical fractures with black and orange staining throughout		
14.20-15.70 14.20-14.42	89	77	9	NI 30 160	10	SPT(c)	N:50 for 115mm (SPT inferred = N:130.43)			(7.16)	
15.70-17.20 15.70-15.92	87	57	29	NI 70 190	11	SPT(c)	N:50 for 105mm (SPT inferred = N:142.86)				
17.20-18.70 17.20-17.48	91	67	45	NI 90 150	12	SPT(c)	N:50 for 125mm (SPT inferred = N:120)		Upper end of weak medium density light creamy white CHALK. Due to drilling disturbance, recovered as non intact sandy clayey angular to sub-rounded fine to coarse GRAVEL. Black and orange staining	17.20 17.40	
	91	49	29								

Drilling Progress and Water Observations						General Remarks					
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth						
						All dimensions in metres		Scale: 1:50			
Method Used: Rotary coring			Plant Used: Comacchio GEO 205			Drilled By: ???		Logged By: CWright		Checked By: 	



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH2
Contract Ref: 340110	Start: 31.10.19 End: 01.11.19	Ground Level (m AOD): 73.58	National Grid Co-ordinate: E:519809.0 N:230975.1		Sheet: 3 of 3

Mechanical Log					Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results					
18.70-20.20 18.70-18.82	91 ↕	49 ↕	29 ↕	NI 40 460	13	SPT(c)	N:50 for 50mm (SPT inferred = N:300)			Upper end of weak medium density light creamy white CHALK. Heavily fractured horizontally and vertically. Fractures clean and close with faces stained black. Orange staining throughout (stratum copied from 17.40m from previous sheet)	(2.95)	
20.20-20.35	95 ↕	87 ↕	63 ↕									
					14	SPT(c)	N:50 for 70mm (SPT inferred = N:214.29)			Borehole terminated at 20.35 m depth.		

Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth		
Method Used: Rotary coring			Plant Used: Comacchio GEO 205		Drilled By: ???	Logged By: CWright	Checked By:

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH3
Contract Ref: 340110	Start: 31.10.19	Ground Level (m AOD): 80.26	National Grid Co-ordinate: E:520218.9 N:230996.2		Sheet: 1 of 3

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
1.20-2.50 1.20-1.53	↑	↑	↑	NI 60 110	1	SPT(c)	N:50 for 180mm (SPT inferred = N:83.33)		Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse flint and chert (AGRICULTURAL TOPSOIL)	0.40	
									Very weak to upper end of weak low to medium density light grey grey CHALK with chalk sand. Orange staining throughout. Weathered (Grade Dc)	(0.80)	
									Zone of core loss	1.20	
										1.67	ZCL
										(0.83)	
2.50-4.00 2.50-2.73	↑	↑	↑	NI 100 220	2	SPT(c)	N:50 for 80mm (SPT inferred = N:187.5)		Upper end of weak medium density light creamy white CHALK with light orange staining. Well fractured with black speckles on fracture faces. Clean and close vertical and horizontal fractures. Contains rare white shell fragments	2.50	
									Zone of core loss	2.62	ZCL
										(1.38)	
4.00-5.50 4.00-4.19	↑	↑	↑	NI 190 220	3	SPT(c)	N:50 for 85mm (SPT inferred = N:176.47)		Upper end of weak medium density light creamy white CHALK with light orange staining. Horizontal and sub-horizontal clean and close fractures. Black speckles on faces. Occasional white shell fragments to 12 mm	4.00	
									Zone of core loss	4.20	ZCL
										4.30	
										(1.20)	
5.50-7.00 5.50-5.71	↑	↑	↑	NI 120 135	4	SPT(c)	N:50 for 95mm (SPT inferred = N:157.89)		Upper end of weak medium density light creamy white CHALK with light orange staining. Due to drilling disturbance, recovered as non intact sandy clayey angular to sub-rounded fine to coarse GRAVEL	5.50	
									Upper end of weak medium density light creamy white CHALK with light orange staining. Frequent white shell fragments up to 25 mm. Clean and close horizontal fractures with black staining	5.86	
										(1.10)	
7.00-8.50 7.00-7.21	↑	↑	↑	NI 95 230	5	SPT(c)	N:50 for 55mm (SPT inferred = N:272.72)		Upper end of weak medium density light creamy white CHALK with light orangish yellow staining. Due to drilling disturbance, recovered as non intact sandy sub-angular to sub-rounded fine to coarse GRAVEL. Contains white shell fragments	6.96	
										7.11	ZCL
										7.25	
										(1.25)	
8.50-10.00 8.50-8.63	↑	↑	↑	NI 80 180	6	SPT(c)	N:50 for 50mm (SPT inferred =		Upper end of weak medium density light creamy white CHALK with light orange staining. Clean and close horizontal and vertical fractures with black speckles and slight greenish hue staining on fracture faces. Occasional white shell fragments to 16 mm	8.50	
										8.62	ZCL
									Zone of core loss		

Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth		
						1. Position scanned with a CAT and Genny prior to excavation. 2. UXO checked before and during drilling. 3. Hand pit to 1.2 mbgl. 4. No groundwater encountered.	
Method Used: Rotary coring						All dimensions in metres	Scale: 1:50
Plant Used: Comacchio GEO 205			Drilled By: ???		Logged By: CWright	Checked By:	



BOREHOLE LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Borehole: BH3
Contract Ref: 340110	Start: 31.10.19	Ground Level (m AOD): 80.26	National Grid Co-ordinate: E:520218.9 N:230996.2		Sheet: 2 of 3

