

**Brookleigh Eastern Primary School,
Brookleigh, Burgess Hill**

Reserved Matters Application

Land Quality Statement

Client



**Homes
England**

Project No

DARTS-OTH-88

Date

October 2025

CampbellReith

Multidisciplinary Consultants

Brookleigh Eastern Primary
School, Brookleigh, Burgess
Hill

Land Quality Statement

For
Homes England

Project No.
14176

Date
October 2025

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CONTENTS

EXECUTIVE SUMMARY	6
1.0 Introduction	8
1.1 Appointment	8
1.2 Objectives	8
1.3 Basis of Assessment	8
1.4 Technical Competence	9
2.0 Site Description and Environment Setting	10
2.1 Site Location	10
2.2 Site Layout	10
2.3 Surrounding Land-Use	11
2.5 Invasive Plant Species	11
2.6 Redevelopment Proposal	11
2.7 Geology	11
2.8 Seismicity	12
2.9 Hydrogeology	12
2.10 Hydrology	13
2.11 Radon	13
2.12 Sensitive Land Uses	14
3.0 Site History and Industrial Setting	15
3.1 Site History	15
3.2 Unexploded Ordnance (UXO)	15
3.3 Tunnels and Infrastructure	15
3.4 Current Industrial Setting	16
4.0 Preliminary Conceptual Site Model	17
4.1 Introduction	17
4.2 Potential Sources of Contamination	17
4.3 Targeted Potential Contaminant Linkages	17
5.0 Site Investigation	19
5.1 Scope of Works	19
5.2 Groundwater Observations	20
5.3 Geotechnical Testing	20
5.4 Contamination Observations and Testing	22
6.0 Geotechnical Evaluation	23
6.1 Ground Conditions	23
6.2 Topsoil/ Made Ground	23
6.3 Weathered Weald Clay Formation	24
6.4 Weald Clay Formation (Bedrock)	26
6.5 Buried Concrete	27
6.6 Infiltration	28
6.7 Groundwater Conditions	28
7.0 Geotechnical Hazards	29
7.1 Geotechnical Hazards	29

8.0	Generic Quantitative Risk Assessment	32
8.1	Assessment Framework.....	32
8.2	Soil	32
8.3	Asbestos	34
8.4	Controlled Waters	34
8.5	Ground Gas	36
9.0	Revised Conceptual Site Model	39
9.2	Classification of Risk	39
10.0	Geotechnical Conclusions and Recommendations	42
10.1	Introduction	42
10.2	Key Considerations	42
10.3	Foundations	42
10.4	Shallow Foundations	42
10.5	Piled Foundations	43
10.6	Floor Slabs	44
10.7	Drainage	44
10.8	Earthworks.....	45
10.9	Road Pavements.....	46
10.10	Ground Improvement.....	47
10.11	Buried Concrete	48
10.12	Desiccation.....	48
10.13	Animal Setts / Burrows.....	49
10.14	General Construction Advice	49
11.0	Environmental Conclusions and Recommendations.....	51
11.2	Data Uncertainties	51
11.3	Summary of Risk and Remedial Requirements – Soils / End Users	51
11.4	Summary of Risk and Remedial Requirements – Controlled Waters	51
11.5	Summary of Risk and Remedial Requirements – Ground Gas / Vapours.....	52
11.6	Additional Remedial Recommendations	52
11.7	Groundworkers	52
11.8	Services	53
11.9	Additional Site Investigation/Assessment.....	53
11.10	Remediation and Verification Documents.....	53
11.11	Waste Management	54
	ENVIRONMENTAL RISK ASSESSMENT STANDARDS AND SUPPORTING INFORMATION.....	55
	Definitions of Consequence, Probability and Risk	61
	LIMITATIONS.....	66

APPENDICES

Appendix 1 Figures	
Appendix 2 Desk Study Information	
Appendix 3 Ground Investigation Information	
Appendix 4 CLEA Land Use Parameter Summary	

TABLES

Table 1-1 Information Reviewed	8
Table 2-1 Summary of Anticipated Geology	11
Table 2-2 Summary of Hydrogeology	12
Table 2-3 Summary of Hydrology	13
Table 2-4 Summary of Designated Sites.....	14
Table 4-1 Potential Sources of Contamination	17
Table 4-2 Targeted Potential Contaminant Linkages	17
Table 5-1 Standpipe Summary	19
Table 5-2 Groundwater Observations.....	20
Table 5-3 In-situ Tests (Geotechnical)	20
Table 5-4 Laboratory Tests (Geotechnical)	21
Table 5-5 Laboratory Tests (Environmental).....	22
Table 6-1 Soil Profile	23
Table 6-2 Summary of Soil Parameters for the Weathered Weald Clay Formation	26
Table 6-3 Summary of Soil Parameters for the Weald Clay Formation (Bedrock).....	27
Table 6-4 Summary of BRE Suite Test Results in reference to BRE Digest SD1	28
Table 6-5 Infiltration Test Results.....	28
Table 7-1 Summary of Geotechnical Hazards	29
Table 8-1 Summary of Soil Analysis	32
Table 8-2 Summary of Water Analysis	35
Table 8-3 Summary of Groundwater Exceedances	36
Table 8-4 Summary Gas Screening Values	37
Table 9-1 Classification of Risk	39
Table 9-2 Groundworkers (Assuming Basic PPE) *	39
Table 9-3 End Users during Occupation	40
Table 9-4 Controlled Waters.....	40
Table 9-5 Buildings.....	40
Table 9-6 Offsite Receptors.....	41

EXECUTIVE SUMMARY

SITE OUTLINE	The site is located in a rural setting on the northern outskirts of the town of Burgess Hill, West Sussex (NGR: 530864E, 120673N). The topography slopes from approximately 27.0m AOD on the northwestern site boundary, down to approximately 23.6m on the southeast boundary, towards the River Adur East. The site was historically open / agricultural fields. The site was also shown on earliest mapping (1874) to include a suspected water course intercepting the northeastern boundary and a suspected path and field boundary encroaching on the southern boundary. In 1937 a field boundary was mapped across what is approximately the centre of the site. By 1969 the suspected water course and field boundary are no longer mapped. The ground conditions encountered during the investigation comprised a sequence of Topsoil / Made Ground into weathered Weald Clay deposits comprised of CLAY, locally SILT, often transitioning into interbedded / interlaminated CLAY and MUDSTONE or locally into MUDSTONE or SILTSTONE bedrock of the Weald Clay Formation.
ENVIRONMENTAL SETTING	The site is considered to have a <u>Very Low</u> hydrogeological sensitivity due to the absence of a groundwater receptor. The site is considered to have a <u>Medium – High</u> sensitivity with respect to hydrology due to the River Adur East being located 90m southeast of the site. The proposed school development is considered to have a <u>Medium</u> sensitivity with respect to end users.
GEOTECHNICAL HAZARDS	The following geotechnical hazards have been identified in relation to the site: ▪ Medium volume change potential soils; ▪ Ground level raise (c. 1m); ▪ Soil desiccation; ▪ Ground conditions aggressive to buried concrete ; ▪ Temporary excavation c. 3m depth, and consequent need for earthworks; ▪ Shallow groundwater level; ▪ Low permeability ground conditions.
CONTAMINATION ISSUES	Risk Summary: ▪ End Users. A VERY LOW risk due to the absence of significant contaminant concentrations. ▪ Groundwater. A VERY LOW risk due to the absence of significant contamination sources. ▪ Surface Water. A VERY LOW risk due to the absence of significant contamination sources. ▪ Ground Gas Characteristic Situation. The site has been classified as a CIRIA Characteristic Situation 1 and gas and vapour protection measures are not required. ▪ Groundworks. A VERY LOW risk has been identified based on the assumption that basic health and safety provisions are in place.
GEOTECHNICAL RECOMMENDATIONS	▪ Shallow foundations founded in firm or better CLAY or intact MUDSTONE (or similar intact bedrock) may be considered. Foundation depths should be determined in accordance with Chapter 4.2 of the NHBC Standards based on medium volume change potential soil.

	▪ Piled foundation solutions may be required due to the structural loads imparted by proposed developments or where deepening requirements are uneconomical (due to presence of mature trees / significant thickness fill etc). Piles should extend to suitable depths into competent bedrock of the Weald Clay Formation. ▪ Suspended floor slabs will be required due to the soil volume change potential. ▪ A design concrete class of DS-1 AC-2z can be considered for the site however, if oxidation of the Weald Clay Formation occurs during construction, a minimum concrete classification of DS-2, AC-3z is required. ▪ The ground conditions have poor drainage characteristics, and it is unlikely soakaways will be viable. An alternative drainage strategy should be considered. ▪ A preliminary CBR value of 3% is considered suitable for road and pavement design.
RECOMMENDATIONS	▪ Soils & Controlled Waters: Remedial measures are not considered necessary. ▪ Ground Gas: Gas protection measures are not required. ▪ Services: Organic resistant pipework for potable water supply is unlikely to be required. The infrastructure designer should assess requirements for pipework with respect to soil contamination and consult statutory utility companies and relevant guidance as necessary. Soil sampling should be carried out if areas of concern are subsequently identified, to confirm if organic resistant pipework is required. ▪ Site Work Controls: A watching brief should be maintained throughout the earthworks to identify any as yet unidentified contaminations that may be present, particularly at excavation formation level and in areas occupied by the site compound and the area along the northeastern boundary adjacent to the re-fuelling area. ▪ Should significant earthworks be required, any reuse of materials on-site or off-site disposal must be undertaken in accordance with current waste guidance. ▪ Invasive plant species, such as Japanese Knotweed, have not been considered and a survey should be carried out if this is of potential concern to the client.
DOCUMENTATION	This report should be submitted as part of the planning process. It is likely that further documentation, such as a Remediation Specification and Verification Report, will be required to discharge contamination related planning conditions.

1.0 INTRODUCTION

1.1 Appointment

1.1.1 This geoenvironmental and geotechnical report has been produced by Campbell Reith Hill LLP (CampbellReith) on behalf of Homes England (the Client) relating to Brookleigh Eastern Primary School, Brookleigh, Burgess Hill (hereafter referred to as the site). The limitations associated with this report follow the main text.

1.1.2 The site is part of the wider development known as Brookleigh (formerly Northern Arc), Burgess Hill. Figures showing the site location, layout and intended development are presented in Appendix 1.

1.2 Objectives

1.2.1 The objective of the report is to review existing ground investigation data for the site obtained in 2020, to determine if this is still relevant considering more recent site uses and updated development proposals. The contamination assessment also takes into consideration any changes to relevant guidance since 2020. The report provides:

- a description of the site;
- a summary of the site's geo-environmental setting and history;
- a conceptual site model and a generic quantitative risk assessment for contamination;
- outline remedial recommendations;
- a preliminary geotechnical evaluation; and,
- a geotechnical risk assessment.

1.3 Basis of Assessment

1.3.1 The standards upon which this report is based are summarised in the Environmental Risk Assessment Standards and Supporting Information section, which follows the main text.

1.3.2 The report is based upon a site reconnaissance visit, regulatory consultations, desk study and ground investigation information. Readily available site-specific reports/ information as detailed in Table 1-1. Technical references are included as footnotes throughout the report.

Table 1-1 Information Reviewed

Reference Details		Author	Reference
Groundsure Enviro Insight and Geo Insight	Reference: GS-6518440 and GS-6518441, dated December 2019	Groundsure	[1]
Northern Arc, Burgess Hill, Land Parcel P1.2, Geotechnical and Geo-environmental Desktop Study	Reference: 13258-CRH-XX-XX-RP-GE-0007_F2, dated June 2020	CampbellReith	[2]
Northern Arc Eastern Bridge & Link Road Ground Investigation Report	Document no: EBLR-TGEE-ZZ-XX-RP-C-0003 Rev P01, dated July 2020	Tony Gee Consulting Engineers	[3]

Reference Details		Author	Reference
Northern Arc, Burgess Hill P1.2 Ground Investigation Factual Report	Reference: GL23484/P1.2, dated August 2020	Harrison Group Environmental Ltd	[4]

1.4 Technical Competence

This report has been authored by Sam Savery CGeol MSc BSc FGS, and Brandon Reilly BSc, MSc, AMIEnvSc. The report has been reviewed by Tom Samson CEng MICE and Samantha Broughton BSc (Hons), MSc, MIEnvSc, CSci.

2.0 SITE DESCRIPTION AND ENVIRONMENT SETTING

2.1 Site Location

- 2.1.1 The site location is presented in Figure 1, Appendix 1. The site covers an area of 2.18ha and is located on Isaac's Lane, Abbotsford, Burgess Hill, Mid Sussex, West Sussex (nearest postcode RH15 8ZH) and Grid Reference 530849, 120735. It is accessed from Isaac's Lane on the western boundary.

2.2 Site Layout

- 2.2.1 An annotated site layout plan is presented in Figure 3, Appendix 1. Reconnaissance site visits were carried out by a member of CampbellReith on 9 January 2020 and 22 January 2025. Photographs from the 2025 site visit are present in Appendix 2.

2020 Site Reconnaissance

- 2.2.2 The site was formed of farm land, comprising a northern grass field occupying the majority of the site, and an additional small strip of grassed field in the south. The fields were separated by a boundary formed of trees and hedgerows. The northern field was observed to be used for grazing of sheep during the site walkover.
- 2.2.3 The north, east and south site boundaries were located within the grass fields. The western site boundary was formed of trees and hedgerow situated between the site and Isaac's Lane (A273). A small scale electric fence was observed to run adjacent to field boundaries, with the exception of the southern field.
- 2.2.4 The site was accessed in the west off Isaac's Lane. A metal gate on the southern field boundary provides vehicular access from the northern field into the southern field. The ground around this access was observed to be saturated with water and very soft during the reconnaissance.

2025 Site Reconnaissance

- 2.2.5 The site is accessed via a gated asphalt access road from Isaac's Lane and comprises former farmland with open fields in the south and in the north. The centre of the site was occupied by a site compound area used for storage of materials from ongoing earthworks / groundworks in the surrounding area, and an asphalt surfaced car park. It is understood the north of the site was also subject to earthworks however is currently unoccupied open space.
- 2.2.6 The site is bound by recently constructed roads associated with the Eastern Bridge and Link Road (EBLR) to the north and the east of the site. The northeast of the site was subject to groundworks and shallow excavations were ongoing during the walkover. An earth bund was located in the northeast of the site. A pump and generator were also present in the east of the site associated with ongoing earthworks along the eastern site boundary where an open excavation c.3m deep to facilitate the construction of temporary foul tanks (photos 16 and 17) was observed.
- 2.2.7 The south of the site comprised an unoccupied field, and several standpipes with raised covers associated with the gas / groundwater monitoring installations from the 2020 ground investigation were observed.

2.2.8 LiDAR data has been obtained for the site, presented as Figure 2. The topography of the site slopes from c. 27.0m AOD on the northwestern boundary down to c. 23.6m on the southeastern boundary.

2.3 Surrounding Land-Use

2.3.1 The access road beyond the eastern boundary was used for site plant storage and contained an above ground fuel tank understood to be used for re-fuelling the earthworks plant. It was also used for stockpiling what appeared to be natural / inert soils.

2.3.2 The wider area comprises generally agricultural fields and active residential development. The outskirts of the town Burgess Hill are c. 200m south of site.

2.3.3 To the northwest of site is a residential estate under construction and is part of the wider residential development in the area. The River Adur East is located to the east / south of site.

2.4 To the west / southwest of the site is Isaac's Lane (A273), beyond which lies predominantly agricultural and some sparse residential land uses.

2.5 Invasive Plant Species

2.5.1 The potential presence of invasive plant species, such as Japanese Knotweed, has not been assessed in this report.

2.6 Redevelopment Proposal

2.6.1 The project comprises the construction of a 2-storey primary school building including a creche, SSC classrooms, main hall, studio spaces, general teaching classrooms and staff/office spaces. Externally a new access road is to be constructed along with a parking/drop-off area, outside teaching spaces and a grass sports pitch.

2.6.2 For the purposes of contamination assessment, the development is considered to have a Medium sensitivity end use.

2.7 Geology

2.7.1 A review of British Geological Survey (BGS) data^{1,2,3} and Groundsure report [1] has been undertaken. The site geology is summarised in Table 2-1.

Table 2-1 Summary of Anticipated Geology

Strata	Depth to Base (m bgl)	Typical Description
Made Ground	Absent to c.1m	Heterogenous imported soils and reworked natural soils.
Alluvium	Absent to c.1m	Low strength CLAY, SILT and SAND with variable organic content.

