

Q-LEVEL	DESCRIPTION	ACC.	Q-LEVEL	DESCRIPTION
Q-L-0	Positive position labels: front/side.	Unlabeled	Q-L-82	Reinforced 4 vertical exterior using only one polypropylene fiber.
Q-L-C	Visual evidence of service location held together by geogrid reinforcement.		Q-L-81	Reinforced 4 vertical interior using multiple polypropylene fibers.
Q-L-84	Unlabeled detection device present (shown as an assumed case, UMI)	U. = Unknown N. = No	Q-L-A	Reinforced 4 vertical posterior reinforced by open construction, channels and/or expansion chambers.
Q-L-83	Reinforced interior by one polypropylene technique for all reinforcement (shown as an assumed case, UMI)			

DRAINAGE SURVEY
All accessible Manholes and Inspection chambers have had their respective covers lifted with pipe sizes, inverts, chamber sizes/types and service data recorded from ground level. All connections from DPs, Gullies, Drains, VPs, RE's and lampholes have been proven wherever possible using audible connections (AC) and/or sonde instrumentation where applicable. Where these methods have proved unsuccessful then assumed (AR) straight line connections will be shown.

All accessible Manholes and Inspection chambers have had their respective covers lifted with pipe sizes, inverts, chamber sizes/type and service data recorded from ground level. Pipework has been traced, accessed and collected for post processing. Drainage layout, including manhole covers not located by topographical survey, may be taken from CCTV chainage and will be shown as indicative only.

Elec cables will have been predominantly located using EML methodology with electronically derived depths shown. GPR techniques will be employed to achieve greater quality levels as required.

BT cables will have been predominantly located using EML methodology with electronically derived depths shown. GPR techniques will be employed to achieve greater quality levels as required. Due to current laws and legislation protecting all BT apparatus, cabling can only be located remotely. We therefore compare all our telecom findings against record information to produce the final service layout. In some instances, where high amount of cable ducts are present, we may only be able to identify a linear centre peak signal rather than identifying all the individual duct positions. For further information regarding Telecoms apparatus, please contact Openreach directly.

CTV and/or Com cables will have been predominantly located using EML methodology with electronically derived depths shown. GPR techniques will be employed to achieve greater quality levels as required.

FO cables will have been predominantly located using GPR methodology. This is due to the materials used within fibre optic cabling. In some rare instances, tracer cabling or conductible non fibre optic cabling will be present within some or all ducting. When this is the case, both EML and GPR methodology will be combined to identify service network and achieve greater quality levels.

LC, TS and/or Sec cables will have been predominantly located using EML methodology with electronically derived depths shown. GPR techniques will be employed to achieve greater quality levels as required.

LMGS and/or WMMs pipe work will have been attempted and located using both EML and GPR methodology with electrically derived depths shown for the former and depths to crown levels shown for the latter.

When the Gas/Water pipe work is constructed using conductive materials, then we are able to employ multiple geophysical techniques to identify service network and achieve greater quality levels. When a non conductive material is used, GPR methodology will be employed to locate and plot the final service layout.

GPR methodology is used to identify and locate all non-metallic, non-conductive piping and cabling. We also employ GPR to obtain a greater accuracy levels on EML located services. The GPR has a greater success rate on pipe or service diameter upward of Ø63mm, C63mm, as size increments increase, so does the chance of detection. The GPR can produces varying results and as such, wouldn't be used as an independent utility surveying instrument.

All UITS will have been predominantly located using EML methodology with electronically derived depths shown. GPR techniques will be employed to achieve greater quality levels as required. Every effort has been made to identify the service but in this instance, is not achievable. We recommend excavation work to determine identity and depth where applicable.

Scarring has been identified on site with a potential of an undetectable service present.

Assumed routes (AR) are shown if there is evidence that a service exists but we are unable to trace it whilst on site. The surveyor will attempt to locate various risers/c/s/valves/meters (service evidence) etc. around site area to successfully determine an assumed route between these points. If there is little evidence on site but they believe a service is still present, then a common sense approach to an assumed route shall be employed.

The areas of dense vegetation to be cleared to allow access if any of these areas are deemed critical or of high importance.

Due to the geophysical nature of subsurface technology, we always recommend excavation works to be carried out within critical areas for verification and to eliminate the possibility of undetectable services present.

[illegible]

All below ground details shown have been identified from above ground without excavation. Survey Solution use electro-magnetic and/or ground penetrating radar (GPR) methods to investigate for underground utilities, services and features. Results using these methods are not infallible and we recommend trial excavations are carried out for verification of positions, depths and identification.

Any areas on the drawing where services or features have not been shown are not necessarily clear of services or features but are an indication that no items have been identified during our investigations. All reasonable care and normal good practice should still be employed during design and construction processes.

Certain types of services such as plastic or concrete pipes, some conduit and ducting where direct access can not be achieved for tracing may not be shown and alternative locating methods should be used.

Survey Solutions has used all reasonable care to research available service records, but the completeness or use of the service records supplied to or by Survey Solutions cannot be guaranteed. Therefore Survey Solutions cannot be held responsible for any features annotated as "taken from records" (TFR).

Depths obtained using electro-magnetic or GPR are effected by ground conditions and should be treated as indicative only. Electro-magnetic depths to utilities and services are generally taken to the centre of a feature, GPR depths to the top of a feature and drainage depth shown to inverts, unless otherwise indicated.

Drainage pipe sizes will be obtained without entering the chamber and therefore should be treated as approximate. Pipe dimensions which have not been obtained visually will be taken from records when available.

All services, drainage and utilities routes are assumed straight between access points, unless otherwise stated. The numbers of cables in runs will not be shown unless specifically requested. All services are below ground unless indicated.

Services, utilities and features may not have been surveyed if obstructed or not reasonably visible or accessible at the time of survey.

Survey Solutions accept no responsibility for the completeness or accuracy of either the topographical survey or base mapping on this project.

All critical dimensions and measurements should be checked and verified with any errors or discrepancies notified to Survey Solutions immediately. The accuracy of

The contractor must check and verify all site and building dimensions, levels, utilities and drainage details and connections prior to commencing work.

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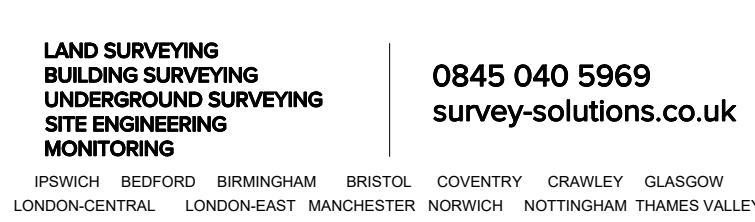
This survey has been carried out in accordance with PAS 128: 2014 & our version of the Royal Institution of Chartered Surveyors (RICS) specification for Measured Surveys of Land, Buildings and Utilities. Our survey extents have been agreed and confirmed with formal acceptance of 67769 from PIGEON INVESTMENT MANAGEMENT LIMITED. If you have any queries regarding the final services layout, please may we ask you to carefully read all the information within this title block in its entirety before continuing to do so.

TOPOGRAPHICAL SURVEY DATE 21/09/2019		
SURVEY TYPE	DESCRIPTION	EFFECT ON SURVEY RESULTS
TOPO	SURVEY SOLUTIONS	
OUTDATED		
OS		
NTS		

AVERAGE	
ADDITIONAL INFORMATION	EFFECT ON SURVEY RESULTS

UTILITY	AVAILABILITY	UTILITY COMPANY PROVIDER
SEWER	NO	N/A
WATER MAIN	NO	N/A
GAS MAIN	NO	N/A
TELECOM	NO	N/A
CABLE TV	NO	N/A
ELECTRICITY	NO	N/A
OIL PIPES	NO	N/A
OTHER	NO	N/A

REV	DESCRIPTION	DRAWN	CHECKED	APPR	SURVEY D
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PROJECT TITLE
LAND AT REDBOURNE ROAD
HEMEL HEMPSTEAD, HP2

DRAWING DETAIL
UTILITIES AND DRAINAGE SURVEY.
SHEET 31 OF 31

PIGEON INVESTMENT MANAGEMENT LIMITED				1:200
SURVEYOR M.B./B.H.	SURVEY DATE SURVDATE	CHECKED BY J.A.B	APPROVED BY J.A.B	DWG STATUS FINAL
DRAWING NUMBER 67769BDUG-01			REVISION	ISSUE DATE 24/02/202



Appendix F – Site Photographs

Appendix A-Site Visit Photos

Description	Photo
Entry to the site and overall topography	

REPORT

'Pond' feature in northeast corner. Raised banks out of ground. Vegetation identified within the feature indicates water present at times



REPORT

Culvert
location on
OS
MasterMap.
Could not
get closer
due to
barbed wire



REPORT

Ditch seen along boundary. Approximately 1m wide and 0.5m deep. Dry at time of visit. Unclear in image.



REPORT

West area
of site.
Inaccessibl
e



REPORT

Culvert at
northwest
corner of
site –
estimated
to measure
200mm
diameter



REPORT

Culvert/outfall to the northeast of the site. Estimated as 200mm diameter



Appendix G - Development Layout



- Key
- Site Red Line 103.75ha (TBC)
 - 01 Vehicular and pedestrian access point
 - 02 Bus only access
 - 03 Sustainable drainage system (SuDS)
 - 04 Retained hedgerow planting
 - 05 HGC Green loop – pelican crossing
 - 06 Active travel: cycle and pedestrian route
 - 07 Two form entry primary school
 - 08 Local Centre (with mobility hub)
 - 09 Care
 - 10 Play area
 - 11 Sport Pitches
 - 12 Allotments
 - 13 Community orchard
 - 14 Future access links
 - 15 High voltage power line
 - 16 Changing rooms
- Indicative bus stop
- STC (Sustainable Transport Corridor)
- Indicative primary connections
- Existing Roads
- PRoW
- Land Uses
- Residential
 - Local Centre & Mixed Use
 - Wider HGC Development Areas

CLIENT:
Bloor Homes / Pigeon

PROJECT:
North Hemel, Hemel Hempstead

DRAWING:
Illustrative Framework Masterplan

PROJECT NUMBER:
1117

DRAWING NUMBER: 005-1
CHECKED BY: MR / SR

REVISION: M
STATUS: Draft

DATE: 17/10/2025
SCALE: 1:5000 A3

Project	North Hemel Hempstead
Drawing Title	Development parcels
Date	25.09.2025

	M2	Hectares
Gross site area	1,037,579.39	103.76

Bloor Homes							
Parcel	M2	Hectares	Character Area	Unit Min	Unit Max	1,570 units	DPH
Residential parcel A	15,536	1.554	Countryside Edge	47	53	51	32.83
Residential parcel B	3,617	0.362	Neighbourhood Street	14	15	15	41.47
Residential parcel D	57,979	5.798	Neighbourhood Street	220	244	236	40.70
Residential parcel E	9,525	0.952	Countryside Edge	29	32	31	32.55
Residential parcel F	2,570	0.257	Neighbourhood Street	10	11	11	42.80
Residential parcel G	7,497	0.750	Neighbourhood Street	28	31	30	40.01
Residential parcel H	58,838	5.884	Neighbourhood Street	224	247	240	40.79
Residential parcel I	12,863	1.286	Countryside Edge	39	44	42	32.65
Residential parcel J	18,571	1.857	Holtsmere End Lane	59	67	64	34.46
Residential parcel K	46,501	4.650	Neighbourhood Street	177	195	190	40.86
Residential parcel M	7,831	0.783	Local Centre	43	59	52	66.40
Residential parcel N	16,391	1.639	Countryside Edge	49	56	53	32.33
LS1	7,031	0.703	Local Centre	39	53	47	66.85
LS2	2,051	0.205	Local Centre	11	15	13	63.39
SCH1	30,001	3.000	N/A	N/A	N/A	N/A	N/A

	M2	Hectares		Unit Min	Unit Max	Min. DPH	Max. DPH	1,570 units	DPH
Residential parcels only (exc. LC)	257,719	25.772		939	1054	36.44	40.90	1015	39.38
Local centre parcels only	9,081	0.908		50	68	55.06	74.88	60	66.07
Grand Total (exc. school)	266,800	26.680		989	1122	37.07	42.05	1075	40.29

Pigeon							
Parcel	M2	Hectares	Character Area	Unit Min	Unit Max	1,570 units	DPH
Residential parcel O	30,662.54	3.066	Neighbourhood Street	117	129	126	41.09
Residential parcel P	7,865.40	0.787	Countryside Edge	24	27	26	33.06
Residential parcel Q	11,643.83	1.164	Holtsmere End Lane	37	42	40	34.35
Residential parcel R	41,326.21	4.133	Neighbourhood Street	157	174	170	41.14
Residential parcel S	8,763.85	0.876	Southern Gateway	35	39	38	43.36
Residential parcel T	5,688.19	0.569	Southern Gateway	23	26	25	43.95
Care home (70 bed)	8,609.85	0.861		70	70	70	81.30

	M2	Hectares		Unit Min	Unit Max	Min. DPH	Max. DPH	1,570 units	DPH
Residential parcels only (exc. care)	105,950	10.595		393	437	37.09	41.25	425	40.11
Care home parcel only	8,610	0.861		70	70	81.30	81.30	70	81.30
Grand Total (exc. Inc. care)	114,560	11.456		463	507	40.42	44.26	495	43.21

Grand total									
	M2	Hectares		Unit Min	Unit Max	Min. DPH	Max. DPH	1,570 units	DPH
Residential parcels only (exc. care)	363,669	36.367		1,332	1,491	36.63	41.00	1,440	39.60
Local centre parcels only	9,081	0.908		50	68	55.06	74.88	60	66.07
Care home parcel only	8,610	0.861		70	70	81.30	81.30	70	81.30
School parcel only	30,001	3.000		0	0	0.00	0.00	0	0.00
Residential Grand Total (inc. care & local centre/excl. school)	381,360	38.136		1452	1629	38.07	42.72	1570	41.17
Grand Total (all uses)	411,361	41.136		N/A	N/A	N/A	N/A	N/A	N/A

Character Areas		
	Min. DPH	Max. DPH
Countryside Edge	30	34
Neighbourbood Street	38	42
Holtsmere End Lane	32	36
Southern Gateway	40	45
Local Centre	55	75

Project	North Hemel Hempstead
Drawing Title	Green & Highway Infrastructure
Date	25.09.2025

Population generation			
	Min.	Max.	Required for a 1500 unit target (not inc. 70 bed care home)
C3 Units (not including C2 care home)	1,382	1,559	1,500
Occupancy	2.40	2.40	
Population	3,317	3,742	3,600

Local Plan Policy (NEB 12)		Multi-functional green space	Green Infrastructure Typology	Policy standards		Based upon development parcel character areas				Required for a 1500 unit target (not inc. 70 bed care home)		Land Budget		
				M2 per person	Hectares per person	Min. requirement		Max. requirement		M2	Hectares	M2	Hectares	
						M2	Hectares	M2	Hectares					
			Amenity green space (including use as multi functional space)	15.3	0.0015	50,750	5.08	57,253	5.73	55,080	5.51	62,274.27	6.23	Does not include LAP's, which are assumed to be part of residential NDA
			Natural and semi-natural green spaces	34.6	0.0035	114,768	11.48	129,473	12.95	124,560	12.46	147,742	14.77	
			Parks and gardens (including use as multi-functional space)	7.1	0.0007	23,551	2.36	26,568	2.66	25,560	2.56	26,063.71	2.61	
			Childrens play area (3 x LEAP & 1 x NEAP)	0.6	0.0001	1,990	0.20	2,245	0.22	2,160	0.22	2,200.44	0.22	
			Allotments	4.5	0.0005	14,927	1.49	16,839	1.68	16,200	1.62	17,004.98	1.70	
			Playing pitch provision & / or financial contributions to accord with Sport England Playing Pitch Calculator	To accord with Sport England Playing Pitch Calculator	To accord with Sport England Playing Pitch Calculator									
						38,643.51	3.86	38,643.51	3.86	38,643.51	3.86	38,643.51	3.86	Maximum and minimum requirements fixed to land budget figure
			Suitable Alternative Natural Greenspace. Multiplier source: DLA Land Use. SANG guidance.	80.00	0.008	265,360	26.54	299,360	29.94	288,000	28.80	289,124.14	28.91	
						244,629	24.46	271,022	27.10	262,204	26.22	293,928.61	29.39	
						509,989	51.00	570,382	57.04	550,204	55.02	583,052.75	58.31	

Note: SuDS included within landscape categories above

Note: SuDS included within landscape categories above

Does not include LAP's, which are assumed to be part of residential NDA

Maximum and minimum requirements fixed to land budget figure

Strategic road infrastructure	Land Budget	
	M2	Hectares
	43,137.59	4.31

Appendix H – Hydraulic Modelling Report

Surface Water Modelling Technical Note

North Hemel

HYD-21786
North Hemel SW
Model Report
Rev01
November 2025

REPORT

Document status					
Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
01	Draft	Caitlin Evans	Krishna Dey	Chris Patmore	10/11/2025

Approval for issue	
C Patmore	10/11/2025

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Prepared by:	Prepared for:
RPS	Bloor Homes

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REPORT

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Appendix A -Site Visit Photos

1 INTRODUCTION AND BACKGROUND

1.1 Introduction

- 1.1.1 RPS Consulting Services Ltd (RPS) were commissioned by Bloor Homes to undertake a hydraulic surface water modelling exercise. The modelling exercise is for a site located at land adjacent to Holtsmere Lane, Hemel Hempstead.
- 1.1.2 The modelling of the site has taken place to support a proposed outline planning application for a mixed development including 1500 homes, a local centre, three form entry primary school, sports pitches and SANG (Suitable Alternative Natural Greenspace). The hydraulic modelling has been requested to understand the hydrological conditions of the site.
- 1.1.3 In addition, the proposed development scenario has also been developed. This modelling report describes the modelling approach and presents the model results.

1.2 Objectives

- 1.2.1 The aim of the modelling is to provide a greater understanding of the site and wider catchment baseline conditions in more detail than is shown in the Environment Agency (EA) Risk of Flooding from Surface Water Flood Map (RoFSW). This modelling report describes the modelling approach and presents the baseline and option model results.
- 1.2.2 The approach includes the build of a new surface water model using TUFLOW version: 2023-03-AF\TUFLOW_isP_w64 which is industry standard modelling software.

1.3 Site Visit

- 1.3.1 A site visit was undertaken on the 7th March 2025 to further understand the topography of the site and surrounding land. The site visit was conducted by 2no. RPS hydrologists. For the days prior to the site visit the weather was sunny approximately 14 degrees. The majority of the ground at the site was not waterlogged, however pooling was identified in some low points.
- 1.3.2 Large topographic dips were seen in the site, correlating to where the EA RoFSW mapping identified areas of risk. Ponding was seen in the northern flow pathway, associated with a topographic dip in the field.
- 1.3.3 No structures were identified on site (i.e. culverts/bridges). Ditches along field boundaries were seen which matched quite well in the LiDAR DTM data.
- 1.3.4 No manhole covers were seen within the site during the visit.
- 1.3.5 Site visit photographs are included in Appendix A.

Environment Agency Mapping

- 1.3.6 The EA's Long-Term Surface Water Flood Map was updated in January 2025 (Figure 1). The risk categories are outlined below:
 - High Chance: Areas that have a chance of surface water flooding of greater than 3.3% each year.
 - Medium Chance: Areas that have a chance of surface water flooding between 1% and 3.3% each year.
 - Low Chance: Areas that have a chance of surface water flooding between 0.1% and 1% each year.

- Very Low Chance: Areas that have less than a 0.1% chance of surface water flooding each year.

- 1.3.7 The EA Flood Map for Surface Water¹, shown in Figure 1 indicates two distinct flow paths (located at north and south of the site boundary) of 'Low' to 'High' surface water risk.
- 1.2 As of January 2025, the EA also provides data for Flood Map for Surface Water including climate change extents, which consider the 'Central' climate change allowance for the 2050s epoch (2040-2060). Within the climate change scenario, it can be noted that the 'Low' to 'High' risk areas of surface water flood risk have larger extents.

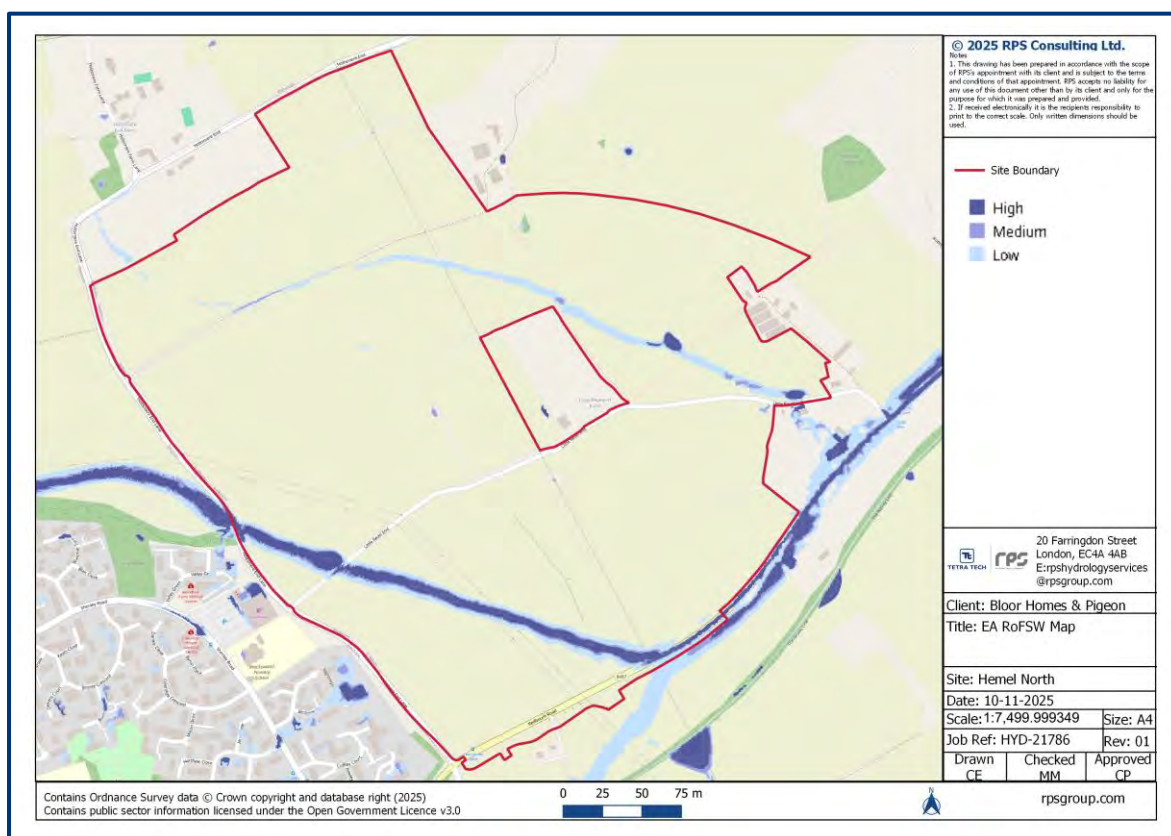


Figure 1. EA Risk of Flooding from Surface Water

- 1.3.1 The EA Risk of Flooding from Surface Water (RoFSW) map is derived from a national model and can be considered relatively broadscale; it may not contain accurate representation of key hydraulically significant features at a site-specific scale. As such it is not always considered reliable to capture site-specific flood risk conditions.

¹ <https://www.gov.uk/check-long-term-flood-risk>, accessed July 2025

2 MODELLING APPROACH

2.1 Introduction

- 2.1.1 A two-dimensional (2D) TUFLOW rain on grid model was used to represent the catchment. The model has been developed in TUFLOW software version: 2023-03-AF\TUFLOW_isP_w64.

2.2 Model Extent

- 2.2.1 The catchment boundary was defined using 'watershed' analysis of the local area based on the LIDAR-derived Digital Terrain Model (DTM) with 1m resolution. This analysis identifies the area which drains to a specific location based on the ground topography. A 100m buffer was added to the derived catchment to provide a conservative approach and ensure any additional surface water pathways with the potential to impact the site were considered.
- 2.2.2 After initial runs of the model, it was decided to increase the buffer to the north of Gaddesden Lane in the northeast to ensure all flows affecting the site were captured.
- 2.2.3 It was also decided that due to the large catchment size, TUFLOW HPC (Highly Parallelised Compute) would be used. This nested mesh grid approach meant that there was a 2m grid cell size within the site boundary and a 4m grid cell size outside of the boundary. This decreased run time whilst still presenting accurate results.
- 2.2.4 The derived catchment boundary is presented in Figure 2.

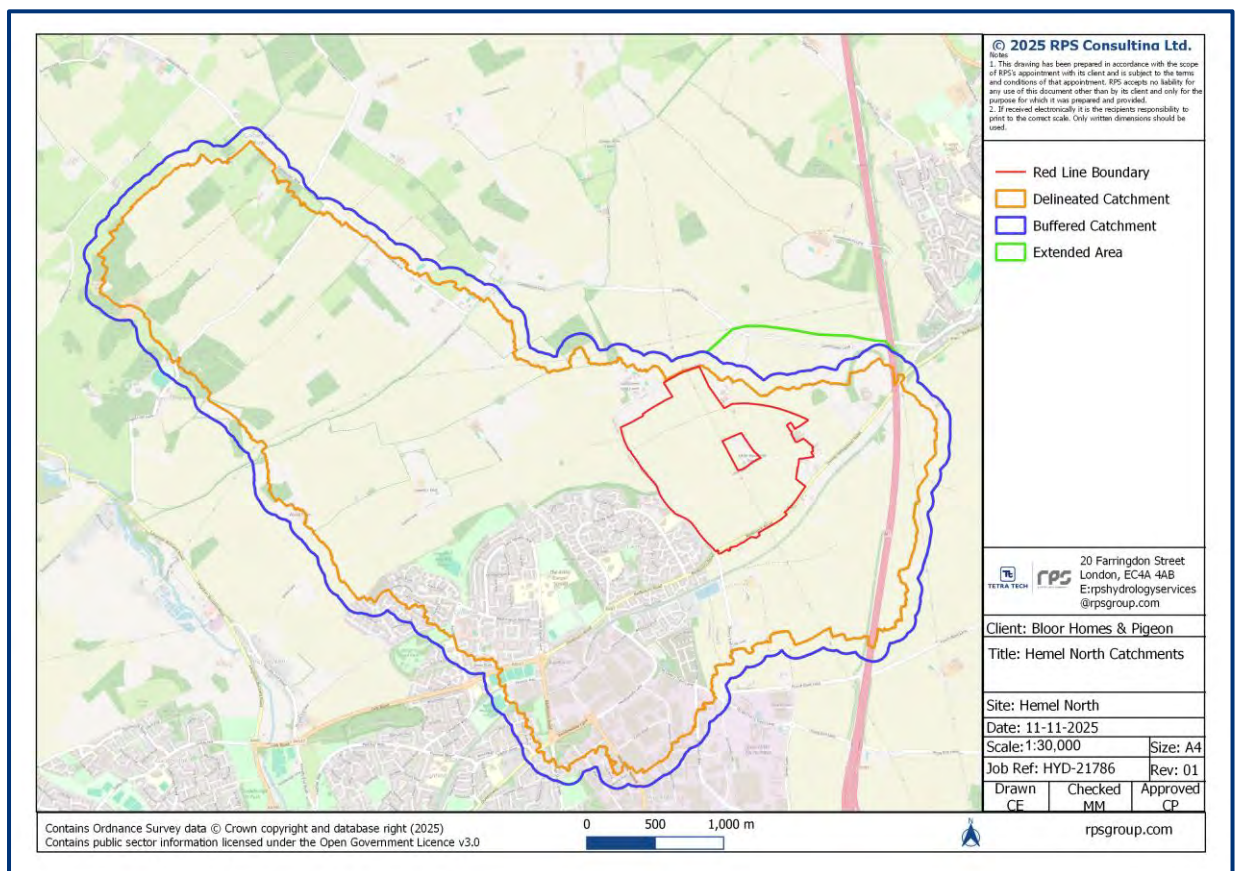


Figure 2. Catchment Boundary

2.3 Topography

- 2.3.1 Topography through the entire catchment has been determined from LiDAR derived DTM with a 1m resolution (2022). Features such as ditches and dips in the landscape identified within the LiDAR data were confirmed during the site visit.
- 2.3.2 A topographic survey was provided for the development site itself. This survey was taken from DWG format to create a TIF titled “Topo Hem” to be read into the model after the LiDAR to capture the more accurate surveyed levels. LiDAR data was compared to the topographic survey and showed a good match.

2.4 Inflows

Climate Change

- 2.4.1 In May 2022 the EA released revised peak rainfall climate change allowances, to reflect the Management Catchment geography. This recent guidance has been used to inform the climate change parameters and is presented for the appropriate management catchment below in Table 1.

Table 1. Colne Management Catchment peak rainfall allowances

1% Annual Exceedance Rainfall Event		
Epoch	Central Allowance	Upper End Allowance
2050s	20%	40%
2070s	25%	40%

- 2.4.2 The site lies within the Colne Management catchment. It is expected that residential developments have a lifetime of over 100 years. As such the 2070’s upper end allowance is used, and a 40% climate change scenario has been considered in the modelling.