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend	
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type						Results
10.00-11.50 10.00-10.15	81	53	29	NI 65 90	7	SPT(c)	N:300)		Upper end of weak medium density light creamy white CHALK with light orange staining. Due to drilling disturbance, recovered as non intact clayey sub-angular to sub-rounded fine to coarse GRAVEL	(0.86)		
												9.48
										(0.52)		
										10.00		
11.50-13.00 11.50-11.58	78	30	0	NI 200 410	8	SPT(c)	N:50 for 40mm (SPT inferred = N:375)		Upper end of weak to moderately weak medium to high density light creamy white CHALK with light orange staining. Vertical and horizontal clean and close fractures. Fracture faces have black speckles and blackish staining	10.40		
												(0.78)
										11.18		
13.00-14.50 13.00-13.09	86	83	7	25 40 300	9	SPT(c)	N:50 for 40mm (SPT inferred = N:375)		Moderately weak high density light creamy white CHALK with light orange staining. Occasional white shell fragments <5 mm. Clean and close horizontal and vertical fractures with black speckles and blackish staining	(3.32)		
												Moderately weak high density light creamy greyish white CHALK with orange staining. Close vertical sub-vertical and horizontal fractures with black speckles and blackish staining. One fracture 3 mm infill of chalk silt with green hue
14.50-16.00 14.50-14.71	89	89	56	NI 60 160	10	SPT(c)	N:50 for 50mm (SPT inferred = N:300)		Moderately weak high density light creamy greyish white CHALK with light orange staining. Due to drilling disturbance, recovered as non intact sandy angular to sub-rounded fine to coarse GRAVEL. Black staining on faces	14.50		
												14.79
										(0.87)		
										15.66		
16.00-17.50 16.00-16.09	78	41	11	NI 45 170	11	SPT(c)	N:50 for 80mm (SPT inferred = N:187.5)		Moderately weak high density light creamy white CHALK with light orangish staining. Occasional greyish bands <15 mm. Clean and close vertical and horizontal fractures with black speckles on faces	16.00		
												(1.50)
									17.50			
17.50-19.00 17.50-17.76	90	44	18	NI 35 260	12	SPT(c)	N:50 for 40mm (SPT inferred = N:375)	Moderately weak high density light creamy white CHALK with light orangish staining. Clean vertical and horizontal fractures with black speckles on faces	17.60			
	79	61	45				N:50 for 105mm (SPT inferred =		Moderately weak high density light creamy white CHALK with orange staining. Due to drilling disturbance, recovered as non intact sandy			

Drilling Progress and Water Observations						General Remarks			
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth				



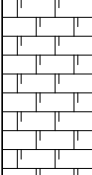
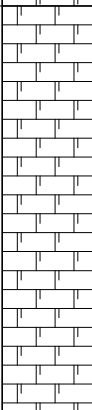
BOREHOLE LOG

Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Borehole: BH3
Contract Ref: 340110	Start: 31.10.19	Ground Level (m AOD): 80.26	National Grid Co-ordinate: E:520218.9 N:230996.2	Sheet: 3 of 3

Mechanical Log				Samples & Testing			Backfill & Instrumentation	Water	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	TCR (%)	SCR (%)	RQD (%)	If (mm)	No	Type	Results				
19.00-20.00	79	61	45	NI 100 180	13	SPT(c)	N:142.86		clayey angular to sub-rounded fine to coarse GRAVEL	(1.40)	
19.00-19.11	90	64	50				N:50 for 20mm (SPT inferred = N:750)		Moderately weak high density light creamy white CHALK with light orangish staining. Well fractured with clean and close horizontal sub-horizontal and vertical fracture with heavy black staining	19.00 19.11 19.28	
20.00-20.07							N:50 for 40mm (SPT inferred = N:375)		Zone of core loss	(0.79)	
					14	SPT(c)			... @17.7 m... 50 mm very spherical ironstone nodule Moderately weak high density light creamy greyish white CHALK with orange staining. Well fractured clean and close horizontal and vertical with black staining (stratum copied from 17.60m from previous sheet) Zone of core loss Moderately weak high density light creamy greyish white CHALK with orange staining. Due to drilling disturbance, recovered as non intact sandy angular to sub-rounded fine to coarse GRAVEL Moderately weak high density light creamy greyish white CHALK with orange staining. Well fractured close and clean horizontal and sub-horizontal with black staining Borehole terminated at 20.07 m depth.	20.07	

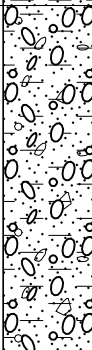
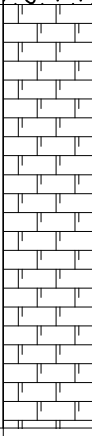
Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth	Casing Depth	Borehole Diameter (mm)	Water Depth		
						All dimensions in metres	Scale: 1:50
Method Used: Rotary coring			Plant Used: Comacchio GEO 205		Drilled By: ???	Logged By: CWright	Checked By:

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA1
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520160.6 N:231575.2		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
1.70	1	D				Brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Occasional chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30)	
						Light yellowish brown gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse chalk and flint. (HEAD DEPOSITS)	(0.70)	
						Very weak low density light creamy grey CHALK. Well fractured with orange staining	(0.60)	
						Upper end of weak to moderately weak medium to high density light creamy grey CHALK. Well fractured with black and orange staining.	(1.35)	
2.30	2	D						
2.90	3	D						
						Trial pit terminated at 2.95 m due to density		

Plan (Not to Scale)			General Remarks		
			1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 1.50 m		
All dimensions in metres			Scale: 1:25		
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



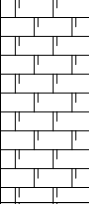
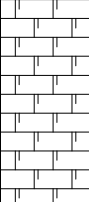
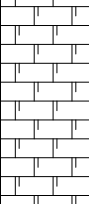
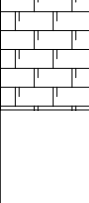
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
1.00	1	D			Brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Occasional chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30) 0.30		
					Light creamy grey gravelly slightly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse upper end of weak medium density chalk and flint. Orange staining. Rare sub-angular flint cobbles (HEAD DEPOSITS)	(1.15) 1.45		
1.90	2	D			Upper end of weak medium density light creamy grey CHALK. Well fractured with black and orange staining	(1.40) 2.85		
2.85	3	D			Trial pit terminated at 2.85 m due to density			

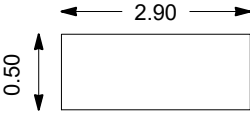
GINT_LIBRARY v8_07.GLB LibVersion: v8_07_001 ProjVersion: v8_07 | Log TRIAL PIT LOG - A4P | 340110_HITCHIN.GPJ - v8_07_07_07 | 24/12/19 - 13:26 | CAW1



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA3
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520125.0 N:231500.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.60	1	D				Brown slightly gravelly slightly silty SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Occasional chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30)	
						Structureless CHALK composed of clayey fine to coarse SAND. Light grey grey with orange mottling. (Grade Dc)	0.30	
							(0.80)	
1.70	2	D				Upper end of weak medium density light creamy grey CHALK. Well fractured with black and orange staining. More competent with depth becoming moderately high density	1.10	
2.30	3	D					(1.70)	
							2.80	
						Trial pit terminated at 2.80 m due to density		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 1.30 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA4
Contract Ref: 340110	Start: 29.10.19 End: 29.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520073.4 N:231470.2		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.90	1	D				Brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Occasional chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.31)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured with black and orange staining. Areas of slightly softer chalk	0.31	
2.00	2	D					(2.29)	
							2.60	
2.90	3	D				Moderately weak high density light creamy grey CHALK. Well fractured with black and orange staining	(0.30)	
						Trial pit terminated at 2.90 m due to density	2.90	