¹ BGS. (2024). GeoIndex (onshore). Retrieved from <https://www.bgs.ac.uk/map-viewers/geoindex-onshore/>

² BGS. (1996). Brighton and Worthing, Sheet number 318/333, Geological Survey of England and Wales 1:63,360/1:50,000 geological map series, New Series. Retrieved from <https://webapps.bgs.ac.uk/data/maps/maps.cfc?method=viewRecord&mapId=10219>

³ Young, B. and Lake, R. D. (1988). Geology of the country around Brighton and Worthing. Memoir for 1:50 000 geological sheets 318 and 333 (England and Wales). Retrieved from <https://webapps.bgs.ac.uk/memoirs/docs/B01700.html>

Strata	Depth to Base (m bgl)	Typical Description
Weald Clay Formation	GL to c.120m	Weathered CLAY grading into extremely weak MUDSTONE with depth. More competent beds on MUDSTONE and SANDSTONE maybe present.

2.7.2 A variable thickness of Made Ground is likely to be present locally at site comprising a heterogeneous mixture of man-made cohesive and granular soils associated with the temporary construction compound. In addition, the presence of localised Made Ground associated with historical and current land uses cannot be fully ruled out.

2.7.3 No superficial deposits are mapped on site however, the presence of Alluvium should not be completely discounted due to the historical watercourse / drain recorded in the north of site and a suspected historical gully in the south [1,2]. Alluvial soils typically comprise low strength unconsolidated clay, silt and sand with variable organic content.

2.7.4 BGS data indicates the bedrock geology mapped at the site comprises the Weald Clay Formation of the Cretaceous Period, typically comprising weathered clay transitioning into mudstones with depth. Weald Clay Formation weathering depths are reported between 3m and 5m³.

2.7.5 The thickness of the Weald Clay Formation is reported between 122m and 460m^{1,2}. A band of Horsham Sandstone Member is recorded 20m northeast of the site. The site geology as shown on BGS mapping is presented in Figure 5, Appendix 1.

2.7.6 The BGS structural data indicates the Weald Clay Formation dips between c.3-5° to the south and the 'Burgess Hill Fault' intercepts a limited area on the northeastern site boundary, roughly trending northwest southeast and dipping to the west.

2.8 Seismicity

2.8.1 The national foreword to BS EN 1998-1:2004+A1:2013⁴ states there are no requirements in the UK to consider seismic loading, and the whole of the UK may be considered an area of very low seismicity in which the provisions of EN 1998 need not apply.

2.9 Hydrogeology

2.9.1 The site hydrogeology has been assessed using desk study information provided by Groundsure [1] and the MAGIC website⁵ and is summarised in Table 2-2.

Table 2-2 Summary of Hydrogeology

Type	Description
Superficial Deposits – None recorded	N/A
Bedrock – Weald Clay Formation	Unproductive Strata

⁴ BS EN 1998-1:2004+A1:2013 'Eurocode 8: Design of Structures for Earthquake Resistance – Part1'.

⁵ Multi Agency Geographic Information for the Countryside (MAGIC Map). Department for Environment, Food & Rural Affairs. <https://magic.defra.gov.uk/magicmap.aspx>

Type	Description
Soil Leaching Potential	Minor Aquifer / Low Leaching Potential
Source Protection Zone	None recorded within 500m of the site
Groundwater Abstractions	None recorded within 2000m

2.9.2 The site is considered to have a Very Low sensitivity with respect to hydrogeology. The sensitivity is based upon the definitions provided in NHBC R&D66⁶, as amended to include the requirements of the Water Framework Directive⁷ and the EA's River Basin Management Plans⁸.

2.9.3 The BGS Groundwater Flooding Confidence Areas rating is Low and there are no groundwater flooding susceptible areas within 50m distance of site [1].

2.10 Hydrology

2.10.1 The site hydrology has been assessed using desk study information provided by Groundsure [1] and the MAGIC website and is summarised in Table 2-3.

Table 2-3 Summary of Hydrology

Type	Distance	Description
Surface Waters	Onsite	Suspected Historical Gully
	Onsite	Historical water course / drain
	90m SE	River Adur East (inland river)
Surface Water Abstractions	-	None recorded within 2000m of site
Flooding	Onsite	Highest Risk of Flooding from Rivers and the Sea is Very Low

2.10.2 The site is considered to have a Medium – High sensitivity with respect to hydrology. The sensitivity is based upon the guidance detailed for the hydrogeological assessment above.

2.10.3 The Environment Agency Flood Risk Map⁹ shows limited areas of the site have a 0.1% chance of surface water flooding in any given year (1 in 1000 year).

2.11 Radon

2.11.1 The Groundsure report states the site is not in a Radon Affected Area, as less than 1% of properties are above the Action Level, and no Radon Protection measures are necessary [1].

⁶ Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH)

⁷ The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017

⁸ <https://www.gov.uk/guidance/river-basin-management-plans-updated-2022#view-river-basin-management-plans>

⁹ Environment Agency. (2024). Risk of Flooding from Surface Water (RoFSW) Extents. Retrieved from <https://arc-gis-hub-home-arcgishub.hub.arcgis.com/maps/d6f09fb2ecd147789ec59545800fdce0/about>

2.12 Sensitive Land Uses

2.12.1 A review has been made of Designated Ecological and Heritage sites using desk study information provided by Groundsure [1] and the MAGIC website⁵ and is summarised in Table 2-4. The main purpose of this is to identify receptors that may be at risk due to potential contamination at the site.

Table 2-4 Summary of Designated Sites

Type	Description
Ecological	No Ancient and Semi-Natural Woodlands are recorded within 100m of the site. Nitrate Vulnerable Zones: On site
Heritage	None recorded
Archaeological	Unknown

3.0 SITE HISTORY AND INDUSTRIAL SETTING

3.1 Site History

3.1.1 Information relating to the site history has been obtained by reference to historical plans provided in the Groundsure report [1] and publicly available satellite imagery¹⁰. The site history is summarised below, for full details consult the Desktop Study [2].

3.1.2 The site was undeveloped until recent use as a construction compound for local development. The construction compound is visible from 2021 on publicly available satellite imagery. The compound comprised temporary cabins and an asphalt surfaced car park. The cabins are no longer present although the car park remains. Key features previously identified during the Desktop Study [2] include a suspected water course intercepting the northeast boundary and potential path and field boundary encroaching on the southern boundary. In 1937 a field boundary is mapped across the central area of the site although this feature is absent from the 1969 map.

3.1.3 Generally, the surrounding setting included residential land uses / farmhouses, ponds, the River Adur East and Isaac's Lane. A sewage works was recorded to the southeast / east of the site from 1897 with redevelopment of the sewage works understood to have taken place between 2015 and 2018. It has been assumed that the redevelopment of the sewage works included remediation where required. No former land uses around the site considered to be a potential source of contamination have been identified.

3.2 Unexploded Ordnance (UXO)

3.2.1 A preliminary review has been made of the UXO risk presented by the site based upon CIRIA C681¹¹ ('Unexploded Ordnance (UXO) – A guide for the construction industry') and the assessment matrices presented in Tables 5.1-5.3 therein.

3.2.2 The site is in a low bombing density recorded area and in a rural setting during wartime. Following review of the UXO PDSA contained within the Desktop Study [2], the UXO risk rating is considered Low.

3.3 Tunnels and Infrastructure

3.3.1 In reference to CampbellReith's online database GISSMO, there are no recorded tunnels underlying the site.

3.3.2 A utility survey undertaken in 2018 maps a potable water pipe adjacent to a section of the northwest site boundary roughly trending north northeast to south southwest [2]. The presence of unrecorded utilities on site cannot be discounted.

3.3.3 It should be noted that the above review does not constitute a formal review of all buried utilities that may be present at the site.

¹⁰ Google. (2025). Google Earth©.

¹¹ CIRIA C681 'Unexploded Ordnance (UXO) – A guide for the construction industry' 2009.

3.4 Current Industrial Setting

- 3.4.1 This section summarises relevant industrial features, which may present a potential source of contamination to the site. It constitutes a review of the Groundsure report [1] and findings of the Desktop Study [2] that should be consulted for full details of industrial setting information. This report identifies the site has more recently been used as a construction compound although significant sources of contamination were not identified during a recent site reconnaissance.
- 3.4.2 The Desktop Study [2] identifies various potential infilled land features between 100 and 150m of the site. The offsite sewage works could be considered a potential source of contamination however considering recent redevelopment of this area, the topographical and the hydrogeological setting of the site, the former sewage works is not considered as a potential off-site source of contamination.

4.0 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 Introduction

4.1.1 Current practice for land contamination evaluation comprises the identification of contaminant source-pathway-receptor pollutant linkages. The sources have been identified in Table 4-1 and Table 4-2 provides a list of the potential contaminant linkages together with the rationale for the site investigation that was carried out.

4.2 Potential Sources of Contamination

4.2.1 Table 4-1 summarises the potential contamination sources that have been identified on or near the site. The potential contaminant types associated with these is then given based upon a review of industry profiles and anecdotal information.

Table 4-1 Potential Sources of Contamination

Feature on or near site	Potential Contaminant
Agricultural Land Uses (On site)	P, HRB
Potential for Made Ground locally from historical and current land uses e.g. agriculture (on site)	M, H, VOC, ACM, GG
Localised organic rich soils / Alluvium (potential for on-site associated with historical watercourse / drain and suspected historical gully)	GG
Notes: M – Metals. TPH – Total Petroleum Hydrocarbons. PAH – Polycyclic Aromatic Hydrocarbons, VOC – Volatile Organic Compounds. ACM – Asbestos containing Materials. GG – Ground Gases. P – Pesticides. HRB - Herbicides	

4.3 Targeted Potential Contaminant Linkages

4.3.1 Table 4-2 provides a list of the potential contaminant linkages together with the rationale for the site investigation design.

Table 4-2 Targeted Potential Contaminant Linkages

Source	Receptor	Exploration
Potential for unrecorded infilled land / Made Ground	End Users	General site coverage and soil sampling.
	Groundworkers	
	Controlled water	Installations provided for groundwater sampling within the Weald Clay. Analysis of representative soils across the site.
Potential for ground gas from organic rich deposits	End users	General coverage and targeted ground gas installation in organic rich deposits associated with the River Adur East.
Farmland use	End users	General site coverage and soil sampling. Analysis of pesticides and herbicides.

- 4.3.2 Whilst it is noted that the site has been recently used as a construction compound, significant sources of contamination were not identified during the recent reconnaissance and so additional intrusive investigations were not considered necessary.
- 4.3.3 The findings of the intrusive investigation of the potential contaminant sources and pathways are reported in Section 5.0. This has informed the Generic Quantitative Risk Assessment presented in Section 8.0, Revised Conceptual Site Model in Section 9.0, and the subsequent conclusions and recommendations regarding risk in Section 11.0.

5.0 SITE INVESTIGATION

5.1 Scope of Works

5.1.1 Intrusive ground investigation works were designed by CampbellReith and undertaken by Harrison Group Environmental between May and June 2020. The associated factual report is included within Appendix 3.

5.1.2 The as dug exploratory locations are shown on Figure 6, Appendix 1. Exploratory holes from investigations associated with the wider development are shown on Figure 7, Appendix 1. A summary of the exploratory holes is given below:

- 1 no. cable percussive borehole (CP7-01), to 15m bgl;
- 7no. windowless sampler boreholes (WS7-01 to WS7-07), to 6m bgl;
- 1 no. trial pit and infiltration test (IN7-01), to 3.50m bgl.

5.1.3 During drilling and excavation, the cable percussive and windowless sampler boreholes and the machine dug trial pit refused on suspected bedrock before reaching their scheduled depths as follows:

- CP7-01 3.20m bgl effective refusal on hard stratum;
- WS7-01 to WS7-07 effective refusals between 2.11m and 2.90m bgl on hard stratum
- IN7-01 terminated at 2.60m bgl on hard stratum.

5.1.4 The ground conditions encountered with respect to the monitoring installations are summarised in Table 5-1. Three visits have been made to site between 15 June and 15 July 2020 to monitor gas and water levels within the installations and to obtain samples.

Table 5-1 Standpipe Summary

Exploratory Hole	Response Zone (m bgl)	Response Zone (m AOD)	Standpipe Diameter (mm)	Full Strata Depth (m bgl)	
CP7-01	1.00 – 3.20	22.72 – 20.52	50	0.10 – 3.20	Weald Clay
WS7-01	1.00 – 2.00	23.76 – 22.76		0.30 – 2.90	Weald Clay
WS7-02	0.90 – 1.90	24.73 – 23.73		0.15 – 2.27	Weald Clay
WS7-03	0.90 – 1.90	23.34 – 22.34		0.15 – 2.27	Weald Clay
WS7-04	0.90 – 1.90	23.11 – 22.11		0.15 – 2.29	Weald Clay
WS7-05	0.90 – 1.90	23.39 – 22.39		0.15 – 2.24	Weald Clay
WS7-06	0.80 – 1.80	23.05 – 22.05		0.15 – 2.11	Weald Clay
WS7-07	0.90 – 1.90	23.66 – 22.66		0.10 – 2.26	Weald Clay

5.2 Groundwater Observations

5.2.1 Water strikes observed during the site works and the results of the monitoring visits are summarised in Table 5-2.

Table 5-2 Groundwater Observations

Exp Hole	Water Strikes				Standing Water Level During Monitoring			
	Struck		Rose to		Shallowest		Deepest	
	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD	m bgl	m AOD
CP7-01	No groundwater strikes encountered				1.66	22.06	2.12	21.60
WS7-01					1.75	23.01	2.02	22.74
WS7-02					1.60	24.03	1.75	23.88
WS7-03					-	-	-	-
WS7-04					-	-	-	-
WS7-05					-	-	-	-
WS7-06					-	-	-	-
WS7-07					1.71	22.85	1.82	22.74

- dry during monitoring visits

5.2.2 Groundwater was not encountered during drilling at any of the exploratory hole locations. Groundwater was encountered at depths from 1.60 to 2.12m bgl within the standpipe installations. Groundwater was generally encountered in the western part of the site with the hydraulic gradient likely towards the east to the River Adur East.

5.3 Geotechnical Testing

5.3.1 In-situ testing was undertaken for geotechnical purposes and samples were obtained for appropriate laboratory analysis. Site based geotechnical testing is summarised in Table 5-3 Any limitations to the testing that require consideration during the evaluation of the data are described in the following paragraphs.

Table 5-3 In-situ Tests (Geotechnical)

Test Type and Reference	Number
Standard penetration test (BS EN ISO 22476-3:2005)	18
Hand shear vane (BS 1377: Part 9: 1990)	17
Hand penetrometer (UK Specification for Ground Investigation, 2 nd Edition)	5
BRE soakaway tests (BRE Digest 365)	1

5.3.2 Although a standardised test, uncorrected Standard Penetration Test (SPT) 'N' values display a considerable amount of scatter. Calibrated SPT hammers were used by the ground investigation contractor and in our appraisal (given in Section 6.0) the results have been

normalised to 'N₆₀' in accordance with Eurocode 7¹². Correcting the tests with respect to energy ratio to determine 'N₆₀' reduces the scatter but does not eliminate it.

- 5.3.3 Some grossly elevated SPT N values, likely to be due to encountering hard strata/ Mudstone/ Siltstone within the Weald Clay Formation, were recorded between 1.80-3.20m bgl. As discussed in section 10, these are not considered representative of the stratum as a whole and have been discounted from subsequent analysis.
- 5.3.4 Hand shear vane tests were undertaken on samples recovered from boreholes and trial pits. Whilst these can be used to estimate the undrained shear strength, due to operational reasons, such values are much less precise than other test methods.
- 5.3.5 Pocket penetrometer apparatus provides only an estimate of undrained shear strength as (due to operational reasons) it is less precise than other tests methods, especially when undertaken on samples obtained from dynamic sampling equipment. Given the limitations of this test method, in isolation, it is not considered sufficiently reliable to estimate of undrained shear strength for use in foundation design. However, it can provide useful information on the relatively intact strength of class so as to assist with the assessment of desiccation.
- 5.3.6 The above factors have been considered in the appraisal of geotechnical results given in Section 6.0.
- 5.3.7 Geotechnical laboratory testing is summarised in Table 5-4.

Table 5-4 Laboratory Tests (Geotechnical)

Test type and reference (BS 1377: 1990 unless stated)	Number
Water (Moisture) Content (Part 2:3.2/BS EN ISO 17892-1).	19
Liquid and plastic limits and plasticity index (Part 2:4.3, 5.3 and 5.4)	10
Particle size distribution - wet sieving (Part 2:9.2/BS EN ISO 17892-4)	2
Particle size distribution - sedimentation by pipette method (Part 2:9.4/BS EN ISO 17892-5)	2
Organic matter content (Part 3:3)	3
Single stage 102mm UU triaxial compression test (Part 7:8)	1
Water soluble sulphate content 2:1 aqueous extract (L038-PL - I2 in house).	9
Total sulphur content (L038-PL - I2 in house).	9
Total Sulphate as SO ₄ (L038-PL - I2 in house)	9
Soil pH (L099-PL - I2 in house)	9
Sulphate content in groundwater	3
Groundwater pH	3

- 5.3.8 As with in situ testing, it is necessary to consider the limitations associated with any laboratory testing and to review any potentially anomalous results. In all geotechnical tests, it should be

¹² EN 1997-2:2007 Eurocode 7 Geotechnical design – Part 2 Ground Investigation and Testing

noted the specimen is selected from a much larger volume of material, which may have an inherent degree of variability, particularly in Made Ground.