2D Inflows

- 2.4.3 The inflows into the model were derived rainfall hyetographs applied to the whole catchment area. These hyetographs were determined for the 30-year, 100-year, and 1000-year rainfall using REFH 2 software. The 100-year rainfall was then multiplied by 1.40 to achieve the appropriate climate change inflow of 100-year+40% climate change.
- 2.4.4 The critical duration from ReFH2 was derived as 1 hour 15 minutes. A range of initial runs were undertaken to ensure that the calculated critical duration was correct when run through the model. Initially the 1 hour 15 minute, 3 hours 15-minute and 6 hours 15-minute durations ran in line with EA RoFSW methodology. The maximum depths were derived during the 1hr 15 minute scenario.
- 2.4.5 The rainfall has been applied across the full model extent and represents total rainfall for the catchment.
- 2.4.6 For the urban areas in the wider catchment, the EA surface water approach² has been used to estimate sub surface drainage in these areas. Although the EA specify using 18mm/hr as a drainage loss, a restricted 12mm/hr rate was applied to present a conservative approach.

² [What is the Risk of Flooding from Surface Water Map?](#)

2.5 Outflows

2D Outflows

- 2.5.1 2D outflows were applied to the model to allow water to flow freely out of the edge of the 2D domain and prevent 'glass walling'. The HQ boundary was applied based on the slope of the ground in that location, dependent on the calculated gradient.

2.6 Overland Flow

Roads

- 2.6.1 For the wider catchment, the roads in the model extent have been lowered by 125mm to ensure that the roads are the preferential flow paths. This is in line with EA surface water modelling guidance (National Scale Surface Water Flood Mapping Methodology, 2019). This reflects the fact that road design incorporates local-scale topographic features e.g. cambers and kerbs/raised pavements, which encourage water to remain within the linear footprint of the road.

Buildings

- 2.6.2 The buildings in the wider catchment have been abstracted from the OS MasterMap dataset. Buildings have been represented in the model by applying stub heights to model topography to represent Finished Floor Levels (FFL's) and to ensure surrounding roads are the preferential flow routes. The stub height applied to the buildings is 300mm, in line with EA guidance (2025)³.
- 2.6.3 A higher roughness value has been applied to the buildings detailed within Manning's roughness section.

2.7 Mannings Roughness

2D Roughness

- 2.7.1 The varying layers for the roughness values have been taken from the OS MasterMap layer. The values assigned are detailed below in Table 2.

Table 2. Mannings Roughness Values

Feature Code	Descriptive Group	Mannings Roughness (n)
10021	Buildings	0.500
10053	General Surface (Multi-surface)	0.040
10056	General Surface (Grass, parkland)	0.030
10062	Buildings (Glasshouse)	0.500
10089	Water (Inland)	0.035
10096	Dense vegetation, natural land form, working slopes or cliff	0.040
10111	Natural Environment (Heavy woodland and forest)	0.100

³ [Risk of flooding from surface water – understanding and using the map - GOV.UK](#)

Feature Code	Descriptive Group	Mannings Roughness (n)
10119	Roads, Tracks and Paths (manmade)	0.020
10123	Paths (tarmac and dirt tracks)	0.025
10172	Roads Tracks And Paths (Tarmac)	0.020
10183	Roads Tracks And Paths (Roadside)	0.020
10185	Structures (Roadside)	0.030
10193	Structures (New)	0.040
10217	Land (Industrial yards, car parks)	0.035

2.8 Infiltration

- 2.8.1 Infiltration losses are applied to permeable surfaces based on the underlying soil textural class. TUFLOW uses the hydraulic properties (hydraulic conductivity, suction and porosity) corresponding to each textural class, as well as the initial moisture content, to vary the rate of infiltration over time.
- 2.8.2 The entirety of the model extent is assumed to be unsaturated at the start of the simulation. Throughout the simulation, TUFLOW monitors the amount of water infiltrated, such that once the soil is saturated, no further infiltration occurs. The presence of no antecedent conditions is in line with EA RoFSW mapping methodology.
- 2.8.3 A 2D_soil layer was created to represent the soils present within the study area based on the Soilsclapes Viewer from Cranfield University's National Soil Resources Institute (NSRI), which is supported by Defra, see Figure 3. The soil textural classes and corresponding TUFLOW codes are defined in the TUFLOW manual and shown in Table 3.
- 2.8.4 An impermeable layer has been defined covering the roads and buildings present in the model. A Soil Type number of '99' has been applied to this layer (shown in Figure3). This represents the fact that buildings and roads have no infiltration.
- 2.8.5 A layer was created to account for the drainage capacity of the urban network in the off-site wider catchment. As discussed above, a standard loss 'drainage rate' of 12mm/hr was applied in these built-up areas to account for the drainage capacity of the sewer system.
- 2.8.6 Figure 3 shows the soil types and urban areas input into the model.

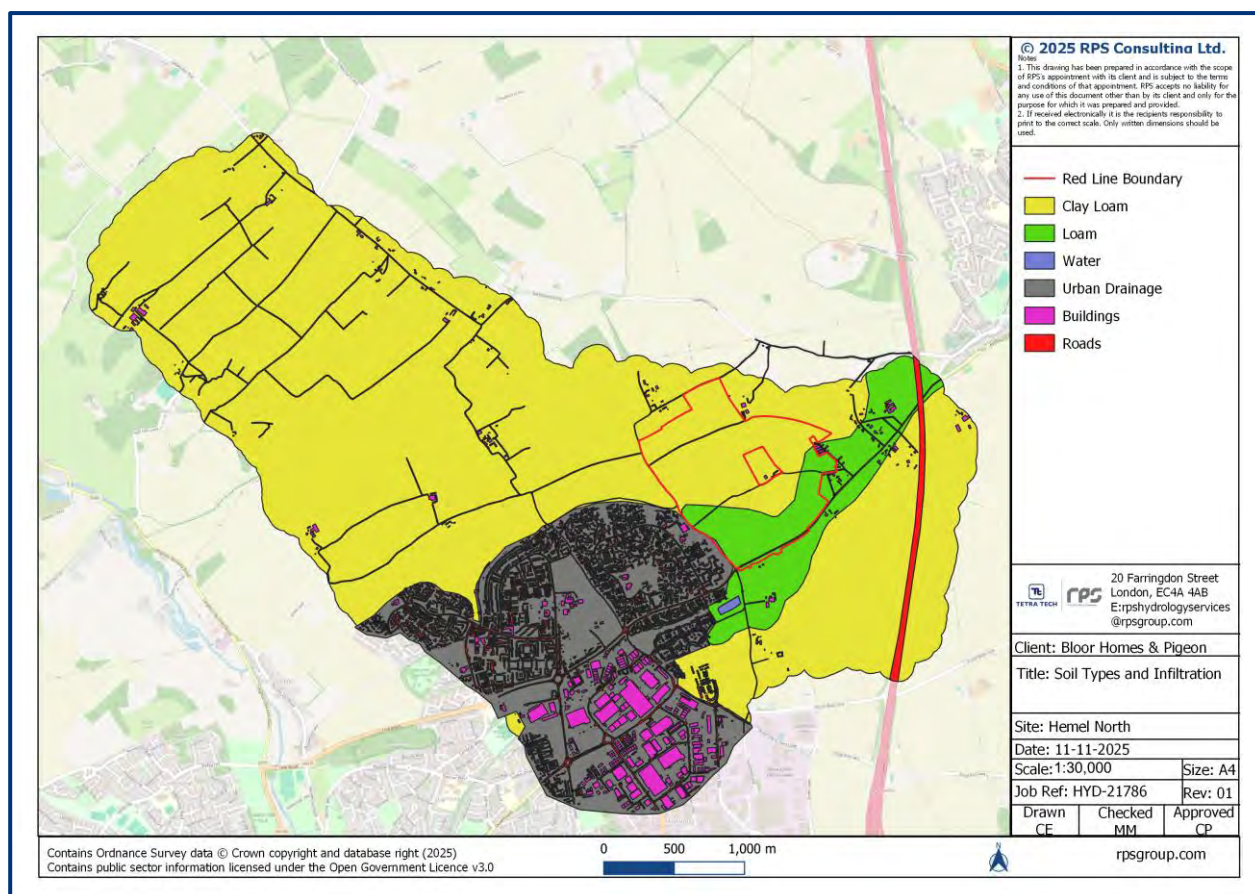


Figure 3. Soil Types within Catchment

Table 3. Soil Types

Soilscape Number	Soil Description	TUFLOW Soil ID	TUFLOW Definition
8	Slightly acid loamy and clayey soils with impeded drainage (Loamy Clayey)	4	Clay Loam
7	Freely draining slightly acid but base-rich soils (Loamy)	8	Loam
N/A	Buildings	99	No Infiltration
N/A	Urban Area	12	12mm/hr

2.9 Model Grid Size

- 2.9.1 The TUFLOW “HPC” (Heavily Parallelised Compute) solver was used for the simulation as this is a powerful solver built into the existing TUFLOW software. TUFLOW HPC uses an explicit solver. The scheme is unlike the TUFLOW classic solution that solves the same equations implicitly using matrices and therefore can successfully overstep the solution using much larger timesteps. Thus, this HPC solver saves simulation time.

2.9.2 This created a mesh area with grid size 2m around the site boundary and retained a 4m cell size for the remainder of the catchment.

2.9.3 This provided a better resolution data at the site, and a good balance between the degree of precision in order to model overland flow routes along roads and around pathways, as well as providing an appropriate model run (simulation) time.

2.10 Simulation Time

2.10.1 The model was run for 10 hours which is sufficient to capture the peak of the flood event passing through the catchment and onset of the receding flood limb.

2.11 Timestep

2.11.1 The model was simulated with a 1 second time step in the 2D domain (TUFLOW), and a 0.5 second time step in the 1D domain (ESTRY) used for proposed option modelling. The chosen time steps were deemed suitable for the model grid size and have been shown to produce stable model results.

2.12 Model Stability

2.12.1 The cumulative mass error (ME) is outputted during the model simulation. This value provides an understanding of the stability of the model as well as the robustness of the model and its ability to stimulate a flood event accurately. A model is considered healthy if it falls between the recommended range of +/- 1% throughout the simulation.

2.12.2 Figure 4 presents the mass error during the 1 in 100-year +40%CC return period.

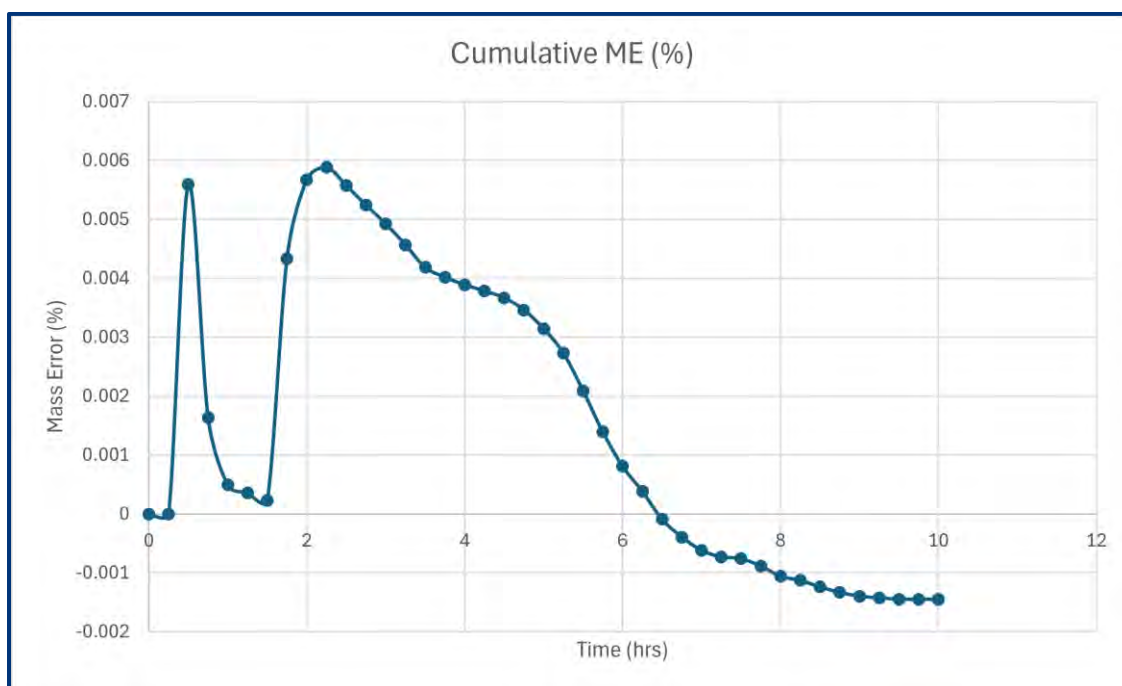


Figure 4. Mass Error in 1 in 100-year +40% CC event

3 MODEL RESULTS

3.1 Introduction

- 3.1.1 Model results are presented as depth and velocity maps for the full suite of return periods in this section. The nature of rain-on-grid surface water modelling is such that all cells in the model area will receive rainfall directly onto them and therefore show a degree of flood depth. The EA's 'Risk of flooding from surface water – understanding and using the map (updated 30 January 2025) excludes depths below 0.075 m in the presentation of results. Therefore, to aid clarity in the presentation of the results, depths below 0.075 m have been excluded in the RPS mapping as well. Thus, the depths map only show depths greater than 0.075 m in magnitude.
- 3.1.2 On request all 'raw' model results files can be provided following completion of the proposed option modelling in electronic format alongside this report to allow further detailed interrogation of the results.

3.2 Baseline (existing) Scenario Result

- 3.2.1 The model has been run for pre-development existing conditions of the site.
- 3.2.2 Figures 5, 6, 7 and 8 shows the maximum flood depths and velocity vectors for the 1 in 30-year year, 1 in 100-year and 1 in 100-year + 40% Climate Change and 1 in 1000-year scenarios respectively. The results and flow mechanisms are relatively similar throughout the return periods with some additional water ponding in the more extreme flood events. Two clear flow pathways are identified in all return periods and exhibit similar velocities.
- 3.2.3 Water follows topography through the site from the northwest to southeast where it follows Hemel Hempstead Road east.
- 3.2.4 The model has been run for pre-development 'baseline' conditions of the site. Figure 9 shows the maximum modelled flood extents for the low (1 in 1000-year), medium (1 in 100-year) and high (1 in 30-year) scenarios based on EA scale and compared to the EA RoFSW mapping shown in Figure 10.

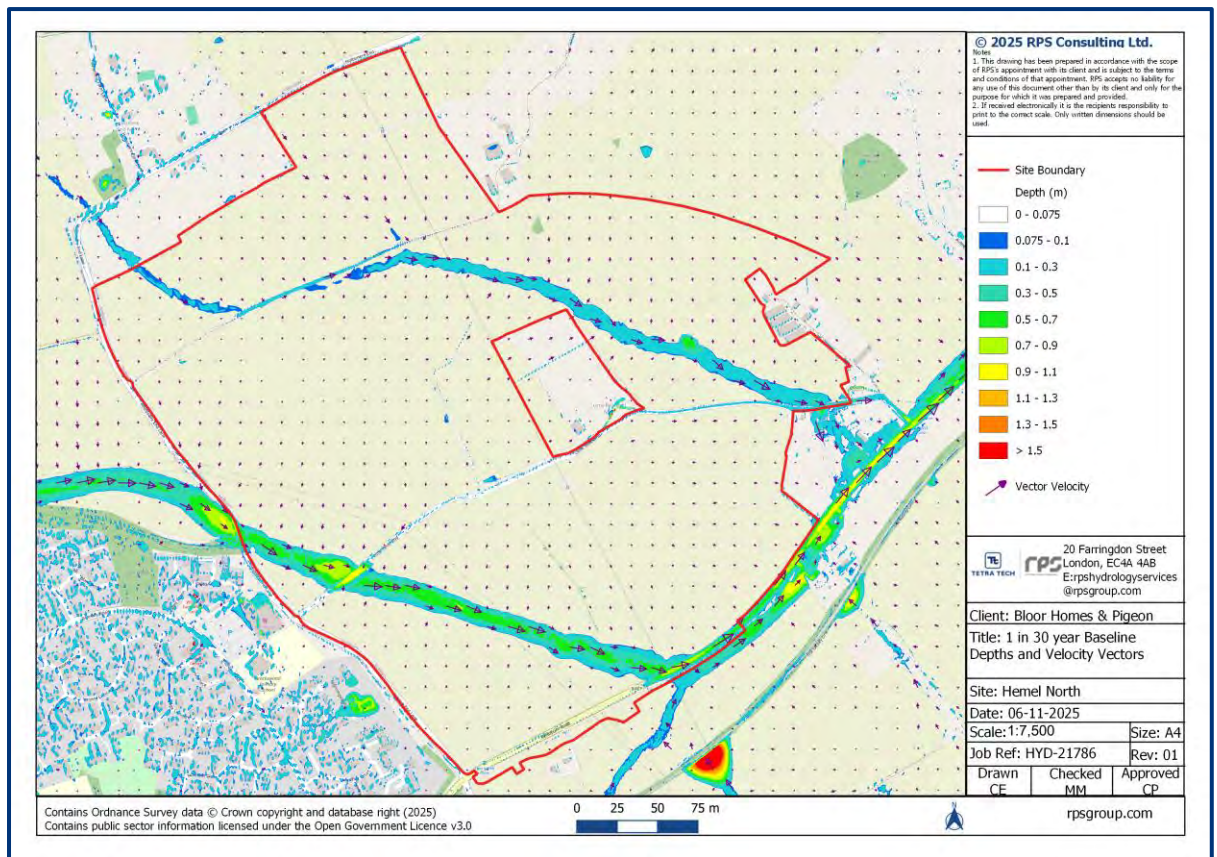


Figure 5. 1 in 30-year Depths and Velocity Vectors

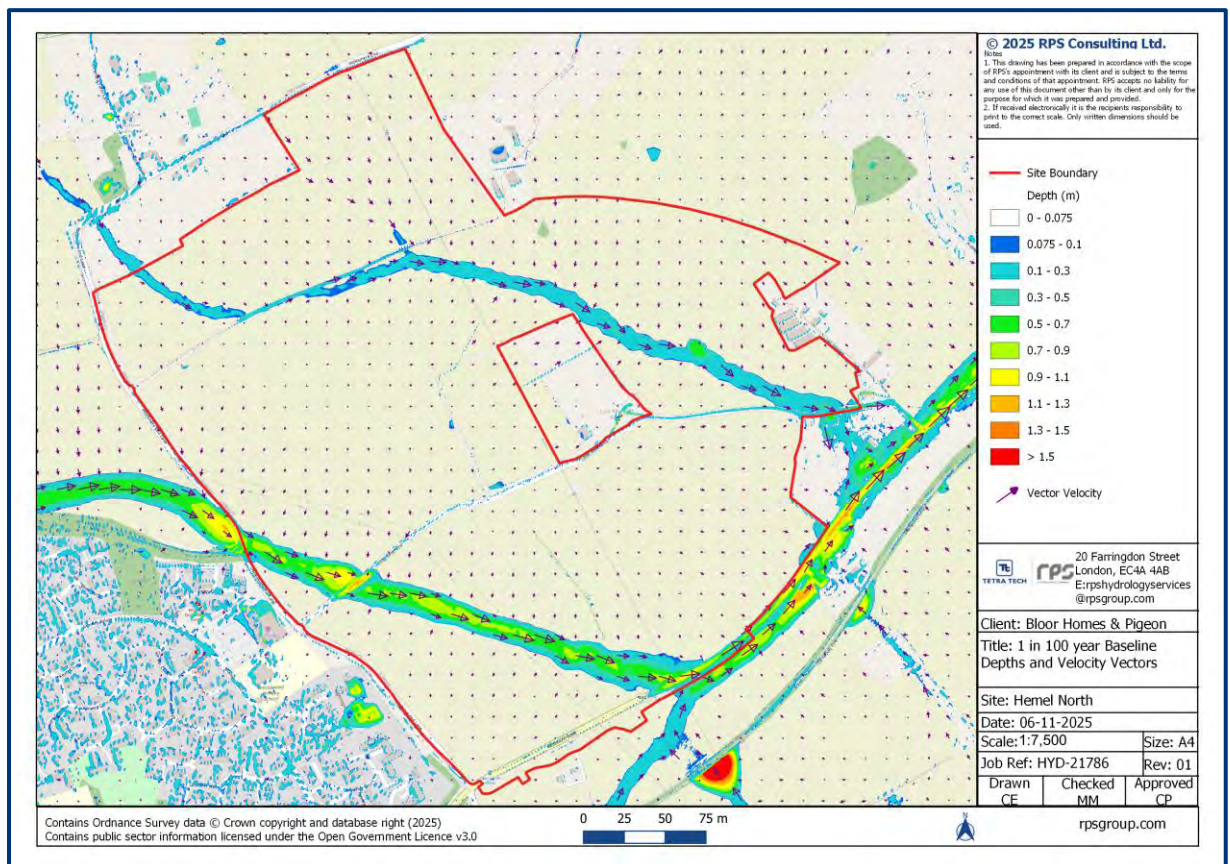


Figure 6. 1 in 100-year Depths and Velocity Vectors

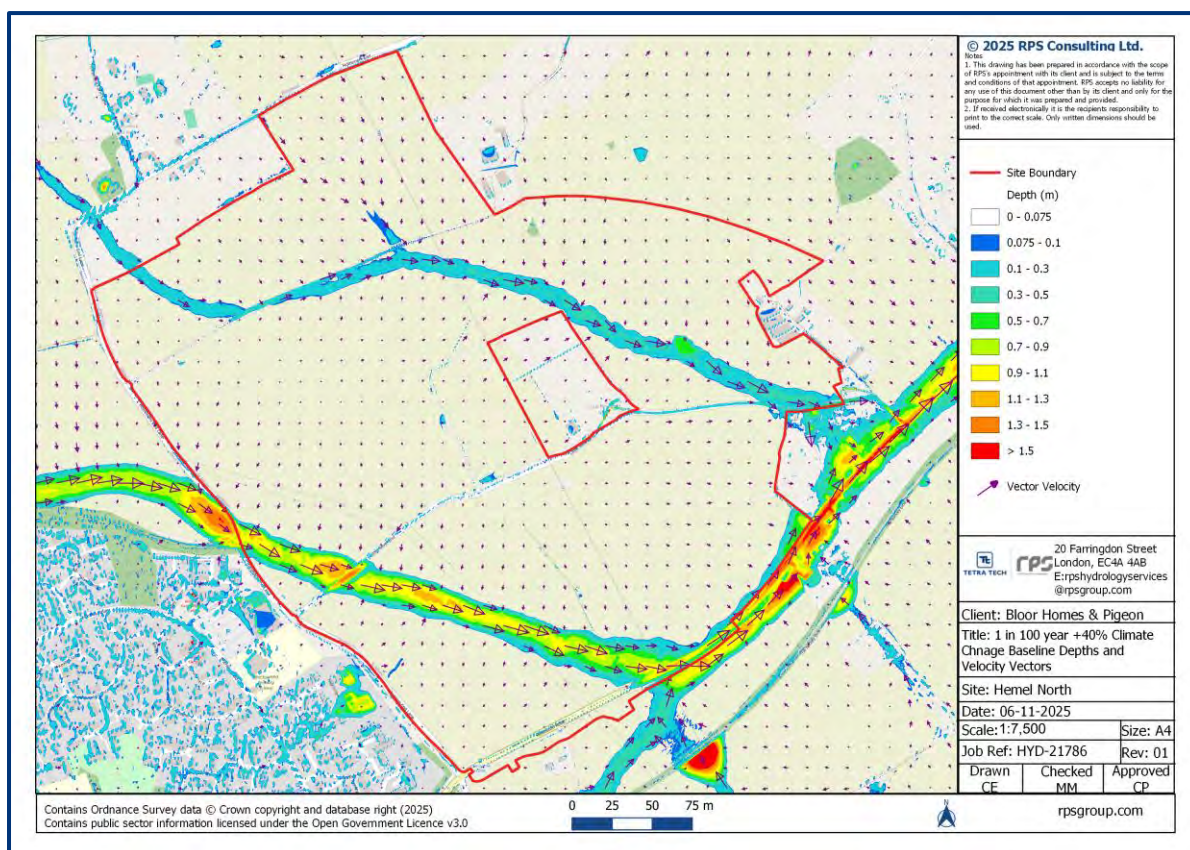


Figure 7. in 100-year +40%CC Depths and Velocity Vectors

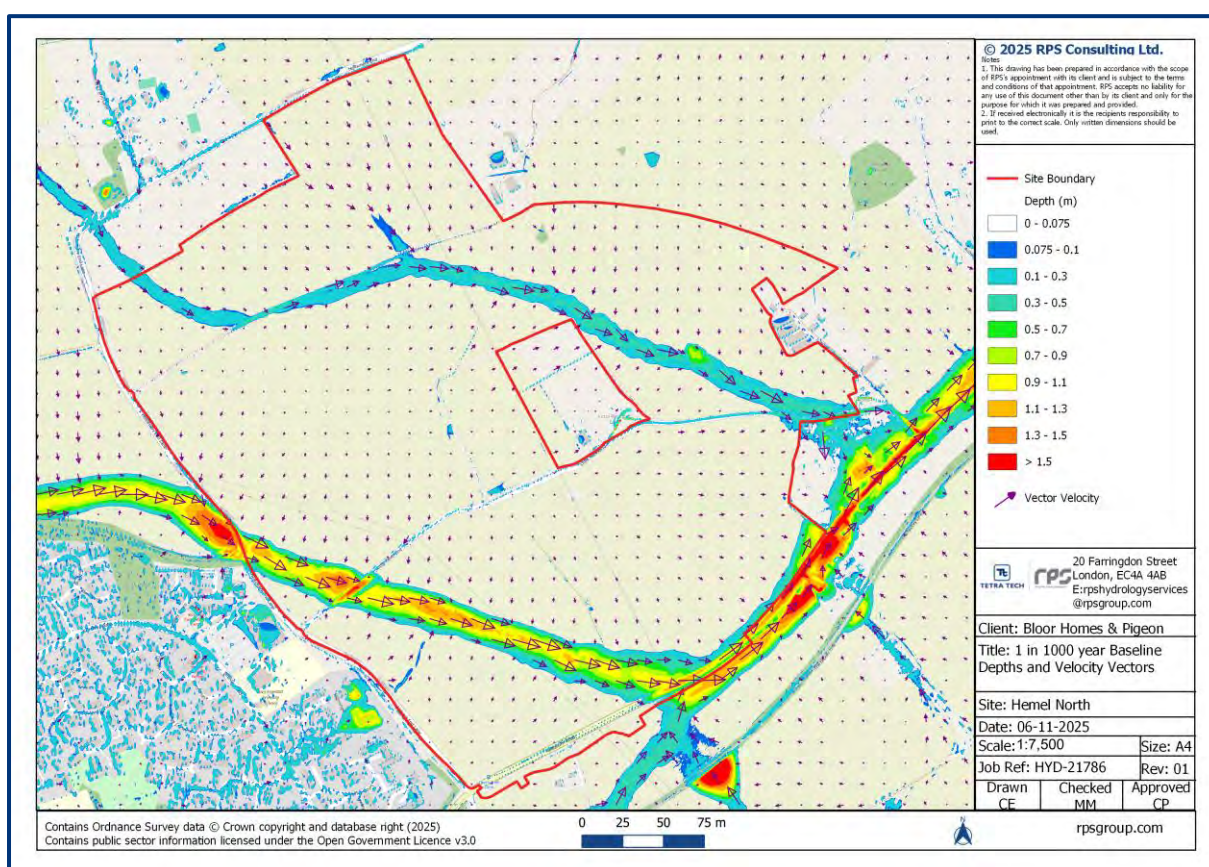


Figure 8. 1 in 1000-year Depths and Velocity Vectors

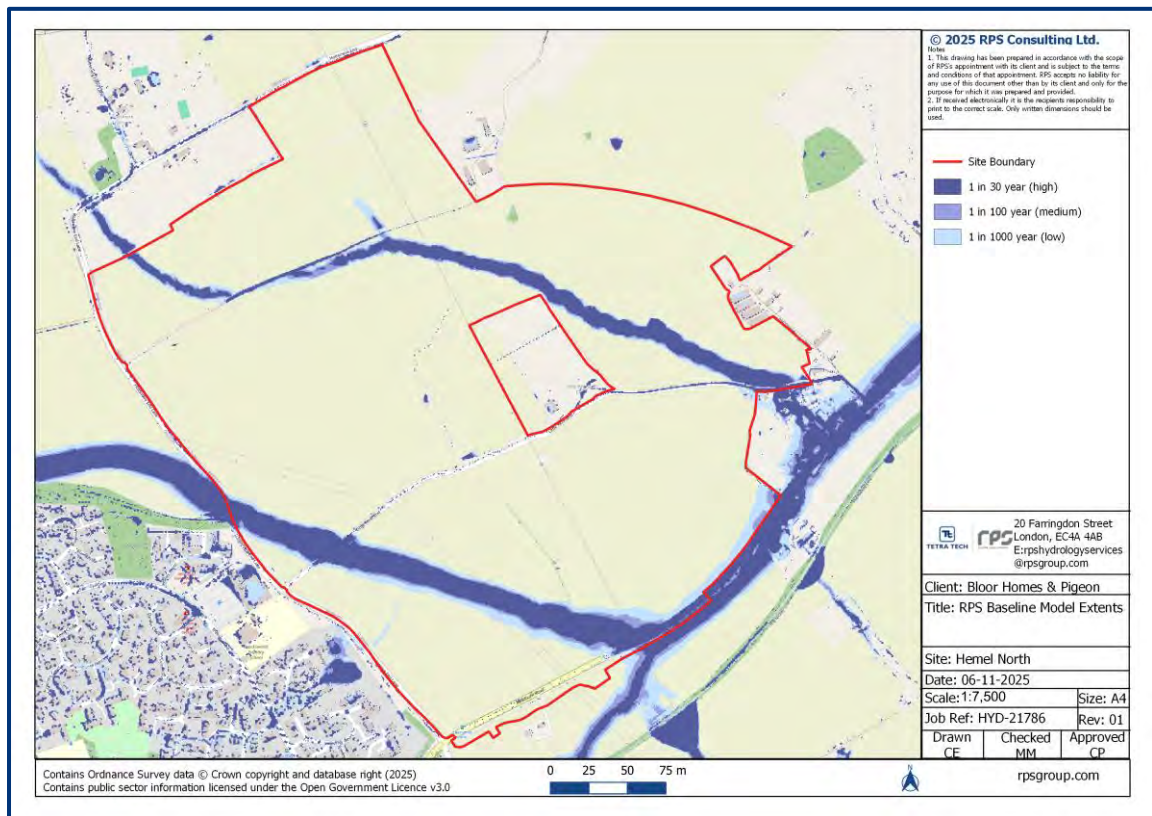


Figure 9. RPS Model Baseline Extents on EA scale

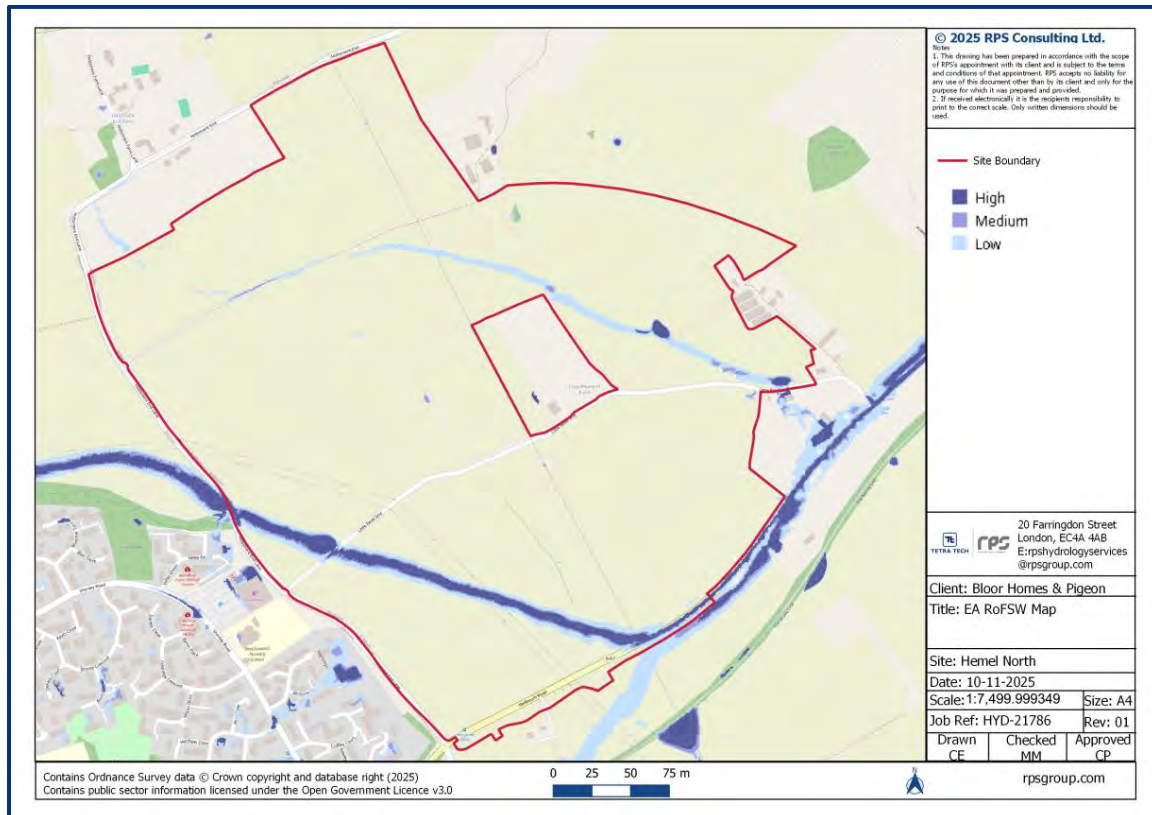


Figure 10. EA RoFSW

3.3 Calibration

- 3.3.1 There are no reliable historic surface water flood risk records against which to calibrate the model. A sense check comparison of the RPS model results with the EA RoFSW mapping has been undertaken and shows a similar pattern of predicted flood risk mechanisms, see Figures 9 and 10.
- 3.3.2 The areas of standing water and dips in topography observed during the site visit are replicated in the modelling.