Plan (Not to Scale)		General Remarks			
		1. Easier to excavate than SA05 2. No groundwater encountered 3. Trial pit remained stable 4. Gravel backfilled to 1.00 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



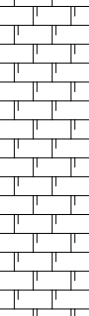
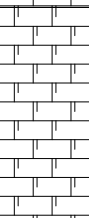
TRIAL PIT LOG

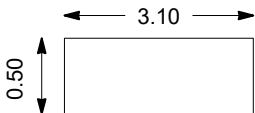
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA5
Contract Ref: 340110	Start: 29.10.19 End: 29.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520050.0 N:231425.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
0.40	2	ES				Upper end of weak medium density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	(1.20) 1.50	
1.30	1	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	(1.40) 2.90	
2.00	2	D						
2.90	3	D				Trial pit terminated at 2.90 m depth		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 1.10 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Trial Pit: SA6
Contract Ref: 340110	Start: 29.10.19 End: 29.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520037.2 N:231386.6	Sheet: 1 of 1

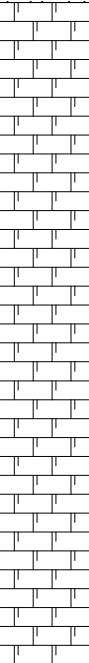
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	0.27	
0.80	1	D				Upper end of weak medium density light creamy grey CHALK. Well fractured, close and clean with black and orange staining. Becoming more competent	(1.13)	
1.50	2	D				Upper end of weak to moderately weak medium to high density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	1.40 (0.70)	
						Trial pit terminated at 2.10 m due to density	2.10	

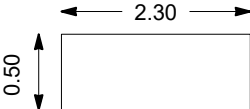
Plan (Not to Scale) 		General Remarks 1. Hard to excavate 2. No groundwater encountered 3. Trial pit remained stable 4. Gravel backfilled to 0.85 m	
Method Used: Machine dug		Plant Used: Wheeled 360° excavator	
Logged By: CWright		Checked By: AGS	
All dimensions in metres		Scale: 1:25	



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA7
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520071.9 N:231350.0		Sheet: 1 of 1

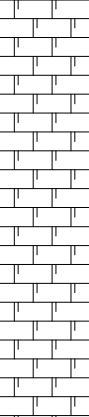
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
						Upper end of weak medium density light creamy white CHALK. Well fractured, close and clean with black and orange staining. Occasional black speckles	(2.20)	
1.90	1	D						
2.50	2	D				Trial pit terminated at 2.50 m depth	2.50	

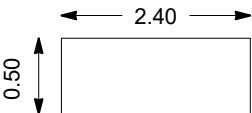
Plan (Not to Scale) 		General Remarks 1. Easier to excavate than SA08 2. No groundwater encountered 3. Gravel backfilled to 0.80 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA8
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:519930.1 N:231314.6		Sheet: 1 of 1

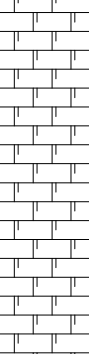
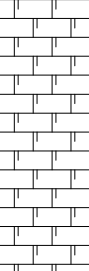
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.31) 0.31	
						Upper end of weak medium density light creamy white CHALK. Well fractured with black and orange staining. Fine chalk sand around fractures	(1.39) 1.70	
1.50	1	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black staining	(0.50) 2.20	
2.20	1	D				Trial pit terminated at 2.20m due to density		

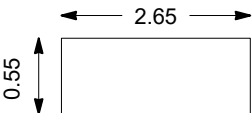
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.85 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA9
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:519862.4 N:231212.2		Sheet: 1 of 1

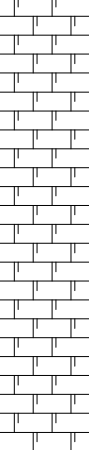
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.29) 0.29	
						Upper end of weak medium density light creamy grey CHALK. Well fractured clean and close with black and orange staining	(1.21) 1.50	
1.00	1	D						
						Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black staining on faces and orange speckles throughout	(0.90) 2.40	
1.70	2	D						
						Trial pit terminated at 2.40 m depth.		

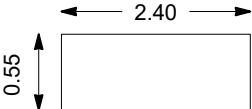
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit stable - fall in fractured 3. Gravel backfilled to 0.90 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA10
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 73.29	National Grid Co-ordinate: E:520222.6 N:231234.8		Sheet: 1 of 1

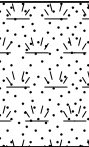
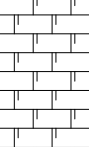
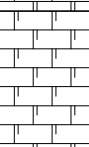
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	0.23	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black staining	(1.57)	
1.30	1	D					1.80	
						Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black stained faces	(0.70)	
						Trial pit terminated at 2.50 m depth.	2.50	

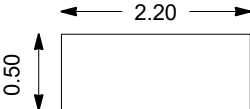
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.65 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA11
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 73.56	National Grid Co-ordinate: E:520086.2 N:231165.6		Sheet: 1 of 1

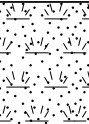
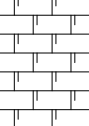
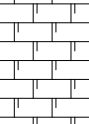
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.48)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured with black staining. Locally weak, weathered?	0.48	
1.20	1	D					(1.22)	
						Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	1.70	
2.20	2	D				Trial pit terminated at 2.20 m due to density	(0.50) 2.20	

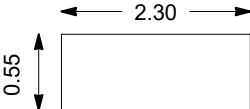
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.50 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA12
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 76.26	National Grid Co-ordinate: E:520253.6 N:231152.7		Sheet: 1 of 1

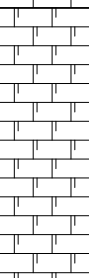
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
1.40	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk (AGRICULTURAL TOPSOIL)	(0.42)	
						Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with black and orange staining	0.42	
							(1.28)	
2.50	2	D				Moderately weak high density light creamy white CHALK. Well fractured, close and clean with black and orange staining	1.70	
							(0.80)	
						Trial pit terminated at 2.50 m depth.	2.50	