- 5.3.9 Water content determinations on disturbed samples may not be wholly representative due to disturbance arising from the sampling process. In addition, moisture content results can be influenced by climatic factors and it cannot be guaranteed that the values determined at the time of investigation will be the same as those that prevail at the time of construction.
- 5.3.10 Obtaining coarse-grained soils from cable tool boreholes can result in a loss of fine materials due to the nature of the sampling process. This can have an influence on the results of particle size distribution analyses.
- 5.3.11 Determinations of undrained shear strength can be affected by sample disturbance. Whilst this is reduced by the use of UT100 sampling equipment, it cannot be fully eliminated and requires due consideration in appraising the results, especially where an elevated number of blows were required to retrieve the sample. Determinations of undrained shear strength can also be affected by the presence of fissures. The application of a suitable confining pressure in the test can reduce this, but fissures can still affect the results when present.
- 5.3.12 The above factors have been considered in the appraisal of geotechnical results given in Section 6.0.

5.4 Contamination Observations and Testing

- 5.4.1 Generally Made Ground was not encountered during the investigation with the exception of locations which included gravel of brick and concrete in topsoil in locations WS7-01 and IT7-01.
- 5.4.2 Table 5-5 summarises the chemical suites that were analysed based upon the preliminary conceptual model and observed site conditions.

Table 5-5 Laboratory Tests (Environmental)

Test type	Number
SOIL	
As, Be, B, Cd, Cr, Cu, Ni, Pb, Hg, Se, V, Zn, Cyanide (total), pH, TPH screen (C6-C40), PAH (16 speciated), Phenol (total)	6
Total organic carbon	2
Pesticide and herbicide suite	1
WATER	
As, Cd, Cr, Cu, Ni, Zn, Pb, Hg, B, Se, hex Cr, Total cyanide, free cyanide, thiocyanate, PAH (total), TPH (total), phenol (total) Sol sulphate, sulphide, free sulphur, pH	3

6.0 GEOTECHNICAL EVALUATION

6.1 Ground Conditions

- 6.1.1 The ground conditions encountered during the 2020 site investigation generally consisted of a thin mantle of Topsoil / Made Ground over the weathered Weald Clay Formation of CLAY and locally SILT. These weathered cohesive soils grade into more competent bedrock materials of the Weald Clay Formation typically comprising interbedded/ laminated CLAY and MUDSTONE or locally into MUDSTONE or SILTSTONE. The general distribution of each stratum is shown in Table 6-1.

Table 6-1 Soil Profile

Stratum	From		To		Average Proven Thickness (m)
	(m bgl)	(m AOD)	(m bgl)	(m AOD)	
Topsoil / Made Ground	0.00	25.63-23.72	0.10-0.30	25.48-23.62	0.17
Weathered Weald Clay Formation	0.10-0.30	25.48-23.62	1.80-2.90	23.36-21.72	1.85
Weald Clay Formation (Bedrock)	1.80-2.30	22.36-21.92*	2.60-3.20	22.06-20.52*	N/A*

*base not proven

- 6.1.2 The ground model as encountered in Table 6-1 broadly agrees with from the conditions anticipated.

6.2 Topsoil/ Made Ground

- 6.2.1 Topsoil was encountered across most of site from ground level except for WS7-01 and IT7-01 where Made Ground was encountered. The Topsoil was typically recorded to depths of between 0.10m and 0.15m bgl. The approximate average proven thickness of the Topsoil / Made Ground is 0.17m.
- 6.2.2 Topsoil was generally described as grass over light brown, locally mottled, variable CLAY soils, locally with rare gravel, with roots/ rootlets. The gravel fractions encountered locally generally comprise sub-angular to rounded fine to coarse flint.
- 6.2.3 Made Ground was recorded to 0.30m bgl at WS7-01 and IT7-01 described as friable Topsoil with the addition anthropogenic material in the form of gravel sized brick fragments, and chalk locally in IT7-01. Consequently, the Made Ground and Topsoil are considered here together. The presence of brick fragments and chalk is likely the result of historical reworking of soils during agricultural processes.
- 6.2.4 No geotechnical testing was undertaken on samples from the Topsoil / Made Ground due to the minor thickness and inherent engineering variability.

6.3 Weathered Weald Clay Formation

- 6.3.1 The weathered Weald Clay was encountered at all exploratory hole locations underlying Topsoil / Made Ground to depths ranging between 1.80m and 2.90m bgl. The approximate average proven thickness of the weathered Weald Clay is 1.85m.
- 6.3.2 At all the windowless sampler borehole locations (WS7-01 to WS7-07) the weathered Weald Clay Formation is considered to have been encountered to exploratory hole completion, represented on all occasions by refusals on hard stratum. The refusals ranged from 2.11-2.90m bgl. It is considered that the refusals occurred at / near to the rock head of the underlying bedrock or alternatively on hard rock bands.
- 6.3.3 The soils of the weathered Weald Clay typically comprised firm to very stiff, locally friable, locally mottled, locally thinly to thickly laminated, grey / orangish / reddish brown, occasionally slightly sandy, occasionally slightly gravelly to gravelly or locally with rare gravel, silty CLAY.
- 6.3.4 Locally the weathered Weald Clay comprised SILT in IT7-01 between 0.60-0.80m bgl, described as light grey, mottled orangish brown, slightly sandy clayey SILT, occasionally stiff silty CLAY. Soils were also recorded to occasionally be of clayey SILT between 0.80-1.60m bgl.
- 6.3.5 Where present, the gravel constituent of the soils of the weathered Weald Clay generally comprised sub-angular to sub-rounded fine to coarse mudstone (occasionally as lithorelicts) with occasional reddish brown staining and siltstone locally.
- 6.3.6 Locally the gravel constituent comprised angular to sub-angular fine to coarse flint e.g. CP7-01 (0.10-0.60-m bgl). The presence of such is indicative of reworking of soils through agricultural processes.
- 6.3.7 In IT7-01 a vertical tension crack, extremely closely spaced, smooth, infilled with loose soil was recorded at 0.30m bgl in very stiff silty CLAY. At the same location, the stiff silty CLAY soil between 0.80-1.60m bgl was described to be fissured. The fissures were described as randomly oriented, closely spaced and smooth.
- 6.3.8 The typical CLAY soils of the weathered Weald Clay often transitioned into generally thinly to thickly interlaminated MUDSTONE and CLAY, generally described as extremely weak to very weak, thinly to thickly laminated, grey / brown, locally mottled, generally de-structured to distinctly weathered MUDSTONE and typically very stiff, locally friable, locally laminated, grey / brown, silty CLAY.
- 6.3.9 Possible relict shear surfaces were recorded at the following locations TP717, IT9-01 and IT12-01 (See Figure 7, Appendix 1) in the Weald Clay between depths of 1.30-2.60m bgl during recent investigations in the local area.
- 6.3.10 All interlaminated CLAY and MUDSTONE materials have been considered here as weathered Weald Clay as the presence of CLAY laminations is considered to have the potential to cause such materials to act more like a CLAY than bedrock from an engineering perspective.
- 6.3.11 In IT7-01 a bed of extremely weak to very weak orangish brown SILTSTONE, recovered as SAND and GRAVEL, with occasional pockets of grey clayey silt and rare black staining was

recorded between 2.00-2.30m bgl. This bed has been considered here as weathered Weald Clay due to the presence of pockets of clayey silt.

6.3.12 Organic material in the form of rare to occasional rootlets were recorded at the following locations: CP7-01 (0.60-1.80m bgl), WS7-01 (0.30-1.30m bgl), WS7-03 (0.15-0.40m bgl), WS7-04 (0.15-1.75m bgl), WS7-06 (0.15-1.15m bgl), WS7-07 (0.10-0.30m bgl) and IT7-01 (0.30-1.60m bgl).

6.3.13 Local rock bands were recorded within the soils of the weathered Weald Clay. Potential / suspected minor rock bands were indicated at the following locations:

- WS7-03: Gravelly between 1.40-1.50m bgl.
- WS7-04 and WS7-06: Gravel becoming abundant between 1.40-1.60m bgl and 1.00-1.15m bgl respectively.

6.3.14 The SPT 'N60' values recorded in the weathered Weald Clay were variable at 1.20m bgl and ranged from 15 to 29. Generally effective refusals (SPT 'N60' >50) were recorded from 1.80m bgl, with the exception of a value of 47 at 2.00m bgl in WS7-01.

6.3.15 It is noted that on occasions the CLAY soils of the weathered Weald Clay were described to transition from stiff or very stiff into firm to stiff or stiff e.g. in WS7-06 and IT7-01, indicating potential desiccation. Moisture content (mc) profiles for soils of the weathered Weald Clay are summarised below and also indicate potentially desiccated soils locally.

- CP7-01: mc of 5% at 0.60m bgl, increasing to 16.40% at 1.00m bgl, reducing down to 2.10% at 1.20m bgl. It is noted that the sample from 1.20-1.65m bgl was described by the laboratory as a GRAVEL as opposed to CLAY with occasional mudstone gravel in the field from 1.60m bgl.
- WS7-02: mc of 22.30% at 1.00m bgl, decreasing to 20.90% at 1.30m bgl, increasing to 22.20% at 1.80m bgl.
- WS7-04: mc of 19.60% at 0.30m bgl, increasing to 22.50% at 1.00m bgl, decreasing down to 16.20% at 1.80m bgl.

6.3.16 Half (5/10) of the modified plasticity index results obtained from samples of the weathered Weald Clay indicate a medium volume change potential material in accordance with the NHBC Standards¹³. The remainder of the modified plasticity index results indicate a low volume change potential material.

6.3.17 Two particle size distribution (PSD) tests and sedimentation by pipette tests undertaken on samples of weathered Weald Clay Formation soils described in the field as a slightly sandy silty CLAY indicated SILT record the following particle size distribution:

- Cobbles: 0%
- Gravel: 0% and 29%;

¹³ NHBC. (2025). NHBC Standards. Retrieved from <https://nhbc-standards.co.uk/>

- Sand: 1% and 11%;
- Silt: 50% and 64%;
- Clay: 10% and 35%.

6.3.18 Consequently, it is considered that soils on site may locally be of SILT or have higher SILT portions than what is indicated by field descriptions.

6.3.19 It is noted that some deposits included in this section as weathered Weald Clay such as those containing gravel constituents not naturally found in the Weald Clay are likely representative of reworked natural materials. However, based on laboratory testing it is not possible to determine this with certainty. Such deposits have therefore been considered here based on their general engineering descriptions.

6.3.20 Estimations of characteristic bulk unit weight follow BS 8004 guidance¹⁴.

6.3.21 Geotechnical parameters for the Weathered Weald Clay Formation are summarised in Table 6-2.

Table 6-2 Summary of Soil Parameters for the Weathered Weald Clay Formation

Soil Parameters	Number of tests	Range of results
Liquid Limit (%)	10	35 – 51
Plastic Limit (%)	10	20 – 28
Plasticity Index (%)	10	10 – 28
Modified Plasticity Index %)	10	10 – 28
Plasticity	10	
Volume Change Potential (NHBC)	10	Low to Medium
Moisture Content (%)	19	2.1 – 47.3
Organic content (%)	3	<0.1 – 0.8
SPT 'N ₆₀ ' Values	16	15 to >50*
Undrained Shear Strength – Hand Shear Vane (kN/m ²)	17	60 – >120
Undrained Shear Strength – UU Triaxial Test (kN/m ²)	1	243
Bulk Unit Weight (kN/m ³)	-	18

*Limited to 50 following effective refusal

6.4 Weald Clay Formation (Bedrock)

6.4.1 Bedrock of the Weald Clay Formation is considered to have been encountered in CP7-01 and IT7-01 underlying weathered materials from depths of 1.80-2.60m bgl down to exploratory hole completion, represented by refusals on hard stratum, at 2.60-3.20m bgl.

¹⁴ British Standard. (2020). Code of Practice for foundations. BS 8004:2015+A1:2020. BSI Standards Publication.

- 6.4.2 As highlighted in Section 6.3.14 the remaining positions where bedrock is not considered to have been encountered recorded refusals on hard stratum at depths ranging from 2.11-2.90m bgl. These refusals potentially indicate the bedrock head of the Weald Clay Formation.
- 6.4.3 In CP7-01 the bedrock encountered from 1.80m bgl comprised extremely weak to weak transitioning into weak thinly laminated brown and grey, partially weathered, MUDSTONE with occasional orangish brown staining.
- 6.4.4 In IT7-01 the bedrock encountered from 2.30m bgl comprised extremely weak orangish brown SILTSTONE recovered as a sandy GRAVEL.
- 6.4.5 During the machine dug trial pitting associated with IT7-01 which utilised a JCB 3CX excavator, hard digging was recorded in the extremely weak SILTSTONE from 2.30m bgl at which point a 450mm toothed bucket was utilised to excavate down to depths of 2.60m bgl where refusal on hard stratum prevented further progress.
- 6.4.6 Both SPT 'N₆₀' values recorded within the bedrock of the Weald Clay Formation were >50 and are consequently representative of effective refusals.
- 6.4.7 Estimations of characteristic bulk unit weight follow BS 8004 guidance¹⁴.
- 6.4.8 Geotechnical parameters for the Weald Clay Formation (Bedrock) are summarised in Table 6-3.

Table 6-3 Summary of Soil Parameters for the Weald Clay Formation (Bedrock)

Soil Parameters	Number of tests	Range of results
SPT 'N ₆₀ ' Values	2	>50*
Density (kN/m ³)	-	18

*Limited to 50 following effective refusal

6.5 Buried Concrete

- 6.5.1 Nine soil samples, comprising seven from the weathered Weald Clay Formation and two from the Weald Clay Formation bedrock were subjected to pH and water-soluble sulphate determinations with reference to BRE Digest SD1¹⁵. All of these samples were subjected to total sulphur and acid soluble sulphate content testing to allow an assessment to be made in relation to the potential thaumasite form of concrete attack.
- 6.5.2 A summary of the results is included in Table 6-4 below.

¹⁵ BRE. (2005). SD1 Concrete in aggressive ground.

Table 6-4 Summary of BRE Suite Test Results in reference to BRE Digest SD1

Strata	Number of Tests	pH	Water Soluble Sulphate as SO ₄ (mg/l)	Total Sulphur as S (%)	Acid Soluble Sulphate as SO ₄ (%)	Total Potential Sulphate (%)	Concrete Class Classification
Weathered Weald Clay Formation	7	4.3-7.3	8.5-87	0.012-0.160	0.031-0.064	0.036-0.480	DS-2 AC-3z
Weald Clay Formation (Bedrock)	2	4.9-6.4	3.7-73.4	0.014-0.079	0.040-0.077	NA	DS-1 AC-1

6.5.3 One of the oxidisable sulphides values calculated from a weathered Weald Clay Formation was in excess of 0.3%. Consequently, the results are considered indicative of significant risk from this form of concrete attack and a modification to DS class is therefore proposed.

6.5.4 Three samples of groundwater obtained during the monitoring programme were subjected to sulphate and pH determinations. The recorded sulphate values ranged from 27.1-114.0mg/l and measured pH values ranged from 6.4-7.0, which suggests, with reference to the BRE Digest a classification DS-1, AC-1.

6.6 Infiltration

6.6.1 An infiltration test in accordance with BRE365 was undertaken at trial pit IT7-01. The result indicates poor drainage characteristics and is summarised in Table 6-5.

Table 6-5 Infiltration Test Results

Exploratory Hole	Stratum	Response Zone (m bgl)	Calculated Permeability (m/s)
IT7-01	Weald Clay Formation (bedrock)	1.80-2.60	Not possible to calculate infiltration rate due to minimal reduction of induced water level.

6.7 Groundwater Conditions

6.7.1 Groundwater observations during the field and the subsequent monitoring are described in Section 5.0 and are summarised in Table 5-2.

6.7.2 No groundwater strikes were recorded during the fieldwork.

6.7.3 During the return monitoring visits standing water was recorded in all locations, with the exception of WS7-03 to WS7-06 which were recorded to be dry. WS7-07 was also indicated to be void of water during the final return visit, being described as 'damp'.

6.7.4 During the return monitoring visits, the shallowest recorded water level was at 1.60m bgl in WS7-02 and the deepest (not including dry / 'damp' positions) was at 2.12m bgl in CP7-01.