3.4 Assumptions and Limitations

- 3.4.1 All modelling exercises are simplifications of real-world processes, and hence by their very nature, a number of assumptions and limitation are implicit inherent within the modelling approach.
- 3.4.2 The following key assumptions and limitations are noted:
- There were no historic surface water flood risk records against which to calibrate the model. A sense check comparison of the RPS model results with the EA RoFSW mapping has been undertaken and shows a similar pattern of predicted flood risk mechanism.
 - Roughness values assigned to the floodplain are assumed to be constant whereas in reality, there will be some seasonal variations owing to the growth and dieback of vegetation. It is assumed that the MasterMap, on which the model roughness values have been based, is up-to-date and correct.
 - Although adoption of best practice industry standard measures has been used to derive model boundary inflows (hyetographs), there are inherent uncertainties associated with the hydrological methodology that remain.
 - The surface water modelling does not consider any groundwater interaction which means no interaction between surface water and groundwater. The current modelling is considered only surface water runoff (rain on grid) modelling.

4 PROPOSED MODELLING

4.1 Introduction

- 4.1.1 A full description of the development is included within the Flood Risk Assessment, along with other reports and information submitted with the outline planning application.
- 4.1.2 In summary, the outline planning application states:
- Outline application (all matters reserved) for residential-led mixed use development comprising up to 1,500 new dwellings (including residential accommodation and specialist accommodation for older people) (Use Class C3 and C2), a care home (Use Class C2), a 3FE primary school (including early years provision) (Use Class F1), a local centre (Use Class E, F1 and F2), mobility hub, open space, amenity space, allotments, green infrastructure, sustainable drainage systems, vehicular and active travel routes, and supporting infrastructure and works. All matters reserved save for access from the B487.*
- 4.1.3 The proposed scenario is a mixed development including 1500 homes, a local centre, three form entry primary school, sports pitches and SANG. There are also proposed roads over the existing surface water flow paths.
- 4.1.4 The development, therefore, incorporates surface water flood risk mitigation measures to reduce the risk of flooding to the proposed 'more vulnerable' development parcels and allow safe access via the proposed on-site road network. Another objective of the mitigation measures is to ensure no increase in flood risk to the surrounding areas outside of the redline boundary.
- 4.1.5 The following features were represented within the proposed scenario model:
- Proposed residential development platforms.
 - Proposed access roads through the scheme and associated culverts where flow paths are crossed.
 - A lowered channel where the existing flow pathway runs through the site.
 - A lowered area of to the east of the proposed spine road to provide storage and conveyance during flood events.

4.2 Representation of Development Features

- 4.2.1 The features were represented within the model using the following files:
- Proposed residential development platforms and access roads: an earthworks model with proposed levels and locations of roads and development parcels was provided by the client. The surface was converted into an ASCII grid and read into the model under 'Proposed_Surface_Oct_02.tif'.
 - Culverts under proposed access roads where flow paths are crossed: 1d_nwk layer in ESTRY (1D). Twin rectangular culverts at both crossings. The culvert sizes were 2.4m height x 6m width and 3.6m height x6m width for the access road and spine road respectively. This conveyed water to a lowered storage area in the east
 - Proposed flood storage area layer: 2d_zsh polygon layer in TUFLOW (2D) lowered to 104.8m AOD. A bund was placed along the southern edge of the storage feature to encourage storage and slows flow, the bund was set to 105.4m AOD and was created with a 2d_zsh line.
 - Extra storage applied for a polygon lowering by 0.15m (2d_z_extra_store_Hem_R_01.shp)

- 4.2.2 The representation of the proposed development scheme modelling is discussed below and shown in Figure 11. More detailed plans are shown in the Appendices of the FRA and submitted alongside this planning application.

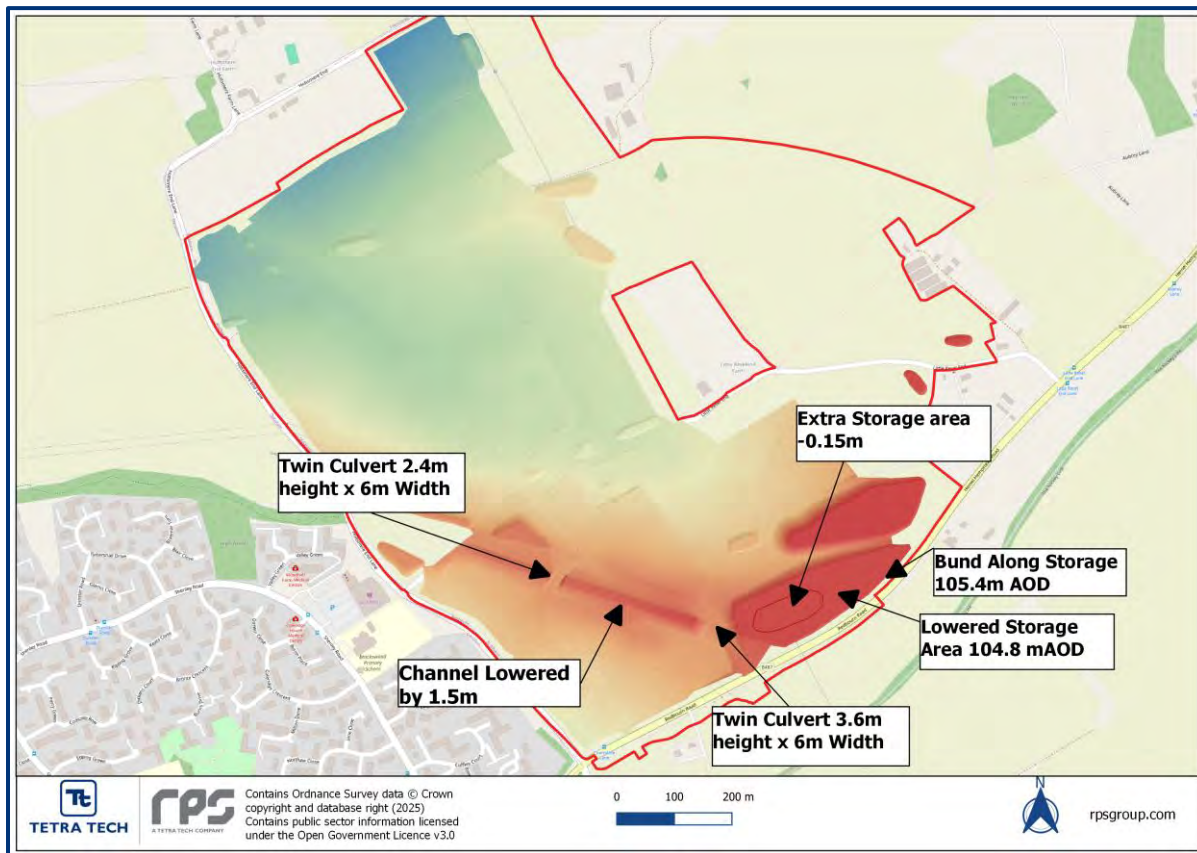


Figure 11. Features within the Proposed Model

4.3 Proposed Development Scenario Results

- 4.3.1 Where land is raised within the surface water floodplain through the development platforms and roads flow is displaced, creating a backup of water and storage of water against the development areas.
- 4.3.2 'Glasswalling' is seen around the raised development platforms where water is building up against the platform. Following refinement of the platforms, this is unlikely to remain as the topography will be levelled to existing ground levels to account for the development.
- 4.3.3 The model has been run for the post development conditions of the site for 1 in 100-year+40% climate change.
- 4.3.4 Figures 12 to 15 show the flood depth and velocity vector maps for the 1 in 30-year, 1 in 100- year, 1 in 100-year+40% climate change and 1 in 1000-year events for the proposed scenario. Velocity vector arrows show how water is steered by areas of lowered and raised ground through the site.
- 4.3.5 During the 1 in 30-year and 1 in 100-year events, water remains confined within the lowered channel. In the 1 in 100-year +40% climate change event (design event) shallow depths of up to 300mm are seen in a small portion of the road, this is expected to be managed by highways drainage.

- 4.3.6 The flood depth difference map is produced by subtracting the baseline depths from the proposed depths. The maximum difference in flood depth between the baseline and development scenario is shown in Figure 16. Increases in on-site depths are seen where water is being stored in the proposed storage area. In addition, where water is held back via culverts, as expected.
- 4.3.7 Outside of the site, there is no change in the upstream off-site depths. Downstream, there is a minor decrease in flood depths by up to 0.1m.

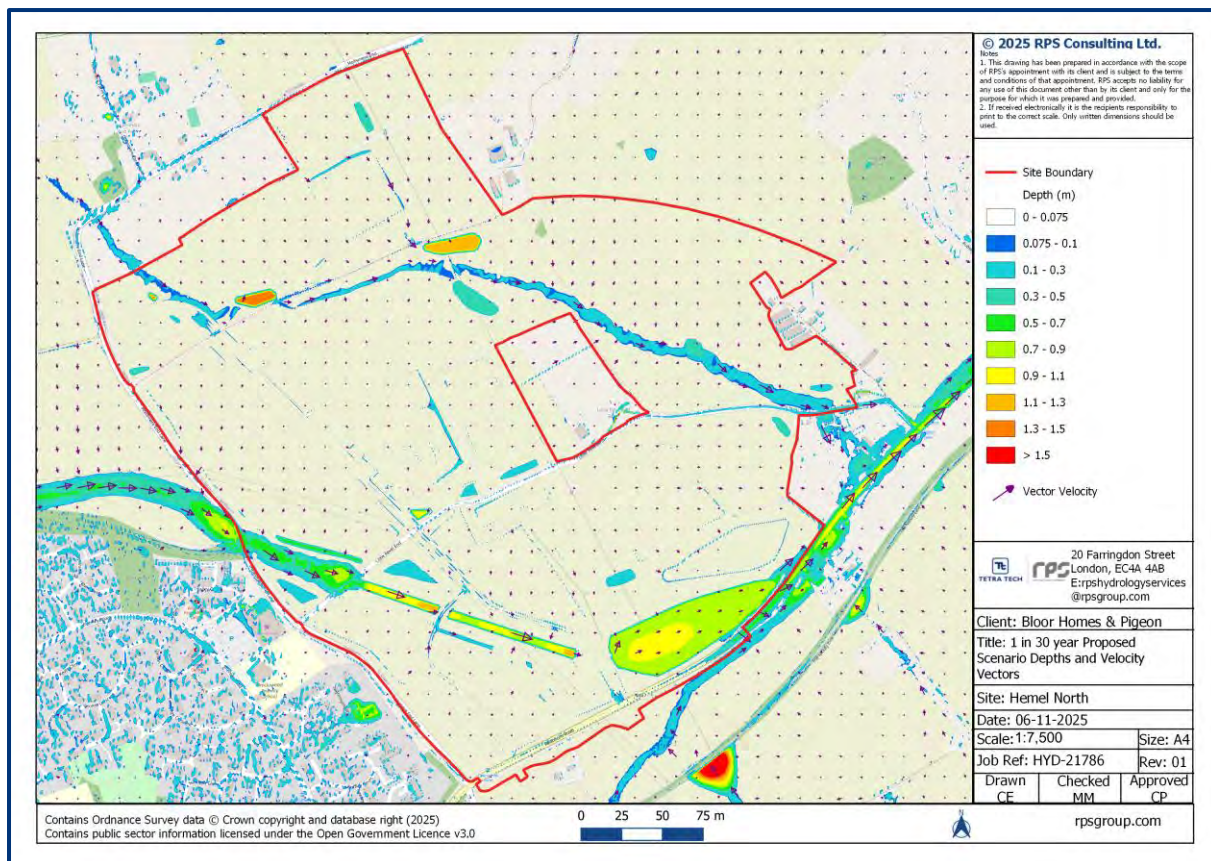


Figure 12. 1 in 30-year Depths and Velocity Vectors – Proposed Scenario

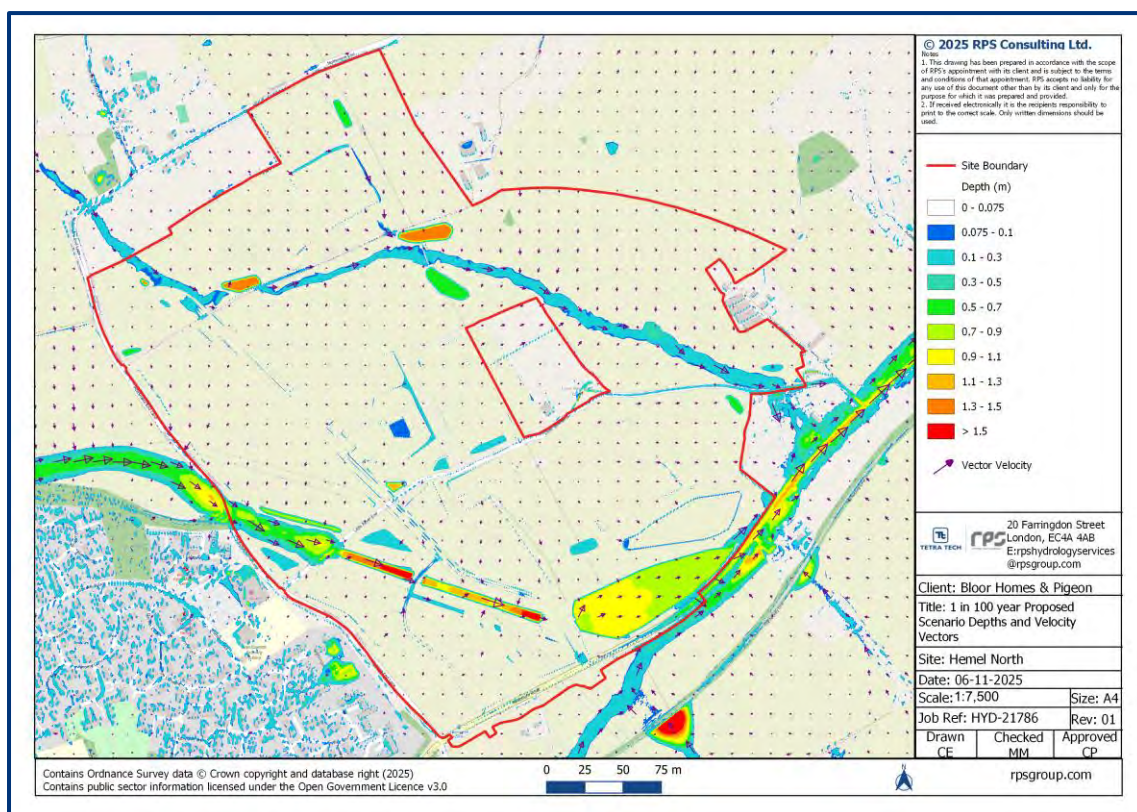


Figure 13. 1 in 100-year Depths and Velocity Vectors – Proposed Scenario

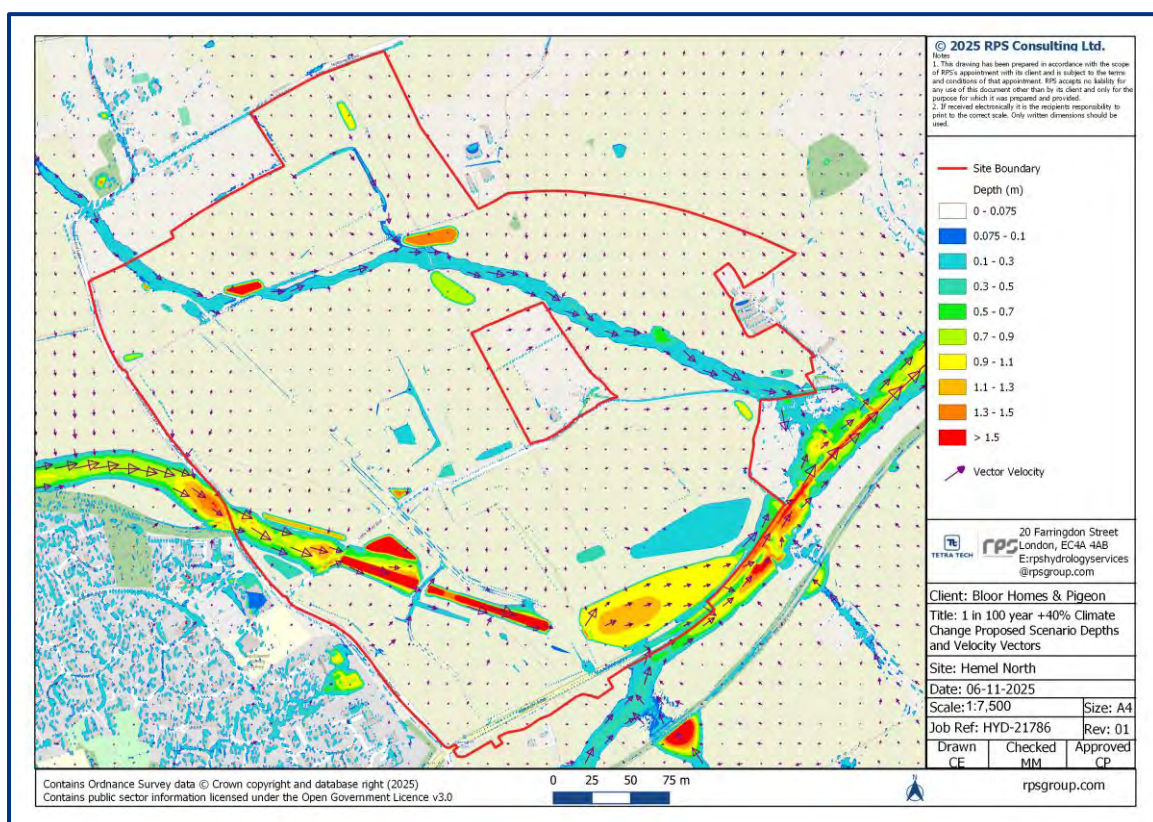


Figure 14. 1 in 100-year +40%CC Depths and Velocity Vectors – Proposed Scenario

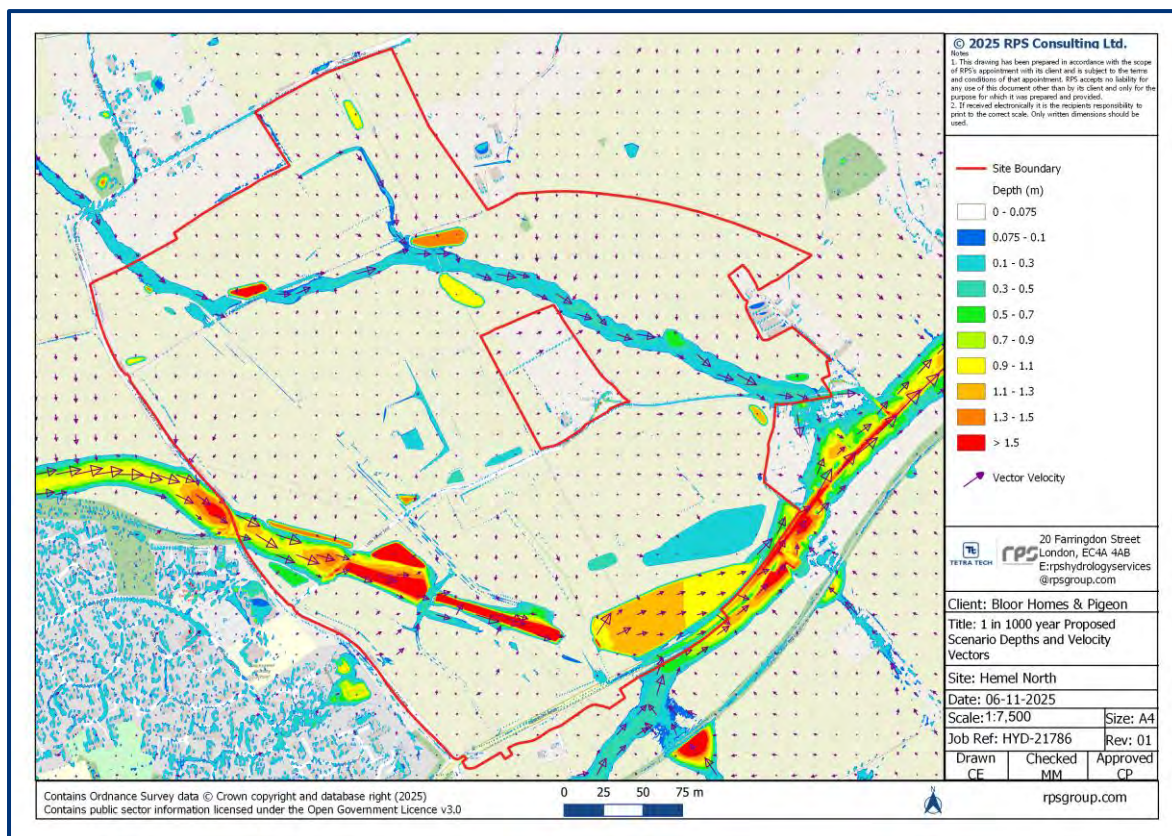


Figure 15. 1 in 1000-year Depths and Velocity Vectors – Proposed Scenario

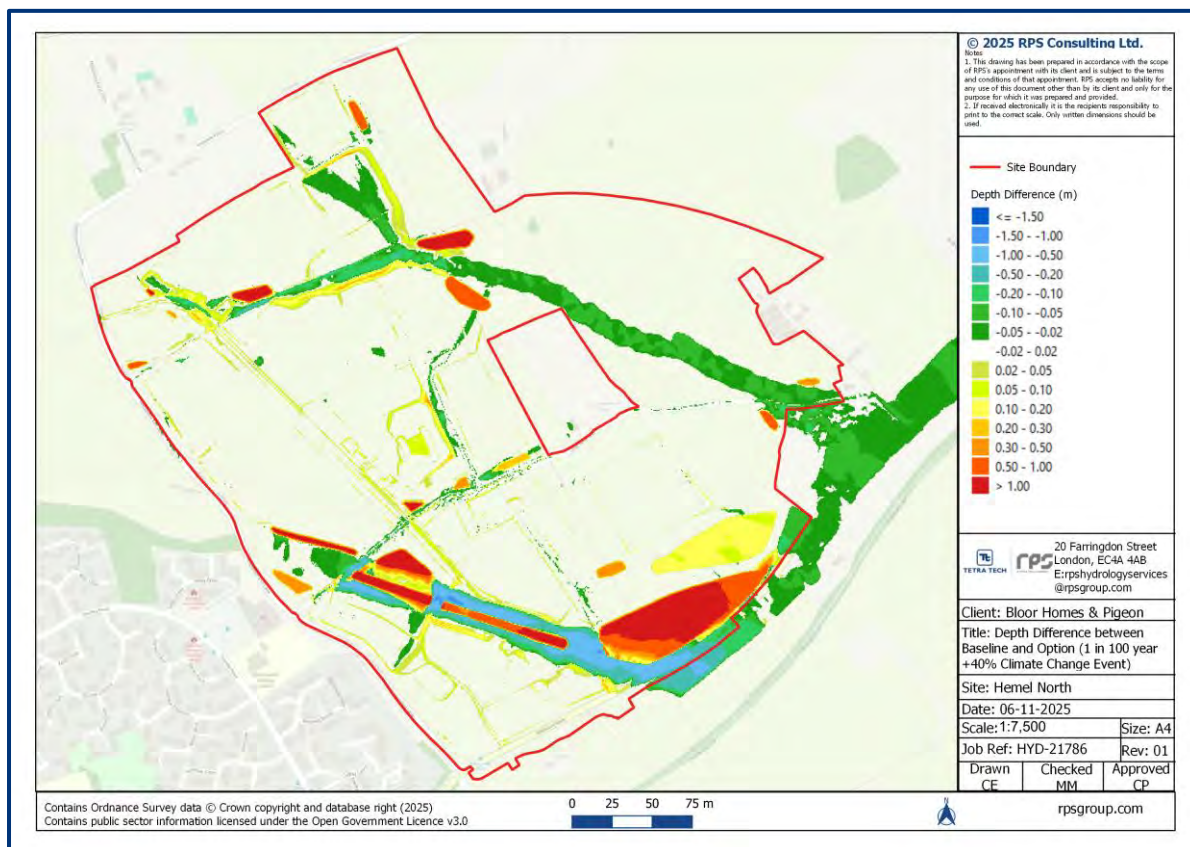


Figure 16. Depth Difference - 1 in 100-year +40% CC

5 CONCLUSION

- 5.1.1 The purpose of this report is to assess the existing surface water flood risk to the site located at land adjacent to Holtsmere Lane, Hemel Hempstead.
- 5.1.2 A 2D TUFLOW rain on grid model was used to represent the catchment, with 1D ESTRY elements used to represent hydraulically significant structures e.g. culverts.
- 5.1.3 Flows enter the site from the north/northwest and generally head towards the southeast corner of the site where they leave the site. Two flow pathways have been identified in the baseline model results, which show similar extents to the EA online mapping.
- 5.1.4 The proposed scheme has been modelled, including appropriate mitigation and the conceptual development scheme (including roads and buildings).
- 5.1.5 The model results have demonstrated at the Outline Planning Application stage that there is a viable scheme incorporating flood risk mitigation measures.
- 5.1.6 The Outline Planning Application and modelling are in line with NPPF requirements. More vulnerable land uses are shown to be safe from flood risk, with no detriment to off-site receptors.

5.2 Next Steps

- 5.2.1 At this stage, the modelling ensures that for the outline planning application, there is a feasible conceptual scheme which meets policy requirements.
- 5.2.2 As the proposed development scheme moves through detailed design, the modelling can be updated, if appropriate, to support the ongoing refinement of the scheme design.