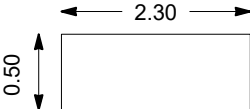
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.80 m			
		All dimensions in metres		Scale:	1:25
Method Used:	Machine dug	Plant Used:	Wheeled 360° excavator	Logged By:	CWright
		Checked By:			



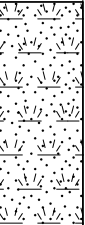
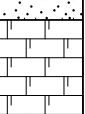
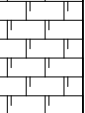
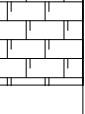
TRIAL PIT LOG

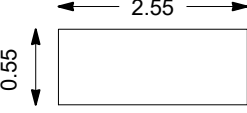
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA13
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 71.73	National Grid Co-ordinate: E:519863.9 N:231085.8		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint, chert and chalk (AGRICULTURAL TOPSOIL)	(0.60) 0.60	
						Upper end of weak medium density light creamy grey CHALK. Yellowish in places. Well fractured, close and clean with black and orange staining	(1.00) 1.60	
1.90	1	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	(0.90) 2.50	
						Trial pit terminated at 2.50 m depth.		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.55 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA14
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 74.96	National Grid Co-ordinate: E:519851.7 N:230932.1		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.80	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.80)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	0.80	
							(0.80)	
						Moderately weak high density light creamy white CHALK. Well fractured, close and clean with black and orange staining	1.60	
							(0.90)	
							2.50	
						Trial pit terminated at 2.50 m depth.		

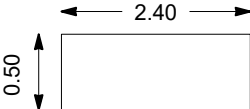
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.70 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA15
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 79.57	National Grid Co-ordinate: E:520161.6 N:230936.5		Sheet: 1 of 1

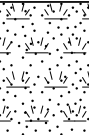
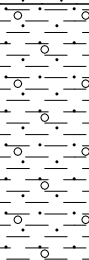
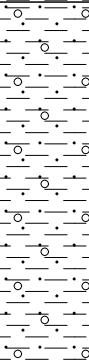
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.51)	
0.40	2	ES				. . . Contains rootlets.	0.51	
						Upper end of weak medium density light creamy grey CHALK. Well fractured with black and orange staining	(1.99)	
						Trial pit terminated at 2.50 m depth.	2.50	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.50 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

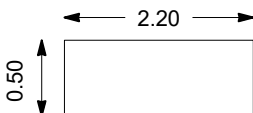


TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA16
Contract Ref: 340110	Start: 05.11.19 End: 05.11.19	Ground Level (m AOD): 72.68	National Grid Co-ordinate: E:519627.9 N:230862.5		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				MADE GROUND: Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets and rare brick (AGRICULTURAL TOPSOIL)	(0.45)	
0.50	2	ES				Stiff friable orangish brown gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse chalk flint and chert (LOWESTOFT FORMATION)	0.45 (0.85)	
1.00	1	D				Stiff friable grey mottled orange very gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse chalk flint and chert (LOWESTOFT FORMATION)	1.30 (1.20)	
2.50	2	D				Trial pit terminated at 2.50 m depth.	2.50	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Trial pit remained stable
3. Gravel backfilled to 0.20 m

All dimensions in metres

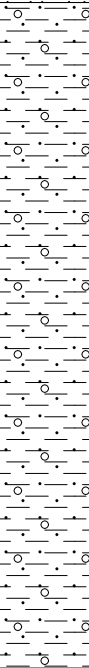
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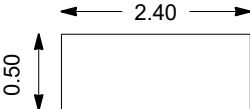
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:	
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TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA17
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 76.86	National Grid Co-ordinate: E:519998.5 N:230726.6		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.20	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30)	
						Stiff friable very gravelly sandy CLAY. Grey mottled orange. Gravel is angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobble (LOWESTOFT FORMATION)	0.30	
2.20	2	D					(2.20)	
						Trial pit terminated at 2.50 m depth.	2.50	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable 3. Gravel backfilled to 0.60 m			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

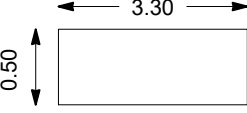
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: SA18
Contract Ref: 340110	Start: 05.11.19 End: 05.11.19	Ground Level (m AOD): 71.00	National Grid Co-ordinate: E:519710.8 N:230663.9		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Grass over dark brown with slight orange hue slightly gravelly clayey SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert (AGRICULTURAL TOPSOIL)	(0.30)	
0.50	2	ES				Stiff friable yellowish brown gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobble (LOWESTOFT FORMATION)	(0.60)	
1.50	1	D				Stiff friable grey mottled orange very gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse chalk flint and chert (LOWESTOFT FORMATION)	(1.60)	
						Trial pit terminated at 2.50 m depth.	2.50	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP1
Contract Ref: 340110	Start: 29.10.19 End: 29.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520174.9 N:231618.3		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	0.27	
0.40	1	D				Orangish brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-rounded to rounded fine to medium flint chert and chalk (HEAD DEPOSITS)	(0.36) 0.63	
1.00	2	D				Light creamy brown gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and very weak low density chalk. Orange staining (HEAD DEPOSITS)	(1.87)	
2.20	3	D					2.50	
2.90	4	D				Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black staining	(0.50) 3.00	
						Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

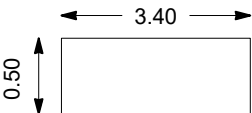
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP2
Contract Ref: 340110	Start: 29.10.19 End: 29.10.19	Ground Level (m AOD): 62.24	National Grid Co-ordinate: E:520156.9 N:231462.3		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.31) 0.31	
0.45	2	ES				Moderately weak medium density light creamy grey CHALK. Well fractured, close and clean with black and orange staining		
0.80	1	D					(1.29)	
1.70	2	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black and orange staining	1.60 (1.40)	
2.50	3	D					3.00	
						Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

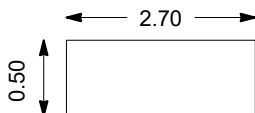
Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Trial Pit: TP3
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520095.9 N:231395.2	Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets. Frequent sub-angular to sub-rounded fine to coarse brick fragments (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
						Slightly orange brown gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and brick fragments. Occasional clayey pockets (AGRICULTURAL TOPSOIL)	0.50	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, close and clean with orange staining. Becoming more competent with depth becoming high density		
1.60	1	D					(2.05)	
2.20	2	D						
							2.55	
						Trial pit terminated at 2.55 m due to density		