The water levels recorded during monitoring visits are considered to generally be representative of groundwater level on site.

7.0 GEOTECHNICAL HAZARDS

7.1 Geotechnical Hazards

The geotechnical hazards associated with the site are summarised in Table 7-1.

Table 7-1 Summary of Geotechnical Hazards

Hazard	Potential presence on site		Identified			Engineering Risk to Proposed Developments
	Yes	No	Yes	Locally	No	
Shrinking and swelling of clay soils including desiccation	☒	☐	☒	☐	☐	The Weald Clay is recorded to exhibit a low to medium volume change potential on changes in moisture content. Locally potentially desiccated soils are suspected alongside the presence of live roots and rootlets. The removal of large trees / hedgerows / dense vegetation may result in significant heave of clay soils.
Hard excavation / shallow bedrock and potential rock bands	☒	☐	☐	☒	☐	Although a veneer of weathered material exists atop of the bedrock and the trial pit could be progressed with a normal excavation plant (JCB 3CX), refusal on hard stratum was recorded at 2.60m bgl. Should deep excavations be proposed then the presence of shallow bedrock on site that is not possible to dig through with conventional lightweight excavation equipment could be present.
Shallow groundwater	☒	☐	☐	☒	☐	Variable groundwater levels are recorded on site and in some areas shallow groundwater is present. Groundwater ingress will have a destabilising effect on cutting faces.
Potential for localised compressible soils e.g. Made Ground and alluvial soils	☒	☐	☐	☐	☒	Although not encountered and highly unlikely to be widespread, the localised presence of unrecorded compressible deposits, e.g. Made Ground associated with agricultural land uses and alluvial soils in the northeast and south associated with a suspected historical water course and gully (although these were not encountered), cannot be entirely ruled out. Such strata may exhibit large total and differential settlements under relatively light loads such as that imparted by low rise buildings, road pavements and earthworks.

Hazard	Potential presence on site		Identified			Engineering Risk to Proposed Developments
	Yes	No	Yes	Locally	No	
Potential for localised slope instability in the south of the site and potential for relict shear surfaces	☒	☐	☐	☐	☒	Although not recorded on site, potential evidence of historical ground movement in the form of relict shear surfaces in the Weald Clay were recorded during recent ground investigations in the localised area. The potential presence of such features on site, especially in sloping topographies (e.g. in the south / adjacent to the south of the site), cannot be discounted.
Presence of natural soils susceptible to frost heave	☒	☐	☐	☒	☐	A number of soils on site are considered to be frost susceptible which can damage foundations and infrastructure.
Site won material unsuitable for re-use for specific applications	☒	☐	☒	☐	☐	Clay and mudstone are considered to be argillaceous in nature and therefore may be unsuitable for certain forms of re-use e.g. as structural fill without suitable processing / or treatment.
Low permeability soils / variable infiltration rates	☒	☐	☒	☐	☐	Infiltration testing indicates that shallow materials of the Weald Clay exhibit poor infiltration characteristics not suitable for soakaway drainage.
Ground conditions aggressive to buried concrete	☒	☐	☒	☐	☐	The ground conditions are considered to be aggressive to buried concrete and therefore buried concrete should be designed accordingly.
Soils susceptible to scour	☒	☐	☐	☒	☐	On site soils are indicated to have high silt portions and are consequently considered to be at risk from scour. Scour risk is considered to be exacerbated where vegetation is removed.

Hazard	Potential presence on site		Identified			Engineering Risk to Proposed Developments
	Yes	No	Yes	Locally	No	
Animal burrows	☒	☐	☐	☐	☒	Animal burrows are understood to be present in the local area. Applying additional load to the ground above disused (or active) animal burrows may cause collapse / settlement and associated foundation failure.
Historical mineral extraction	☐	☐	☐	☐	☒	Although not encountered, a number of historical surface pits have been recorded in the wider area and, based on the geological conditions recorded on site, the presence of unrecorded mineral extraction features cannot be fully discounted. If present unrecorded mineral extraction features may conflict with future intrusive ground works and proposed developments.
Temporary foul storage system excavation	☒	☐	☐	☒	☐	It is understood that the buried foul storage system located at the east of the site will be removed prior to development of the school site. Consideration should be given to effectively grubbing this out and ensuring the excavation is backfilled in accordance with an engineered specification to minimise surface settlement.

8.0 GENERIC QUANTITATIVE RISK ASSESSMENT

8.1 Assessment Framework

8.1.1 In order to assess the risk to the identified human, controlled water and gas risk receptors the collected data have been compared against generic screening values. The guidance used to / select or calculate these values is provided in the Environmental Risk Assessment section at the rear of the report text.

8.2 Soil

8.2.1 With respect to risk to end users, soil screening values for a school end use have been selected based upon the proposed development as a Primary School. The soil screening values for a school end use have been developed by CampbellReith using CLEA v1.071. Toxicity values are based on those used by LQM in the derivation of S4ULs. Exposure values are based on the C4SL approach but amended for a primary school end user. A summary of the input values is provided in Appendix D.

8.2.2 The assessment assumes a Soil Organic Matter (SOM) content of 1% considering only two samples were scheduled for Total Organic Carbon analysis.

8.2.3 The results have been reviewed for evidence of potential zoning across the site and/or between the various soil strata and as a consequence, the statistical assessment has treated the site as a single averaging area and screened in its entirety. The assessment has included the upper 1.0m depth of the Made Ground or natural soils where Made Ground was absent.

8.2.4 The results were compared against the screening values and are summarised in Table 8-1. The statistical assessment methodology is based on CL:AIRE's Professional Guidance¹⁶, as detailed in the Environmental Risk Assessment section to the rear of this report. In summary, the 95% Upper Confidence Limit (95% UCL) of the mean concentration of the sample population/s has been calculated where there were exceedances of the screening value. Where the 95%UCL exceeds the screening values, these results are highlighted and discussed. The remainder are not considered indicative of significant contamination for the proposed end use and are not discussed further.

Table 8-1 Summary of Soil Analysis

Contaminant	Units	Exceeding	Max	GAC
Arsenic	mg/kg	0 / 6	11	150 ^D
Boron	mg/kg	0 / 6	1.7	1700 ^D
Beryllium	mg/kg	0 / 6	1.1	11 ^D
Cadmium	mg/kg	0 / 6	<0.2	28 ^D
Chromium	mg/kg	0 / 6	33	8800 ^D
Copper	mg/kg	0 / 6	23	14000 ^D
Lead	mg/kg	0 / 6	45	850 ^D
Mercury	mg/kg	0 / 6	0.4	200 ^D
Nickel	mg/kg	0 / 6	19	570 ^D
Selenium	mg/kg	0 / 6	2.8	1700 ^D

¹⁶ CL:AIRE Comparing Soil Contamination Data with a Critical Concentration (v1.1 February 2021)

Contaminant	Units	Exceeding	Max	GAC
Vanadium	mg/kg	0 / 6	47	2400 ^D
Zinc	mg/kg	0 / 6	90	24000 ^D
Cyanide	mg/kg	0 / 6	<1	24 ^C
Total Petroleum Hydrocarbons				
TPH >C6-40	mg/kg	0 / 6	21	320 ^D
EPH/TPH C6-10	mg/kg	0 / 6	<0.1	320 ^D
TPH >C10-40	mg/kg	0 / 6	21	460 ^D
Polycyclic Aromatic Hydrocarbons				
Naphthalene	mg/kg	0 / 6	<0.05	120 ^D
Acenaphthylene	mg/kg	0 / 6	<0.05	1000 ^D
Acenaphthene	mg/kg	0 / 6	<0.05	1300 ^D
Fluorene	mg/kg	0 / 6	<0.05	970 ^D
Phenanthrene	mg/kg	0 / 6	0.62	530 ^D
Anthracene	mg/kg	0 / 6	<0.05	13000 ^D
Fluoranthene	mg/kg	0 / 6	0.94	1500 ^D
Pyrene	mg/kg	0 / 6	0.96	3300 ^D
Benzo (a) anthracene	mg/kg	0 / 6	0.49	36 ^D
Chrysene	mg/kg	0 / 6	0.55	63 ^D
Benzo (b) fluoranthene	mg/kg	0 / 6	0.49	10 ^D
Benzo (k) fluoranthene	mg/kg	0 / 6	0.29	300 ^D
Benzo (a) pyrene	mg/kg	0 / 6	0.43	8.6 ^D
Indeno (1,2,3 - cd) pyrene	mg/kg	0 / 6	0.27	110 ^D
Dibenzo (ah) anthracene	mg/kg	0 / 6	<0.05	0.94 ^D
Benzo (ghi) perylene	mg/kg	0 / 6	0.32	1200 ^D
Speciated Phenols				
Phenol (Monohydric)	mg/kg	0 / 6	<1	950 ^D
Herbicides and Acid Herbicides				
2,3,6-Trichlorobenzoic Acid (Tba)	mg/kg	- / 1	<0.05	n/a
2,4,5-Trichlorophenoxy Acetic Acid (T)	mg/kg	- / 1	<0.01	n/a
Silvex	mg/kg	- / 1	<0.01	n/a
2,4-Dichlorophenoxy Acetic Acid (D)	mg/kg	- / 1	<0.01	n/a
Butyric Acid (4-(2,4-dichlorophenoxy)-Butanoic acid (DB))	mg/kg	- / 1	<0.01	n/a
4-Cpa	mg/kg	- / 1	<0.02	n/a
Aldicarb	mg/kg	- / 1	<0.01	n/a
Aldicarb Sulfone	mg/kg	- / 1	<0.01	n/a
Atrazine	mg/kg	0 / 1	<0.01	23 ^D
Bromacil	mg/kg	- / 1	<0.01	n/a
Bromoxynil	mg/kg	- / 1	<0.01	n/a
Carbaryl	mg/kg	- / 1	<0.01	n/a
Carbofuran	mg/kg	- / 1	<0.01	n/a
Chlortoluron	mg/kg	- / 1	<0.01	n/a
Clopyralid	mg/kg	- / 1	<0.1	n/a
Cyanazine	mg/kg	- / 1	<0.01	n/a
Dicamba	mg/kg	- / 1	<0.02	n/a
2-(2,4-Dichlorophenoxy)propionic Acid	mg/kg	- / 1	<0.01	n/a
2-sec-Butyl-4,6-dinitrophenol	mg/kg	- / 1	<0.01	n/a
Diuron	mg/kg	- / 1	<0.01	n/a
Flamprop	mg/kg	- / 1	<0.05	n/a
Flamprop-isopropyl	mg/kg	- / 1	<0.01	n/a

Contaminant	Units	Exceeding	Max	GAC
Ioxynil	mg/kg	- / 1	<0.01	n/a
Isoproturon	mg/kg	- / 1	<0.01	n/a
Linuron	mg/kg	- / 1	<0.02	n/a
MCPA	mg/kg	- / 1	<0.01	n/a
MCPB	mg/kg	- / 1	<0.02	n/a
Mecoprop (MCP) (2-(4-chloro-2-methylphenoxy)	mg/kg	- / 1	<0.01	n/a
Methiocarb	mg/kg	- / 1	<0.01	n/a
Methomyl	mg/kg	- / 1	<0.01	n/a
Oxamyl	mg/kg	- / 1	<0.01	n/a
Picloram	mg/kg	- / 1	<0.05	n/a
Prometryne	mg/kg	- / 1	<0.01	n/a
Propazine	mg/kg	- / 1	<0.01	n/a
Propoxur	mg/kg	- / 1	<0.01	n/a
Siduron	mg/kg	- / 1	<0.01	n/a
Simazine	mg/kg	- / 1	<0.01	n/a
Tebuthiuron	mg/kg	- / 1	<0.01	n/a
Terbuthylazine	mg/kg	- / 1	<0.01	n/a
Terbutryn	mg/kg	- / 1	<0.01	n/a
Trietazine	mg/kg	- / 1	<0.01	n/a

School End Use assuming 1.0% SOM Generic Assessment Criteria (GAC): ^aAcute Risk GAC (SoBRA derived). ^bGAC derived using CLEA v1.071.

8.2.5 Exceedances of the screening criteria have not been identified for any of the contaminants analysed.

8.2.6 A single sample WS7-01 at 0.15m bgl was scheduled for pesticides and herbicides in soils. The sample was selected on a due diligence basis rather than based on visual/olfactory evidence of contamination. Detectable concentrations of herbicides were not encountered. Herbicides and pesticides are not considered to pose a significant risk to end users.

8.2.7 A significant risk is not considered to exist to end users with respect soil contamination.

8.3 Asbestos

8.3.1 It is noted that there are no UK generic quantitative assessment criteria for asbestos in soils. A summary of the results for asbestos is presented below.

8.3.2 Instances of Made Ground were limited to gravel of brick in topsoil. There were no visual instances of suspected asbestos in soils. On this basis, asbestos screening was not conducted. The associated risk is considered low.

8.3.3 Should any material be encountered which is suspected to be asbestos containing, the area should be segregated and an appropriate investigation conducted. Dust suppression measures should be applied on site in accordance with generally good environmental practice on construction sites.

8.4 Controlled Waters

8.4.1 A controlled water risk assessment has been undertaken using as available Environmental Quality Standards (EQS) for the protection of aquatic life due to the site's location in proximity

to the River Adur East. The statistics associated with groundwater analysis are summarised in Table 8-2.

Table 8-2 Summary of Water Analysis

Contaminant	Units	Exceeding	Max	GAC
Metals & Inorganics				
Arsenic	µg/l	0/ 3	6.7	50 ^{B*}
Boron	µg/l	0/ 3	240	2000 ^C
Cadmium	µg/l	2/ 3	1.6	0.08 ^B
Chromium	µg/l	0/ 3	<0.2	4.7 ^B
Chromium - Hexavalent	µg/l	3/ 3	<5	3.4 ^{A*}
Copper	µg/l	3/ 3	5.4	1 ^{B#}
Lead	µg/l	0/ 3	0.3	1.2 ^{B*#}
Mercury	µg/l	0/ 3	<0.05	0.07 ^{B*}
Nickel	µg/l	3/ 3	100	4 ^{B#}
Selenium	µg/l	0/ 3	1.8	7.5 ^A
Zinc	µg/l	3/ 3	22	10.9 ^{B#}
Cyanide	µg/l	0/ 3	1	1 ^B
Cyanide Free	µg/l	- / 3	<1	n/a
Thiocyanate	µg/l	- / 3	<200	n/a
Total Petroleum Hydrocarbons				
TPH >C10-40	µg/l	0/ 3	<10	74 ^B
Polycyclic Aromatic Hydrocarbons				
Naphthalene	µg/l	0/ 3	<0.01	2 ^B
Acenaphthylene	µg/l	- / 3	<0.01	n/a
Acenaphthene	µg/l	- / 3	<0.01	n/a
Fluorene	µg/l	- / 3	<0.01	n/a
Phenanthrene	µg/l	- / 3	<0.01	n/a
Anthracene	µg/l	0/ 3	<0.01	0.1 ^{B*}
Fluoranthene	µg/l	3/ 3	<0.01	0.0063 ^{B*}
Pyrene	µg/l	- / 3	<0.01	n/a
Benzo (a) anthracene	µg/l	- / 3	<0.01	n/a
Chrysene	µg/l	- / 3	<0.01	n/a
Benzo (b) fluoranthene	µg/l	- / 3	<0.01	n/a
Benzo (k) fluoranthene	µg/l	- / 3	<0.01	n/a
Benzo (a) pyrene	µg/l	3/ 3	<0.01	0.00017 ^{B*}
Indeno (1,2,3 - cd) pyrene	µg/l	- / 3	<0.01	n/a
Dibenzo (ah) anthracene	µg/l	- / 3	<0.01	n/a
Benzo (ghi) perylene	µg/l	- / 3	<0.01	n/a
Speciated Phenols				
Phenol	µg/l	0/ 3	<0.5	7.7 ^B
Total Speciated Phenols	µg/l	0/ 3	<3.5	7.7 ^B

^ARiver Basin Districts Typology, Standards and Groundwater threshold values (WFD) (England & Wales) Directions 2010. ^BThe Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. ^CSupporting Guidance (WAT-SG-53), Environmental Quality Standards and Standards for Discharge to Surface Waters. V6.1, SEPA, Feb 2018. *hazardous substance (according to Groundwater Directive 2006/118/EC). #assumes 100% bioavailability. – Not calculated.