APPENDICES

Appendix A-Site Visit Photos

Description	Photo
Entry to the site and overall topography - Pooling in low points	

Dip near
centre of
site where
vegetation
present,
this is seen
on LiDAR



Looking to
the east
corner
where flow
path leaves
site



Dip in
centre of
land where
flow path
present



Another dip
in
topography
where flow
path seen



Appendix I – Ground Investigation Reports



Ground Investigation Report

Land Adjacent to Holtsmere End Lane (South)

Hemel Hempstead
HP2 7HP

Prepared for:

**Pigeon Investment Management
Ltd**

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On Behalf of **Pigeon
(Hemel Hempstead) Ltd**

EPS Project Reference: UK19.4388B

Pigeon Reference Number: 0093

Date Issued: 6th September 2019

Report Status: Issue 1



LAND ADJACENT TO HOLTSMEERE END LANE (SOUTH), HEMEL HEMPSTEAD

NON-TECHNICAL CLIENT SUMMARY

This report presents the findings of a Ground Investigation undertaken to initially assess the infiltration and drainage characteristics of the soils throughout the area. Pertinent findings and conclusions may be summarised as follows:

- The site is currently occupied by fields used as arable farmland with a below ground oil pipeline which runs through its centre. The area is being considered for a mixed use residential and commercial scheme.
- Intrusive investigations comprised the forming of four deep boreholes to a maximum depth of 18.37m below ground level and four shallow trial pits to 2.9m below ground level with in-situ testing to assess the drainage characteristics of the soils encountered.
- Ground conditions were found to comprise a thin layer of topsoil underlain by a varying thickness (0.45m to 1.8m) of clay with flints overlying chalk. Groundwater was struck within one borehole when drilling, at a depth of 14.8m, located in the north western area and has been monitored weekly over a 1 month period only being encountered in two boreholes located in the west and north western sections of the site.
- Testing within the trial pits suggest that the upper chalk soils have a low to medium permeability, whilst tests completed within the deeper boreholes generally show that the calculated infiltration rates for the deeper chalk soils suggest a low permeability and are likely to be less favourable in terms of infiltration drainage compared to the shallow soils. However, it is considered likely that infiltration drainage would be appropriate at the site.
- A short ground gas monitoring programme has also been completed on a precautionary basis and the results from the four monitoring visits indicate that the site falls within a Characteristic Situation 1 'very low risk' scenario whereby no ground gas protection measures are considered necessary.

The above points represent a simplified summary of the findings of this assessment and should not form the basis for key decisions for the proposed development. A thorough review of the details is contained within the following report, or alternatively get in touch and we'll talk you through it.



Project Reference:	UK19.4388B
Pigeon Reference:	0093
Title:	Ground Investigation Report, Land Adjacent to Holtsmere End Lane (South), Hemel Hempstead
Client:	Pigeon Investment Management Ltd on Behalf of Pigeon (Hemel Hempstead) Ltd
Date:	6 th September 2019
EPS Contact Details:	7B Caxton House Broad Street Cambourne Cambridge CB23 6JN T: 01954 710666 F: 01954 710677 E: info@epstrategies.co.uk W: www.epstrategies.co.uk
Status:	Issue 1

Author:	Reviewed:	Authorised:
		
James Bowley	Tom Androsiuk	Steve Bullock
Consultant	Senior Consultant	Director

This report has been prepared for Pigeon Investment Management on behalf of Pigeon (Hemel Hempstead) Ltd as listed on the report title page. EPS accepts no liability or responsibility for use of, or reliance upon, this report and / or the information contained within it by third parties.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS.

This report and its contents, together with any supporting correspondence or other documentation, remain the property of Environmental Protection Strategies Ltd until paid for in full.

Where ground investigations have been conducted, these have been limited to the level of detail required for the site in order to achieve the objectives of the investigation.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework 2019 requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

As stated within DEFRA's Contaminated Land Statutory Guidance (2012), with any complex risk assessment it is possible that different suitably qualified people may reach slightly different conclusions when interpreting the same information. EPS recognises this and considers the conclusions presented within this report to be robust and appropriate but input from the Local Authority and their judgement in line with this guidance would still be welcomed.

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1 INTRODUCTION

In July 2019, Environmental Protection Strategies Ltd (EPS) was commissioned by Pigeon Investment Management Ltd on behalf of Pigeon (Hemel Hempstead) Ltd to complete a Ground Investigation for a plot of land adjacent to Holtsmere End Lane (South), Hemel Hempstead, HP2 7HP ('the site'); see Figure 1.

This report has been prepared for Pigeon Investment Management Ltd and the contents should not be relied upon by others without the express written authority of EPS. If any unauthorised third party makes use of this report they do so at their own risk and EPS owes them no duty of care or skill.

The work was commissioned in order to initially assess the infiltration and drainage characteristics of the soils throughout the area. It is understood that the area is being considered for a mixed use residential and commercial scheme.

This report presents the findings, conclusions, and recommendations of the Ground Investigation undertaken as instructed.

1.1 Summary of Previous Reports

A number of previous reports have been completed that pertain to the site, for background information, it is recommended that the reader review the reports listed below.

1.1.1 Geo-Environmental Investigations

- *Phase 1 Geo-Environmental Desk Study – Redbourn Road / Hemel Hempstead Road, Hemel Hempstead (Ref: 19-0138) – Rolton Group (12th February 2018)*
- *PBA Natural and Mining Cavities Databases Search with Cavities Occurrence Assessment for the Site at Land Adjacent to Holtsmere End Lane, Hemel Hempstead, AL3 7AW (Ref: 45635//CBH/JW/HG) – Peter Brett Associates (6th February 2019)*
- *Preliminary Ground Investigation Report, Holtsmere End Lane (South), Report Reference: UK19.4388 – EPS Ltd, June 2019*
- *Phase 1 Geo-Environmental Assessment, Holtsmere End Lane, Hemel Hempstead, Report Reference: UK19.4575 – EPS Ltd, July 2019*

1.1.2 Geophysical Surveys

- *Geophysical Survey Report, Land adjacent to Holtsmere End Lane Hemel Hempstead, Hertfordshire, Survey Report Reference MSTL461 – Magnitude Surveys, April 2019*
- *Geophysical Survey Report, Holtsmere End Lane, Hemel Hempstead, Survey Report Reference SOR14814 – Sumo Geophysics Ltd, April 2019*

1.2 Objectives

The objectives of this investigation were as follows:

- a) Undertaking soakaway infiltration tests in general accordance with BRE Digest 365 to provide an assessment of the infiltration characteristics of the underlying soils to assist in drainage design.

- b) Completion of 'falling head' infiltration tests within deep boreholes to provide an assessment of the infiltration characteristics of the underlying deeper soils.
- c) Collect and present information on the deeper soils which could be used at later stages during the development such as for potential pile foundation design.
- d) Confirm that the contaminant linkages associated with ground gas identified through EPS' Phase I Geo-Environmental Assessment are not plausible and do not represent any unacceptable risks to future site users / constraints to the development.

1.3 Scope of Work

To perform an exploratory assessment of the site in accordance with the principles and requirements of DEFRA's 'Contaminated Land Statutory Guidance' (2012), BS10175 – 'Investigation of Potentially Contaminated Sites' and BS5930:2015 'Code of practice for ground investigations', the following tasks were undertaken:

Intrusive Investigation:

- Health and safety briefing / site supervision.
- Drilling of four cable percussive (shell & auger) boreholes to a maximum depth of 18.37m below ground level (bgl), with 'falling head' infiltration tests completed in each borehole and the installation of combined groundwater and ground gas monitoring wells at each borehole location.
- Excavation of four trial pits to a maximum depth of 2.9m bgl throughout the site to allow for soakaway tests to be completed in general accordance with BRE Digest 365 in order to initially assess the drainage characteristics of the underlying soils.
- Initial monitoring of groundwater levels over a period of approximately 4 weeks / 1 month comprising 1 return visit per week.
- Initial monitoring of ground gas concentrations over a period of approximately 4 weeks / 1 month comprising 1 return visit per week.
- Continual logging of ground conditions including inspection of samples for visual and olfactory contamination, and geotechnical laboratory analysis of selected representative samples.

Reporting:

- Data collection
- Interpretation of data
- Reporting.

The findings and conclusions of these investigations are presented in the following sections.

1.4 Limitations and Constraints

The purpose of this report is to present the findings of a soil sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements: No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes to recover soil and / or groundwater samples. The locations of these sampling points are considered to be representative



of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the conditions encountered may differ to those found during the investigation.

EPS has no reason to believe that Japanese Knotweed is or was present at the Site during the time at which this report was compiled and no visible evidence of Japanese Knotweed was identified during the site works. It is noted that, this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its presence at certain times of the year. For this reason, EPS cannot confirm that Japanese Knotweed rhizomes do not exist and it is recommended that if it is suspected that this species, or other similarly invasive plants are present at the Site, that the pursuant of the Site appoint a specialist contractor to make a detailed assessment.

This report does not include specific investigation for the presence of either Potential Asbestos Containing Material (PACM) at the subject site however, if obvious evidence of PACM is observed during EPS' site walkover, details will be provided in this report. Specialist contractors should be commissioned to make detailed assessments and recommendations if these materials are suspected.

'The Consultant (EPS) grants to the Beneficiary (Pigeon Investment Management Ltd on behalf of Pigeon (Hemel Hempstead) Ltd), with immediate effect, an irrevocable, non-exclusive, non-terminable, royalty-free licence to use and reproduce for any purpose relating to the Property all documents, reports, drawings, calculations and specifications (and the designs contained in them) which have been or will be prepared by the Consultant or on its behalf in connection with the Reports, and the Consultant agrees to supply to the Beneficiary on request copies of such materials (subject to reimbursement of the Consultant's reasonable copying charges).'

The investigation was carried out to initially assess the drainage characteristics of the soils encountered at the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made. It should be appreciated that this report is not intended to fully characterise the entirety of the site and future investigations in the form of a Phase II Geo-Environmental Assessment of area will be required to achieve this.

2 SUMMARY OF INTRUSIVE INVESTIGATIONS

Intrusive ground investigations were undertaken between the 15th & 19th July 2019 in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of all site activities is presented in the following sections:

2.1 Site Location & Description

Detail	Description
Location	The site covers approximately 20.6 hectares and is located northeast of the town of Hemel Hempstead.
National Grid Reference	508390, 210200
Topography	The ground levels slope down from the north and south forming a central channel that runs from east north east to west south west throughout the majority of the site. The maximum elevation is approximately 120m AOD (above ordnance datum) in the north and south with the minimum elevation approximately 105m AOD in the central valley.
Description of Site (July 2019)	The Southern development area which is the focus of this report appears to be undeveloped agricultural land comprising a rectangular shaped field taking up the majority of the area, with crops present throughout the field. Access to the area is obtained via a gate in the southern corner of the field where Holtsmere End Lane meets the B487 road. There is a smaller section of field in the northern part of the site that is separated from the main field by mature trees. The eastern section of the field also has a row of mature trees going from the northwest to southeast partially splitting the field. The western corner of the site was left uncultivated with natural grasses noted. An oil pipeline is known to run through the centre of the site in a northwest to southeast direction with the marker posts located on the north and south boundaries of the field. Additionally, two wooden overhead power lines following the same approximate route as the oil pipeline passing through the site. An un-named road lined with medium to large mature trees and a hedgerow form the northern boundary. The eastern boundary is specified by the large lattice type electricity pylons which runs through the field. The southern boundary is a hedgerow with some occasional trees present separating the field from the B487 and the western boundary along Holtsmere End Lane is also marked by large mature trees and shrubs.
Surrounding Land Use	The areas to the north, east and south mainly consist of agricultural land and some limited residential and agricultural buildings. To the west the land use is predominantly residential properties with some retail shops and schools. Further afield, approximately 1km to the south is the Buncefield Oil Terminal.
Geology	Geological maps of the area show superficial Clay-with-Flints Formation mapped in the northern and southern areas as well as possibly encroaching the sites western border. The bedrock geology is mapped as the Lewes Nodular Chalk Formation and Seaford Chalk Formation

Detail	Description
	(undifferentiated).

2.2 Borehole & Trial Pit Locations

Borehole and trial pit locations were agreed with the drainage consultants for the project. When selecting borehole and trial pit locations, consideration was also given to location of below ground utilities as well, operational and health & safety implications and the findings of previous intrusive investigations undertaken.

Four cable percussive (shell & auger) boreholes (BH201-BH204) were drilled to a maximum depth of 18.37m to provide information on the quality and nature of soils at depth and to facilitate 'falling head' infiltration tests in the boreholes. Additionally, the boreholes were also formed to provide information on the groundwater level and to facilitate the installation of combined groundwater and ground gas monitoring wells. It should be appreciated that the maximum target depth of 30m could not be achieved by the boreholes due to the nature of the ground conditions encountered.

Four trial pits (TP201-TP204) were excavated to a maximum depth of 2.9m to complete soakaway infiltration tests in general accordance with BRE Digest 365.

Combined gas and groundwater monitoring wells were installed in all four of the boreholes formed at the site (BH201-BH204). These monitoring wells were installed using 50mm diameter uPVC well casing and fitted with a gas tap. Slotted casing (1mm slot) was installed at each location from the base of the borehole to approximately 2.0m below the surface and the installations were completed above the ground surface using plain casing. A filter pack of 2-3mm washed gravel extended from the base of the boreholes to approximately 0.1m above the slotted section with a bentonite seal to surface. These monitoring wells were installed in order to allow for return visits to be completed to measure groundwater levels and to initially assess the gassing regime throughout the area. Each monitoring point was left protruding above surface level and lockable steel headworks were concreted around each monitoring positions in order to protect the monitoring wells and to allow identification of the monitoring wells during farming works.

A borehole and trial pit location plan is presented as Figure 2 and information obtained from the return visits to measure groundwater levels is included as Table 1.

2.3 In-Situ Testing & Soil Sampling

In-situ strength testing was undertaken within the boreholes by completing standard penetration tests (SPTs) at regular intervals within the boreholes. The number of blows required to advance a standard split spoon, over the final 300mm of a 450mm total drive was recorded, and is shown on the borehole records at the penetration resistance ("N" value).

Soil samples were also collected from the borehole and trial pits for record purposes and for laboratory analysis. Selection of samples for laboratory analysis focused on providing an assessment of the geotechnical properties of the soils encountered which is anticipated to be used by the

drainage consultants for the project along with the design of piled foundation for the redevelopment.

2.4 Laboratory Testing

Geotechnical testing was undertaken by Soil Property Testing, Huntingdon, a UKAS accredited laboratory. Copies of chain of custody documentation are held by EPS and will be made available on request.

2.5 Monitoring of Groundwater Levels

Resting groundwater levels within the monitoring wells at each borehole (BH201-BH204) have been recorded on four occasions on the 26th July 2019, 31st July 2019, 6th August 2019 & 15th August 2019 following the completion of the site works on 15th – 19th July 2019. The depths of resting groundwater recorded on each of the above locations are presented in Table 1 of this report.

2.6 Soil Gas Monitoring

Four rounds of ground gas monitoring were also completed on a precautionary basis. These took place on an approximately weekly basis on the 26th July 2019, 31st July 2019, 6th August 2019 & 15th August 2019 to measure the presence and concentration of ground gas (including carbon dioxide, oxygen and methane) and organic vapour using a GFM 435 gas analyser, PID and flow meter.. Measured ground gas concentrations and the calculated gas screening values (GSV's) are presented as Table 2.

3 FINDINGS OF THE INVESTIGATION

This section of the report provides a summary of the findings of the various aspects of the ground investigation.

3.1 Ground Conditions

As part of this phase of investigation, four cable percussive (shell & auger) boreholes and four trial pits were formed. The ground conditions were noted to be similar to the previous investigation completed by EPS and, were found to comprise:

- Topsoil
- Clay-with-Flints Formation
- Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated)

Site specific borehole and trial pit logs are included as Appendix A and give descriptions and depths of strata encountered. A summary of the general strata encountered across the site is provided in the table below, with more detailed descriptions given in the following sub sections.

Geological Strata	Maximum Depth to Base of Strata (m bgl)	Strata Thickness (m)
Topsoil	0.3	0.1 – 0.3
Clay-with-Flints	2.0	0.45 – 1.8
Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated)	Not Proven (>18.37)	Not Proven

Please note, the depths presented in this table are based solely on the works completed as part of this phase of works and not as part of previous phases of work.

3.1.1 Topsoil

Topsoil was encountered from the surface in all of the boreholes and trial pits. The material was recovered as slightly sandy slightly silty slightly gravelly clay containing some rootlets. The depth of the topsoil ranged from approximately 0.1m to 0.3m in thickness.

3.1.2 Clay-with-Flints Formation

Natural soils indicative of the Clay-with-Flints Formation were encountered below the topsoil at all borehole locations. These soils can generally be described as firm slightly gravelly slightly sandy silty clay, containing some flint and chert gravel. This material ranged from 0.45m to 1.8m in thickness across the boreholes and trial pits. Chalk gravel was also noted within these soils which is not uncommon within a glacial deposit such as this.

3.1.3 Lewes Nodular Chalk Formation and Seaford Chalk Formation (Undifferentiated)

Underlying the superficial Clay-with-Flints Formation, soils considered representative of the Lewes Nodular Chalk Formation and Seaford Chalk Formation (Chalk) were encountered. These soils were recovered as a structureless chalk composed of a brownish white sandy, silt dominated

matrix. The gravel is sub-angular to angular and fine to coarse medium density chalk with sub-angular flints also present. The Chalk was interpreted to be Grade Dm matrix dominated chalk. At greater depths within boreholes BH201 and BH203, the chalk can be described as above but with greater than 50% intact chalk fragments thus representing a more clast dominated Grade Dc Chalk.

The maximum target depth of the boreholes of 30.0m could not be achieved due to the strength of the Chalk and flint gravel and cobbles contained within.

3.2 Groundwater

Groundwater was not encountered during the forming of any of the trial pits. However, a Groundwater strike was recorded within BH201 at roughly 14.8m during the intrusive works, and after a 20 minute rest period there was no rise in the groundwater level.

Ground levels of each borehole position above an ordnance datum and the resulting range of groundwater levels at each borehole location are presented below.

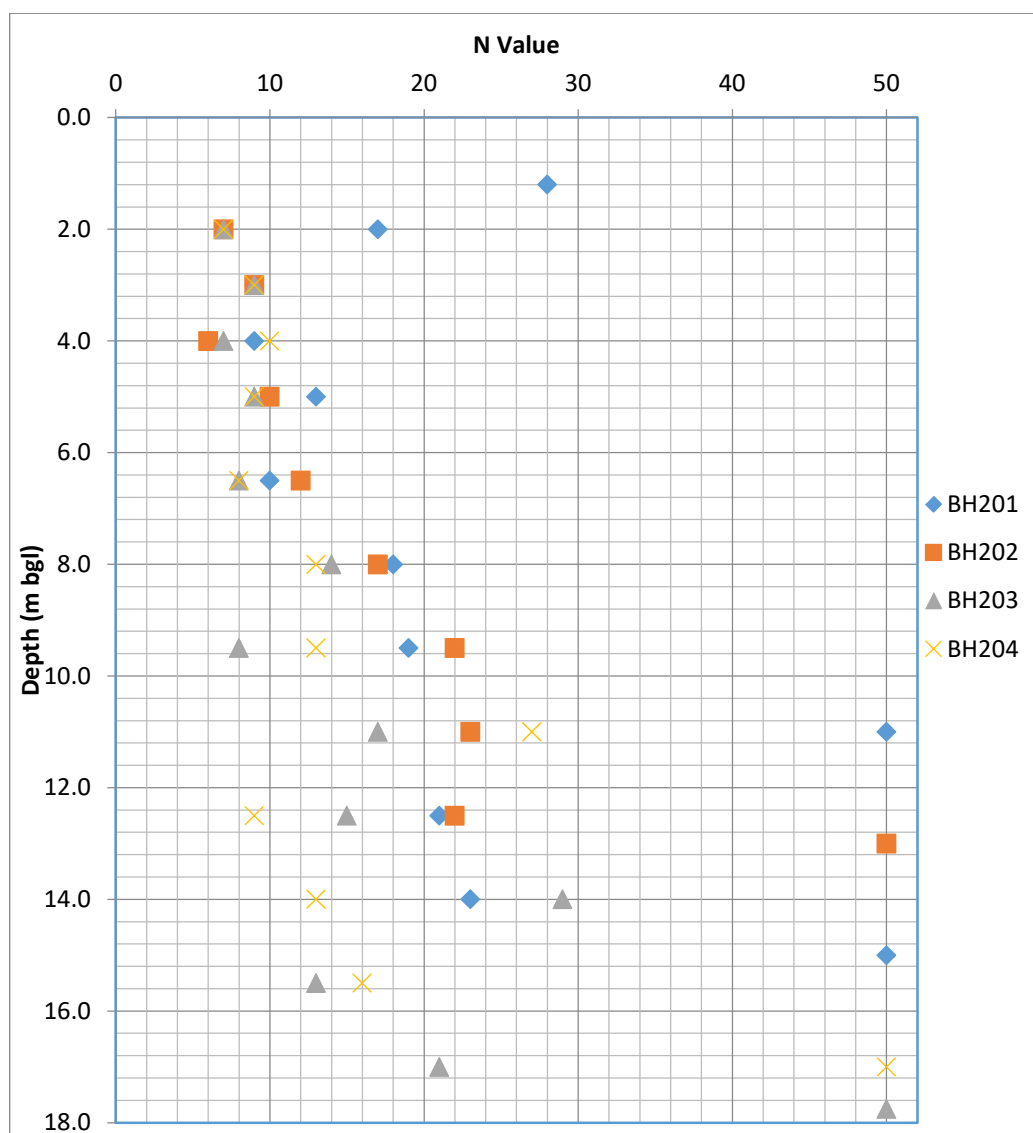
Borehole Location	Elevation (m AOD)	Highest Groundwater Elevation (m bgl)	lowest Groundwater Elevation (m bgl)	Highest Groundwater Elevation (m AOD)	Lowest Groundwater Elevation (m AOD)
BH201	106.88	14.930	Dry	91.950	Dry
BH202	104.79	Dry	Dry	Dry	Dry
BH203	112.73	Dry	Dry	Dry	Dry
BH204	113.72	17.453	Dry	96.267	Dry

It should be appreciated that to date, the groundwater levels have only been recorded over a period of one month / four weeks in summer when the groundwater table is likely to be at its lowest elevation. As such it would be prudent to complete additional monitoring of the groundwater levels through the autumn / winter season when the groundwater table reaches its peak so that the groundwater table can be more thoroughly understood prior to development works commencing.

3.3 Geotechnical Testing

3.3.1 In-Situ Geotechnical Testing

The results of in-situ geotechnical testing (SPT's) completed within the boreholes are summarised in the graph below.



The results of in-situ geotechnical testing show that 'N' values generally increase incrementally with depth as the strata changes from the matrix dominated Chalk to the more clast dominated Chalk. Drilling was abandoned in all of the boreholes due to refusals (i.e. 'N' = ≥ 50) within the deeper Chalk. These refusals were most likely due to the flint or denser chalk and / or intact fragments of chalk obstructing the drilling / testing equipment.

3.3.2 Laboratory Geotechnical Testing

The results of geotechnical laboratory testing is summarised in the table below and all geotechnical sample results obtained from the laboratory are included as Appendix B. The key results of laboratory testing on geotechnical soil samples are summarised in the tables below.

Strata	Range of Parameters									
	Moisture Content (%)		Saturated Moisture Content (%)		Bulk Density (Mg/m ³)		Dry Density (Mg/m ³)		Shear Strength (kPa)	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
Clay-with-Flints Formation	20.5	30.5	-	-	1.87	2.11	1.43	1.75	73	167
Chalk	9.6	22.9	9	23	2.01	2.36	1.62	2.15	-	-

The natural moisture content was established for two samples of soil in accordance with BS EN ISO 17892-1: 2014 & BS EN ISO 17892-2: 2014.

The saturation moisture content and intact dry density was established for three soil samples in accordance with BS1377: Part 1: 2016: 8 & BS1377: Part 2: 1990: 3.3.

The density, water content and undrained shear strength was also determined for two samples using triaxial compression testing (without measurement of pore pressure) in accordance with BS 1377: Part 1: 1990: 7.4.2 & 8, Part 2: 1990: 7.2, Part 7: 1990: 8.3 and BS 1377: Part 2: 1990:3 Determination of Moisture Content, Part 2: 1990:7 Determination of Density, Part 7: 1990: 8 Undrained Shear Strength, 9 Multistage Loading.

A geotechnical laboratory testing schedule is presented as Table 3.

3.4 Ground Gas Monitoring & Initial Ground Gas Risk Assessment

The results of four rounds of ground gas monitoring which have taken place on a weekly basis on 26th July 2019, 31st July 2019, 6th August 2019 & 15th August 2019 are presented as Table 2 along with calculated gas screening values, set out in CIRIA guidance '*Assessing Risks Posed by Hazardous Ground Gases to Buildings*'.

Results of the ground gas monitoring show that no discernible flow was detected at any of the boreholes and levels of methane did not exceed minimum instrument detection limits of <0.1% v/v at any borehole location across the monitoring period. Carbon dioxide was recorded at low concentrations across the monitoring period with concentrations ranging from 0.1% v/v to a maximum recorded concentration of 2.2 % v/v recorded at BH203 & BH204 on 31st July 2019 and again on the 6th and 15th August 2019 in BH203.

VOC concentrations have generally not been detected above minimum instrument detection limits of <0.1ppm/v with the exception of the monitoring visit undertaken on 31st July 2019 when VOC concentrations were recorded slightly above the minimum instrument detection limits with a maximum concentration of VOC's recorded as 0.5ppm/v.

The subsequently calculated gas screening values have been found to fall into the 'very low risk' classification for both Carbon Dioxide and Methane, in line with CIRIA Guidance document 665 – *Assessing Risks Posed by Hazardous Ground Gases to Buildings* (2007) for a gassing regime defined as Characteristic Situation 1, whereby no ground gas protection measures are considered necessary in

any new or existing buildings at the site. This aligns with the initial risks associated with ground gas considered within EPS' Phase I Geo-Environmental Assessment which were considered to be sufficiently low for no specific ground gas monitoring to be required.

3.5 Results of Soakaway Tests & 'Falling Head' Infiltration Testing

The ground conditions investigated through this phase of works have been found to comprise layers of topsoil underlain by natural Clay-with-Flints Formation soils. Below the Clay-with-Flints, Lewes Nodular Chalk Formation and Seaford Chalk Formation (undifferentiated) soils are present.

3.5.1 Soakaway Test Results

Soakaway tests were undertaken at all four trial pit locations, three tests were completed within each trial pit in general accordance with BRE Digest 365 and the calculated infiltrations rates are presented in the below table. .

Location & Depth (m)	Infiltration Rate (m/s)			
	Test 1	Test 2	Test 3	Representative Infiltration Rate
TP201 (2.9m)	1.161E ⁻⁵	9.724E ⁻⁶	2.325E ⁻⁵	1.65E ⁻⁵
TP202 (2.7m)	5.080E ⁻⁴	3.272E ⁻⁴	3.774E ⁻⁴	3.52E ⁻⁴
TP203 (2.65m)	3.753E ⁻⁵	3.719E ⁻⁵	5.336E ⁻⁵	4.53E ⁻⁵
TP204 (2.85m)	1.252E ⁻⁴	9.164E ⁻⁵	1.082E ⁻⁴	9.99E ⁻⁵

Representative infiltration rates have been calculated for each trial pit location following best practice and in accordance with the relevant guidance. These indicate infiltration rates have been calculated by taking an average of the 2nd and 3rd tests and discounting the first test result as the first test is completed under unsaturated ground conditions.