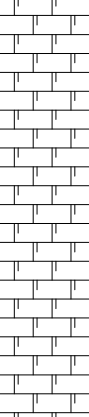
Plan (Not to Scale) 		General Remarks 1. No groundwater encountered 2. Trial pit remained stable	
Method Used: Machine dug		Plant Used: Wheeled 360° excavator	
Logged By: CWright		Checked By: AGS	
All dimensions in metres		Scale: 1:25	

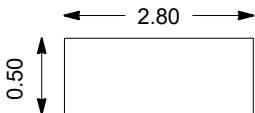
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP4
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520140.8 N:231393.1		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.90	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets. Frequent sub-angular to sub-rounded fine to coarse brick fragments (AGRICULTURAL TOPSOIL)	(0.33)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with orange and black staining	0.33	
1.60	2	D					(1.57)	
							1.90	
2.50	3	D				Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	(0.90)	
							2.80	
Trial pit terminated at 2.80 m depth.								

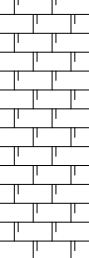
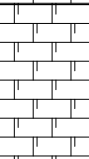
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

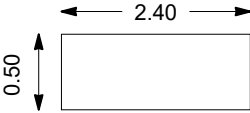
Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Trial Pit: TP5
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520200.3 N:231383.6	Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets. Frequent sub-angular to sub-rounded fine to coarse brick fragments (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
0.75	1	D				Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with orange and black staining	(1.40) 1.70	
2.10	2	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black staining	(1.30) 3.00	
3.00	3	D				Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale) 		General Remarks 1. No groundwater encountered 2. Trial pit remained stable	
Method Used: Machine dug		Plant Used: Wheeled 360° excavator	
Logged By: CWright		Checked By: AGS	
All dimensions in metres		Scale: 1:25	

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP6
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520160.4 N:231318.9		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly slightly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert. Contains rootlets. Frequent sub-angular to sub-rounded fine to coarse brick fragments (AGRICULTURAL TOPSOIL)	0.27	
0.50	2	ES				Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black and orange staining		
							(1.63)	
1.20	1	D				. . . @ 1.30 m... 40 mm nodule of ironstone		
							1.90	
2.40	2	D				Moderately weak high density light creamy grey CHALK. Well fractured, close and clean with black and orange staining		
							(1.20)	
							3.10	
						Trial pit terminated at 3.10 m depth.		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

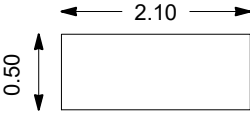
Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Trial Pit: TP7	
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520218.4 N:231310.4	Sheet: 1 of 1	

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.80	1	D				Brown slightly gravelly clayey fine and coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30)	
						Upper end of weak medium to high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	0.30	
1.60	2	D					(2.55)	
2.60	3	D					2.85	
Trial pit terminated at 2.85 m due to density								

Plan (Not to Scale) 		General Remarks	
		1. No groundwater encountered 2. Trial pit remained stable	
All dimensions in metres		Scale: 1:25	
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP8
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520011.2 N:231233.2		Sheet: 1 of 1

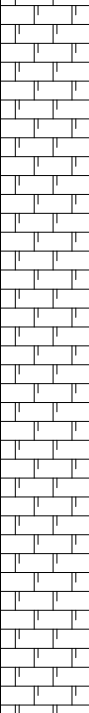
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	0.27	
0.40	2	ES				Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black and orange staining. Chalk sand between fractures in places		
0.60	1	D						
								
							(1.83)	
								
								
1.70	2	D						
							2.10	
						Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining		
							(0.90)	
								
								
2.90	3	D				. . . @ 2.80 m 20mm shell fragments	3.00	
						Trial pit terminated at 3.00 m depth.		

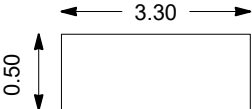
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP9
Contract Ref: 340110	Start: 28.10.19 End: 28.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:520155.9 N:231236.7		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
1.00	1	D				Brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	0.26	
						Upper end of weak medium to high density light creamy white CHALK. Well fractured, clean and close with black staining <1 mm black speckles	(2.44)	
1.60	2	D						
2.40	3	D						
						Trial pit terminated at 2.70 m due to density	2.70	

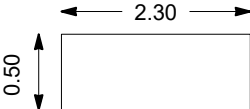
Plan (Not to Scale) 		General Remarks 1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP10
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): 68.89	National Grid Co-ordinate: E:519800.8 N:231146.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				MADE GROUND: Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert chalk and occasional brick. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	(1.30)	
1.50	1	D				Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining. Occasional black speckles	1.60 (0.40)	
2.00	2	D				Trial pit terminated at 2.00 m due to density	2.00	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

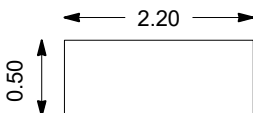


TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP11
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): ---	National Grid Co-ordinate: E:519932.9 N:231163.1		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.50	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert chalk. Contains rootlets (AGRICULTURAL TOPSOIL)	0.21	
						Light orangish brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk (AGRICULTURAL TOPSOIL)	(0.49)	
						Upper end weak medium density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	0.70	
2.10	2	D				Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	(1.10)	
							1.80	
3.00	3	D				Trial pit terminated at 3.10 m depth.	(1.30)	
							3.10	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Trial pit remained stable

All dimensions in metres

Scale: **1:25**

Method Used:

Machine dug

Plant Used:

Wheeled 360° excavator

Logged By:

CWright

Checked By:

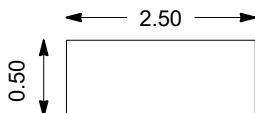




TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP12
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 73.57	National Grid Co-ordinate: E:520003.0 N:231092.5		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
						Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert chalk and occasional brick. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.37)	
						Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with black and orange staining	0.37	
							(1.33)	
							1.70	
1.90	1	D				Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black and orange staining	(0.80)	
						. . . @ 2.30 m Yellow staining	2.50	
2.50	2	D				Trial pit terminated at 2.50 m due to density		

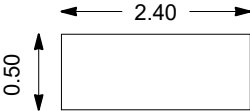
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used:	Machine dug	Plant Used:	Wheeled 360° excavator	Logged By:	CWright
		Checked By:			