Table 8-3 Summary of Groundwater Exceedances

Contaminant	Hole ID	Concentration (µg/l)	GAC (µg/l)
Cadmium	CP7-01	1.6	0.08
Cadmium	WS7-02	0.19	0.08
Copper	CP7-01	3.2	1
Copper	WS7-01	2.3	1
Copper	WS7-02	5.4	1
Nickel	CP7-01	100	4
Nickel	WS7-01	31	4
Nickel	WS7-02	22	4
Zinc	CP7-01	22	10.9
Zinc	WS7-01	17	10.9
Zinc	WS7-02	18	10.9

8.4.2 Groundwater results exceeded the screening criteria for various metals are listed in Table 8-3. Generally, exceedances are within an order of magnitude of the screening criteria and considering the absence of visual observations of contamination, it is considered unlikely that a significant risk to the River Adur East exists.

8.4.3 Some results have been reported below the laboratory detection limit, but the detection limit exceeds the screening criteria. These exceedances are considered unlikely to represent an unacceptable risk to controlled waters and as such have not been highlighted as true exceedances.

8.5 Ground Gas

8.5.1 Following a review of the Groundsure Report [1] and the factual Ground Investigation Report [4], a significant source of potentially hazardous ground gases that could affect the site has not been identified. Considering this, the potential risk for ground gas generation is considered to be low. The monitoring data have been assessed to confirm this.

8.5.2 Made Ground was generally absent however was encountered at two exploratory hole locations to a maximum depth of 0.30m bgl. The engineer's logs do not indicate that a significant source of degradable organic material was encountered. Total organic carbon (TOC) was only scheduled on one sample of Made Ground which had a TOC of 2.0%.

8.5.3 Three rounds of ground gas monitoring were completed between 15 June and 15 July 2020. All of the ground gas monitoring installations were installed within natural strata and as such are not considered to target a potential significant source of ground gas generation. The results have however been included for completeness.

8.5.4 A worst-case Gas Screening Value (GSV) has been calculated for each monitoring location and these are presented in Table 8-4. These are based on credible worst-case concentrations and flows. Non-representative data not included in the calculations are discussed separately below the table.

Table 8-4 Summary Gas Screening Values

Borehole	Worst Case Concentration (%) and Flow (l/hr)			Gas Screening Value (l/hr)	
	CH ₄	CO ₂	Flow	CH ₄	CO ₂
CP7-01	<0.1	3.6	0.0	0.0001	0.0036
WS7-01	<0.1	0.8	0.0	0.0001	0.0008
WS7-02	<0.1	1.9	0.0	0.0001	0.0019
WS7-03	0.1	1.1	0.0	0.0001	0.0011
WS7-04	<0.1	1.7	0.0	0.0001	0.0017
WS7-05	<0.1	1.4	0.0	0.0001	0.0014
WS7-06	<0.1	1.2	0.0	0.0001	0.0012
WS7-07	<0.1	1.4	0.0	0.0001	0.0014

All percentage figures are by measurement of volume. Concentrations and flows are based on steady state conditions.

- 8.5.5 Reference to Table 8-4 indicates the GSV calculated for all installations would be classified as a CIRIA Characteristic Situation 1. In addition, given the absence of significant thicknesses of Made Ground or natural strata with a high degradable organic content, the soils at site are considered to have a low – very low gas generation potential.
- 8.5.6 The data are considered representative and appropriate for recommendations to be made regarding ground gas risk.
- 8.5.7 Nominal concentrations of carbon monoxide up to 2.0ppm (steady state) were encountered in all locations during the first monitoring visit of 15 June 2020. Steady state carbon monoxide concentrations were not encountered in the subsequent monitoring visits. The screening concentration for carbon monoxide, based on guidance in EH50/2005 HSE Workplace Exposure Limits for long-term exposure, is 20ppm. As such, the carbon monoxide concentrations historically encountered are not considered to pose a risk to end users.
- 8.5.8 Steady state detectable concentrations of hydrogen sulphide (up to 1ppm) were encountered at WS7-01 on 2 July 2020. These were not encountered at this location during the remaining monitoring visits and were not recorded at any other location. The concentration encountered is therefore not considered to be significant.
- 8.5.9 Nominal concentrations of VOCs were encountered in all locations during the 2020 monitoring visits. The maximum steady state concentration encountered was 6.9ppm in CP7-01 during the monitoring visit of 15 June 2020. This had reduced to 2.6ppm by the final monitoring visit of 15th July 2020. Concentrations at other locations also showed a general reduction over the monitoring period. A source of VOC contamination was not identified in the engineer's logs and/or soils analysis. The concentrations encountered are therefore not considered to be significant and do not require further consideration.

- 8.5.10 Based upon the conceptual site model, as informed by the monitoring data, the site is considered to be representative of CIRIA Characteristic Situation 1 and as such, gas and/or vapour protection measures are not required.

9.0 REVISED CONCEPTUAL SITE MODEL

9.1.1 The potential contamination linkages, as detailed in Table 4-2, have been investigated and assessed. The Conceptual Site Model (CSM) can now be revised to account for site-specific data, which informs the risks associated with the proposed development and, therefore, enables appropriate remedial measures to be recommended.

9.2 Classification of Risk

9.2.1 Risk is defined by the combination of two factors: i) the probability of an occurrence (expressed as a likelihood); and ii) the consequence of it happening (expressed as a severity). The definitions of these categories are included in the Environmental Risk Assessment Standards and Supporting Information section to the rear of this report, together with definitions of the classifications of probability and consequence, but the procedure for classifying risk is summarised in Table 9-1.

Table 9-1 Classification of Risk

Probability (Likelihood)		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

9.2.2 A qualitative risk assessment for the receptors identified in Table 4-2 is presented below in Tables 9-2 to 9-6.

Table 9-2 Groundworkers (Assuming Basic PPE)*

Pathway	Risk	Comments
Ingestion of soil/dust	Very Low	Significant contaminant concentrations or a potential source of contamination has not been encountered.
Inhalation of soil/dust	Very Low	
Dermal contact with soil/dust/water	Very Low	Redevelopment or maintenance of the site may involve ground workers coming into contact with the underlying soils and water.
Inhalation of vapour from soil/dust	Very Low	Normal Health and Safety precautions associated with a site where potential contamination may exist (of the levels identified), will mitigate the general risk.
Inhalation of vapour from groundwater	Very Low	

Pathway	Risk	Comments
Migration of soil gases to confined spaces	Very Low	There is a potential risk if previously unforeseen contamination is later found to be present.

* Additional assessments are required by the Contractor in relation to asbestos risk.

Table 9-3 End Users during Occupation

Pathway	Risk	Comments
Inhalation of dust	Very Low	No exceedances of the screening criteria were noted for the proposed schools end use and Made Ground on the site was minimal, therefore the associated risk is considered very low.
Ingestion of soil/dust	Very Low	
Dermal contact with soil/dust/water	Very Low	Inspections across the former site compound should be completed following removal and a watching brief maintained throughout groundworks. Specific inspections should be completed along the northeastern boundary, adjacent to the off-site above ground fuel tank.
Consumption of vegetables/plants	Very Low	
Inhalation of vapour from soil/dust	Very Low	
Inhalation of vapour from groundwater	Very Low	There is a potential risk if previously unforeseen contamination is later found to be present.
Migration of soil gases to confined spaces/structure	Very Low	
Movement of contaminants to engineered structures (e.g. water pipes)	Very Low	
Uptake by flora/fauna	Very Low	

Table 9-4 Controlled Waters

Pathway	Risk	Comments
Migration of water borne contaminants from site to surface waters	Very Low	Generally, contamination levels are low and elevated determinands are considered likely to be indicative of background geochemistry rather than being associated with a contamination source.
Migration of water borne contamination from off site	Very Low	
Migration of contamination from surface and/or subsurface to groundwater	Very Low	

Table 9-5 Buildings

Pathway	Risk	Comments
Movement of contaminants to engineered structures (e.g. water pipes)	Very Low	Based on the concentrations of hydrocarbons encountered organic resistant pipework is not considered to be required across most of the site with

Pathway	Risk	Comments
		respect to potable water supply. If hydrocarbons are encountered, additional soil sampling may be required to determine the requirement for organic resistant pipework.
Migration and accumulation of flammable gases beneath the building footprint.	Very Low	Detectable concentrations of methane were not encountered.

Table 9-6 Offsite Receptors

Pathway	Risk	Comments
Dermal contact with soil/dust/water	Very Low	Contamination levels are low and associated risks to offsite receptors are considered very low.
Inhalation/ingestion of dust	Very Low	
Inhalation of vapour from soil/dust	Very Low	
Inhalation of vapour from groundwater	Very Low	
Migration of soil gases to confined spaces/structure	Very Low	
Movement of contaminants to engineered structures (e.g. water pipes)	Very Low	

10.0 GEOTECHNICAL CONCLUSIONS AND RECOMMENDATIONS

10.1 Introduction

10.1.1 It is proposed to develop the site as a school. Current proposals are indicated in Figure 4, Appendix 1. It is understood that site levels will be altered using site won materials from the local residential development, raising the existing ground level by c. 1m.

10.1.2 Details of the structure and anticipated loadings were under development at the time of the writing of this report. Further investigation will be required once proposals are fully developed and it is recommended that a detailed Geotechnical Design Report is prepared. The primary purpose of this report is to identify risk and to inform design development.

10.2 Key Considerations

10.2.1 The ground investigation has identified several geotechnical risks at the site. These are summarised below and discussed in more detail in the following sections.

- Medium volume change potential soils;
- Ground level raise (c. 1m);
- Soil desiccation;
- Ground conditions aggressive to buried concrete ;
- Temporary excavation c. 3m depth, and consequent need for earthworks;
- Shallow groundwater level;
- Poor drainage characteristics.

10.3 Foundations

10.3.1 As described in Section 6.0, much of the site is underlain by Topsoil over weathered Weald Clay Formation comprised of locally silty CLAY, typically grading into interbedded / interlaminated CLAY and MUDSTONE or MUDSTONE / SILTSTONE bedrock of the Weald Clay Formation.

10.3.2 It should be noted that the possibility of groundwater strikes additional to those encountered during the ground investigation works cannot be ruled out.

10.4 Shallow Foundations

10.4.1 The use of shallow foundations founded in firm or better CLAY or intact MUDSTONE (or similar intact bedrock) may be considered for the proposed developments as long as such strata are encountered at suitable strengths, depths and homogenous and suitably vertically and horizontally continuous thicknesses.

10.4.2 Foundation depths should be determined in accordance with Chapter 4.2 of the NHBC Standards¹³ based on medium volume change potential soils. The determined depths should also factor in the presence of trees that are existing / planned / to be removed and the presence of any desiccated soils and live roots. It is noted that the depths provided in the

NHBC Standards are depths below existing ground level rather than the new site levels. Therefore should traditional pad and strip foundations be adopted, the depth may be in excess of >2m deep to meet the requirements of the NHBC Standards.

10.4.3 Should shallow foundations be used at the proposed development site the below preliminary allowable bearing pressures may be considered for outline design, assuming foundation widths of 1m embedded into suitably thick and laterally continuous founding strata. Once designs are developed these values should be confirmed by an experienced geotechnical engineer.

- Firm CLAY – 125kPa
- Weak intact MUDSTONE – 250kPa

10.4.4 Should foundations be proposed to bear onto the bedrock then the design should take into account potential failure mechanisms; shear failure of unsupported rock columns, wedge failure of closed joints, splitting and punching failure due to an underlying weak layer and sliding failure along weak joint planes.

10.4.5 Heave protection will be required on site in accordance with the NHBC Standards and should be designed based on the medium volume change potential of the soils found on site.

10.4.6 For any load bearing formations, careful inspection should be undertaken to ensure placement in competent natural strata unless ground treatment has been carried out and properly validated. All Topsoil, Made Ground and any soft / loose / organic rich materials should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground.

10.4.7 It is recommended that shallow foundations do not straddle two differing strata, including those that are differentially weathered / structured, to avoid issues with differential settlement. In areas where such conditions are encountered, deepening of foundations should be considered or alternatively providing reinforcement to the base of foundations.

10.4.8 The potential presence of pre-existing shear surfaces should be considered during the design of shallow foundations.

10.5 Piled Foundations

10.5.1 Piled foundation solutions may be required on site where the use of shallow foundations is precluded e.g. due to the structural loads imparted by proposed developments or where deepening requirements are uneconomical (due to presence of mature trees / significant thickness fill etc).

10.5.2 The advice of reputable piling specialists, experienced in the ground conditions considered here, should be sought. They should be responsible for the selection of appropriate piling equipment and the final design of the piles. Given below are some preliminary comments.

10.5.3 It is envisaged that the piles would extend to suitable depths into competent bedrock of the Weald Clay Formation. It is anticipated that high bearing capacities will be achieved by either bearing on, or rock socketing into, this formation. The allowable bearing capacity achievable by piled foundations will be highly dependent on the pile installation technique utilised and

consequently due to the fact that outline design proposals have not yet been prepared, preliminary pile safe working loads have not been provided within this report.

10.5.4 Due to the medium volume change potential soils on site, the specialist pile designer should consider the potential for desiccation, shrink / swell clays and the requirements for void formers below ground beams and pile caps and against the inside faces of external ground beams and piles caps where clay soils are present, so as to provide a suitable minimum void dimension as per NHBC guidelines.

10.5.5 The adoption of maintained load tests in accordance with EC7¹² would enable increased capacities or shorter piles to be adopted.

10.5.6 The parameters adopted by the piling specialist should be verified by an experienced geotechnical engineer.

10.6 Floor Slabs

10.6.1 Within the zone of influence of trees previously removed, to be retained or removed as part of the development, suspended floor slabs are recommended because of the potential for heave. Void formers are required in accordance with Chapter 4.2 of the NHBC Standards based on medium volume change potential.

10.6.2 In relation to piled construction, void formers in accordance with NHBC Standards will be required below all ground beams and pile caps and against the inside faces of external ground beams and piles caps.

10.7 Drainage

10.7.1 Any proposed drainage and other services will likely be affected by heave resulting from the medium volume change potential of soils, which will be pronounced in areas of vegetation. Consequently, drainage should be laid with increased falls and flexible service connections.

10.7.2 As some soils on site may be considered frost susceptible, drainage should be placed at sufficient depth so as to avoid the impacts of frost heave.

10.7.3 Due to the presence of significant silty and generally fine soils on site, drainage infrastructure should be wrapped in geotextile to prevent the ingress of fines and silting up of drainage systems.

10.7.4 Due to the presence of potentially erodible silty soils, scour protection measures should be considered on site, particularly within any new or altered drainage channels, ditches or watercourses.

10.7.5 The design of drainage should take into account the shallow and variable groundwater levels on site and the likelihood for seasonal variations in these. Temporary dewatering measures may be required within areas of high groundwater unless suitable water lowering measures are put in place pre-development of drainage e.g. land drains.

10.7.6 Additional drainage should be incorporated into detailed design if any unidentified springs / water sources are identified on site.

10.7.7 Infiltration testing in accordance with BRE 365 was attempted on site however, no infiltration was recorded over a 1 hour period. Consequently, it is considered that the use of infiltration drainage devices is unfeasible on site.

10.8 Earthworks

10.8.1 It is envisaged that minor localised earthworks will be utilised locally on site to form level development platforms for the proposed developments. The feasibility and ease of any cut and fill works will largely depend on the ease of excavation, excavation stability and suitability of material for re-use.

10.8.2 Locally the magnitude of fill will influence the stability of slopes, foundation solutions chosen and CBR values selected for road pavements.

10.8.3 It is recommended that slope stability analysis is undertaken on any slopes where significant fill is to be placed or where material is to be removed on sloping topographies as the placement of additional load or the removal of toe support could instigate slope failure. This slope stability analysis should take into account the potential presence of relict shear surfaces and the potential for soils at residual strengths.

10.8.4 Below are some preliminary comments and recommendations in relation to any proposed earthworks on site.

Fill Works

10.8.5 It is recommended that the suitability of materials is assessed and confirmed through testing in accordance with the Specification for Highway Works (SHW) Series 600¹⁷ and an engineer's defined specification. If site won material is considered unsuitable for re-use, suitable imported material or treatment will be required.

10.8.6 It is considered that CLAY soils and MUDSTONE of the Weald Clay are argillaceous and therefore may be considered unsuitable for use as certain types of structural fill.

10.8.7 Prior to the placement of fill all Topsoil, Made Ground and any soft / loose / organic rich / putrescible / desiccated materials, alongside any soft spots or large cobbles / boulder sized inclusions, should be excavated and the formation level inspected and proof rolled.

10.8.8 If significant fill is proposed on site, it is recommended that settlement analysis is undertaken in order to assess the degree of short term, long term and creep settlement induced by the loading of natural strata with fill material. It is recommended that strata susceptible to compression e.g. Made Ground and potential alluvial soils are not loaded with fill material to avoid unacceptable degrees of settlement and the negative impacts this may have (e.g. negative skin friction).

10.8.9 Suitable slope angles for any proposed embankments will be dependent on the fill material chosen to form them and the utilisation of reinforcement (e.g. geogrids) and should be suitably assessed in a GDR.