3.5.2 'Falling Head' Infiltration Results

Falling head infiltration tests were undertaken at all four borehole locations at a variety of depths. The infiltration rates are summarised in the table below:

Location	Infiltration Rate (m/s) & Depth		
	Test 1	Test 2	Test 3
BH201	7.421E ⁻⁶ 7.0m	1.087E ⁻⁵ 13.0m	-
BH202	3.313E ⁻⁶ 5.45m	1.186E ⁻⁶ 8.45m	2.931E ⁻⁶ 12.95m
BH203	6.238E ⁻⁵ 6.0m	6.486E ⁻⁶ 9.0m	4.334E ⁻⁶ 11.45m
BH204	5.289E ⁻⁶ 5.45m	6.052E ⁻⁶ 8.45m	6.058E ⁻⁶ 12.0m

Please note, infiltration rates calculated from 'falling head' infiltration tests completed within the boreholes in accordance with BS5930

3.6 Discussion of Soakaway Tests & 'Falling Head' Infiltration Testing

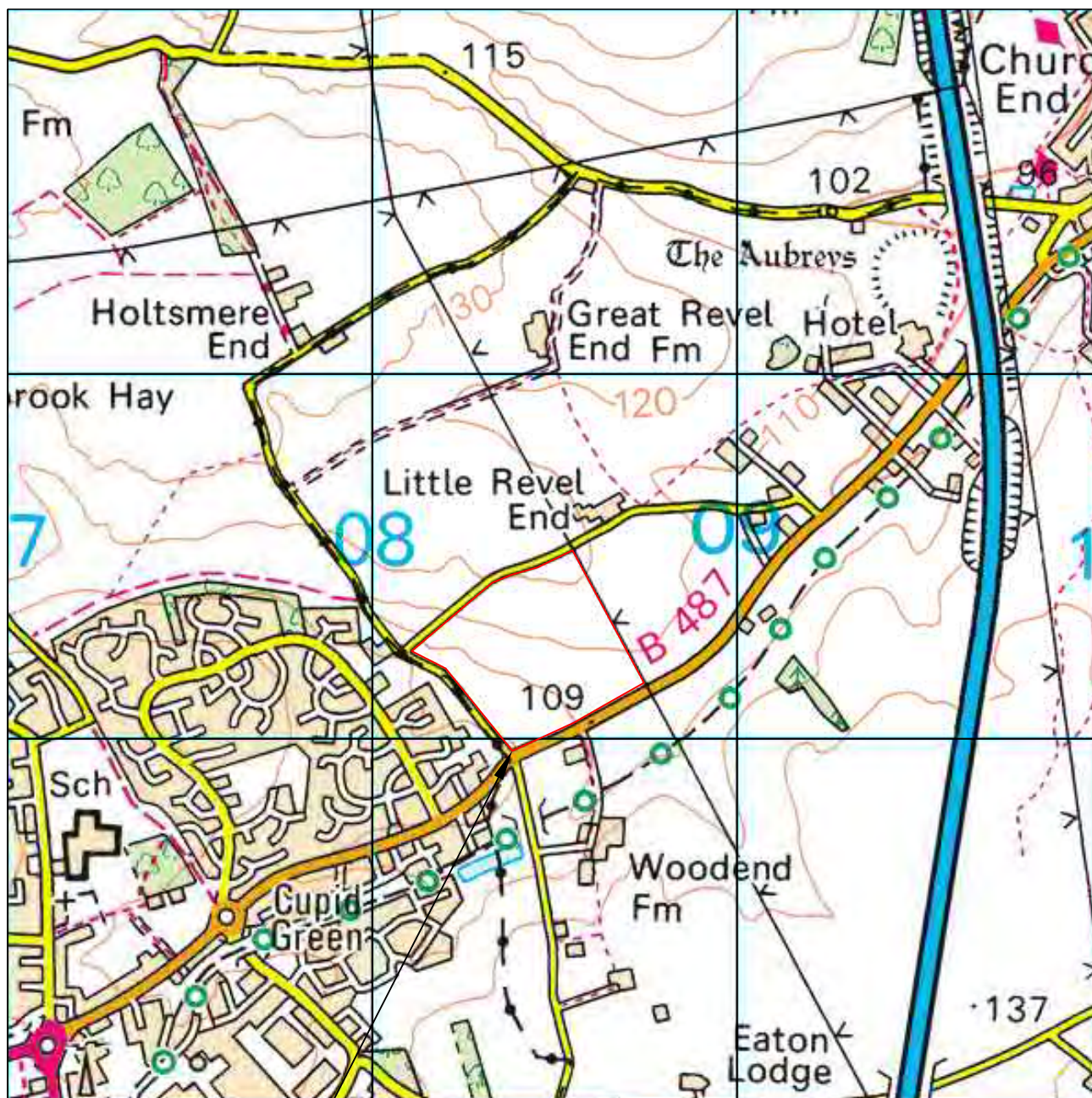
The results of the soakaway test suggest that the upper chalk soils have a low to medium level of permeability.

The results of the 'falling head' infiltration tests completed within the boreholes and the subsequent calculated infiltration rates for the deeper chalk soils suggest a low permeability. The deeper chalk soils may hence likely to be less favourable in terms of infiltration drainage as opposed to the shallow soils as evidenced by comparing the infiltration rates calculated from trial pits (in shallow chalk soils) to those calculated from the 'falling head' infiltration tests completed within the boreholes (in deeper chalk soils).

Nonetheless it is considered possible that infiltration via either traditional soakaways or deeper soakaways could be viable for the proposed development.

Whilst investigations undertaken to date are not considered to have indicated the presence of dissolution features, previous phases of work have suggested a relatively high risk of these occurring. As concentrated discharge of water can initiate new dissolution features and as the chalk at shallow depths is considered low density, it is recommended that if infiltration drainage systems (including soakaways) are to be incorporated into the redevelopment of the area, these features should be located at least 10m from any proposed structures.

FIGURES



Approximate Site Boundary

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Licence Number: 100054115



Title: Site Location Plan

Project: Land Adjacent to Holtsmere End Lane, (South) Hemel Hempstead

Fig No: 1 **Pigeon Ref:** 0093

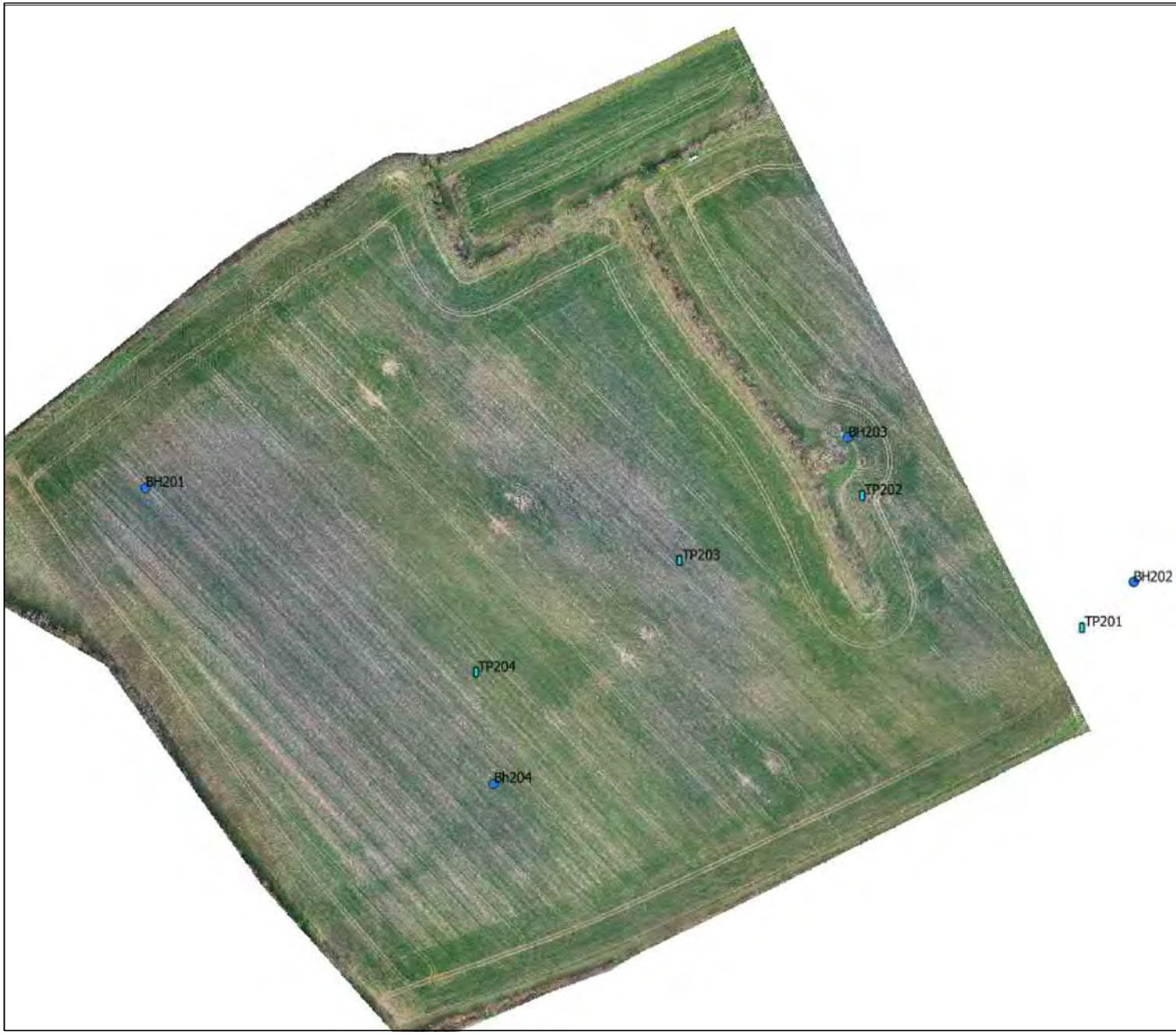
Scale: NTS

Drawn By: TA **Approved By:** WE

Job No: UK19.4388b

Dwg No: HoltsmereEndLn/0619/01

Date: June 2019



KEY:	
	Approximate Borehole Location
	Approximate Trial Pit Location

Please Note: BH202 & TP201 were formed outside of the site boundary at the request of the client.

Aerial Photography Captured 18/03/2019

Fig No: 2 **Pigeon Ref: 0093**

Title: IntrusiveInvestigationLocationPlan
Project: Land Adjacent to Holstmere End Lane (South), Hemel Hempstead

Scale: NTS - For Illustration purposes only
Drawn By: JB
Job No: UK19.4388B
Dwg No: HolstmereEndLn/0819/02
Date: August 2019





TABLES

Table 1 – Monitoring of Groundwater Levels

Monitoring Location	Groundwater Level 26/07/19 (m bgl)	Groundwater Level 31/07/19 (m bgl)	Groundwater Level 6/08/19 (m bgl)	Groundwater Level 15/08/19 (m bgl)
BH201	14.930	14.980	Dry	Dry
BH202	Dry	Dry	Dry	Dry
BH203	Dry	Dry	Dry	Dry
BH204	17.453	Dry	Dry	Dry

m bgl metres below ground level

Monitoring Location & Ground Level (m AOD)	Groundwater Level 26/07/19 (m AOD)	Groundwater Level 31/07/19 (m AOD)	Groundwater Level 6/08/19 (m AOD)	Groundwater Level 15/08/19 (m AOD)
BH201 (106.88)	91.950	91.900	Dry	Dry
BH202 (104.79)	Dry	Dry	Dry	Dry
BH203 (112.73)	Dry	Dry	Dry	Dry
BH204 (113.72)	96.267	Dry	Dry	Dry

m AOD metres above ordnance datum

Table 2 – Ground Gas Monitoring Well Analysis

Ground Gas Monitoring - 26/07/19

BH ID	Flow (1/hr)	CH ₄ (%v/v)		CO ₂ (%v/v)		O ₂ (%v/v)		H ₂ S (ppm)	VOC (ppmV)	Gas Screening Value (1/hr) (CH ₄)	Gas Screening Value (1/hr) (CO ₂)
		Peak	Steady	Peak	Steady	Peak	Steady	Peak			
BH201	<0.1	<0.1	<0.1	1.5	1.5	19.3	19.3	<1	<0.1	<0.0001	<0.0015
BH202	<0.1	<0.1	<0.1	0.3	0.3	20.5	20.5	<1	<0.1	<0.0001	<0.0003
BH203	<0.1	<0.1	<0.1	1.6	1.6	19.5	19.5	<1	<0.1	<0.0001	<0.0016
BH204	<0.1	<0.1	<0.1	1.1	1.1	19.5	19.5	<1	<0.1	<0.0001	<0.0011

Readings collected at an atmospheric pressure of 999 mbar remaining constant on a rainy day.

Ground Gas Monitoring - 31/07/19

BH ID	Flow (1/hr)	CH ₄ (%v/v)		CO ₂ (%v/v)		O ₂ (%v/v)		H ₂ S (ppm)	VOC (ppmV)	Gas Screening Value (1/hr) (CH ₄)	Gas Screening Value (1/hr) (CO ₂)
		Peak	Steady	Peak	Steady	Peak	Steady	Peak			
BH201	<0.1	<0.1	<0.1	1.2	1.2	20.4	20.4	<1	0.1	<0.0001	<0.0012
BH202	<0.1	<0.1	<0.1	0.1	0.1	20.4	20.4	<1	0.1	<0.0001	<0.0001
BH203	<0.1	<0.1	<0.1	2.2	2.2	18.8	18.8	<1	0.2	<0.0001	<0.0022
BH204	<0.1	<0.1	<0.1	2.2	2.2	18.0	18.0	<1	0.5	<0.0001	<0.0022

Readings collected at an atmospheric pressure of 999 mbar rising to 1000mbar on a cloudy but warm day.



Ground Gas Monitoring - 6/08/19

BH ID	Flow (1/hr)	CH ₄ (%v/v)		CO ₂ (%v/v)		O ₂ (%v/v)		H ₂ S (ppm)	VOC (ppmV)	Gas Screening Value (1/hr) (CH ₄)	Gas Screening Value (1/hr) (CO ₂)
		Peak	Steady	Peak	Steady	Peak	Steady	Peak			
BH201	<0.1	<0.1	<0.1	2.1	2.1	19.0	19.0	<1	<0.1	<0.0001	<0.0021
BH202	<0.1	<0.1	<0.1	0.3	0.3	20.5	20.5	<1	<0.1	<0.0001	<0.0003
BH203	<0.1	<0.1	<0.1	2.2	2.2	18.7	18.7	<1	<0.1	<0.0001	<0.0022
BH204	<0.1	<0.1	<0.1	2.2	2.2	19.0	19.0	<1	<0.1	<0.0001	<0.0022

Readings collected at an atmospheric pressure of 999 mbar remaining constant on a cloudy day.

Ground Gas Monitoring - 15/08/19

BH ID	Flow (1/hr)	CH ₄ (%v/v)		CO ₂ (%v/v)		O ₂ (%v/v)		H ₂ S (ppm)	VOC (ppmV)	Gas Screening Value (1/hr) (CH ₄)	Gas Screening Value (1/hr) (CO ₂)
		Peak	Steady	Peak	Steady	Peak	Steady	Peak			
BH201	<0.1	<0.1	<0.1	1.4	1.4	19.3	19.3	<1	<0.1	<0.0001	<0.0014
BH202	<0.1	<0.1	<0.1	0.1	0.1	20.2	20.2	<1	<0.1	<0.0001	<0.0001
BH203	<0.1	<0.1	<0.1	2.2	2.2	18.4	18.4	<1	<0.1	<0.0001	<0.0022
BH204	<0.1	<0.1	<0.1	0.5	0.5	20.1	20.1	<1	<0.1	<0.0001	<0.0005

Readings collected at an atmospheric pressure of 996 mbar remaining constant on a clear, sunny and warm day.

Table 3 – Geotechnical Laboratory Testing Schedule

Sample ID	Sample Depth (m bgl)	Moisture Content	Density Determination	Saturation Moisture Content	Triaxial Test
BH201	1.2	1	1	-	-
BH202	4.0	1	1	-	-
BH202	10.0	-	-	1	-
BH203	1.2	-	-	-	1
BH203	15.0	-	-	1	-
BH203	17.0	-	-	1	-
BH204	1.2	-	-	-	1

Notes

mbgl

1

-

meters below ground level

Sample Analysed

Sample Not Analysed



APPENDICES

APPENDIX A

Site Specific Borehole Logs



Borehole Log

Borehole No.

BH201

Sheet 1 of 2

Project Name: Holtsmere End Lane (South),
Hemel Hempstead

Project No.
EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -48143.05 - 6760548.64

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

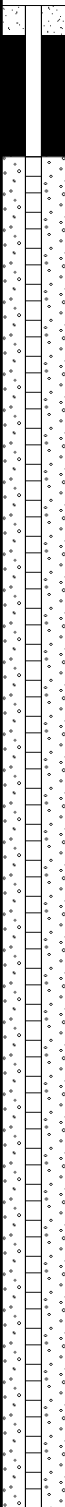
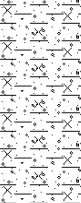
Level: 106.88

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 15/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		0.20			0.20	106.68		Topsoil: Dark brown slightly sandy slightly silty slightly gravelly CLAY with common roots.	1
		1.00	D					Firm to stiff orangish brown gravelly slightly sandy silty CLAY (CWF). Gravel is white, grey and brown fine to coarse angular to sub-rounded chert.	
		1.20		N=28 (5,6/8,6,6,8)					
		1.20 - 1.65	D						
		1.20 - 1.70	B		1.65	105.23		Structureless CHALK (LNCF) composed of a brownish white sandy silt dominated matrix. Gravel is sub angular to angular fine to coarse medium density chalk with sub angular flints (Grade Dm)	2
		2.00		N=17 (7,11/8,3,3,3)					
		2.00 - 2.45	D						
		3.00		N=9 (2,1/2,2,3,2)					3
		3.00 - 3.45	D						
		4.00		N=9 (1,2/1,3,3,2)					4
		4.00 - 4.45	D						
		5.00		N=13 (1,2/2,2,2,7)					5
		5.00 - 5.45	D						
		6.50		N=10 (2,2/2,3,3,2)					6
		6.50 - 6.95	D						
		7.00							7
		8.00		N=18 (5,8/7,3,3,5)					8
		8.00 - 8.45	D						
		9.50		N=19 (3,4/8,3,4,4)					9
		9.50 - 9.95	D						
									10

Continued on next sheet

Remarks

Clays - with - Flints formation - CWF
Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF
Groundwater Encountered at 14.8m





Borehole Log

Borehole No.

BH201

Sheet 2 of 2

Project Name: Holtsmere End Lane (South),
Hemel Hempstead

Project No.

EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -48143.05 - 6760548.64

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

Level: 106.88

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 15/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		11.00 11.00	D	50 (4,12/50 for 200mm)					11
		12.50 12.50 - 12.95	D	N=21 (1,2/4,7,5,5)					12
		14.00 14.00 - 14.45	D	N=23 (2,4/7,6,4,6)					13
		15.00 15.00	D	50 (25 for 55mm/50 for 45mm)	14.50 15.00	92.38 91.88			14
								Structureless CHALK (LNCF) composed of a brownish white sandy silt dominated matrix. Gravel is sub angular to angular fine to coarse medium density chalk with sub angular flints (Grade Dc)	15
								End of borehole at 15.00 m	16
									17
									18
									19
									20

Remarks

Clays - with - Flints formation - CWF

Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF

Groundwater Encountered at 14.8m







Borehole Log

Borehole No.

BH202

Sheet 2 of 2

Project Name: Holtsmere End Lane (South),
Hemel Hempstead

Project No.

EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -47256.02 - 6760463.54

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

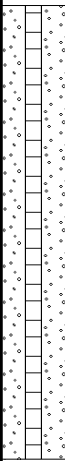
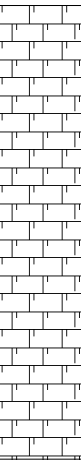
Level: 104.79

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 16/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		11.00 11.00 - 11.45	D	N=23 (6,6/6,7,5,5)					11
		12.00	D						12
		12.45 - 12.95 12.50	D	N=22 (3,4/3,5,7,7)					
		13.00		50 (25 for 10mm/50 for 0mm)	13.00	91.79			13
								End of borehole at 13.00 m	
									14
									15
									16
									17
									18
									19
									20

Remarks

Clays - with - Flints formation - CWF

Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF

Groundwater Not Encountered





Borehole Log

Borehole No.

BH203

Sheet 1 of 2

Project Name: Holtsmere End Lane (South),
Hemel Hempstead

Project No.

EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -47512.21 - 6760593.36

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

Level: 112.73

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 17/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.10	112.63		Topsoil: Dark brown slightly sandy slightly silty slightly gravelly CLAY with common roots. Firm orangish brown gravelly slightly sandy silty CLAY (CWF). Gravel is white, grey and brown fine to coarse angular to sub-rounded chert and flint.	
		1.00	D						1
		1.20 - 1.65	U						
		1.40 - 1.90	B						
		2.00			1.90	110.83		Structureless CHALK (LNCF) composed of a brownish white sandy silt dominated matrix. Gravel is sub angular to angular fine to coarse medium density chalk with sub angular flints (Grade Dm)	2
		2.00 - 2.45	D	N=7 (3,2/1,2,2,2)					
		3.00							3
		3.00 - 3.45	D	N=9 (2,1/2,3,2,2)					
		4.00							4
		4.00 - 4.45	D	N=7 (3,2/2,2,1,2)					
		5.00							5
		5.00 - 5.45	D	N=9 (2,3/3,2,2,2)					
		6.50							6
		6.50 - 6.95	D	N=8 (1,2/1,3,2,2)					
		7.00	D						7
		8.00							8
		8.00 - 8.45	D	N=14 (2,2/3,4,3,4)					
		9.50							9
		9.50 - 9.95	D	N=8 (1,2/2,2,2,2)					
									10

Continued on next sheet

Remarks

Clays - with - Flints formation - CWF

Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF

Groundwater Not Encountered





Borehole Log

Borehole No.

BH203

Sheet 2 of 2

Project Name: Holtsmere End Lane (South),
Hemel HempsteadProject No.
EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -47512.21 - 6760593.36

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

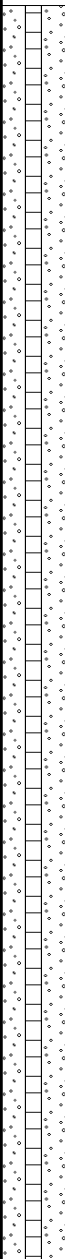
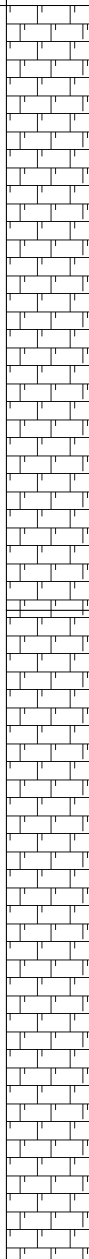
Level: 112.73

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 17/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
		11.00 11.00 - 11.45	D	N=17 (2,3/3,3,4,7)	14.00	98.73		Structureless CHALK (LNCF) composed of a brownish white sandy silt dominated matrix. Gravel is sub angular to angular fine to coarse medium density chalk with sub angular flints (Grade Dc)	11
		12.50 12.50 - 12.95	D	N=15 (2,2/3,4,4,4)					12
		14.00 14.00 - 14.95	D	N=29 (2,3/4,4,7,14)					13
		15.50 15.50 - 15.95	D	N=13 (4,5/4,3,3,3)					14
		17.00 17.00 - 17.95	D	N=21 (5,5/4,5,6,6)					15
		17.75		50 (25 for 35mm/50 for 15mm)					16
					18.37	94.36		End of borehole at 18.37 m	17
									18
									19
									20

Remarks

Clays - with - Flints formation - CWF
Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF
Groundwater Not Encountered



Borehole Log

Borehole No.

BH204

Sheet 1 of 2

Project Name: Holtsmere End Lane (South),
Hemel Hempstead

Project No.
EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -47830.23 - 6760283.12

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

Level: 113.72

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 18/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.30	113.42		Topsoil: Dark brown slightly sandy slightly silty slightly gravelly CLAY with common roots.	
		1.00	D					Firm reddish brown gravelly slightly sandy silty CLAY (CWF) with rare reddish yellow mottling, and chalk pockets. Gravel is white, grey and brown fine to coarse angular to sub-rounded chert and flint.	1
		1.20 - 1.65	U						
		1.50 - 2.00	B						
		2.00			2.00	111.72		Structureless CHALK (LNCF) composed of a brownish white sandy silt dominated matrix. Gravel is sub angular to angular fine to coarse medium density chalk with sub angular flints (Grade Dm)	2
		2.00 - 2.45	D	N=7 (2,1/1,2,2,2)					
		3.00							3
		3.00 - 3.45	D	N=9 (1,1/2,3,2,2)					
		4.00							4
		4.00 - 4.45	D	N=10 (2,1/2,3,2,3)					
		5.00							5
		5.00 - 5.45	D	N=9 (1,3/2,3,3,1)					
		6.50							6
		6.50 - 6.95	D	N=8 (1,2,1,3,2)					
		7.00	D						7
		8.00							8
		8.00 - 8.45	D	N=13 (2,2/3,4,4,2)					
		9.50							9
		9.50	D	N=13 (2,3/3,4,3,3)					
									10

Continued on next sheet

Remarks

Clays - with - Flints formation - CWF
Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF
Groundwater Not Encountered





Borehole Log

Borehole No.

BH204

Sheet 2 of 2

Project Name: Holtsmere End Lane (South),
Hemel HempsteadProject No.
EPS Ref UK19.4388B, Pigeon Ref: 0093

Co-ords: -47830.23 - 6760283.12

Hole Type
CP

Location: Holtsmere End Lane, Hemel Hempstead

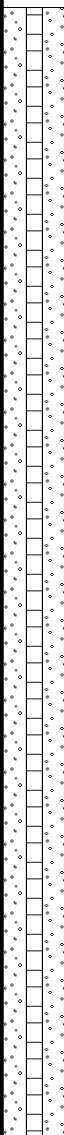
Level: 113.72

Scale
1:50

Client: Pigeon Investment Management Ltd

Dates: 18/07/2019 -

Logged By

Well	Water Strikes	Samples and In Situ Testing			Depth (m)	Level (m)	Legend	Stratum Description						
		Depth (m)	Type	Results										
		11.00 11.00 - 11.45	D	N=27 (5,6/8,8,7,4)	17.47	96.25			11					
		12.50 12.50 - 12.95	D	N=9 (4,4/3,2,2,2)					12					
		13.00	D						13					
		14.00 14.00 - 14.95	D	N=13 (3,3/4,3,2,4)					14					
		15.00	D						15					
		15.50 15.50 - 15.95	D	N=16 (3,3/3,4,4,5)					16					
		17.00 17.00	D	50 (25 for 20mm/50 for 0mm)					17					
		End of borehole at 17.47 m								18				
										19				
										20				

Remarks

Clays - with - Flints formation - CWF
Lewes Nodular Chalk Formation and Seaford Chalk Formation - LNCF
Groundwater Not Encountered

APPENDIX B

Laboratory Results – Geotechnical



TEST REPORT
ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/08/2019



Contract	UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)		
Serial No.	35598		
Client: Environmental Protection Strategies Ltd Unit 7 Caxton House Broad Street Great Cambourne Cambridge CB23 6JN		Soil Property Testing Ltd 15, 16, 18 Halcyon Court, St Margaret's Way, Stukeley Meadows, Huntingdon, Cambridgeshire, PE29 6DG Tel: 01480 455579 Email: enquiries@soilpropertytesting.com Website: www.soilpropertytesting.com	
Samples Submitted By: Environmental Protection Strategies Ltd Samples Labelled: UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)		Approved Signatories: ☒ J.C. Garner B.Eng (Hons) FGS Technical Director ☐ S.P. Townend FGS Quality Manager ☐ W. Johnstone Materials Lab Manager ☐ D. Sabnis Operations Manager 	
Date Received: 26/07/2019		Samples Tested Between: 26/07/2019 and 08/08/2019	
Remarks: For the attention of James Bowley Your Reference No: UK19.4388B Your Order No: 22523			
Notes: 1 All remaining samples or remnants from this contract will be disposed of after 21 days from today, unless we are notified to the contrary. 2 (a) UKAS - United Kingdom Accreditation Service. (b) Opinions and interpretations expressed herein are outside the scope of UKAS accreditation. 3 Tests marked "NOT UKAS ACCREDITED" in this test report are not included in the UKAS Accreditation Schedule for this testing laboratory. 4 This test report may not be reproduced other than in full except with the prior written approval of the issuing laboratory.			



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/08/2019



0998

Contract	UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)
Serial No.	35598

DETERMINATION OF DENSITY AND WATER CONTENT

Borehole /Pit No.	Depth (m)	Sample		Water Content (%)	Bulk Density (Mg/m3)	Dry Density (Mg/m3)	Description	Remarks
		Type	Reference					
BH201	1.20 - 1.70	B	3	20.5	2.11	1.75	Firm yellowish brown slightly gravelly slightly sandy silty CLAY with occasional recently active roots. Gravel is brown, black and white fine to coarse angular and subangular chert and rare chalk	
BH202	4	D	7	23.7	2.01	1.62	Structureless white CHALK with occasional harder intact chalk fragments or fine to medium gravel size, and rare black flint gravel.	

Method of Preparation:	
Method of Test:	BS EN ISO 17892-1: 2014 & BS EN ISO 17892-2: 2014
Type of Sample Key:	U = Undisturbed, B = Bulk, D = Disturbed, J - Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:	
Remarks to Include:	Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample. Oven drying temperature if not 105-110°C.