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP13
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): 70.89	National Grid Co-ordinate: E:519792.1 N:231073.8		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.20	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert chalk and occasional brick. Contains rootlets (AGRICULTURAL TOPSOIL)	(0.30)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black stained faces. More competent with depth	0.30	
2.80	2	D				Trial pit terminated at 3.00 m depth.	3.00	

Plan (Not to Scale)		General Remarks			
		1. Easier to excavate than TP10 2. No groundwater encountered 3. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



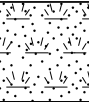
TRIAL PIT LOG

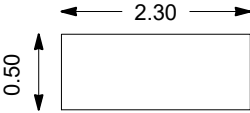
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP14
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 77.96	National Grid Co-ordinate: E:520236.4 N:231086.9		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly slightly clayey fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse flint and chert (AGRICULTURAL TOPSOIL)	(0.31) 0.31	
0.50	2	ES				Very weak to upper end of weak low to medium density light creamy grey CHALK with fine chalk sand. Orange staining throughout. Structureless in parts near to top of unit.	(0.89) 1.20	
0.90	1	D						
						Moderately weak to weak medium to high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	(1.40) 2.60	
2.10	2	D						
						Trial pit terminated at 2.60 m due to density		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP15
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 75.97	National Grid Co-ordinate: E:520101.8 N:231070.3		Sheet: 1 of 1

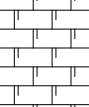
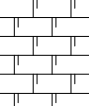
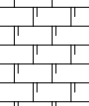
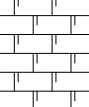
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.33)	
0.50	2	ES				Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with orange staining	(1.32)	
1.80	1	D				Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black staining. Contains occasional white shell fragments	(1.35)	
						Trial pit terminated at 3.00 m depth.	3.00	

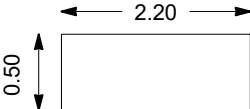
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



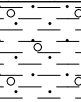
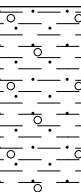
TRIAL PIT LOG

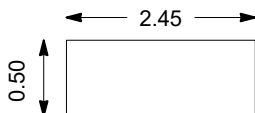
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP16
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): 71.82	National Grid Co-ordinate: E:519805.1 N:231040.7		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.35)	
0.50	2	ES				Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black stained faces	0.35	
							(1.95)	
1.60	1	D					2.30	
						Moderately weak high density light creamy grey CHALK. Well fractured, clean and close with black and orange staining	(0.70)	
2.90	2	D					3.00	
						Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP17
Contract Ref: 340110	Start: 30.10.19 End: 30.10.19	Ground Level (m AOD): 72.55	National Grid Co-ordinate: E:519715.6 N:230999.7		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.31) 0.31	
0.50	1	D				Stiff orangish brown slightly gravelly sandy CLAY. Gravel is sub-rounded fine to medium flint chert and chalk (LOWESTOFT FORMATION)	(0.35) 0.66	
0.90	2	D				Stiff yellowish brown very gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse chalk and flint. Occasional sub-angular to sub-rounded cobbles of flint (LOWESTOFT FORMATION)	(0.62) 1.28	
2.00	3	D				Upper end of weak medium density CHALK. Well fractured with black and orange staining. Mixed with chalk sand. Locally structureless at top of unit	(1.72) 3.00	
Trial pit terminated at 3.00 m depth.								

Plan (Not to Scale) 		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
Method Used: Machine dug		Plant Used: Wheeled 360° excavator		Logged By: CWright	Checked By: 
All dimensions in metres			Scale: 1:25		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP18
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 73.98	National Grid Co-ordinate: E:519937.6 N:231013.7		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.32)	
						Upper end of weak medium density light grey CHALK. Well fractured, clean and close with black and orange staining	0.32	
2.10	1	D				Moderately weak high density light grey CHALK. Well fractured, clean and close with black staining	2.00	
						Trial pit terminated at 2.20 m due to density	2.20	

Plan (Not to Scale) 		General Remarks 1. No groundwater encountered 2. Trial pit remained stable	
		All dimensions in metres	Scale: 1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:



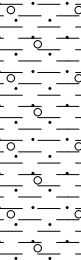
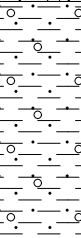
TRIAL PIT LOG

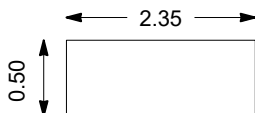
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP19
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 76.99	National Grid Co-ordinate: E:520088.6 N:231012.8		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.30	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.31)	
						Upper end of weak medium density light creamy grey CHALK. Well fractured, clean and close with black and orange staining. Weathered at top of unit	0.31	
2.10	2	D				Upper end of weak to weak medium to high density light creamy grey CHALK. With frequent shell fragments to 25 mm. Well fractured, clean and close with black staining on faces	(1.59)	
							1.90	
							(0.80)	
						Trial pit terminated at 2.70 m due to density	2.70	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used:	Machine dug	Plant Used:	Wheeled 360° excavator	Logged By:	CWright
		Checked By:			

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP20
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 74.20	National Grid Co-ordinate: E:519778.1 N:230921.6		Sheet: 1 of 1

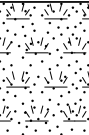
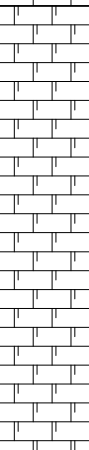
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.90	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL) Firm slight orangish brown slightly gravelly sandy CLAY. Gravel is sub-rounded fine to medium flint chert and chalk (LOWESTOFT FORMATION)	(0.30) 0.30 (0.90) 1.20	 
1.60	2	D				Light orangish brown very gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded cobbles of flint (LOWESTOFT FORMATION)	(1.00) 2.20	
2.40	3	D				Stiff grey mottled orange gravelly slightly sandy CLAY. Gravel is sub-rounded fine to coarse flint chert and chalk (LOWESTOFT FORMATION)	(0.80) 3.00	
						Trial pit terminated at 3.00 m depth.		