¹⁷ Standards for Highways. (2017). Series 600. Specification for Highway Works. Earthworks. Retrieved from <https://www.standardsforhighways.co.uk/>

Excavations

- 10.8.10 With the exception of bedrock of the Weald Clay Formation e.g. MUDSTONE and SILTSTONE, all other encountered strata are considered to be amenable to conventional excavation equipment. Should bedrock or rock bands be anticipated locally in areas of cut, plant capable of hard digging should be considered. The requirement for plant capable ripping of bedrock is considered unlikely, however cannot be fully discounted, especially if significant cut works are proposed.
- 10.8.11 Stability in excavation faces in Weald Clay Formation cannot be relied on due to the combination of fissures and shallow groundwater. Allowance should be made for battering faces back to a safe angle of repose, or providing shuttering. Support or battering of the excavation faces to a safe angle of repose will be required for all excavations where man entry is necessary, the nature and extent of which will need to be evaluated under CDM regulations¹⁸.
- 10.8.12 Groundwater was recorded to range from 1.60 to 2.12m bgl on site during return monitoring visits, with the exception of WS7-03, WS7-04, WS7-05 and WS7-06 which were recorded to be dry. WS7-07 was also indicated to be void of water during the final return visit, being described as 'damp'.
- 10.8.13 It should be noted that groundwater levels will vary seasonally. Groundwater monitoring was undertaken between June and July, consequently, the presence of shallower groundwater levels over typically wetter months e.g. during the winter should be anticipated.
- 10.8.14 In general groundwater ingress should be anticipated in excavations and areas of cut. Consequently, it is recommended that stability and groundwater ingress mitigation measures should be allowed for, such as sump pumping and battering.
- 10.8.15 All cuttings should be inspected for the potential presence of pre-existing shear surfaces and water seepages. If groundwater or pre-existing shear surfaces are encountered, additional stabilisation measures may be required.
- 10.8.16 If significant cuttings are proposed, due to the presence of materials susceptible to volume change, foundations, services etc. will need to be designed to withstand heave pressures caused by unloading associated with excavation.
- 10.8.17 Due to the presence of silt rich soils and relatively shallow water, the ground may exhibit a 'mattressing' effect in areas of cut due to pore water dissipation / capillary action. This issue typically solves itself as pore waters reach equilibrium, however, use of temporary drainage may be required to remediate the issue.

10.9 Road Pavements

- 10.9.1 The composition of formation soils on which any road pavements will be constructed will be largely dependent on the magnitude of fill on site.

¹⁸ CITB. (2015) The Construction Design & Management Regulations.

- 10.9.2 Due to the medium volume change potential soil at the site, pavement surfaces should be constructed in flexible materials such as bituminous compounds or block paving which are more easily able to accommodate ground movement and can be more easily repaired. The formation level should be rolled and inspected for any soft or loose material. These materials should be removed and replaced with granular fill placed and compacted in accordance with suitable specification.
- 10.9.3 Based on correlations between CBR value with Atterberg limit tests as per IAN73¹⁹, taking an upper bound 'worst case' plasticity, assuming a thin road pavement, a high water table and average construction conditions, a preliminary long term equilibrium CBR value of 3% is considered suitable for CLAY soils of the weathered Weald Clay on site.
- 10.9.4 In order to achieve recommended CBR values, formation levels should be rolled and inspected for any soft or loose material. These materials should be removed and replaced with granular fill placed and compacted in accordance with suitable specification.
- 10.9.5 A higher CBR value could be considered where formation soils comprise intact bedrock of MUDSTONE or similar. In such circumstances CBR values should be confirmed by additional testing.
- 10.9.6 Laboratory test results were indicative of frost susceptibility.
- 10.9.7 Due to the presence of significant silt portions in soils, any formation levels should be subjected to minimal trafficking, especially during periods of wet weather. The pavement formation level should be protected as soon as practically possible following exposure.
- 10.9.8 The use of separation geotextiles is recommended between imported granular material and natural strata to prevent the migration of fines (silt and clay) into the pavement subbase / capping.
- 10.9.9 Where road pavement is to be constructed on fill, it is recommended that such fill is placed and compacted in accordance with a suitable specification based on the Specification for Highway Works. Pavement surfaces should be constructed in flexible materials such as bituminous compounds or block paving. The CBR value to be adopted would depend on nature of the fill specification adopted and the as built quality of the fill, however, assuming site won soils are used and/or to be consistent with road pavements in other parts of the site and that the soils are suitably compacted, it is recommended that CBR value of 3% is adopted. Additional testing of the fill just prior to road construction is recommended, so as to confirm matters.
- 10.10 **Ground Improvement**
- 10.10.1 With respect to ground improvement options, the advice of reputable specialist contractors experienced in the ground conditions considered here should be sought. They should be responsible for the selection of appropriate equipment and the final design of the treatment.

¹⁹ Highways England. (2020). Design for new pavement foundations (formerly IAN 73/06 revision 1 (2009), HD 25/94). Rev 1.

Given below is a discussion in relation to forms of ground treatment more commonly adopted in the UK.

- 10.10.2 Should significantly desiccated soils be encountered then locally the consideration of lime / cement stabilisation to stabilise desiccated soils and remove the potential for heave could be considered as an alternative to replacement of in-situ soils with imported fill material on site or deepening of foundations. The sulphate / oxidisable sulphide content of some soils could preclude the use of certain lime / cement mixes.
- 10.10.3 The restrictions that should be considered by the specialist include: noise and vibration, organic and other deleterious matter content in the ground, sulphates in the ground, proximity of nearby structures and sensitive site environmental receptors. Often specialist contractors would request to observe ground conditions for themselves through trials pits or other investigation methods before the suitability of any given technique can be confirmed.
- 10.10.4 Should any form of ground improvement be adopted this should be informed by a suitable design trial and the main works validated by an appropriate programme of testing. If ground improvement is implemented then it should be possible to adopt pad footings or a 'semi-raft' foundation, depending on the nature and degree of treatment.
- 10.11 Buried Concrete
- 10.11.1 In the consideration of sulphate attack on buried concrete, reference has been made to BRE Special Digest 1, which classifies the site as a greenfield site with a mobile groundwater conditions. The results of the concrete classification tests received have indicated a DS-1 classification in the Weald Clay Formation, together with the pH values indicates that an ACEC AC-2z should be adopted.
- 10.11.2 Additionally, as the Weald Clay Formation can be pyrite bearing, it has also been necessary to assess the potential for the thaumasite form of attack. Levels of oxidisable sulphides of more than 0.3% were recorded from a sample of the weathered Weald Clay. Consequently, as sulphides are indicated to be present locally in the materials of the Weald Clay, it is recommended that the designer considers whether or not ground conditions will become disturbed in a way that could cause oxidation of sulphides when selecting an appropriate design sulphate class.
- 10.11.3 If the oxidation of materials of the Weald Clay is considered possible during construction a minimum concrete classification of DS-2, AC-3z should be considered based on the average of the highest two associated total potential sulphate values recorded on site.
- 10.12 Desiccation
- 10.12.1 Although not always considered a definitively reliable indication of desiccation, comparisons between liquid limits of three samples of the soils of the weathered Weald Clay indicate desiccated soil²⁰.

²⁰ BRE. (1996). Desiccation in clay soils. Digest 412 CI/SfB (A3s).

10.12.2 Medium volume change potential soil was encountered on site therefore it should be conservatively assumed that the soils within the vicinity of any semi mature and mature vegetation could be desiccated. Due consideration should be given to the effects of heave due to the removal of the on-site vegetation and the effects this will have on the proposed developments.

10.12.3 The designer should consider the potential for desiccation in soils, especially in vicinity to mature vegetation and proposed new trees such as the tree-lined public square. Locally deepening of foundations, road pavements etc. past zones of desiccation may be required.

10.13 Animal Setts / Burrows

10.13.1 Badger setts are understood to be present in the local area. It is expected that where badger setts are to be retained, there will be an appropriate buffer between the sett / any identified entrances and built development. It is also expected that where any sett is to be removed, this will be appropriately undertaken under a license from Natural England.

10.13.2 If a badger sett or any previously un-identified animal burrows / setts are identified during construction and conflict with proposed development works an ecologist should be notified.

10.13.3 Applying additional load to the ground above active or redundant animal burrows may cause collapse / settlement and associated foundation failure. An ecologist should be consulted regarding the infilling / removal of any animal burrows, including the removal of any burrows identified under the proposed developments required under licence and any exclusion zones associated with badger setts. Suitable remediation of burrows should be agreed between the engineer and an ecologist.

10.14 General Construction Advice

10.14.1 It should be possible to use conventional excavators to form excavations in the soils encountered during the investigation. However, old foundations, temporary drainage construction and the like, may require the use of breaking apparatus.

10.14.2 For any load bearing formations, careful inspection should be undertaken to ensure placement in competent natural strata unless ground treatment has been carried out and properly validated. Any soft spots identified should be excavated and replaced with compacted granular fill or lean mix concrete. Concrete should be placed as soon as possible following excavation to avoid softening of the ground. A similar recommendation is also made for road pavement formations, although compacted granular fill could be used instead of concrete.

10.14.3 Any relict foundations or other subterranean structures beneath the footprint of the proposed buildings should be fully grubbed out. Such excavations should be surveyed and backfilled with an acceptable granular fill, placed and compacted to an engineering specification. The same recommendations are made for excavations that may be required to remove soil contamination.

10.14.4 In areas of road pavements and hard standing, relic subterranean structures should be broken down to around 1m below finished site level to minimise the risk of differential settlement due

to the presence of hard spots. In soft landscaped areas, it may be possible to limit such operations to 0.50m bgl.

- 10.14.5 There are a number of monitoring wells remaining on site from the 2020 ground investigation. These should be decommissioned in line with the Environment Agency publication *Good practice for decommissioning redundant boreholes and wells*.²¹

²¹ Environment Agency. (2018). Good practice for decommissioning redundant boreholes and wells.

11.0 ENVIRONMENTAL CONCLUSIONS AND RECOMMENDATIONS

11.1.1 Desk study and subsequent site investigation information have confirmed the respective levels of risk to receptors (end users, groundwater, etc.) associated with the proposed primary school development. The risks and any remedial requirements are summarised for the long-term receptors in Sections 11.3 – 11.6. Sections 11.7 – 11.8 summarise the risks and remedial requirements for groundworkers and services. Sections 11.9 – 11.11 then detail the requirements for further investigation and/or assessment, reporting, and waste soils management.

11.1.2 Remedial recommendations are provided based on the current understanding of the site. These requirements should be re-assessed following any additional investigations /assessments that are may be carried out since these could lead to their modification. Detailed remedial works should be finalised in a Groundworks/ Remediation Specification.

11.2 Data Uncertainties

11.2.1 It is noted that the ground investigation was completed in 2020, and some minor earthworks/groundworks have been undertaken/are currently ongoing at the site and adjacent areas. Based on visual observations from the 2025 site walkover, the earthworks are considered unlikely to present a potential source of contamination. A watching brief will be required to confirm the absence of contamination particularly in areas of site previously occupied by the site compound, and in the area along the northeastern site boundary adjacent to a fuel storage area.

11.3 Summary of Risk and Remedial Requirements – Soils / End Users

11.3.1 Generally, a VERY LOW RISK is considered to exist with respect to end users due to the absence of significantly elevated contaminant concentrations and potential sources of contamination.

11.3.2 Given the site has undergone earthworks since the completion of the ground investigation including the establishment of a site compound, a watching brief should be maintained across the site particularly in the area of the compound and the northeastern boundary near the offsite fuel storage area.

11.3.3 Results to date indicate that on-site soils may be suitable for re-use on site. These will require chemical analysis in accordance with an appropriate Remediation Specification to confirm soil concentrations are below an agreed set of limiting values. Re-use must also be carried out in accordance with waste guidance. Records as detailed within the Remediation Specification and/or Groundworks Specification should be maintained to certify the source, chemical suitability and appropriate placement of the soils.

11.4 Summary of Risk and Remedial Requirements – Controlled Waters

11.4.1 The underlying Weald Clay is classified as Unproductive Strata and a continuous groundwater body was not encountered at the site. In addition, significantly elevated contaminant concentrations were not encountered in groundwater or soil samples. As such, the risk to the

underlying aquifer is considered to be VERY LOW and remedial works are not required with respect to groundwater.

- 11.4.2 The risk to surface water receptors i.e. River Adur East is considered to be VERY LOW due to the absence of significant contaminant concentrations.

11.5 Summary of Risk and Remedial Requirements – Ground Gas / Vapours

- 11.5.1 The risk from ground gas is VERY LOW and the site has been classified as a CIRIA Characteristic Situation 1. Made Ground and organic rich soils were generally not encountered. Gas protection measures are not required.

- 11.5.2 Vapour protection measures are not required.

11.6 Additional Remedial Recommendations

- 11.6.1 In addition to the requirements noted above, a watching brief should be maintained throughout the groundworks in order to identify any previously undetected areas of contamination, such as asbestos containing materials and/or stained/odorous soils. These should be assessed by an Environmental Consultant if identified.

11.7 Groundworkers

- 11.7.1 The qualitative assessment identified a potentially VERY LOW RISK to groundworkers who may come into contact with contaminated soils and waters. In general, standard Health and Safety precautions associated with a site where potential contamination may exist will mitigate the general risk (gloves, no eating/drinking on site, dust suppression etc.)

- 11.7.2 The Contractor should prepare risk assessments and method statements in view of the identified and foreseeable ground conditions and include these within the Health and Safety Plan: for example, these should consider worker protection from skin contact, ingestion and inhalation of contaminants, asbestos in soils and ground gas. In order to achieve satisfactory control, CampbellReith recommend that Health and Safety provisions in accordance with HSE Publication HS(G) 66²² and CIRIA Report 132²³ are considered. The Contractor must also control matters such as any contracted CDM responsibilities.

- 11.7.3 In relation to presence of asbestos in soils, the Contractor should formulate their working arrangements in view of the requirements of the Control of Asbestos Regulations (2012)²⁴ and the associated ACoP (L143)²⁵. Additional interpretation on the application of these regulations is presented in publications prepared by CL:AIRE (CAR-SOIL™)²⁶ and additional guidance is provided in CIRIA C765²⁷.

²² HSG 66 Protection of workers and the general public during the development of contaminated land. 1991

²³ CIRIA REP R 132 Guide for safe working on contaminated sites. 1996

²⁴ HSE Control of Asbestos Regulations, 2012

²⁵ HSE Managing and Working with Asbestos, L143. 2013

²⁶ CL:AIRE. Joint Industry Working Group. Control of Asbestos Regulations 2012, Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials, 2016; and the associated JIWG decision support tool, 2017

²⁷ CIRIA C765 Asbestos in Soil and Made Ground Good Practice Site Guide, 2017

11.8 Services

11.8.1 Based on the hydrocarbon concentrations encountered it is considered unlikely that there will be a requirement for the protection of public water supply pipework, such as the use of organic resistant pipework. If hydrocarbons are encountered, additional soil sampling may be required to inform the requirement for organic resistant pipework. The infrastructure designer should assess requirements for pipework with respect to soil contamination and consult statutory utility companies and relevant guidance as necessary. Guidance on this topic is presented in UKWIR Report 'Publication UKWIR Report'²⁸.

11.9 Additional Site Investigation/Assessment

11.9.1 The potential presence of invasive plant species, such as Japanese Knotweed, has not been assessed and it is recommended that a survey is carried out by an appropriately qualified specialist if this is of concern to the client.

11.10 Remediation and Verification Documents

11.10.1 A Remediation/Groundworks Specification should be produced to ensure that the recommendations made in this report are correctly carried out and recorded during the site works. The Specification should:

- detail the requirements associated with specific watching brief inspections and actions for any contamination that may be identified in these areas;
- specify the necessary requirement for inspections/ record keeping/ actions for unforeseen contamination (for example, if fuel tanks are encountered which were not known about then removal of any such features will be required in accordance with an appropriate tank removal specification) and Contractor's method statements, together with appropriate validation);
- detail the requirements for the control of imported material;
- provide appropriate guidance on the production of method statements relating to health and safety, work with asbestos containing materials, etc.;
- provide details regarding waste soil management; and,
- provide details of what is required in the Verification Report.

11.10.2 On completion of the remedial works and / or earthworks, a Verification Report should be produced to demonstrate that the works have been successfully carried out in accordance with the Remediation Specification such that the site is suitable for its proposed end use. As well as being a likely requirement of the planning process, the report can also be used to provide assurance to funders and / or future site purchasers that the site has been successfully remediated.