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/08/2019



0998

Contract	UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)
Serial No.	35598

DETERMINATION OF DENSITY, WATER CONTENT AND UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole /Pit No.	Depth (m)	Type	Reference	Water Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)	Lateral Pressure (kPa)	Deviator Stress (kPa)	Shear Stress (kPa)	Mohr's Circle Analysis		Description
										Cu (kPa)	Ø degrees	
BH203	1.20 - 1.65	U	2	30.5	1.87	1.43	27	333	167			Very stiff (very high strength) fissured gravelly slightly sandy CLAY with occasional carbonaceous speckling. Gravel is white and grey fine to coarse angular to subrounded chert.
BH204	1.20 - 1.65	U	2	30.5	1.99	1.52	22	145	73	19	36.9	Friable reddish yellow slightly gravelly slightly sandy silty CLAY with rare black carbonaceous speckling. Gravel is white and grey fine to coarse angular to subangular chert.
							49	225	113			
							73	284	142			

Method of Preparation: BS 1377: Part 1: 1990: 7.4.2 & 8, Part 2: 1990: 7.2, Part 7: 1990: 8.3
Method of Test: BS 1377: Part 2: 1990:3 Determination of Moisture Content, Part2: 1990:7 Determination of Density, Part 7: 1990: 8 Undrained Shear Strength, 9 Multistage Loading
Type of Sample Key: U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:
Remarks to Include: Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample, oven drying temperature if not 105-110°C



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/08/2019



0998

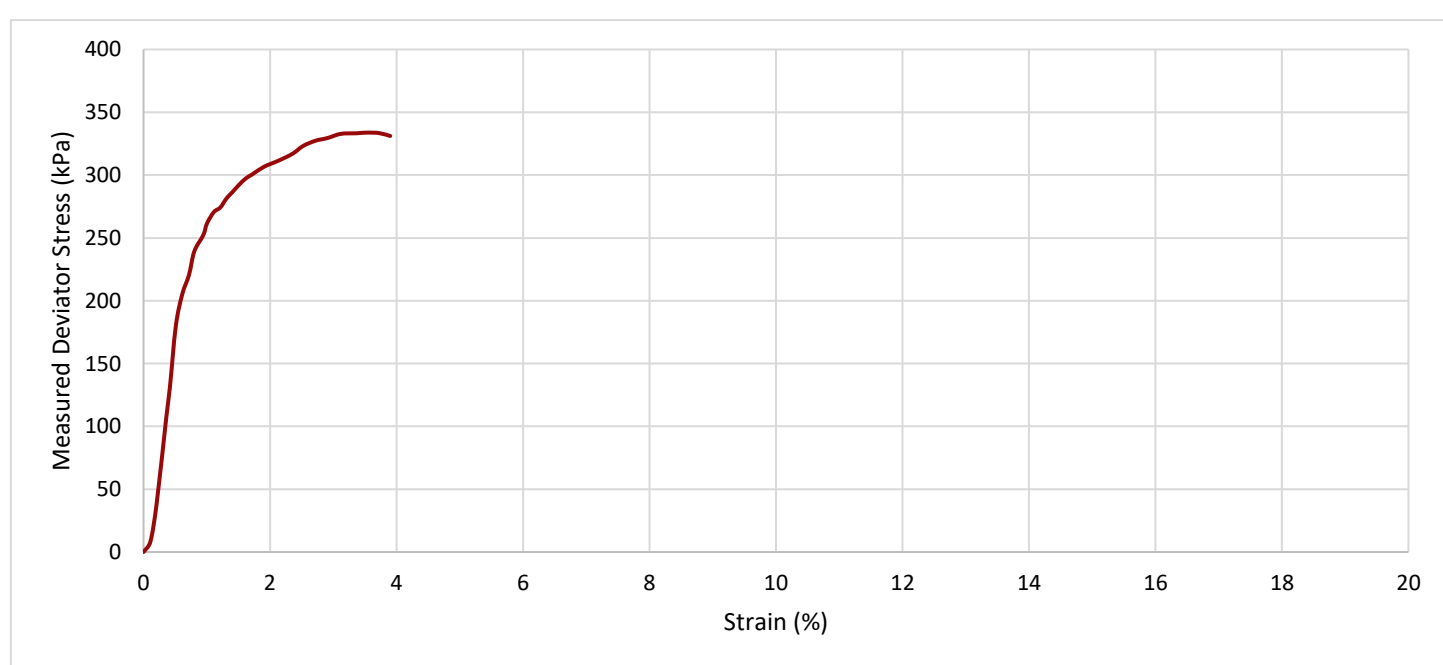
Contract	UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)
Serial No.	35598

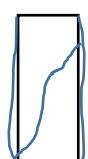
DETERMINATION OF UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole /Pit No.	Depth (m)	Type	Reference	Description	Remarks
BH203	1.20 - 1.65	U	2	Very stiff (very high strength) fissured gravelly slightly sandy CLAY with occasional carbonaceous speckling. Gravel is white and grey fine to coarse angular to subrounded chert.	Premature failure at 3.5% strain. Specimen failed during first pressure increment. Coarse gravel noted in specimen after test.

Initial Specimen		Height (mm)	Diameter (mm)	Weight (g)	Water Content (%)	Bulk Density (Mg/m ³)	Dry Density (Mg/m ³)
	Depth of Top of Specimen (m)	154.2	102.6	2379	30.5	1.87	1.43

TEST INFORMATION	Rate of Strain	1.5	% per Min	Rubber Membrane Thickness	0.6	mm
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Specimen at failure	Measured Cell Pressure, σ_3 (kPa)	Strain at Failure (%)	Stress Corrections (kPa)		Corrected Max. Deviator Stress, $(\sigma_1 - \sigma_3)_f$ (kPa)	Shear Stress C_u , $\frac{1}{2}(\sigma_1 - \sigma_3)_f$ (kPa)	Mohr's Circle Analysis	
			Rubber Membrane	Piston Friction			C_u (kPa)	ϕ (degrees)
	27	3.5	0.6	\	333	167		

Method of Preparation:	BS 1377: Part 1: 1990
Method of Test:	BS 1377: Part 7: 1990: 8 Definitive Method, 1990: 9 Multi-stage loading
Type of Sample Key:	U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:	Tested in Vertical Condition UKAS Calibration - loads from 0.2 to 10kN
Remarks to Include:	Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample, oven drying temperature if not 105-110°C



TEST REPORT

ISSUED BY SOIL PROPERTY TESTING LTD
DATE ISSUED: 08/08/2019



0998

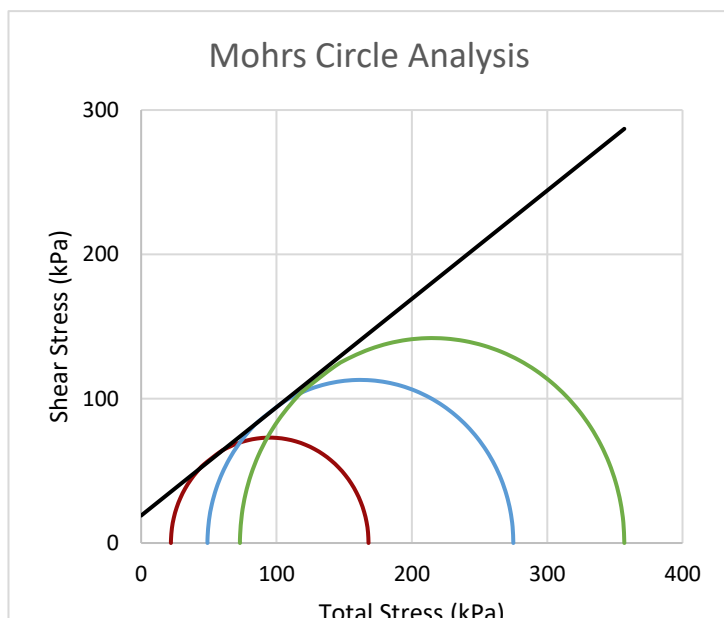
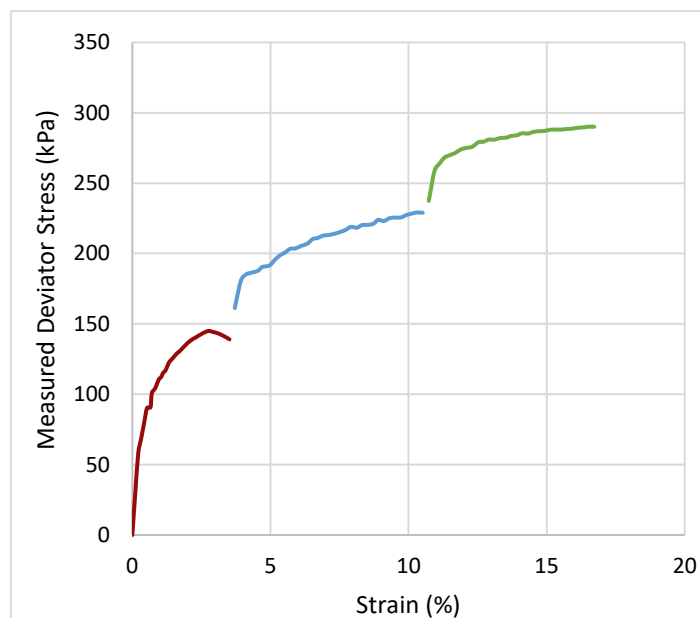
Contract	UK19.4388B - Holtsmere End Lane, Hemel Hempstead (South)
Serial No.	35598

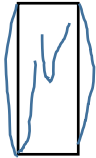
DETERMINATION OF UNDRAINED SHEAR STRENGTH IN TRIAXIAL COMPRESSION WITHOUT MEASUREMENT OF PORE PRESSURE

Borehole / Pit No.	Depth (m)	Type	Reference	Description	Remarks
BH204	1.20 - 1.65	U	2	Friable reddish yellow slightly gravelly slightly sandy silty CLAY with rare black carbonaceous speckling. Gravel is white and grey fine to coarse angular to subangular chert.	Coarse gravel noted in specimen after test.

Initial Specimen		Height (mm)	Diameter (mm)	Weight (g)	Water Content (%)	Bulk Density (Mg/m³)	Dry Density (Mg/m³)
	Depth of Top of Specimen (m) 1.34	168.9	103.1	2802	30.5	1.99	1.52

TEST INFORMATION	Rate of Strain	2.0	% per Min	Rubber Membrane Thickness	0.6	mm
------------------	----------------	-----	-----------	---------------------------	-----	----



Specimen at failure	Measured Cell Pressure, σ_3 (kPa)	Strain at Failure (%)	Stress Corrections (kPa)		Corrected Max. Deviator Stress, $(\sigma_1 - \sigma_3)_f$ (kPa)	Shear Stress C_u , $\frac{1}{2}(\sigma_1 - \sigma_3)_f$ (kPa)	Mohr's Circle Analysis	
			Rubber Membrane	Piston Friction			C_u (kPa)	ϕ (degrees)
	22	2.7	0.4	/	145	73	19	36.9
	49	10.3	1.3	2.2	225	113		
	73	16.5	1.9	3.9	284	142		

Method of Preparation:	BS 1377: Part 1: 1990
Method of Test:	BS 1377: Part 7: 1990: 8 Definitive Method, 1990: 9 Multi-stage loading
Type of Sample Key:	U = Undisturbed, B = Bulk, D = Disturbed, J = Jar, W = Water, SPT = Split Spoon Sample, C = Core Cutter
Comments:	Tested in Vertical Condition UKAS Calibration - loads from 0.2 to 10kN
Remarks to Include:	Sample disturbance, loss of moisture, variation from test procedure, location and origin of test specimen within original sample, oven drying temperature if not 105-110°C



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Ground Investigation Report

Land at Holtsmere End Lane

Hemel Hempstead
St Albans
Hertfordshire
AL3 7AW

Prepared for:

Pigeon (Hemel Hempstead) Limited

Salisbury House
Station Road
Cambridge
CB1 2LA

&

Bloor Homes South Midlands

Bewick House
6 Cygnet Drive
Swan Valley
Northampton
NN4 9BS

EPS Project Reference: UK24.7212b

Date Issued: 30th May 2025

Report Status: Issue 1

LAND AT HOLTSMEER END LANE, HEMEL HEMPSTEAD

NON-TECHNICAL CLIENT SUMMARY

This report presents the findings of a Ground Investigation undertaken to determine ground conditions and provide relevant information for use in the infiltration design for the site and its future development. Pertinent findings and conclusions are summarised as follows:

- The study area comprises several adjoining agricultural fields to the northeast of Hemel Hempstead and accessed via Great Revelend Farm. The land covers around 50 hectares and all of the fields had crops growing at the time of the investigation.
- The site works involved the excavation of six trial pits to a maximum depth of 2.6m, to allow for soakaway testing over three consecutive days. Ground conditions comprised a layer of topsoil above gravelly clay, anticipated to be the locally mapped superficial Clay-with-Flints. In some cases, the clay extended to beyond the base of the trial holes, but in others, chalk bedrock was encountered at depths ranging between 1.4m and 2.0m respectively. Groundwater wasn't recorded in any location.
- Based on the results of the soakaway testing, it is evident that infiltration drainage is likely to be feasible within the chalk bedrock that prevails across the site, but typically below 1-2m of superficial Clay-with-Flints. The calculated rates with the chalk bedrock are generally representative of 'low permeability conditions', and are summarised in Section 4.4 of this report. The overlying clay is not suitable for infiltration drainage with the testing confirming these soils are 'practically impermeable'.
- Furthermore, there is a potential risk for dissolution features to be created from any infiltration drainage infrastructure that is to be included as part of the proposed scheme, and this will require all due consideration as part of future design.

The above points represent a simplified summary of the findings of this assessment and **must not** form the basis for key decisions for the proposed development. A thorough review of the details is contained within the following report, or alternatively get in touch and we'll talk you through it.

Project Reference:	UK24.7212b	
Title:	Ground Investigation Report – Land at Holtsmere End Lane, Hemel Hempstead	
Client:	Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands	
Date:	30 th May 2025	
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Status:	Issue 1	

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The report has been written, reviewed, and authorised by the persons listed above. It has also undergone EPS' in house quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

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1 INTRODUCTION

In March 2025, Environmental Protection Strategies Ltd (EPS) was commissioned by Pigeon (Hemel Hempstead) Limited and Bloor Homes South Midlands to complete a Ground Investigation for a portion of the site known as Land at Holtsmere End Lane, Hemel Hempstead, St Albans, Hertfordshire, AL3 7AW ('the site'). A site location plan is presented as Figure 1 and selected site photographs are included as Appendix A.

The work was commissioned to investigate the nature of the ground conditions and to undertake infiltration testing to assist the drainage strategy for the site. This was completed in wider support of an upcoming planning submission for a residential scheme comprising significant provision for new dwellings as well as recreational, amenity and public open spaces, together with associated access and infrastructure works.

1.1 Scope of Works

To perform an exploratory assessment of the site in accordance with the principles and requirements of BS 5930:2015+A1:2020 '*Code of practice for ground investigations*,' the following tasks were undertaken.

Intrusive Investigation:

- Site walkover/ obtaining photographic records.
- Health and safety briefing/site supervision.
- Formation of six trial holes to a maximum depth of 2.6m below ground level (bgl), using a mechanical excavator, and subsequent infiltration testing undertaken in general accordance with *BRE Digest 365 'Soakaway Design'*.
- Continual logging of the ground conditions.
- Reinstatement.

Reporting:

- Data collection and interpretation.
- Reporting.

The findings of these investigations and their conclusions are presented in the following sections.

1.2 Limitations and Constraints

The purpose of this report is to present the findings of a soil sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements:

No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and/ or trial pits to recover soil and/ or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site sub-surface however, ground conditions are naturally variable, and it may be possible that the conditions encountered may differ to those found during the investigation.

This report does not include specific investigation for the presence of either Potential Asbestos Containing Material (PACM) or Japanese Knotweed at the subject site however, if obvious evidence of either is observed during EPS site walkover, details will be provided in this report. Specialist contractors should be commissioned to make detailed assessments and recommendations if these materials are suspected.

Whilst it is recognised that information contained within this report may assist relevant and suitably qualified professionals, this report does not provide a geotechnical appraisal of ground conditions with respect to suitability of foundations or future structures, nor does it intend to identify a need for any associated geotechnical ground improvement works.

2 SITE CONTEXT

The following section provides a summary of the information collected in relation to the site location and geo-environmental hazards which may be pertinent to this phase of works. The information has been sourced from a Phase I Desk Study written for the wider site by EPS in March 2025, as referenced below:

- *Phase I Geo-Environmental Desk Study – Land at Holtsmere End Land, Hemel Hempstead (Issue 2); dated 7th March 2025 – EPS Report Ref: UK24.7212*

It should be noted that the above document also includes a thorough review of several previous phases of geo-environmental assessment completed for the site by EPS and third parties, and should be read in conjunction with this report.

2.1 Site Location and Context

Detail	Description
Location	The site covers an area in the region of 50 hectares of largely undeveloped land situated northeast of Hemel Hempstead, between Little Revel End (south), Holtsmere End Lane (west) and Gaddesden Lane (north).
National Grid Reference	508198, 210892 (approximate centre of the site)
Topographic Elevation	Ground levels vary throughout the area with the highest elevation of approximately 130m Above Ordnance Datum (AOD) in the northwest and the lowest elevation of approximately 115m in the southeast.
Description of Site (May 2025)	During the most recent site visit in May 2025 the specific study area was noted as a series of adjacent agricultural fields accessed from Great Revelend Farm, located just southwest of Gaddesden Lane. The northern and eastern fields had relatively young crops, and the southern (largest) field had a more established grain crop. No buildings or structures are present within any of the fields, with the closest are some barns to the east, which are part of the nearby holding. The ground was firm and dry at the time of the investigation due to recent warm weather. Hedgerows and mature trees surrounded the fields along the perimeter, and the land was largely open and accessible.

Detail	Description	
Geology	Geological mapping indicates the site to be underlain by the bedrock geology, Lewes Nodular Chalk Formation and Seaford Chalk Formation. There are superficial deposits of Clay-with-Flints Formation mapped as clay, silt, sand, and gravel over certain areas of the site, coming through in two main sections, trending roughly northwest to southeast.	
Geological Hazards	Hazard	On Site Risk
	Mining (non-coal)	Rare
	Collapsible Ground	Very Low
	Compressible Ground	No Hazard
	Ground Dissolution	Moderate
	Running Sand	Very Low
	Landslide	Very Low
	Shrinking / Swelling Clay	Low
	Several chalk pits are present in the local area, including Flamsteadbury Farm Chalk Pit approximately 150m north and 330m north. Additionally, a sand and gravel pit is recorded within the grounds of Little Revelend Farm around 105m east.	
	A man-made mining cavity is recorded within the northern area, approximately 80m south of Great Revel End Farm, with a further, similar feature also reported in excess of 1km south.	
A single natural cavity is recorded in the surrounding area, this is located approximately 950m south of the southwestern corner of the study area and relates to a chalk solution pipe.		
Known Site Drainage & Utilities	An oil pipeline is known to run beneath the site on a northwest/southeast trend with marker posts located on at the edge of each field where the pipeline is situated.	
	Additionally, overhead power lines held up by wooden pylons have been identified and given a few farms are present within the wider site, albeit the holdings themselves are excluded from the study area, it is likely that below ground services such as potable water supply and drainage as well as other utilities will feed into and away from these properties, and should be considered through future development proposals.	

3 SUMMARY OF INVESTIGATIONS

The intrusive investigation was undertaken between the 6th and 8th May 2025, in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of the site activities is presented in the following sections:

3.1 Trial Pit Locations

Trial pit positions were initially selected by the projects engineers based on the anticipated development layout and potential locations for any drainage infrastructure to be installed as part of the scheme. Subsequent adjustments were based on the potential locations of existing below ground utilities as well as operational and health & safety considerations and access constraints highlighted by the landowner. Once excavated, the trial holes were covered with heras fencing and marked with cones to secure the locations which were left active overnight.

The objective in terms of trial pit locations was to assess the nature of the ground conditions and the potential suitability of the underlying soils for the adoption of infiltration drainage. Six locations were completed (TP01-TP06), formed to a maximum depth of 2.6m bgl.

All trial holes were fully reinstated upon completion of the works, firstly with compacted natural soil arising's and then the topsoil replaced and levelled at the surface.

The location of the trial pits is presented on Figure 2.

3.2 Infiltration Testing

Trial pits were logged for ground conditions encountered and soakaway infiltration testing was subsequently attempted in all locations, in general accordance with BRE Digest 365 'Soakaway Design', in order to assess the permeability of the shallow soil layers.

These tests were undertaken exclusively within the profile of the natural soils and in accordance with the methodology outlined in BS 5930:2015+A1:2020 'Code of practice for ground investigations'.

4 FINDINGS OF THE INVESTIGATION

This section of the report provides a summary of the findings of the various aspects of the ground investigation.

4.1 Ground Conditions

Site specific trial pit logs are included as Appendix B and give descriptions and depths of strata encountered. Based on the nature of the recovered soils and mapped geology of the area, the ground conditions encountered during the intrusive assessment have been interpreted to consist of the following:

- Topsoil
- Clay-with-Flints Formation
- Lewes Nodular Chalk Formation and Seaford Chalk Formation (Chalk Bedrock)

A summary of the general strata encountered across the site is provided in the table below, with a more detailed description given in the following sub-sections.

Geological Strata	Maximum Depth to Base of Strata (m bgl)	Range of Strata Thickness (m)
Topsoil	0.7	0.35-0.7
Clay-with-Flints Formation	>2.2	>0.6->1.85 (not always proven)
Lewes Nodular Chalk Formation & Seaford Chalk Formation (Chalk Bedrock)	>2.6	>0.6->0.8 (not proven)

4.1.1 Topsoil

A consistent layer of topsoil measuring between 0.35m and 0.7m thick was identified at all trial pit locations and comprised brown slightly gravelly, slightly silty clay with some rootlets.

4.1.2 Clay-with-Flints Formation

Beneath the topsoil, materials interpreted to be representative of the mapped superficial Clay-with-Flints Formation were encountered in all of the trial pits and extended beyond the base of TP04-TP06; which were progressed to depths of at least 2.0m. These locations were formed through the central belt of the site, coinciding with where superficial deposits were anticipated, whereas the depth was proven in TP01-TP03, and was shallowest in TP02 (1.4m) and TP02 (1.7m), which are relatively low lying sections just inside the southern border.

The soils were described as orangish brown, slightly gravelly, slightly silty, clay, with gravels consisting of fine-coarse subrounded to subangular flints. At TP05 & TP06 the composition of the clay was noticeably more sandy and silty.

4.1.3 Lewes Nodular Chalk Formation & Seaford Chalk Formation (Chalk Bedrock)

Beneath the superficial deposits, the chalk bedrock was encountered in TP01-TP03 and extended beyond the base of these trial pits, with the total depth ranging between 2.0m in TP02 and 2.6m in TP01. The soils were described as white, structureless chalk recovered as rare chalk gravel in a silt matrix.

4.2 Groundwater

No groundwater was encountered during the ground investigation.

4.3 Physical Evidence of Contamination

No made ground materials or physical evidence of contamination, such as soil staining, odour, or putrescible material, was encountered in any of the soils recovered as part of this investigation.

4.4 Infiltration Testing Results

Infiltration testing was attempted at all six trial pit locations (TP01 – TP06), the results of which are summarised in the table below.

Trial Pit Location	Depth of Trial Pit (m bgl)	Infiltration Rate (m/s)	Comments
TP01 (Test 1)	2.6	8.716×10^{-5}	Three complete tests achieved.
TP01 (Test 2)		1.600×10^{-5}	
TP01 (Test 3)		1.790×10^{-5}	
TP02 (Test 1)	2.0	2.608×10^{-6}	Two complete tests achieved, both of which were left running overnight.
TP02 (Test 2)		2.930×10^{-6}	
TP03 (Test 1)	2.5	3.135×10^{-6}	Two complete tests achieved, both of which were left running overnight.
TP03 (Test 2)		2.160×10^{-6}	
TP04 (Test 1)	2.0	Not Calculable	Test failed to reach even 25% completion in a period in excess of 24 hours.
TP05 (Test 1)	2.1	Not Calculable	Test failed to reach even 25% completion in a period in excess of 24 hours.
TP06 (Test 1)	2.2	Not Calculable	Test failed to reach even 25% completion in a period in excess of 24 hours.

The above summary confirms that all tests conducted within the profile of the chalk bedrock (TP01-TP03) successfully reached 75% completion, with repeats achieved in each of these positions. Overall, the calculated rates in TP01 were the most favourable, and this might have been due to the composition of the bedrock itself (i.e. slightly more chalk gravel as oppose to silt).

However, tests at TP04-TP06, where clay-based superficial deposits were encountered through the full profile, failed to reach even 25% completion, with negligible infiltration recorded after approximately 24 hours in all of these trial pits.

4.5 Conclusions

Based on the results of the soakaway testing, it is evident that infiltration drainage is likely to be feasible within the chalk bedrock that prevails across the site, but typically below 1-2m, of superficial Clay-with-Flints. The calculated rates with the chalk bedrock are generally representative of 'low permeability conditions'.

However, the same cannot be said for the superficial clay strata (Clay-with-Flints) making up the full profile within TP04-TP06, where negligible infiltration was observed over the testing period; confirming these soils are 'practically impermeable' and not suitable for infiltration drainage. This is common of clay soils of this nature, which are typically fine and low permeability.

As a result, the use of infiltration drainage is considered feasible for the site, however any features such as soakaways installed as part of the development will have to extend to penetrate the superficial clay and reach the profile of the chalk bedrock. Based on the ground conditions identified in the trial holes, the top surface of the chalk ranges from around 1.4m, but in excess of 2.2m in other area; and further variation is possible in sections not covered by the initial assessment.

It's important to note that while no groundwater was encountered within 2.6m during the initial site works, the depth to groundwater could vary, especially during the winter months or following periods of heavy or sustained rainfall, particularly in lower lying sections of the site.

Furthermore, consideration should be given to the potential for dissolution features to be created from any infiltration drainage infrastructure that is to be adopted as part of the proposed scheme. It would be prudent to consider the risk of creating such features by discharging surface waters into the ground at a focussed point. This was highlighted within the Envirocheck data report (sourced for the wider site), which confirms a moderate risk of dissolution, and at least one natural cavity entry within 1km of the boundary.

Therefore, it is recommended to consult the building control department of the Local Authority to confirm any mitigation measures that would typically be expected, as part of the development of the drainage strategy.

FIGURES



Rev	Date	Drawn	Description	Chkd



The Geotechnical and Environmental Engineers
www.epstrategies.co.uk

Site
Land at Holtsmere End Lane, Hemel Hempstead
St Albans, Hertfordshire, AL3 7AW

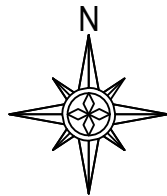
Client
Pigeon (Hemel Hempstead) Limited &
Bloor Homes South Midlands

Title
Figure 1 - Site Location Plan

Surveyed by:		Drawn by:	OB
Checked by:	BV	Date:	21/05/2025

Scale	(A4 Sheet)	Drawing Reference
Not to Scale		UK24.7212b_01

Job No	Rev
UK24.7212b	01



KEY:
— SITE BOUNDARY
■ EPS TRIAL PIT / SOAKAWAY

Rev	Date	Drawn	Description	Chk'd



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Site
Land at Holtsmere End Lane, Hemel Hempstead
St Albans, Hertfordshire, AL3 7AW

Client
Pigeon (Hemel Hempstead) Limited &
Bloor Homes South Midlands

Title
Figure 2 - Trial Pit Location Plan

Surveyed by:	BV	Drawn by:	OB
Checked by:	BV	Date:	21/05/2025

Scale	(A4 Sheet)	Drawing Reference
Not to Scale		UK24.7212b_02

Job No	Rev
UK24.7212b	01

APPENDICES

APPENDIX A

Selected Site Photographs



KEY:

— SITE BOUNDARY

➔ DIRECTION OF SITE PHOTOGRAPH

○ SITE PHOTOGRAPH NUMBER

Rev	Date	Drawn	Description	Crkd



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Site
Land at Holtsmere End Lane, Hemel Hempstead
St Albans, Hertfordshire, AL3 7AW

Client
Pigeon (Hemel Hempstead) Limited &
Bloor Homes South Midlands

Title
Appendix A - Photo Location Plan

Surveyed:		Drawn by:	OB
Checked by:	BV	Date:	21/05/2025

Scale	(A4 Sheet)	Drawing Reference
Not to Scale		UK24.7212b_03

Job No	Rev
UK24.7212b	01

Site Photos UK24.7212b – Land at Holtsmere End Lane, Hemel Hempstead

Photo 1: Facing north from Trial Pit TP02



Photo 2: Facing south along access road, showing marker for high pressure oil pipe



Photo 3: Facing west from Trial Pit TP03



Photo 4: Facing east from near Trial Pit TP04



Photo 5: Facing north from Trial Pit TP06



Photo 6: Facing southeast from Trial Pit TP06



Photo 7: Facing northeast from access road near Trial Pit TP01



Photo 8: Facing east from Trial Pit TP02



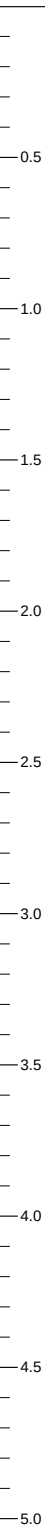
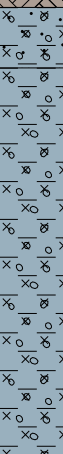
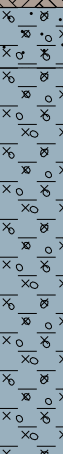
Photo 9: Facing southeast from Trial Pit TP04.