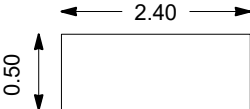
Plan (Not to Scale) 		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
Method Used: Machine dug		Plant Used: Wheeled 360° excavator		Logged By: CWright	Checked By: 
All dimensions in metres			Scale: 1:25		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP21
Contract Ref: 340110	Start: 01.11.19 End: 01.11.19	Ground Level (m AOD): 75.93	National Grid Co-ordinate: E:519940.6 N:230930.4		Sheet: 1 of 1

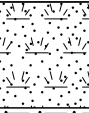
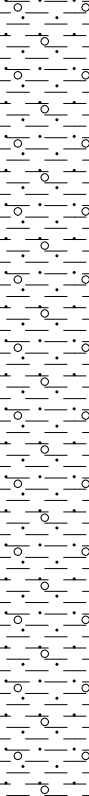
Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.00	1	D				Dark brown slightly gravelly clayey SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert with rare brick fragments (AGRICULTURAL TOPSOIL)	(0.45)	
						Structureless CHALK composed of gravelly fine to coarse SAND .Gravel is sub-angular to sub-rounded fine to coarse CHALK. Light yellowish brown. (Grade Dc)	(0.75)	
						Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with black and orange staining	(1.50)	
2.70	2	D				Trial pit terminated at 2.70 m due to density	2.70	

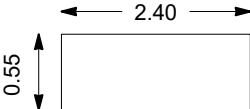
Plan (Not to Scale) 		General Remarks 1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		



TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP22
Contract Ref: 340110	Start: 05.11.19 End: 05.11.19	Ground Level (m AOD): 73.57	National Grid Co-ordinate: E:519817.9 N:230870.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint chert and chalk (AGRICULTURAL TOPSOIL)	(0.35)	
1.30	1	D				Stiff friable grey mottled very gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk (LOWESTOFT FORMATION)	(2.65)	
2.80	2	D				Trial pit terminated at 3.00 m depth.	3.00	

Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

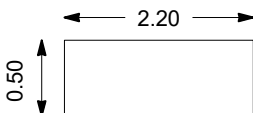


TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP23
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 76.31	National Grid Co-ordinate: E:519923.8 N:230879.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint chert and chalk (AGRICULTURAL TOPSOIL)	(0.30) 0.30	
0.50	2	ES				Light creamy brown very gravelly fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse moderately weak medium density chalk and flint. Stained orange. (LOWESTOFT FORMATION)	(1.05) 1.35	
1.00	1	D						
1.70	2	D				Upper end of weak medium to high density light creamy white CHALK. Well fractured with black orange staining. Some fractures infilled with chalk sand	(0.75) 2.10	
2.80	3	D				Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black and orange staining	(0.90) 3.00	
						Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Trial pit remained stable

All dimensions in metres

Scale: **1:25**

Method Used:

Machine dug

Plant Used:

Wheeled 360° excavator

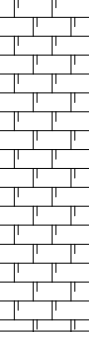
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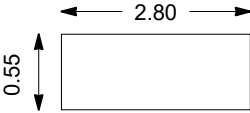
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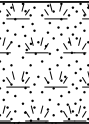
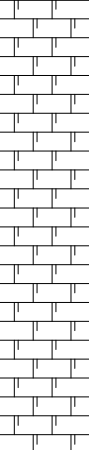


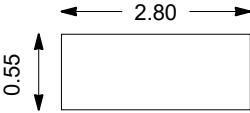
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP24
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 77.64	National Grid Co-ordinate: E:520071.0 N:230877.5		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.15	1	ES				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint chert and chalk (AGRICULTURAL TOPSOIL)	(0.30)	
						Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with black and orange staining	0.30	
							(1.10)	
1.50	1	D				Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black and orange staining	1.40	
							(1.10)	
2.50	2	D				... @ 2.40 m 50 mm bivalve fossil Trial pit terminated at 2.50 m due to density	2.50	

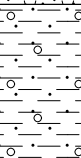
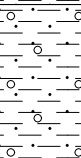
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

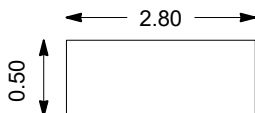
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP25
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 77.69	National Grid Co-ordinate: E:520148.3 N:230850.3		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
1.50	1	D				Dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to rounded fine to coarse flint chert and chalk with occasional sub-rounded flint cobbles (AGRICULTURAL TOPSOIL)	(0.40)	
						Upper end of weak medium density light creamy white CHALK. Well fractured, clean and close with orange staining	0.40	
						Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black and orange staining	1.90	
2.80	2	D				... @ 2.80 m shell fragments	3.00	
Trial pit terminated at 3.00 m depth.								

Plan (Not to Scale)			General Remarks		
			1. No groundwater encountered 2. Trial pit remained stable		
All dimensions in metres			Scale: 1:25		
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin		Client: Gallagher Developments Group Ltd.		Trial Pit: TP26
Contract Ref: 340110	Start: 05.11.19 End: 05.11.19	Ground Level (m AOD): 74.54	National Grid Co-ordinate: E:519750.4 N:230838.2	Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.90	1	D				Grass over dark brown with slight orange hue slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint and chert (AGRICULTURAL TOPSOIL)	(0.58)	
						Stiff very friable orangish brown very gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobbles (LOWESTOFT FORMATION)	(0.52)	
1.90	2	D				Very stiff friable grey mottled orange very gravelly sandy CLAY. Gravel is sub-angular to rounded fine to coarse flint chert and chalk. (LOWESTOFT FORMATION)	(1.90)	
2.90	3	D				Trial pit terminated at 3.00 m depth.	3.00	

Plan (Not to Scale)		General Remarks		
		1. No groundwater encountered 2. Trial pit remained stable		
All dimensions in metres		Scale: 1:25		
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:	

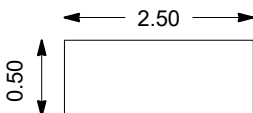


TRIAL PIT LOG

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP27
Contract Ref: 340110	Start: 04.11.19 End: 04.11.19	Ground Level (m AOD): 76.75	National Grid Co-ordinate: E:519900.0 N:230825.0		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.60	1	D				Grass over dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and rare brick (AGRICULTURAL TOPSOIL)	(0.30)	
						Stiff orange slightly gravelly sandy CLAY. Gravel is sub-rounded fine to medium flint and chert. Contains rootlets (LOWESTOFT FORMATION)	0.30	
1.10	2	D				Orangish brown gravelly clayey fine to coarse SAND. Gravel is angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobbles (LOWESTOFT FORMATION)	(0.60)	
							0.90	
1.70	3	D				Very stiff grey mottled orange very gravelly slightly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobbles. Rare sub-rounded flint boulder to 30 cm (LOWESTOFT FORMATION)	(0.75)	
							1.65	
3.00	4	D					(1.35)	
						Trial pit terminated at 3.00 m depth.	3.00	