11.10.3 The Remediation Specification and Verification Report will likely require submission to the Local Authority for review and approval as part of the planning process, to fulfil the requirements of any land quality planning condition. Failure to submit the required documentation could result in refusal to discharge associated Land Quality Planning Conditions, and discussions should be held with the relevant Officer at an early stage to ensure

²⁸ Publication UKWIR Report Ref 10/WM/03/21: Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites - Final Project Report, as amended by the Contaminated Land Assessment Guidance (Water UK, January 2014)

all necessary information is obtained and collated for their review and approval. Once the Remediation Specification is approved, it will be the Contractor's obligation to fulfil the agreed requirements and to produce the Verification Report.

11.11 Waste Management

11.11.1 A hazardous properties assessment of waste soils has not been undertaken as part of this report. The soil results can, however, be used by the Contractor as a basis for waste soil classification and disposal purposes; however, additional testing may be required, particularly if non-representative soils are uncovered such as those that are stained, odorous or containing asbestos

11.11.2 All waste related activities must be undertaken in accordance with the Waste Management and Landfill Regulations. Any proposed reuse of materials must be in accordance with the Waste (England and Wales) Regulations 2011 (as amended) and will likely require one or more of the following: Environmental Permit, Exemption, Materials Management Plan.

11.11.3 With respect to waste soils disposal, as a minimum, the following information should be collected and retained by the Contractor for subsequent validation:

- source and origin of the waste;
- information on the process producing the waste;
- European Waste Catalogue code and characteristics of material;
- for hazardous waste, definition of the relevant properties according to the Hazardous Waste Directive (Annex III 91/689/EC);
- confirmation that waste is not prohibited waste;
- appearance of the waste;
- landfill class; and,
- Duty of Care records including full and completed chain of custody documentation.

11.11.4 The final waste classification is the responsibility of the Contractor and should be determined in conjunction with the receiving landfill and in liaison with the Environment Agency (and their technical guidance). It is noted that, depending on the landfill selected, additional soils testing information and independent verification of the materials of the materials being received by the landfill may be required.

11.11.5 As the correct classification of waste may have a significant impact on the redevelopment budget, the waste classification should be reviewed independently at an early stage in the project management stage. In addition, contractors should be asked to confirm that their tenders consider the full requirements of the Landfill Directive and associated waste legislation. This is to ensure waste is correctly classified and costed at the inception of the project.

11.11.6 A separate assessment should be made for the rate of Landfill Tax (where applicable) in accordance with HMRC Excise Notice LFT1²⁹.

²⁹ HMRC Excise Notice LFT1: a general guide to landfill tax.

ENVIRONMENTAL RISK ASSESSMENT STANDARDS AND SUPPORTING INFORMATION

Normative Standards

Contamination

The report has been produced in general accordance with the procedures for ground investigation, interpretation and reporting set out in Land Contamination Risk Management (LCRM) (England) BS 5930:2015 (+A1:2020), BS 10175:2011 (+A2:2017) and BS EN 1997 (Eurocode 7).

This assessment considers the objectives of the National Planning Policy Framework which requires information to demonstrate that a site is suitable for its new use (taking account of ground conditions and land instability) and not capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990 (after remediation). The NPPF requires adequate site investigation information, prepared by a competent person.

Geotechnics

The geotechnical appraisal has been carried out in accordance with Eurocode 7. Sections 2, 3, 5 and 6, together with Appendix 3, comprise the Ground Investigation Report. Preliminary geotechnical recommendations are presented in Section 10 and these should be verified in a Geotechnical Design Report once structural details of the proposed development are confirmed.

Soil Screening Values

The Environment Agency (EA) has published non-statutory technical guidance for Regulators and their advisors to assess the chronic risk posed to human health from land contamination, known as the Contaminated Land Exposure Assessment (CLEA) Framework. Following a number of updates, CLEA v1.071 is the current version of the EA's risk assessment software.

Soil Guideline Values (SGVs) were produced by DEFRA/EA and Generic Assessment Criteria (GACs) have been produced by CampbellReith and others. These are based on the CLEA model and supporting guidance (SR2³⁰ and SR3³¹). With respect to toxicity, SGV/S4UL/in-house GAC are based on health criteria values (HCV), as defined in SR2, which represent a tolerable/minimal level of risk.

In 2014 DEFRA released C4SL (Category 4 Screening Levels) for 6 No. contaminants (As, benzene, BaP, Cd, Cr (VI) and Pb), along with the associated Policy Companion Document and an Erratum³². They are based on a low level of toxicological concern (LLTC) and are, by definition, less conservative than HCV. They represent contaminant soil concentrations, which present a low level of risk within the context of Part 2A, i.e. they are representative of Category 4 sites. In the Contaminated Land Statutory Guidance³³, sites under Part 2A assessments are categorised 1 - 4, with Category 1 being definitely Part 2A and Category 4 definitely not Part 2A ('where there is no risk or the level of risk posed is low').

³⁰ Environment Agency Report Ref: SC050021/SR2 – Human Health Toxicological Assessment of Contaminants in Soil. January 2009

³¹ Jeffries, J. and Martin, I. (2009). Science Report SC050021/SR3 Updated technical background to the CLEA model. Environment Agency.

³² SP1010 – Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination. Revision 2. September 2014

³³ Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance, April 2012

DEFRA have confirmed that C4SLs can be used in the planning regime and DCLG (Department for Communities and Local Government) amended Planning Practice Guidance (PPG) on Land Affected by Contamination (12 June 2014)³⁴ which stated that C4SLs provide a simple test for deciding when land is suitable for use and definitely not contaminated land'. On 03 September 2014 the Secretary for the Environment, Lord de Mauley, issued a letter to all Local Authorities, which references DCLG's PPG and confirms that C4SLs could be used in planning and provide a simple test for establishing when sites are suitable for use. The LCRM also states 'Where an SGV and a C4SL are available for the same contaminant, we expect you to use the C4SL'.

LQM/CIEH issued S4ULs in December 2014 for 89 contaminants (metals, BTEX, banded TPH, speciated PAH, chlorinated solvents, phenols, chlorophenols, chlorobenzenes, pesticides and a number of miscellaneous others). The S4ULs have generally adopted the revisions to the exposure modelling that were developed in the production of the C4SLs. Critically, however, they are based on HCVs to produce concentrations, which are indicative of a minimal/tolerable level of risk. CampbellReith have produced GACs which use the same approach to that taken by LQM but also uses the top two approach to homegrown produce that was developed for the C4SLs. CampbellReith's GACs (and S4ULs) are therefore used as the preliminary stage of soil assessments since they are indicative of minimal/tolerable level of risk. If these are exceeded, then the C4SLs are used (if available and shown to be appropriate for the particular assessment) to determine if the risk could be described as low.

Selection of Appropriate [Tier 2] Soil Screening Values

The CLEA model is based upon defined exposure scenarios and six generic land uses have been established for the C4SLs and S4ULs. These set out a discrete set of circumstances where exposure may occur, including a source, the pathways, and the exposed population.

The three generic land use scenarios used in the development of SGVs are:

- commercial/industrial;
- allotments; and,
- residential with plant uptake;
- residential without plant uptake;
- public open space (residential);
- public open space (parks)

It is noted that the CLEA screening values are generic and not always applicable. Where the CLEA conceptual model is not appropriate it will be necessary to develop site-specific Detailed Quantitative Risk Assessment screening values as a further stage of assessment.

It is noted that the CLEA model does not consider risks from contaminated waters beneath the site to human health and the model also assumes that no free product is present. Should such conditions exist at the subject site the requirement for application of an alternative risk assessment model should be

³⁴ <http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance/>

assessed. Alternatively, construction workers are potentially exposed to acute risk and therefore require separate consideration.

Statistical Analysis of Soil Analytical Results

Statistical analysis of soil sample analytical results has been undertaken in accordance with CL:AIRE Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration (v1.1 February 2021).

This approach emphasises the use of summary statistics - primarily the use of confidence intervals around mean soil contaminant concentrations - as only one tool in assessing soil contamination data. Key questions being asked are:

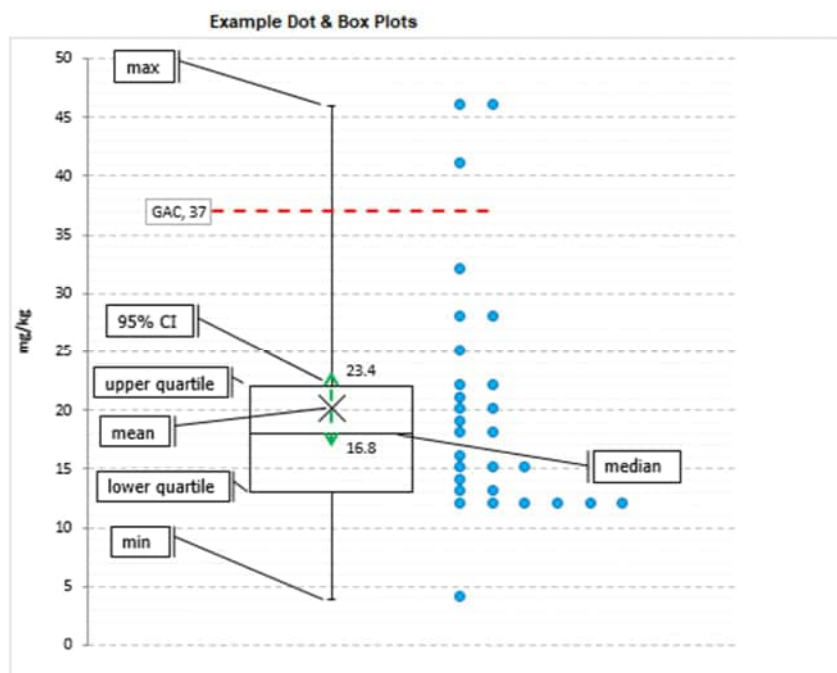
1 - what is the true mean contaminant concentration for the averaging zone or area being sampled?; and,

2 - does our sampling strategy and Conceptual Site Model (CSM) allow us to answer the first question?

For a planning scenario, when the distribution of the contaminant concentration data is well understood by the CSM, the question is then asked 'can we confidently say that the mean concentration is below the critical concentration?'; while for a Part 2A scenario the question is 'can we say on the balance of probabilities that the mean concentration is above the critical concentration'.

Site information is reviewed to determine if zoning of the site is appropriate. This includes assessment of: history and differing land uses, known areas of infilling, anecdotal information, exploratory hole logging and images of soil profiles, and looking for any discernible pattern in the results themselves. Additional summary tables are presented where appropriate to reflect distinct zones relevant to the CSM. The soil results may also be assessed as an averaging area where the end use dictates, for example for an area of proposed residential housing with gardens and a separate area of public open space.

An example is shown below of dot and box plots and summary statistics from assessment of the soil sample analysis results. This summary aids in interpreting the results and checking that they 'make sense' in relation to the CSM. For example, if the mean and upper confidence interval are below the critical concentration, yet there are results that still exceed, are these results from the expected distribution, or is there a separate zone or soil layer which these results represent? Looking at all of the site information and always trying to better understand the CSM is essential to interpreting the results. It may be that insufficient information has been gathered in order to confidently answer the key questions posed.



Example Summary Statistics

Sample number	29
Maximum	46
Upper Quartile	22
Median	18
Lower Quartile	13
Minimum	3.9
GAC value	37
Number exceeding	3 / 29
Mean 'X'	20.1
Standard deviation	10.3
Interquartile range	9.0
95% Confidence Interval	
16.8	23.4

The 95% confidence intervals are adopted under planning scenarios in order to be risk conservative and aid in decision making. Use of a narrower confidence interval i.e. 80%, or even the mean may be used, if deemed appropriate by the Local Authority, under a Part 2A scenario. The use of confidence intervals in our assessments is underpinned by the Central Limit Theorem, which can be briefly stated as 'The distribution of sample means converge to a normal distribution as the sample size increases'. The confidence intervals are calculated:

- Lower confidence limit (LCL) = Sample Mean – T × Standard Error
- Upper confidence limit (UCL) = Sample Mean + T × Standard Error

Where T is the T-statistic as derived from the Student T distribution based on the desired confidence level C% and the number of degrees of freedom (sample size -1).

The confidence intervals calculated in this way assume that the sample mean comes from a normal distribution regardless of what distribution the individual samples themselves come from. However, the Central Limit Theorem, and therefore this assumption, only holds if the sample size is sufficiently large. How many samples is 'sufficient' varies from site to site, and the sampling strategy must take into account the sampling pattern and frequency that will be required.

There are three main types of sample result distribution: symmetric (following a normal distribution); log-symmetric (log-transformed values follow a normal distribution); or, fat-tailed (with one or more extreme values in the results). While the confidence intervals may be applied to the mean for all three types of distribution, it is apparent that this may be increasingly skewed towards either very small or very large values within the results.

In addition to visually assessing the distribution, a potential outlier test is applied. This is calculated as values that are greater than 1.5 times the interquartile range. These values are flagged for further assessment. The CSM is revisited to see if there is either evidence of diffuse contamination poorly mixed

with 'cleaner' soils, or there is the potential for 'hotspot/s'. If the latter, then the results are assessed separately and further delineation of the hotspot could be carried out.

Water Screening Values

This assessment considers potential risks to controlled waters (groundwater and surface waters) in relation to risks from any historical contamination. The most stringent test is that defined for Contaminated Land under Part 2A of the Environmental Protection Act, 1990. However, it should be recognised that a wider evaluation of risk is considered within the planning regime and EA's Land Contamination Risk Management.

The Environment Agency has a wider policy agenda for the protection of controlled waters that will impinge upon judgements in relation to land contamination issues. This includes those for the Water Framework Directive and Groundwater Directive and wider legislation for both groundwater, surface water and associated elements (such as fisheries)³⁵.

The results of water analysis have been compared to screening values selected to assess the potential risk to the identified controlled water receptors in the Conceptual Model. The specific standards utilised for this purpose are considered in the assessment table footnotes and typically comprise: Environmental Quality Standards for the protection of aquatic life; Surface Water Standards; EC, UK and WHO Drinking Water Standards; or Background water quality (where no applicable standard exists).

The initial assessment considers the sensitivity of the receptor in the selection of the screening value. Advice for this purpose has been obtained principally from Environment Agency Technical Advice to Third Parties on Pollution of Controlled Waters for Part 2A of the Environmental Protection Act 1990, No 07/02, EA, 2002 (INFO-RA2-3e), as informed by the EA's GP3.

Where a viable potential contaminant linkage is considered to be present and the screening criteria exceeded, a Qualitative Risk Assessment is presented with associated recommendations. Depending on the specific objectives, policy and practice of the Environment Agency, discussion of water screening values may be subsequently required.

The water quality standards have been chosen in accordance with section 4.2 of the EA's Remedial Targets Methodology as informed by the EA's Groundwater Protection Guides (2017).

Generic Screening Values

The sources of the screening values and associated guidance are provided below.

	Key Guidance
Soil	LQM/CIEH S4ULs for Human Health Risk Assessment.*
	Defra Development of Category 4 Screening Levels Main Report and associated documents
	GAC derived in-house using Environment Agency CLEA Version 1.071 software, Environment Agency Science Reports SC050021 SR2/SR3, LQM/CIEH S4UL, and application of the top two approach to homegrown produce.
	CIRIA - Asbestos in soil and made ground: a guide to understanding and managing risks, March 2014
Water	EA Groundwater Protection Guides, March 2017.

³⁵ Refer to Environmental Agency Publications for Groundwater Protection Policy and Practice (GP3)

	Key Guidance
	The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015
	Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations 2015
	EC and UK Drinking Water Standards.
	WHO Drinking Water Standards.
	Background Water Quality.
Gas	CIRIA C748, 'Guidance on the use of plastic membranes as VOC vapour barriers'.
	CIRIA C735, 'Good practice on the testing and verification of protection systems for buildings against hazardous ground gases'.
	BS 8576:2013, 'Guidance on investigations for ground gas – permanent gases and VOCs'
	CIRIA Report C665, 'Assessing Risks Posed by Hazardous Ground Gases to Buildings'
	CIRIA Report C682, 'VOCs Handbook: investigating, assessing and managing risks from inhalation of VOCs at land affected by contamination'
	British Standard BS:8485+A1:2019, 2015, 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'.
	CIRIA Report 150 'Methane Investigation Strategies'.
	BRE 414 'Protective Measures for Housing on Gas Contaminated Land', 2001.
	The Building Regulations 2000, Approved Document C, Section 2. Updated 2004.
	BR211, 'Radon: Guidance on Protective Measures for New Buildings', 2015.
	Health Protection Agency Publication HPA RPD-033, 2007, 'Indicative Atlas of Radon in England and Wales'.

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DEFINITIONS OF CONSEQUENCE, PROBABILITY AND RISK

The categories of risk have been based upon those defined in the Guidance for the Safe Development of Housing on Land Affected by Contamination, R&D66: 2008 Volume 1 (Environment Agency, NHBC and CIEH). The classification process is shown in the table below. In summary, risk is defined by the combination of two factors: i) the probability of an occurrence (expressed as a likelihood); and ii) the consequence of it happening (expressed as a severity).