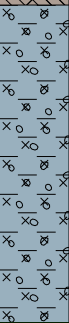
APPENDIX B

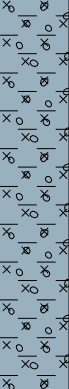
Site Specific Trial Pit Logs

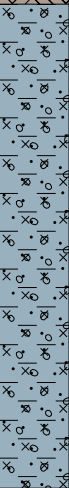


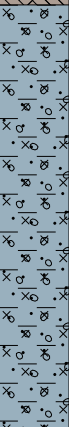
Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (thickness) (m)	Strata		
		Depth (m)	Type/ Ref	Results			Legend	Description	
						(0.50)		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.	
						(1.30)		Orangish brown, slightly gravelly, slightly sandy, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation) Orangish brown, gravelly, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)	0.5

Method, Plant, Stability, Dimensions	Logger
0.00 - 2.60m TP JCB	OB
$L = 1.85m$  $W = 0.40m$	

				Trial Pit				TP02 Sheet 1 of 1					
Hole Type		Easting		Northing		Ground Level (m)		Scale					
TP		508090.00		210288.00				1:25					
Project Name				Project No.		Start Date		End Date					
Land at Holtsmere End Lane, Hemel Hempstead				UK24.7212b		2025-05-06		2025-05-06					
Client				Consultant		Contractor							
Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands				OB									
Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (m)	Strata						
		Depth (m)	Type/ Ref	Results			Legend	Description					
						(0.35)		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.	0.5				
										Orangish brown, gravelly, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)	1.0		
												White structionless CHALK recovered as rare chalk gravel in a silt matrix. (Lewes Nodular Chalk Formation & Seaford Chalk Formation)	1.5
						2.00		End of Trial Pit at 2.00m	2.0				
									2.5				
									3.0				
									3.5				
									4.0				
									4.5				
									5.0				
Remarks								Method, Plant, Stability, Dimensions		Logger			
Groundwater not encountered								0.00 - 2.00m TP JCB		OB			
								L = 2.00m W = 0.40m					

				Trial Pit				TP03 Sheet 1 of 1			
Hole Type		Easting		Northing		Ground Level (m)		Scale			
TP		508384.00		210487.00				1:25			
Project Name				Project No.		Start Date		End Date			
Land at Holtsmere End Lane, Hemel Hempstead				UK24.7212b		2025-05-06		2025-05-06			
Client				Consultant		Contractor					
Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands				OB							
Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (m)	Strata				
		Depth (m)	Type/ Ref	Results			Legend	Description			
						(0.40)		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.		0.5	
						(1.30)		Orangish brown, gravelly, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)		1.0	
						(1.70)		White structionless CHALK recovered as rare chalk gravel in a silt matrix. (Lewes Nodular Chalk Formation & Seaford Chalk Formation)		2.0	
						(2.50)		End of Trial Pit at 2.50m		2.5	
										3.0	
										3.5	
										4.0	
										4.5	
										5.0	
Remarks								Method, Plant, Stability, Dimensions		Logger	
Groundwater not encountered								0.00 - 2.50m TP JCB		OB	
								L = 1.50m W = 0.40m			

				Trial Pit				TP04 Sheet 1 of 1			
Hole Type		Easting		Northing		Ground Level (m)		Scale			
TP		508041.00		210820.00				1:25			
Project Name				Project No.		Start Date		End Date			
Land at Holtsmere End Lane, Hemel Hempstead				UK24.7212b		2025-05-06		2025-05-06			
Client				Consultant		Contractor					
Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands				OB							
Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (m)	Strata				
		Depth (m)	Type/ Ref	Results			Legend	Description			
						(0.40)		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.			
						0.40		Orangish brown, slightly gravelly, slightly sandy, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)		0.5	
										1.0	
										1.5	
										2.0	
										2.5	
										3.0	
										3.5	
										4.0	
										4.5	
										5.0	
Remarks								Method, Plant, Stability, Dimensions		Logger	
Groundwater not encountered								0.00 - 2.00m TP JCB		OB	
								L = 1.40m W = 0.40m			

				Trial Pit				TP05 Sheet 1 of 1			
Hole Type		Easting		Northing		Ground Level (m)		Scale			
TP		508236.00		210928.00				1:25			
Project Name				Project No.		Start Date		End Date			
Land at Holtsmere End Lane, Hemel Hempstead				UK24.7212b		2025-05-06		2025-05-06			
Client				Consultant		Contractor					
Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands				OB							
Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (m)	Strata				
		Depth (m)	Type/ Ref	Results			Legend	Description			
						(0.70)		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.		0.5	
						0.70		Orangish brown, slightly gravelly, slightly sandy, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)		1.0	
						(1.40)				1.5	
						2.10		End of Trial Pit at 2.10m		2.0	
										2.5	
										3.0	
										3.5	
										4.0	
										4.5	
										5.0	

Remarks	Groundwater not encountered		Method, Plant, Stability, Dimensions		Logger
			0.00 - 2.10m TP JCB		
			L = 1.50m		
			W = 0.40m		



Trial Pit

TP06

Sheet 1 of 1

Hole Type

TP

Easting

508330.00

Northing

210845.00

Ground Level (m)

Scale

1:25

Project Name

Land at Holtsmere End Lane, Hemel Hempstead

Project No.

UK24.7212b

Start Date

2025-05-06

End Date

2025-05-06

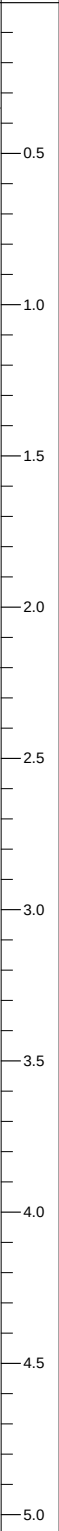
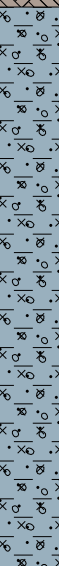
Client

Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands

Consultant

OB

Contractor

Inst/ Backfill	Water Levels	Samples and Tests			Level (m)	Depth (thickness) (m)	Strata		
		Depth (m)	Type/ Ref	Results			Legend	Description	
						0.35		TOPSOIL. Brown, slightly gravelly, slightly sandy, silty CLAY, with rootlets. Gravels consist of fine-coarse, subrounded-subangular flint.	
						0.35		Orangish brown, slightly gravelly, slightly sandy, silty CLAY. Gravels consist of fine-coarse, subrounded-subangular flint. (Clay-with-Flints Formation)	
						(1.85)			
						2.20		End of Trial Pit at 2.20m	

Remarks

Remarks
Groundwater not encountered

Method, Plant, Stability, Dimensions

0.00 - 2.20m

 $L = 1.20m$

$$L = 1.2011$$

$$W = 0.40m$$

Logger

OB



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Phase I Geo-Environmental Desk Study

Land at Holtsmere End Lane

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EPS Project Reference: UK24.7212

Date Issued: 18th November 2025

Report Status: Issue 3

LAND AT HOLTSMEER END LANE, HEMEL HEMPSTEAD

NON-TECHNICAL CLIENT SUMMARY

This report presents the findings of a Phase I Geo-Environmental Desk Study which was carried out to assess risks posed by contaminated land and to provide an initial assessment of geological/ geotechnical hazards, and how the proposed scheme might be affected.

- The land at Holtsmere End Lane is currently occupied by fields used as arable farmland and has remained largely undeveloped throughout its history, with the exception of some suspected infilled chalk pits, and other minor areas of infilling where made ground could be present. It is understood that outline development proposals are for a notable residential scheme.
- Geological mapping suggests the ground conditions consist of Clay-with-Flints or superficial Head Deposits over chalk bedrock. Some previous intrusive investigations carried out by EPS in 2019 and 2020 in the southern parcel found the superficial Clay-with-Flints to extend to a maximum depth of 6.7m, with chalk below.
- The main risk identified with respect to the proposed development is the potential for the interaction between groundworkers and future site users (residents) with potentially contaminated shallow soils. Therefore, further assessment is recommended to assess soil quality across the site, with particular focus given to areas where infilled features or made ground might be expected based on historical mapping and geophysical surveys completed by third party consultants.
- Risks to future site users from the generation and accumulation of ground gases have also been highlighted, primarily associated with the historic chalk pits recorded onsite, but also a nearby landfill. Therefore, additional ground gas monitoring to complement the existing data has also been recommended. Furthermore, some of the site lies within an area where basic radon protective measures will likely be required in the construction of new buildings, and it is recommended that a detailed radon report is obtained and compared against future development proposals once this has been made available.
- A moderate risk of the presence of chalk dissolution has also been identified. This must be given full consideration in future design, albeit current indications suggest that this will not represent a significant constraint to development; based on the findings of initial ground investigation works conducted by EPS, although it is recognised that further detail and coverage is required for this to be conclusive.

By their very nature, the above bullet points represent a simplified summary of our work and **must not** be relied upon to form the basis for key decisions for the proposed development. A full picture is provided in the following report, or alternatively give us a call and we'll talk you through it.



Project Reference:	UK24.7212	
Title:	Phase I Geo–Environmental Desk Study – Land at Holstmere End Lane, Hemel Hempstead	
Client:	Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands	
Date:	18 th November 2025	
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Status:	Issue 3	
Changes since last issue (Issue 2, 24th March 2025)	Figure 1 adjusted to reflect up to date site boundary and adjusted references to site boundary / description throughout	

Author:	Reviewed:	Authorised:
		
Tom Androsiuk	Ben Virtue	Ben Virtue
Principal Consultant	Associate Director	Associate Director

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If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS however, EPS cannot guarantee the validity of these data.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS. This report and its contents, together with any supporting correspondence or other documentation, remain the property of Environmental Protection Strategies Ltd until paid for in full.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' in house quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

The National Planning Policy Framework requires a competent person to prepare site investigation information, which is defined as a person with a recognised relevant qualification, sufficient experience in dealing with the type(s) of pollution or land instability, and membership of a relevant professional organisation. EPS considers that it fulfils these criteria and would welcome any request for staff CVs or case studies to demonstrate it.

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Figure 1 Site Location Plan

Appendices

Appendix A	Selected Site Photographs & Walkover Notes
Appendix B*	Surrounding Land Use
Appendix C*	Geological Context
Appendix D*	Groundwater Vulnerability and Flood Maps
Appendix E*	A Selection of Historic Maps

*Please note that the site boundary shown on Appendices B – E are not reflective of the latest site boundary as of November 2025 which is presented on Figure 1.

1 INTRODUCTION

In December 2024, Environmental Protection Strategies Ltd (EPS) was commissioned by Pigeon (Hemel Hempstead) Limited & Bloor Homes South Midlands to complete a Phase I Geo-Environmental Desk Study for Land at Holstmere End Lane, Hemel Hempstead, St Albans, Hertfordshire, AL3 7AW ('the site'); see Figure 1.

The work was commissioned to support outline planning proposals for a residential scheme comprising significant provision for new dwellings as well as recreational, amenity and public open spaces together with associated access and infrastructure works.

This report presents the findings, conclusions, and recommendations of the Phase I Desk Study undertaken for the site as instructed, and also summaries a number of previous documents produced for portions of the same study area by both EPS and third parties.

1.1 Objectives

The purpose of this desk study is to evaluate the potential contaminant linkages which may be active at the site in its current condition, or could become active in future, and to determine if any action is required to investigate them further or to break them.

This is achieved by carrying out the following activities:

- a) Examining the site history - late 1800s to present day, through collection of historical maps of the area, site records, records held by relevant local authorities, the Environment Agency and review of other information databases.
- b) Characterising the site's environmental and geological sensitivity through examination of existing geological, hydrogeological, topographical, and historical maps and aerial photographs of the area.
- c) Identifying Potential Areas of Concern (PAOC's) through a combination of historical map and data review.
- d) Consideration of any future plans for the site and the effects any proposed changes may have on contaminant linkages over time.
- e) Development of a Conceptual Site Model through a Preliminary Risk Assessment to evaluate the potential risks posed by the site and make recommendations for any further work that may be required to ensure suitability for use and safe development. In accordance with the Environment Agency's *Land Contamination: Risk Management* guidance and the *National Planning Policy Framework*.

1.2 Project Limitations and Constraints

The purpose of this report is to present the findings of a Phase I Geo-Environmental Desk Study conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, EPS makes the following statements:



This report does not include specific investigation for the presence of either Potential Asbestos Containing Material (PACM) or Japanese Knotweed at the subject site however, if obvious evidence of either is observed during EPS site walkover, details will be provided in this report. Specialist contractors should be commissioned to make detailed assessments and recommendations if these materials are suspected.

2 SITE CHARACTERISATION

The following section provides a summary of the information collected in relation to the site location and history.

2.1 Site Location and Description

Detail	Description
Location	The site covers an area in the region of 105 hectares of largely undeveloped land situated northeast of Hemel Hempstead, between Hemel Hempstead Road (south), Holstmere End Lane (west) and Gaddesden Lane (north).
Grid Reference	508471, 210766 (approximately central)
Topographic Elevation	Ground levels vary throughout the area with the highest elevation of approximately 132m Above Ordnance Datum (AOD) present in the northwest and the lowest elevation of approximately 106m in the southeast.
Description of Site	The study area is an irregularly shaped parcel of land characterised by a number of agricultural fields located adjacent to one another and bound by country lanes and local roads as well as field boundaries marked with mature hedgerows. Approximately a third of the way along the western boundary, from the southwestern corner, an unnamed road extends northeast from Holstmere End Lane, towards Little Revelend Farm (albeit the holding itself is not part of the study area); which is situated just to the southeast of centre. This road extends further east (past the farmyard) and eventually joins a short lane known as Little Revelend and then onto Hemel Hempstead Road (B487). A caravan park, some larger agricultural stores, poultry houses and a few residential dwellings are located just off site in this area. Another unnamed road further northwest along Holstmere End Lane provides access to Great Revel End Farm (which is also excluded from the study area), from Holstmere End Lane. A number of small tracks link between the fields and these two farmyards. No buildings or structures appear to be present within any of the fields, with the nearby farms and properties outlined above not forming part of the study area itself. During a site walkover in February 2025, the fields were planted with a range of different crops with the ground surface soft and 'boggy' in selected areas. Surface water features in the form of small ponds are present within the bounds of the site and these is located in and amongst some trees immediately south of Great Revel End Farm.

Detail	Description
Description of Site (cont.)	Occasional instances of 'fly tipped' waste were also noted during the site walkover, these appeared to be confined to the tracks/ roads between some of the fields and bordering the area of investigation (particularly adjacent to Holtsmere End Lane).
Surrounding Land Use	To the northwest, northeast and south the land appears to be agricultural / arable farmland with some limited residential and agricultural buildings. To the west the land use is predominantly residential properties with some retail shops and schools. To the east is further arable farmland interspersed with agricultural buildings along with a few dwellings, a hotel and the M1 motorway. Further afield, approximately 1.4km south of the study area is the Buncefield Oil Terminal.

A plan showing the site location is provided as Figure 1. Selected Site Photographs are included as Appendix A along with the Walkover Notes, and relevant extracts of a Landmark Envirocheck report are included as Appendix B.

2.2 Geo-Environmental Setting

Detail	Description
Geology	Geological maps show that superficial clay, silt, sand and gravel of the Clay-with-Flints Formation are mapped across central and eastern sections, with a few narrow outcrops spanning from east to west. Superficial clay, silt, sand and gravel of the Head Deposits are also mapped encroaching the southeastern corner of the area. The bedrock geology is mapped as chalk of the Lewes Nodular Chalk & Seaford Chalk Formations (undifferentiated). No artificial geology is mapped on site or in the surrounding area. Information on the site's geological context is included as Appendix C.
British Geological Survey (BGS) & Site Specific Geology	A number of historic borehole records hosted by the BGS are present in the surrounding area including one drilled within the grounds of Great Revel End Farm. This borehole reports the Clay-with-Flints to be present to approximately 30.5m, with chalk then recorded to the base of the borehole at approximately 60.4m. This borehole was drilled in 1947 and resting groundwater was recorded at a depth of approximately 24.7m. A copy of the historic borehole is also included within Appendix C. Having undertaken some limited intrusive investigation in select parts of the site, EPS also have some information on the site-specific geology and this is referenced in greater detail in Section 2.3.

Detail	Description	
Geological Hazards	Hazard	On Site Risk
	Mining (non-coal)	Rare
	Collapsible Ground	Very Low
	Compressible Ground	No Hazard
	Ground Dissolution	Moderate
	Running Sand	Very Low
	Landslide	Very Low
	Shrinking / Swelling Clay	Low
	Several chalk pits are present in the local area, including Flamsteadbury Farm Chalk Pit approximately 150m north and 330m north. Additionally, a sand and gravel pit is recorded within the grounds of Little Revelend Farm around 105m east of the southeastern corner of the study area. A man-made mining cavity is recorded within the northern area, approximately 80m south of Great Revel End Farm, with a further, similar feature also reported approximately 500m south. A single natural cavity is recorded in the surrounding area, this is located approximately 470m south of the southwestern corner of the study area and relates to a chalk solution pipe.	
Radon	Since EPS' previous phases of work at this site (see Section 2.3 for further detail), radon maps have been updated, and therefore, so have the protection requirements. At the time of writing, the Envirocheck report indicates that the majority of the site appears to lie within an area where the percentage of homes above the radon action level is 3% - 5%. As such, basic radon protection will likely be required for a significant portion of the proposed dwellings / buildings. It is recommended that once development plans are finalised that a site-specific radon report is obtained from the BGS to determine which specific plots will require basic or even full radon protection measures to be incorporated; and this should be agreed with the building control department of the Local Authority.	
Hydrogeology	Groundwater vulnerability maps for the area show that the superficial Clay-with-Flints Formation is classified as Unproductive Strata while the superficial Head Deposits are mapped as a Secondary (undifferentiated) Aquifer. The bedrock Lewes Nodular Chalk & Seaford Chalk Formations (undifferentiated) are classified as a sensitive Principal Aquifer. The entire site area lies within a Total Catchment (Zone 3) Source Protection Zone for local groundwater abstraction.	

Detail	Description
Hydrogeology (cont.)	Two groundwater abstractions are reported within approximately 150m east of the southeastern corner of the study area where groundwater is reported to be abstracted from a borehole for general farming and agricultural use. A groundwater abstraction is also recorded at Great Revelend Farm adjacent to the east where groundwater is abstracted for general farming and domestic use. Two groundwater abstractions are also located approximately 250m north of the northwestern corner, where groundwater is abstracted for general agriculture and for private household use. Groundwater vulnerability maps are included as Appendix D.
Hydrology & Flood Risk	On-site surface water features are known to be present in the form of small ponds in and amongst some trees immediately south of Great Revel End Farm. Some further ponds or basins are located adjacent to the M1 to the east. It is also possible that small scale drainage ditches are present within the hedgerows that separate the fields within the area of investigation. A number of discharge consents are held within the surrounding area, with the closest of these being located adjacent to the sites northern corner, within approximately 100m of the eastern limit and within approximately 400m of the sites southern corner. The nearest entry relates to final/ treated effluent being released to land via a soakaway. No surface water abstractions are recorded within 1km. Review of the EA Flood Zone Map for the area indicates that the entire site area lies within Flood Zone 1, which is defined as the area with a low potential risk of flooding from fluvial or tidal sources. It should be noted that the EA maps do not take into account flooding from poor drainage, or groundwater. A copy of the flood maps for the site and surrounding area is also included within Appendix D.
Known Site Drainage & Utilities	An oil pipeline is known to run beneath the site on a northwest/ southeast trend with marker posts located on at the edge of each field where the pipeline runs through. Additionally, overhead power lines held up by wooden pylons follow the same approximate route through the southern area, but then divert towards the southwestern corner in the northern parcel. Given a few farms are present within the wider site, albeit the holdings themselves are excluded from the study area, it is likely that below ground services such as potable water supply and drainage as well as other utilities will feed into and away from these

	properties, and should be considered through future development proposals.		
Detail	Description		
Landfill & Waste	A landfill recorded by the local authority is located approximately 290m southeast of the sites southern corner, while no additional information about this landfill is provided, this area now appears to be occupied by residential housing.		
	A relatively small and historic landfill is located adjacent to the eastern corner of the site (at the junction of Hempstead Road and Little Revelend). This facility is recorded to have accepted inert waste between August 1962 and December 1963.		
	One small area of potentially infilled land (possible pit or pond) is recorded just inside the western boundary of the site (around the midpoint). Additional entries are highlighted within 200m of the eastern border and approximately 150m/ 330m north (coinciding with the aforementioned Flamsteadbury Farm Chalk Pits).		
	No licensed waste management facilities or registered waste transfer, treatment or disposal sites are recorded within 500m.		
Permitted Industrial Activity	Two sites are licensed by the local authority for industrial activity within the surrounding area. These include 'Flint To Cell Limited' approximately 930m southwest, where the use of generators is authorised and 'Itab Uk Ltd', based in a similar location, where metal decontamination processes are permitted.		
Industrial Land Use & Points of Interest	The Envirocheck report lists a number of industrial land uses within the surrounding area and the closest/ most pertinent of these are summarised below.		
	Land Use	Approximate Distance & Direction	Status
	C Brown & Sons (Car Breakers & Dismantlers)	50m southeast	Inactive
	Apple Tree Dry Cleaners (Dry Cleaners)	40m west	Inactive
	Woodhall Hardware & DIY (Hardware)	40m west	Inactive
	C Brown & Sons (Car Breakers & Dismantlers)	50m southeast	Inactive
	There are no records of any fuel station entries within 1km.		

Detail	Description		
Pollution Incidents	Several pollution incidents are also recorded within 1km and these are summarised in the below.		
	Pollutant, Receiving Water & Date of Pollution Incident	Approximate Distance & Direction	Incident Severity / Category
	Oils (unknown), unknown/ not given, April 1990	250m south	Category 3 (minor) Incident
	Oils (unknown), unknown/ not given, October 1992	520m east	Category 3 (minor) Incident
	Chemicals (unknown), unknown/ not given, October 1995	780m southwest	Category 3 (minor) Incident
	There are no records on the substantiated pollution incident register within the surrounding 1km and similarly there are no records of any prosecutions relating to controlled waters or authorised processes within the same radius.		
Previous Investigation or Remediation	EPS have undertaken several phases of work for a range of different purposes in select parts of the site. A summary of the assessments completed by EPS and third parties is presented in Section 2.3 below.		
Sensitive Land Use	The site lies within a Nitrate Vulnerable Zone where surface water is identified as being at risk from nitrates leaching from agricultural land. The area of investigation is also within an area of adopted Green Belt.		

2.3 Summary of Previous Reports

A number of previous assessments have been completed (by EPS and third parties), that relate to selected parts of the study area. For background information, it is recommended that the reader review the following reports in full, with any pertinent points which may impact the findings of this risk assessment summarised below.

- *Phase 1 Geo-Environmental Desk Study – Redbourn Road / Hemel Hempstead Road, Hemel Hempstead (Ref: 19-0138) – Rolton Group, (February 2018)*

This Phase 1 Geo-Environmental Desk Study covered the southern parcel of the wider area and did not identify any likely sources of significant contamination. However, due to the presence of an old chalk pit in the north and the oil pipeline running through the centre, some made ground used to fill/ level areas was noted to potentially be present, but the associated contaminants were deemed to be relatively stable and not high risk.

Additionally, there was deemed to be a 'significant possibility' of below ground cavities existing from natural dissolution or physical removal associated with the old chalk pits on and neighbouring the site.

Additional investigation into the site was recommended including a geophysical survey to assess for the presence of cavities and a subsequent intrusive ground investigation to identify any anomalies.

- *PBA Natural and Mining Cavities Databases Search with Cavities Occurrence Assessment for the Site at Land Adjacent to Holtsmere End Lane, Hemel Hempstead, AL3 7AW (Ref: 45635//CBH/JW/HG) – Peter Brett Associates, (February 2019)*

This correspondence includes a review of natural and mining cavity records for the local area along with a cavity occurrence assessment for the site (southern area only). The database search identified two natural cavity locations within 2km of southern parcel. The closest is located 160m south-southeast and relates to a solution pipe while the other cavity is approximately 1.5km south-southwest and relates to 10 solution pipes. One mining cavity was also recorded within the surrounding area at 710m north and is referred to as a chalkwell.

The cavity occurrence assessment provided a rating of 'moderately high' due to the superficial Clay-with-Flints Formation that could under-drain into the chalk below, creating the potential for solution features to occur. The assessment also suggests that the local area is well known for historic chalk mining, and two old chalk pits on the northern and eastern boundaries of the site are highlighted in historic mapping.

Recommendations were made to prepare a hazard zoning map to assist in undertaking a ground investigation and a geophysical survey was also recommended.

- *Geophysical Survey Report, Land adjacent to Holtsmere End Lane Hemel Hempstead, Hertfordshire, Survey Report Reference MSTL461 – Magnitude Surveys, (April 2019)*

Two geophysical surveys have been carried out within the southern area, the first of these had the objective to assess the subsurface archaeological potential and involved a fluxgate magnetometer survey. The key results of the survey are summarised below;

- The survey identified anomalies forming an open sided footing for a structure surrounded by rubble, which is possibly linked to the demolition of a building in the north-western area. If these anomalies are to be interpreted as a former on-site structure, this would pre-date historical mapping.

- In the northern area of the southern parcel, evidence of chalk extraction was recorded as anomalies coinciding with the historic chalk pit shown on maps from 1878. This area was defined by a copse of trees on subsequent historic records. A smaller extraction feature (chalk pit) was also interpreted approximately 100m south of the mapped chalk pit which seemingly coincides with a potential un-mapped chalk pit evidenced on an aerial photograph from the 1940's.
- *Geophysical Survey Report, Holtsmere End Lane, Hemel Hempstead, Survey Report Reference SOR14814 – Sumo Geophysics Ltd, (April 2019)*

The second geophysical survey involved completing an electromagnetic field to search for evidence of solution features and possible mine workings. The results are summarised below;

- In total, sixteen anomalies were identified from the conductivity data. Of those, six conductivity highs (C4, C6, C7, C8, C9 and C10) and six conductivity lows (C1, C2, C3, C5, C14 and C15) were interpreted to be associated with potential dissolution features. It should be noted that these anomalies can be produced by changes in the ground conditions and not just solely dissolution features.
- Four discrete conductivity anomalies (C11, C12, C13 and C16) were deemed small enough to be potentially associated with mineshafts.
- Recommendations were made to target the anomalies by follow up intrusive investigations.

Following the completion of these geophysical surveys, a preliminary ground investigation was completed by EPS in the southern parcel, in order to initially assess the ground conditions across this portion of the site.

- *Preliminary Ground Investigation Report, Holtsmere End Lane (South), Report Reference: UK19.4388 – EPS Ltd, (June 2019)*

The preliminary ground investigation involved the formation of twenty boreholes, drilled throughout the southern site area with dynamic probing also completed at each borehole location in order to assess the potential risks associated with chalk dissolution features and historic chalk mining. From the preliminary ground investigation, the risks associated with chalk dissolution were considered to be low, however further detailed investigation was recommended at a later stage.

- *Ground Investigation Report, Land Adjacent to Holtsmere End Lane (South), Report Reference: UK19.4388b – EPS Ltd, (September 2019)*

This ground investigation focused on initially assessing the infiltration and drainage characteristics of the soils in the southern site area. The intrusive investigations involved the drilling of four deep boreholes to a maximum depth of 18.37m below ground level (bgl) and excavating four trial pits to 2.9m.

Ground conditions were found to comprise a thin layer of topsoil underlain by a varying thickness (0.45m to 1.8m) of Clay-with-Flints overlying chalk. Groundwater was struck within one borehole when drilling, at a depth of 14.8m.

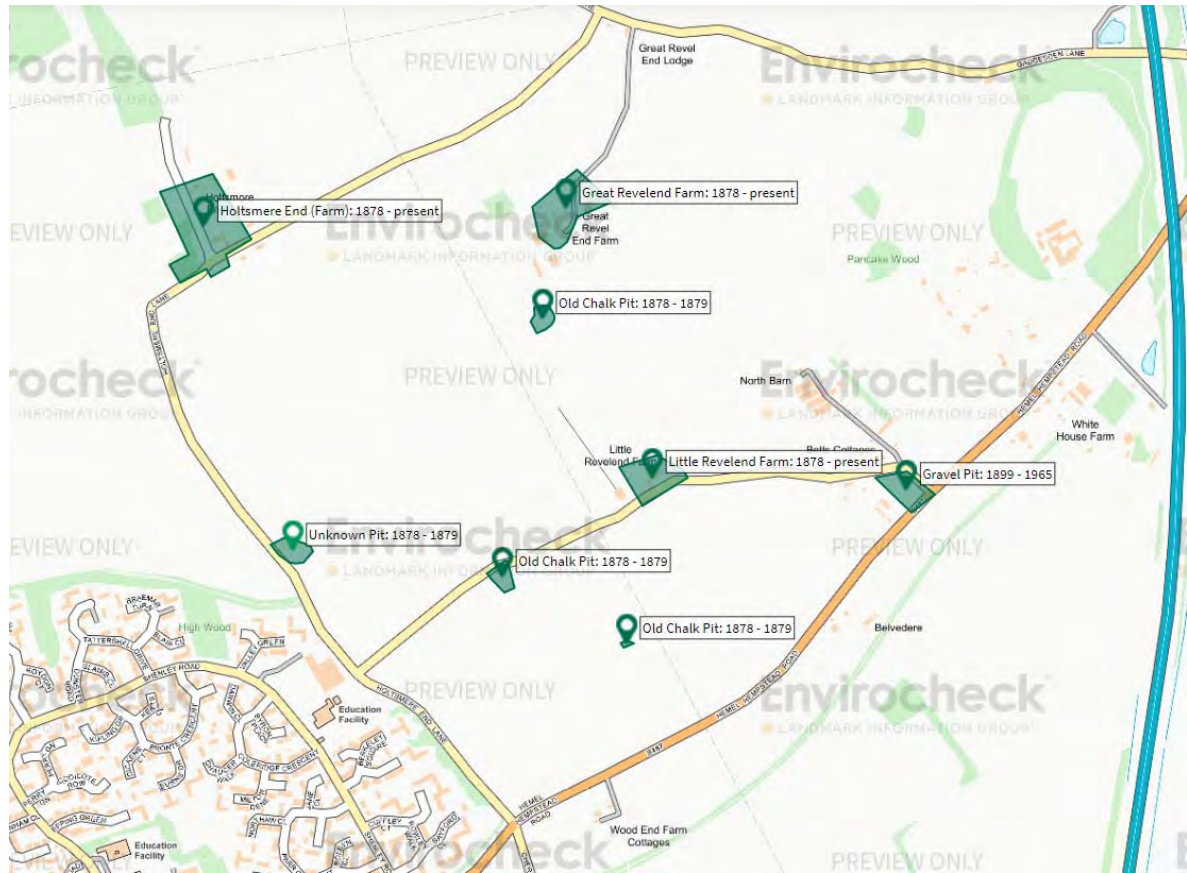
A ground gas monitoring programme and initial ground gas risk assessment was also undertaken as part of this ground investigation and the results from the four monitoring visits indicate that the southern site area falls within a Characteristic Situation 1 'very low risk' scenario, whereby no ground gas protection measures are considered necessary.

- *Email Summary of Groundwater Levels, Holstmere End Lane (South), Hemel Hempstead, Project Reference: UK19.4388b – EPS Ltd, (March 2020)*

Following the issue of EPS' Ground Investigation Report for the southern site area in September 2019, EPS continued to monitor groundwater levels in the boreholes drilled as part of the initial ground investigation. The programme took place to March 2020 and the results were provided in a summary email to the client. As expected, groundwater levels were found to have rose throughout the monitoring period over the autumn/winter which was suggested to have been a result of seasonal changes influenced by rainfall and other factors. The shallowest level at which groundwater was recorded was ~10.9m bgl at BH202 on 6th March 2020.