Plan (Not to Scale)



General Remarks

1. No groundwater encountered
2. Trial pit remained stable

All dimensions in metres

Scale: **1:25**

Method Used:

Machine dug

Plant Used:

Wheeled 360° excavator

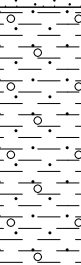
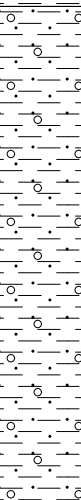
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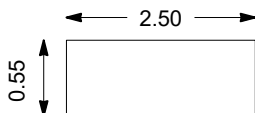
CWright

Checked By:

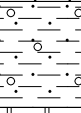


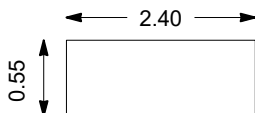
Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP28
Contract Ref: 340110	Start: 05.11.19 End: 05.11.19	Ground Level (m AOD): 73.16	National Grid Co-ordinate: E:519711.5 N:230779.7		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Grass over dark brown slightly gravelly slightly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and rare brick (AGRICULTURAL TOPSOIL)	(0.46)	
1.10	1	D				Stiff friable slight orangish brown gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse chalk chert and flint (LOWESTOFT FORMATION)	(0.89)	
2.20	2	D				Stiff friable grey mottled orange very gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse chalk and flint with occasional sub-rounded flint cobbles. (LOWESTOFT FORMATION)	(1.65)	
						Trial pit terminated at 3.00 m depth.	3.00	

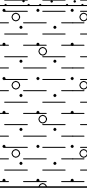
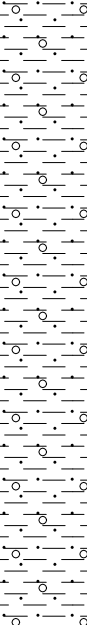
Plan (Not to Scale)		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
		All dimensions in metres		Scale:	1:25
Method Used: Machine dug	Plant Used: Wheeled 360° excavator	Logged By: CWright	Checked By:		

Contract: Highover Farm, Hitchin			Client: Gallagher Developments Group Ltd.		Trial Pit: TP29
Contract Ref: 340110	Start: 31.10.19 End: 31.10.19	Ground Level (m AOD): 77.62	National Grid Co-ordinate: E:520010.5 N:230787.4		Sheet: 1 of 1

Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Depth	No	Type	Results					
0.45	1	D				Grass over dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and rare brick (AGRICULTURAL TOPSOIL)	0.20	
						Stiff slightly orange gravelly sandy CLAY. Gravel is sub-angular to sub-rounded fine to coarse flint chert and chalk. Contains rootlets (LOWESTOFT FORMATION)	(0.35) 0.55	
						Upper end of weak medium density light creamy grey CHALK. Well fractured with black and orange staining	(1.40) 1.95	
1.80	2	D				Moderately weak high density light creamy white CHALK. Well fractured, clean and close with black staining and rare orange and black speckles	(1.05) 3.00	
						Trial pit terminated at 3.00 m depth.		

Plan (Not to Scale) 		General Remarks			
		1. No groundwater encountered 2. Trial pit remained stable			
Method Used: Machine dug		Plant Used: Wheeled 360° excavator		Logged By: CWright	Checked By: 
All dimensions in metres			Scale: 1:25		



Samples and In-situ Tests				Water	Backfill	Description of Strata	Depth (Thick ness)	Material Graphic Legend
Depth	No	Type	Results					
0.20	1	ES				Grass over dark brown slightly gravelly clayey fine to coarse SAND. Gravel is sub-angular to sub-rounded fine to coarse flint chert and rare brick (AGRICULTURAL TOPSOIL)	(0.30)	
0.70	1	D				Firm orange slightly gravelly sandy CLAY. Gravel is sub-rounded fine to medium flint and chert. Contains rootlets (LOWESTOFT FORMATION)	(0.60)	
1.10	2	D				Very stiff friable grey mottled orange very gravelly sandy CLAY. Gravel is angular to sub-rounded fine to coarse flint chert and chalk. Occasional sub-rounded flint cobbles. Rare sub-rounded flint boulders up to 35 cm (LOWESTOFT FORMATION)	(2.10)	
2.10	3	D					3.00	
						Trial pit terminated at 3.00 m depth.		

GINT_LIBRARY v8_07.GLB LibVersion: v8_07_001 ProjVersion: v8_07 | Log TRIAL PIT LOG - A4P | 340110_HITCHIN.GPJ - v8_07_07_24/12/19 - 13:27 | CAW1 |

WINDOW SAMPLE LOG

Contract:		Client:		Window Sample:
Highover Farm, Hitchin		Gallagher Developments Group Ltd.		WS1
Contract Ref:	Start: 12.11.19	Ground Level (m AOD):	National Grid Co-ordinate:	Sheet:
340110	End: 12.11.19	---	E:520071.5 N:231300.5	1 of 1

Progress	Samples / Tests				Water	Backfill	Description of Strata	Depth (Thickness)	Material Graphic Legend
Window Run	Depth	No	Type	Results					
							Firm dark brown slightly gravelly slightly sandy CLAY. Sand is fine to coarse gravel is angular to sub-rounded fine to coarse chalk and flint. (AGRICULTURAL TOPSOIL)	0.20	
	1.00-1.45	1	SPT	N=16			CHALK recovered as cream slightly gravelly sandy SILT. Gravel is very weak low density with occasional black specks and rounded.	(2.23)	
	2.00-2.43	2	SPT	N:50 for 275mm (SPT inferred = N:54.5)				2.43	
							Window sample hole refused at 2.43 m		

Drilling Progress and Water Observations						General Remarks	
Date	Time	Borehole Depth (m)	Casing Depth (m)	Borehole Diameter (mm)	Water Depth (m)		
							1. Position scanned with a CAT and Genny prior to excavation. 2. UXO checked before and during drilling. 3. Trial pit to 1.20 mbgl. 4. On completion, borehole backfilled with arisings. 5. Refused at 2.00 mbgl. 6. No groundwater encountered.
All dimensions in metres					Scale:	1:28	
Method Used:	Tracked window sampling		Plant Used:	Premier 110		Drilled By: ??? Logged By: HSalkeld	Checked By: 