2.4 Site History

A summary of historical map data from 1878 to 2025 is provided below. Key points are highlighted and copies of relevant historic maps examined during the investigation are included in this report as Appendix E.



- Historical mapping shows that Holstmere End Farm, Great Revel End Farm and Little Revelend Farm have all been present from the late 1800's, with these holdings still present and active at the time of writing. Both Great Revel End Farm and Little Revelend Farm are excluded from the proposed development area.
- Three old chalk pits (two towards the south and one the north) are mapped from the 1870s, additionally an unspecified (unknown) pit is also mapped in the west of the northern area over the same time period, and this feature also coincides with an area of potentially infilled land.
- A gravel pit is annotated approximately 130m east of the southern site area, on maps from 1899 to 1965, this gravel pit appears to have been redeveloped into the current buildings and associated caravan park (annotated as Tullochside on some maps) including an electricity substation sometime between 1981 and 1999 and it also broadly aligns with the historic landfill that accepted inert waste between August 1962 and December 1963 in this area.
- The only other potentially contaminative features that appear on historical maps is a fireworks factory mapped within the now residential housing estate to the west from 1938 to 1982. The other major historical changes of the surrounding area relate to the gradual and continued development of the residential housing estate to the west and southwest throughout the mid to late 1900's and the construction of the M1 motorway to the east sometime between 1960 and 1964.

3 PRELIMINARY RISK ASSESSMENT & CONCEPTUAL SITE MODEL

In accordance with the Environment Agency's *Land Contamination: Risk Management* guidance, there are three stages to managing contaminated land (Risk Assessment, Remedial Options Appraisal / Remediation and Verification). This section outlines the first tier of Stage 1, the Preliminary Risk Assessment.

The following section provides a review of the contaminant linkages that may be active at the site, whereby EPS have examined the potential sources that may be present as a result of historic and / or current site activities and where potential interaction between these sources and the identified human / environmental receptors may occur.

3.1 Background

A Desk Study comprises the first stage of any geo-environmental assessment, the purpose of which is to determine what potentially contaminative activities may have occurred at the property or the surrounding area which may pose an environmental or geological risk to site users, the surrounding environment or proposed development, either at present or in the future.

The method used in this investigation to assess the environmental risk posed is based on the concept of 'contaminant linkage', which considers the following three factors:

Source	The location from which an environmentally hazardous / contaminative substance is, (or was,) derived.
Pathway	A route or mechanism via which a source could come into contact with a receptor to cause significant harm.
Receptor	An environmentally sensitive object or condition e.g. person, property, controlled water, or ecological system, which may be present now or in future.

If all three factors are identified, there is the potential for a 'contaminant linkage' to be active, which could result in significant harm being caused to the environment or human health.

3.2 Source Characterisation

The following potential contaminant sources have been identified at the site and in the surrounding area:

Potential Source	Source Description	Principal Contaminants of Concern
Natural Geology	Radioactive decay of Natural Geology	Radon Gas
Current & Historic Site Use	Potentially infilled chalk pits/ land entries within the site boundaries and the possibility of infill material of unknown origin (made ground). This includes an anomaly interpreted as a former on-site structure during a third party geophysical survey in April 2019, as well as beneath current roads, which may be adjusted to align with future layout.	PAH, Metals, ACM, Ground Gas (CO ₂ , CH ₄)
	Active BPA oil pipeline running through the study area.	TPH
	Current and historic use of the site as arable farmland.	Pesticides & Herbicides
Current and Historical Surrounding Land Use	Evidence of fly-tipped waste adjacent to Holstmere End Lane and surrounding local area, with the potential for asbestos containing materials to be present.	ACM
	Current / historical industrial land use of the surrounding area including a dry cleaners and historic car breakers/ dismantlers as well as an electricity sub-station.	PAH, Metals, TPH (incl. MTBE & BTEX), VOC's/ SVOC's & PCB's
	Current and historic farms surrounded by the area of investigation (Great Revel End Farm & Little Revelend Farm) and in the surrounding area (Holstmere End Farm and poultry houses adjacent to the east).	
	Historic gravel pit/ landfill approximately 130m east.	Ground / landfill Gas (CO ₂ , CH ₄)

Notes:

PAH	Polycyclic Aromatic Hydrocarbons	ACM	Asbestos Containing Materials
CO ₂	Carbon Dioxide	CH ₄	Methane
TPH	Total Petroleum Hydrocarbons	MTBE	Methyl Tertiary Butyl Ether
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes	VOC's	Volatile Organic Compounds
SVOC's	Semi Volatile Organic Compounds	PCB's	Polychlorinated Biphenyls

3.3 Potential Receptors

A framework for the assessment of risks arising from the presence of contamination in soils has been produced by the Environment Agency and the Department for the Environment, Food and Rural Affairs (DEFRA) and is presented with the report: *'Using Science to Create A Better Place: Updated Technical Background to the CLEA Model – Science Report SC050021/SR3'*.

This guidance document defines a series of standard land-uses which have been further developed into six generic landuses in the Category 4 Screening Levels project for Land Affected by Contamination (DEFRA/Contaminated Land: Applications in Real Environments (CL:AIRE) Project Report SP1010, 2014) which form a basis for the development of the Conceptual Site Model.

Risks posed to controlled waters have been considered in line with the *Environment Agency's approach to groundwater protection (v1.2, 2018)* and associated position statements.

It is understood that outline planning proposals are for a residential scheme comprising significant provision for new dwellings as well as recreational, amenity and public open spaces together with associated access and infrastructure works. While some commercial spaces may also be incorporated into the proposed scheme, the most sensitive land use has been considered (on a precautionary basis), and is as follows:

- Residential (with home-grown produce)

In view of the environmental setting, current and potential future land use of the site and surrounding sites, the potential receptors for any contaminant impact are discussed below:

Receptor	Site Specific Description
Human	Future site users, construction workers involved in the site redevelopment, and those working and living in the surrounding area have the potential to be at risk from exposure to potential contaminants of concern (CoCs).
Groundwater	The underlying geology comprises superficial Clay-with-Flints Formation, which is defined as an Unproductive Aquifer along with superficial Head Deposits classified as a Secondary Aquifer. Furthermore, the chalk bedrock is classified as a sensitive Principal Aquifer. The entire site area also lies within a Total Catchment (Zone 3) SPZ for local groundwater abstraction and hence with all due consideration given to the above, groundwater should be considered as a sensitive receptor to site derived contaminants.
Surface Water	The nearest surface watercourses appear to be small ponds within the northern section and within the grounds of Great Revel End Farm. It is possible that site derived contaminants of concern may enter these and other nearby watercourses (such as any field drains) by overland flow, migration through unsaturated soils or entering shallow surface drainage / historical land drainage which discharges to such features. Therefore, surface waters must also be considered as a sensitive receptor within the conceptual site model.

Receptor	Site Specific Description
Flora and Fauna	The proposed development will likely include the provision of domestic garden areas as well as recreational, amenity and public open space. Some of the identified contaminants of concern are known to be phytotoxic and as such, the potential for this impact should be considered.
Buildings & Infrastructure	Subsurface structures are likely to be present at the site which may be adversely affected by the potential presence of the identified contaminants of concern (primarily from off-site sources). These include concrete used in building foundations, buried potable water supply pipes and other service lines and pipes.
Adjacent Land	Adjacent properties including the residential land use to the west and the farms surrounded by the site could also be at risk from potential contaminants found at the site.

3.4 Potential Pathways

Where contaminants may be present in soil, there are a number of potential pathways that enable human receptors to come into contact with or be exposed to them. The most direct pathways, considered under current UK legislation, can be summarised as follows:

- Direct ingestion of contaminated soil
- Ingestion of household dust
- Ingestion of contaminated vegetables
- Ingestion of soil attached to vegetables
- Dermal contact with contaminated soil
- Dermal contact with household dust
- Inhalation of fugitive soil dust
- Inhalation of fugitive household dust
- Inhalation of vapours outdoors
- Inhalation of vapours indoors

Clearly, not all of these potential pathways apply for every standard land-use. For example, ingestion of contaminated vegetables will not apply to land uses other than residential with plant uptake and allotments.

However, in addition to direct exposure pathways, a number of physical transport mechanisms / pathways may also exist at a site that allow remote or less accessible contaminants in soil or groundwater to reach human or environmental receptors both at a site and beyond the site boundary. These include the following:

- Downward and lateral movement of contaminants in soil either by gravity or through being 'leached' by percolating rainwater.
- Lateral migration of contaminants dissolved in groundwater.
- Direct seepage or leaching of contaminants from soil into subsurface drains or supply pipework.
- Volatilisation of contaminants from groundwater or unsaturated soils into buildings or outdoor air.

Through examination of the standard land use and environmental setting at each site, the presence of pathways and transport mechanisms described above must be considered when assessing whether a contaminant linkage may plausibly be active, and therefore be included in the conceptual site model.

3.5 Summary of Contaminant Linkages

Considering the site use and environmental setting, and the proposed land use; the plausible contaminant linkages that have been identified through the Preliminary Risk Assessment which require further investigation are summarised in the following table:

Source	Pathway	Receptor
Natural Geology	Migration of radon gas to indoor air	Site users
Contaminated Soil (incl. potentially infilled chalk pit and infilled land entries)	Direct contact and inadvertent ingestion by eating or smoking with dirty hands	Construction workers during redevelopment & site users
	Inhalation of fugitive dusts	Site users
	Direct uptake and / or adherence of contaminated soil to vegetation and subsequent ingestion	
	Migration of ground gas to indoor & outdoor air	
	Direct uptake via root systems	Plants

The following comments are made with respect to contaminant linkages which have been considered through development of the conceptual model, but have not been concluded as 'plausible' – i.e. through which a significant possibility of significant harm could occur to an identified receptor:

- Pesticides and herbicides have been identified as potential contaminants of concern associated with the use of the study area as arable farmland. The application of modern pesticides and herbicides follows strict guidelines which aim to minimise their effects on the environment and human health. Additionally, as no storage of pesticide and herbicides appears to have taken place, a plausible contaminant linkage has not been recognised.

- PAH's and metals have been identified as contaminants of concern associated with the historic onsite infilled pits and other potential features. However, these contaminants are considered to be relatively immobile in the environment by virtue of their very low solubility and volatility. On this basis, plausible pathways by which these potential contaminants could pose a significant risk to the underlying groundwater or nearby surface waters are not considered to be active.
- It is possible that inadvertent damage could occur to the oil pipeline during the proposed development phase but it is anticipated that all works will be carried out by competent professional contractors provided with appropriate plans of buried plant and adhering to BPA's exclusion zone/ easement around the pipeline. Therefore, this infrastructure is not considered to be a significant source of contamination at this stage, particularly given the modern leak detection systems in place to ensure the integrity of the pipeline.
- Several commercial and industrial land uses are located in the surrounding area, the most significant of which are considered to be a dry cleaners, vehicle dismantlers and a number of small farm holdings (including Great Revel End & Little Revelend Farm), which are surrounded by land being considered for future development. However, given the nature and status of these land uses and the low likelihood of any significant fuel or chemical storage associated with them (including the farm holdings which are only of limited scale), together with the absence of shallow groundwater, these sources are not considered to pose a significant risk to the proposed development.
- Given the likely shallow nature of impacts to surface soils, as well as the contaminants of concern associated with the established on-site sources, no significant risk to the foundations of any on-site buildings or infrastructure such as new services is recognised.
- Occasional fly tipped waste was observed adjacent to Holtsmere End Lane (but not within the formal boundaries of the area of investigation). Whilst there is the potential for this waste to contain ACM, given that this material is located off-site, it is unlikely to pose a significant risk to future site users post completion of the redevelopment works.

The following diagram provides an illustration of the plausible contaminant linkages that may be active at the site and which may need further investigation or control to ensure safe development:

Land Holtsmere End Lane, Hemel Hempstead – Illustrative Conceptual Site Model

Proposed Residential Scheme



Potential Pathways:

1. Migration of radon gas to indoor & outdoor air
2. Direct / inadvertent contact with ingestion of soil & inhalation of fugitive dusts
3. Direct uptake and / or adherence of contaminated soil to vegetation and subsequent ingestion
4. Migration of ground gas to indoor & outdoor air (from on and off-site sources)

3.6 Key Areas of Potential Concern & Uncertainty

Overall, the majority of the site is considered to have a low risk in terms of the potential for future site users and environmental receptors being exposed to contamination. The key areas of concern are the potentially infilled chalk pits and localised sections where made ground could be present such as an anomaly picked up on a third party geophysical survey or areas where existing roads and pavements are present.

Some of these features, which are likely to be very discrete in scale in the context of the overall parcel of land, also have the potential to generate ground gas (although this is also considered to be limited), and the infilled soils may also not meet the quality standards required for a modern residential gardens. As such, future phases of intrusive investigation and assessment should target these features to assess the identified risks and confirm the assertions made in this and other phases of work.

4 GEOTECHNICAL GROUND MODEL

Geological records indicate the ground conditions to comprise superficial Clay-with-Flints and Head Deposits with the bedrock geology mapped as chalk of the Lewes Nodular Chalk & Seaford Chalk Formations. The presence of the Clay-with-Flints has been confirmed within the southern area via EPS's ground investigation work, as has the presence of chalk at depth. Made ground materials associated with potentially infilled land entries and isolated sections of current or historic development are also anticipated.

A preliminary geotechnical ground model commenting on individual design aspects is presented below. This is not intended to inform geotechnical design, but give an indication of the constraints which might be anticipated.

Element	Anticipated Strata	Parameter(s)	Anticipated Conditions
Foundations	Clay-with-Flints Formation & Head Deposits	Allowable Bearing Pressure	50kN/m ² to 125kN/ m ²
		Settlement	Low to medium sensitivity depending on soil composition
		Volume Change	Low to medium volume change potential depending on soil composition
	Chalk	Allowable Bearing Pressure	75kN/m ² to 150kN/m ²
		Settlement	Low risk
		Volume Change	Low volume change potential
Drainage	Clay-with-Flints Formation & Head Deposits	Permeability	Might be suitable for infiltration drainage depending on soil composition
	Chalk	Permeability	Likely to be suitable for infiltration drainage
Concrete grade	Clay-with-Flints Formation & Head Deposits	Grade	Low to moderate risk of high sulphate levels
	Chalk	Grade	Low risk of high sulphate levels

Potential Hazard	Comment
Trees & Vegetation	Trees and hedgerows are present throughout the area particularly along the borders of the fields. Depending on final development proposals, the proximity of buildings/ infrastructure to trees and hedgerows and the specific heave potential of the underlying superficial deposits or shallow chalk, this could lead to the localised deepening of foundations.
Chalk Dissolution & Historic Chalk Mining	Risks associated with chalk dissolution and historic chalk mining are considered to be relatively low based on the ground investigation works completed to date. However, this should be confirmed through additional phases of intrusive works, completed in greater detail and across areas/ features which haven't been covered to date.
Subsurface Structures & Existing Overground Cables	An underground BPA oil pipeline runs through the site, this feature along with the overhead cables and pylons that are also present throughout the site should be considered during any upcoming design and redevelopment work.

5 CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusions

This Phase I Desk Study has established the site as relatively low risk in terms of plausible contaminant linkages that have the potential to become active if and when the land is to be developed into a residential housing scheme.

The main area of concern identified with respect to the proposed development is the potential for the interaction between groundworkers and future site users (residents) with potentially contaminated shallow soils. This could be either during the construction works and post-development, mainly relating to the possible presence of made ground on site, associated with localised infill from former chalk pits/ infilled ground, as well as existing roadways/ infrastructure; the construction of which might have encroached within the study area.

Risks to future site users from the generation and accumulation of ground gases (CO₂, CH₄) have also been identified, primarily associated with the historic chalk pits recorded onsite, but also a nearby historic landfill.

Some of the site lies within an area where the percentage of homes above the radon action level is between 3% and 5%. As such, basic radon protective measures will likely be required in the construction of selected new buildings, and it is recommended that a detailed radon report is obtained and compared against future development proposals.

A moderate risk of the presence of chalk dissolution has also been identified. This must be given full consideration in future design, albeit current indications suggest that this will not represent a significant constraint to development; based on the findings of initial ground investigation works conducted by EPS, although it is recognised that further detail and coverage is required for this to be conclusive.

It should be appreciated that due to the size of the proposed development site, not all of the potential contamination linkages which have been identified through the risk assessment process apply across the wider plot. The layout of proposed infrastructure and consequently the distance from potential sources should be given all due consideration through further stages of risk assessment.

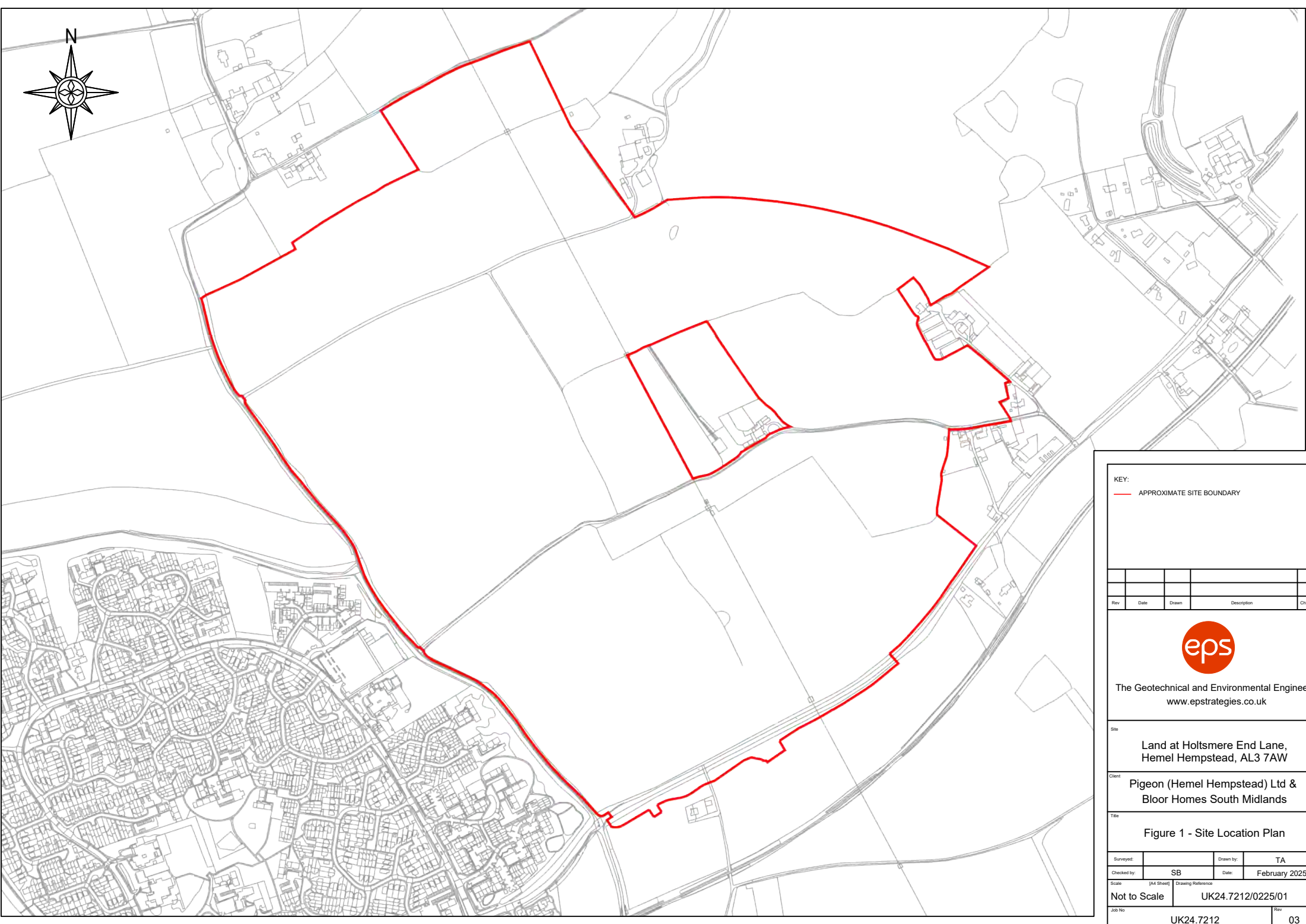
5.2 Recommendations

The scope of future phases of intrusive investigation (ideally informed by a formal development proposal/ layout), should include the following:

- a) Sampling of shallow soils on a regularly spaced grid throughout the area to confirm the quality of the materials present, but also with focus given to targeting specific features such as the potentially infilled chalk pits, and any areas where made ground might be expected. Subsequent environmental (chemical) laboratory analysis of the recovered soil samples should then be undertaken to confirm their suitability in a residential setting.
- b) Additional monitoring wells should be installed in boreholes drilled in close proximity to the potential sources of ground gas (infilled chalk pits and areas of potentially infilled land/ adjacent landfilling) so that ground gas monitoring can be undertaken. This should include and focus towards potential sources that have not been investigated to date (i.e. those in the northern parcel). The results of additional ground gas monitoring should then be used to supplement the existing dataset and determine/ confirm if ground gas protection measures will be required for future buildings.
- c) Furthermore, to address risks from potential generation of radon gas migrating into the proposed buildings and structures, basic radon protection will likely need to be installed within selected proposed buildings including any ancillary structures. Consultation should be undertaken with the building control department of the Local Authority to confirm the specifics of the radon protection measures and the installation and verification of such measures should be undertaken by a qualified contractor. It is also recommended that a detailed radon report is obtained and compared against future development proposals to support this process.
- d) Due to the notable potential for dissolution features, further site investigation is considered necessary to target any potential areas where voids or low strength/ infilled ground might be present. Areas targeted should be identified through review of the historic mapping and geophysical surveys, and should be conducted via a fixed grid of boreholes or dynamic probes completed to a sufficient depth and spacing across these potential areas of concern, to confirm or discount the presence of such features. Such work could also be combined with a wider geotechnical assessment, to support design and construction of the proposed buildings and infrastructure.

A copy of this report should be provided to the Environmental Health department of St Albans City & District Council and Dacorum Borough Council so that the information may be used to support planning proposals for the site. This report should satisfy the outline requirements of the planning process relating to contamination and the issue of contaminated land does not appear to present a barrier to a viable redevelopment. Additional phases of intrusive investigation required can likely be carried out under a conditional planning consent.

FIGURES



KEY:
— APPROXIMATE SITE BOUNDARY

Rev	Date	Drawn	Description	Chkd



The Geotechnical and Environmental Engineers
www.epstrategies.co.uk

Site
**Land at Holtsmere End Lane,
Hemel Hempstead, AL3 7AW**

Client
**Pigeon (Hemel Hempstead) Ltd &
Bloor Homes South Midlands**

Title
Figure 1 - Site Location Plan

Surveyed by:	SB	Drawn by:	TA
Checked by:		Date:	February 2025

Scale	(A4 Sheet)	Drawing Reference
Not to Scale		UK24.7212/0225/01

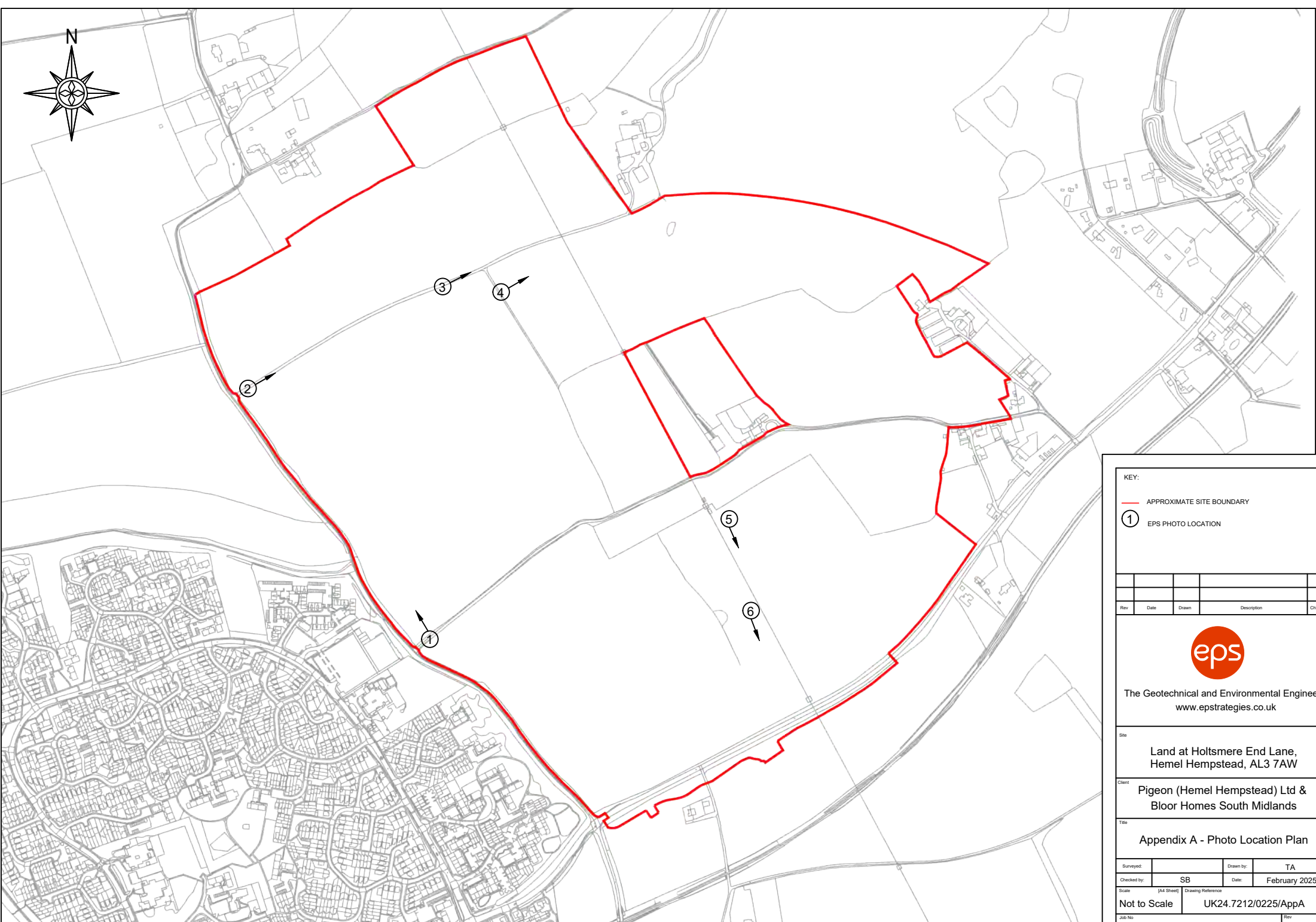
Job No	Rev
UK24.7212	03



APPENDICES

APPENDIX A

Selected Site Photographs & Walkover Notes



KEY:

- APPROXIMATE SITE BOUNDARY
- ① EPS PHOTO LOCATION

Rev	Date	Drawn	Description	Chkd



The Geotechnical and Environmental Engineers
www.epstrategies.co.uk

Site
**Land at Holtsmere End Lane,
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Client
**Pigeon (Hemel Hempstead) Ltd &
Bloor Homes South Midlands**

Title
Appendix A - Photo Location Plan

Surveyed:		Drawn by:	TA
Checked by:	SB	Date:	February 2025

Scale	(A4 Sheet)	Drawing Reference
Not to Scale		UK24.7212/0225/AppA

Job No	Rev
UK24.7212	03

Photo 1: Image looking northwest across the southwestern corner of the northern site area. 	Photo 2: Image looking northeast along the track through the northern site area. 
Photo 3: Image looking northeast along the track through the northern site area. 	Photo 4: Image looking northeast across the central eastern field of the northern site area. 
Photo 5: Image looking southeast through the central part of the southern site area. 	Photo 6: Image looking southeast through the central part of the southern site area. 

Job No.	UK24.7212
Date	14.2.25
Who?	TA

To be completed by consultant for all Phase I Desk Studies and form must be scanned/photographed and saved in job folder under 'Scanned Site Notes'. EPS Minor Works Risk Assessment (EPS025a) also must be completed and scanned.



Site Walkover Checklist V3.1

Geotechnical		COMMENTS
	Are there any abrupt changes in slope profiles?	Hilly landscape throughout fields depending on specific area
	Is there evidence of overburden on the slopes?	No
	Is there evidence of excavation at the base of a slope?	No
	Are there signs of landslide, such as tilting trees/posts?	No
	Are there signs of subsidence?	No
	Is there evidence of cracked ground?	No
	Is there evidence of compressible ground (i.e. Peat)?	Some areas of wet and boggy ground in and around fields and tracks, likely due to the time of year and wet weather
	Is there evidence of an abrupt change in ground conditions?	No, in some fields, shallow / near surface soils appear to be chalky, others appear to be very 'flinty'
	Is there evidence of high groundwater, such as areas of waterlogged ground?	Some areas of wet and boggy ground in and around fields and tracks, likely due to the time of year and wet weather
	Do signs of water loving plants such as reeds exist?	No
	Are there any ponds, streams, ditches (even if dry), springs or wells?	See site description, on-site surface water features not inspected
	What is the nature of the vegetation?	Hedgerows and small to large size, mature deciduous trees with coniferous trees also anticipated in some areas
	Species & Height of trees	Small to large, deciduous and coniferous
	What is the nature and condition of vegetation on adjoining land?	Farmhouses, small commercial / industrial units and agricultural buildings, occasional residential dwellings
	Is there evidence of former vegetation?	No