Classification of Risk

Probability (Likelihood)		Consequence			
		Severe	Medium	Mild	Minor
	High likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Moderate/low risk	Low risk
	Low likelihood	Moderate risk	Moderate/low risk	Low risk	Very low risk
	Unlikely	Moderate/low risk	Low risk	Very low risk	Very low risk

The key to the classification is that the designation of risk is based upon the consideration of both:

- the magnitude of the potential consequence (i.e. severity).
[takes into account both the potential severity of the hazard and the sensitivity of the receptor]
- the magnitude of probability (i.e. likelihood).
[takes into account both the presence of the hazard and receptor and the integrity of the pathway]

Classification of Consequence

Classification	Definition	Examples
Severe	Highly elevated concentrations likely to result in "significant harm" to human health as defined by the EPA 1990, Part 2A, if exposure occurs. Equivalent to EA Category 1 pollution incident including persistent and/or extensive effects on water quality; leading to closure of a potable abstraction point; major impact on amenity value or major damage to agriculture or commerce.	Significant harm to humans is defined in circular 01.2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Major fish kill in surface water from large spillage of contaminants from site. Highly elevated concentrations of List I and II substances present in groundwater close to small potable abstraction (high sensitivity).

Classification	Definition	Examples
	Major damage to aquatic or other ecosystems, which is likely to result in a substantial adverse change in its functioning or harm to a species of special interest that endangers the long-term maintenance of the population. Catastrophic damage to crops, buildings or property.	Explosion, causing building collapse (can also equate to immediate human health risk if buildings are occupied).
Medium	Elevated concentrations which could result in "significant harm" to human health as defined by the EPA 1990, Part 2A if exposure occurs. Equivalent to EA Category 2 pollution incident including significant effect on water quality; notification required to abstractors; reduction in amenity value or significant damage to agriculture or commerce. Significant damage to aquatic or other ecosystems, which may result in a substantial adverse change in its functioning or harm to a species of special interest that may endanger the long-term maintenance of the population. Significant damage to crops, buildings or property.	Significant harm to humans is defined in circular 01/2006 as death, disease*, serious injury, genetic mutation, birth defects or the impairment of reproductive functions. Damage to building rendering it unsafe to occupy e.g. foundation damage resulting in instability. Ingress of contaminants through plastic potable water pipes.
Mild	Exposure to human health unlikely to lead to "significant harm". Equivalent to EA Category 3 pollution incident including minimal or short lived effect on water quality; marginal effect on amenity value, agriculture or commerce. Minor or short lived damage to aquatic or other ecosystems, which is unlikely to result in a substantial adverse change in its functioning or harm to a species of special interest that would endanger the long-term maintenance of the population. Minor damage to crops, buildings or property.	Exposure could lead to slight short-term effects (e.g. mild skin rash). Surface spalling of concrete.

Classification	Definition	Examples
Minor	No measurable effect on humans. Equivalent to insubstantial pollution incident with no observed effect on water quality or ecosystems. Repairable effects of damage to buildings, structures and services.	The loss of plants in a landscaping scheme. Discoloration of concrete.

Classification of Probability

Classification	Definition	Examples
High likelihood	There is potential contaminant linkage and an event would appear very likely in the short-term and almost inevitable over the long-term, or there is evidence at the receptor of harm or pollution.	a) <i>Elevated concentrations of toxic contaminants are present in soils in the top 0.5m in a residential garden.</i> b) <i>Ground/groundwater contamination could be present from chemical works, containing a number of USTs, having been in operation on the same site for over 50 years.</i>
Likely	There is potential contaminant linkage and all the elements are present and in the right place which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short-term and likely over the long-term.	a) <i>Elevated concentrations of toxic contaminants are present in soils at depths of 0.5-1.0m in a residential garden, or the top 0.5m in public open space.</i> b) <i>Ground/groundwater contamination could be present from an industrial site containing a UST present between 1970 and 1990. The tank is known to be single skin. There is no evidence of leakage although there are no records of integrity tests.</i>
Low likelihood	There is potential contaminant linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a long period such an event would take place, and is less likely in the shorter term.	a) <i>Elevated concentrations of toxic contaminants are present in soils at depths >1m in a residential garden, or 0.5-1.0m in public open space.</i> b) <i>Ground/groundwater contamination could be present on a light industrial unit constructed in the 1990s containing a UST in operation over the last 10 years – the tank is double skinned but there is no integrity testing or evidence of leakage.</i>

Classification	Definition	Examples
Unlikely	There is potential contaminant linkage but circumstances are such that it is improbable that an event would occur even in the very long-term.	a) <i>Elevated concentrations of toxic contaminants are present below hardstanding.</i> b) <i>Light industrial units <10 yrs old containing a double-skinned UST with annual integrity testing results available.</i>

Note: A potential contaminant linkage must first be established before probability is classified. If there is no pollution linkage then there is no potential risk. If there is no potential contaminant linkage then there is no need to apply tests for probability and consequence.

For example, if there is surface contamination and a principal aquifer is present at depth, but this principal aquifer is overlain by an aquiclude of significant thickness then there is no pollution linkage and the risks to the principal aquifer are not assessed. The report should identify both the source and the receptor but state that because there is no linkage there are no potential risks.

Description of the Classified Risks

Very high risk

There is a high probability that severe harm could arise to a designated receptor from an identified hazard at the site without remediation action OR there is evidence that severe harm to a designated receptor is already occurring. Realisation of that risk is likely to present a substantial liability to be site owner/or occupier. Investigation is required as a matter of urgency and remediation works likely to follow in the short-term.

High risk

Harm is likely to arise to a designated receptor from an identified hazard at the site without remediation action. Realisation of the risk is likely to present a substantial liability to the site owner/or occupier. Investigation is required as a matter of urgency to clarify the risk. Remediation works may be necessary in the short-term and are likely over the longer term.

Moderate risk

It is possible that harm could arise to a designated receptor from an identified hazard. However, it is either relatively unlikely that any such harm would be severe, and if any harm were to occur it is more likely, that the harm would be relatively mild. Further investigative work is normally required to clarify the risk and to determine the potential liability to site owner/occupier. Some remediation works may be required in the longer term.

Low risk

It is possible that harm could arise to a designated receptor from identified hazard, but it is likely at worst, that this harm if realised would normally be mild. It is unlikely that the site owner/or occupier would face substantial liabilities from such a risk. Further investigative work (which is likely to be limited) to clarify the risk may be required. Any subsequent remediation works are likely to be relatively limited.

Very low risk

It is a low possibility that harm could arise to a designated receptor, but it is likely at worst, that the harm if realised would normally be mild or minor.

No potential risk

There is no potential risk if no pollution linkage has been established.

LIMITATIONS

Environmental & Geotechnical Interpretative Reports

1. This report provides available factual data for the site obtained only from the sources described in the text and related to the site on the basis of the location information provided by the client.
2. Where any data or information supplied by the client or other external source, including that from previous studies, has been used, it has been assumed that the information is correct. No responsibility can be accepted by CampbellReith for inaccuracies within this data or information. In relation to historic maps the accuracy of maps cannot be guaranteed and it should be recognized that different conditions on site may have existed between and subsequent to the various map surveys
3. This report is limited to those aspects of historical land use and enquiries related to environmental matters reported on and no liability is accepted for any other aspects. The opinions expressed cannot be absolute due to the limit of time and resources implicit within the agreed brief and the possibility of unrecorded previous uses of the site and adjacent land.
4. The material encountered and samples obtained during on-site investigations represent only a small proportion of the materials present on the site. There may be other conditions prevailing at the site which have not been revealed and which have therefore not been taken into account in this report. These risks can be minimised and reduced by additional investigations. If significant variations become evident, additional specialist advice should be sought to assess the implications of these few findings.
5. The generalised soil conditions described in the text are intended to convey trends in subsurface conditions. The boundaries between strata are approximate and have been developed on interpretations of the exploration locations and samples collected.
6. Water level and gas readings have been taken at times and under conditions stated on the exploration logs. It must be noted that fluctuations in the level of groundwater or gas may occur due to a variety of factors, which may differ from those prevailing at the time the measurements were taken.
7. Please note that CampbellReith cannot accept any liability for observations or opinions expressed regarding the absence or presence of asbestos or on any product or waste that may contain asbestos. We recommend that an asbestos specialist, with appropriate professional indemnity insurance, is employed directly by the client in every case where asbestos may be present on the site or within the buildings or installations. Any comments made in this report with respect to asbestos, or asbestos containing materials, are only included to assist the client with the initial appraisal of the project and should not be relied upon in any way.
8. The findings and opinions expressed are relevant to those dates of the reported site work and should not be relied upon to represent conditions at substantially later dates.
9. This report is produced solely for the benefit of the client, and no liability is accepted for any reliance placed upon it by any other party unless specifically agreed in writing.

Appendix 1

Figures

Figure 1: Site Location Plan

Figure 2: Topography

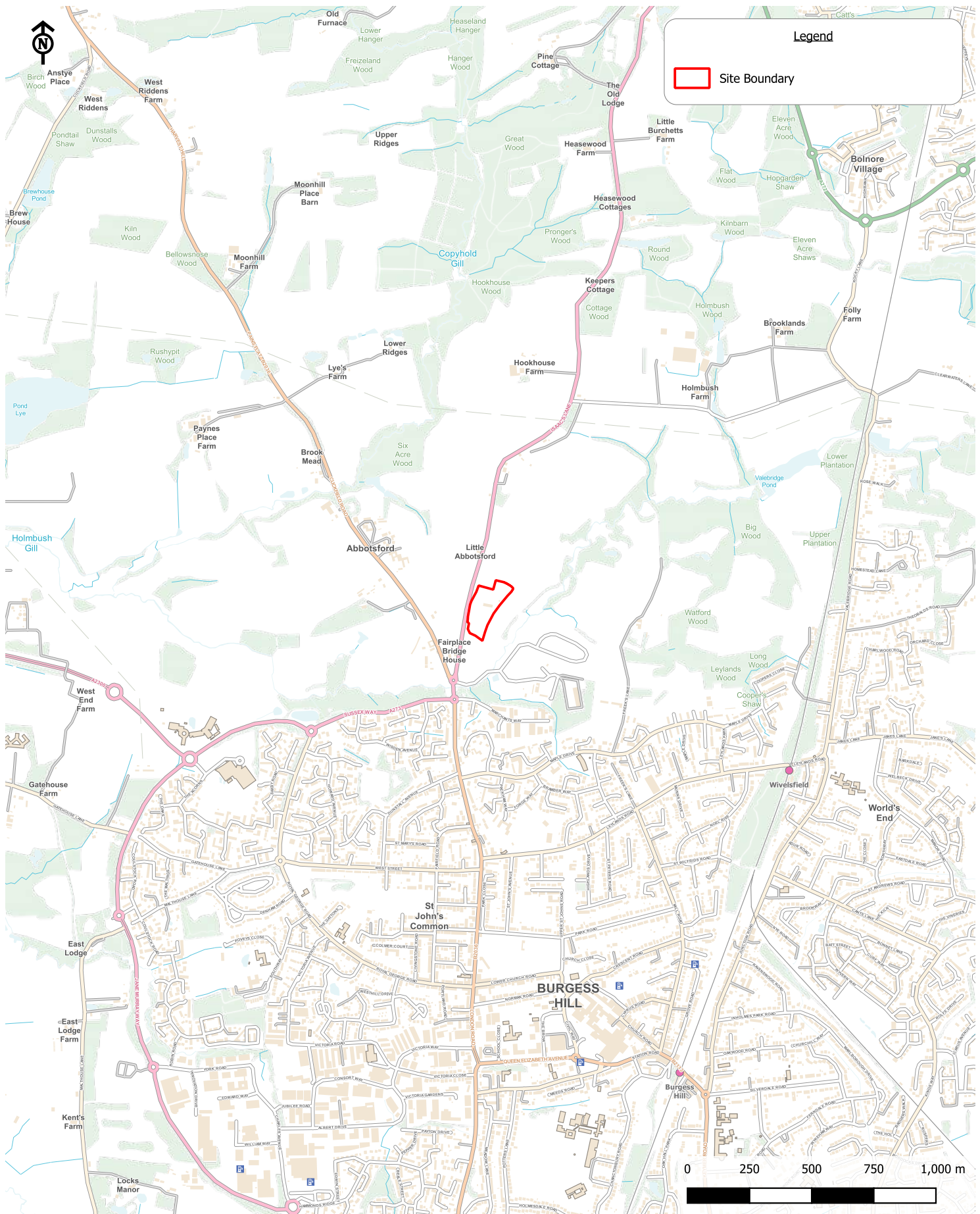
Figure 3: Annotated Site Layout

Figure 4: Proposed Development

Figure 5. Site Geology as Recorded
by BGS

Figure 6: Exploratory Hole Locations

Figure 7: Overall Exploratory Hole
Locations



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Client: Homes England

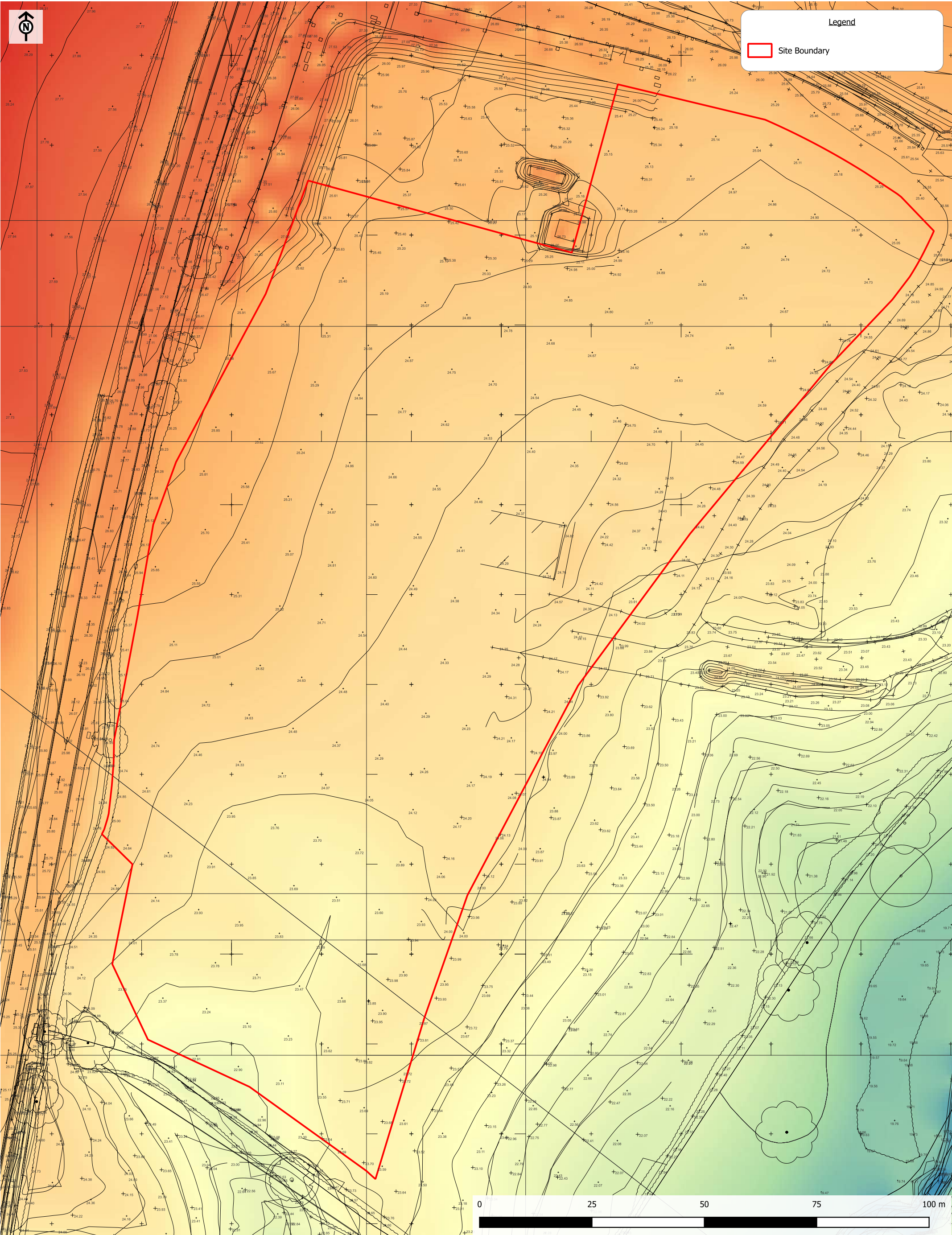
Figure 1:
Site Location Plan

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Figure 2:
Topography

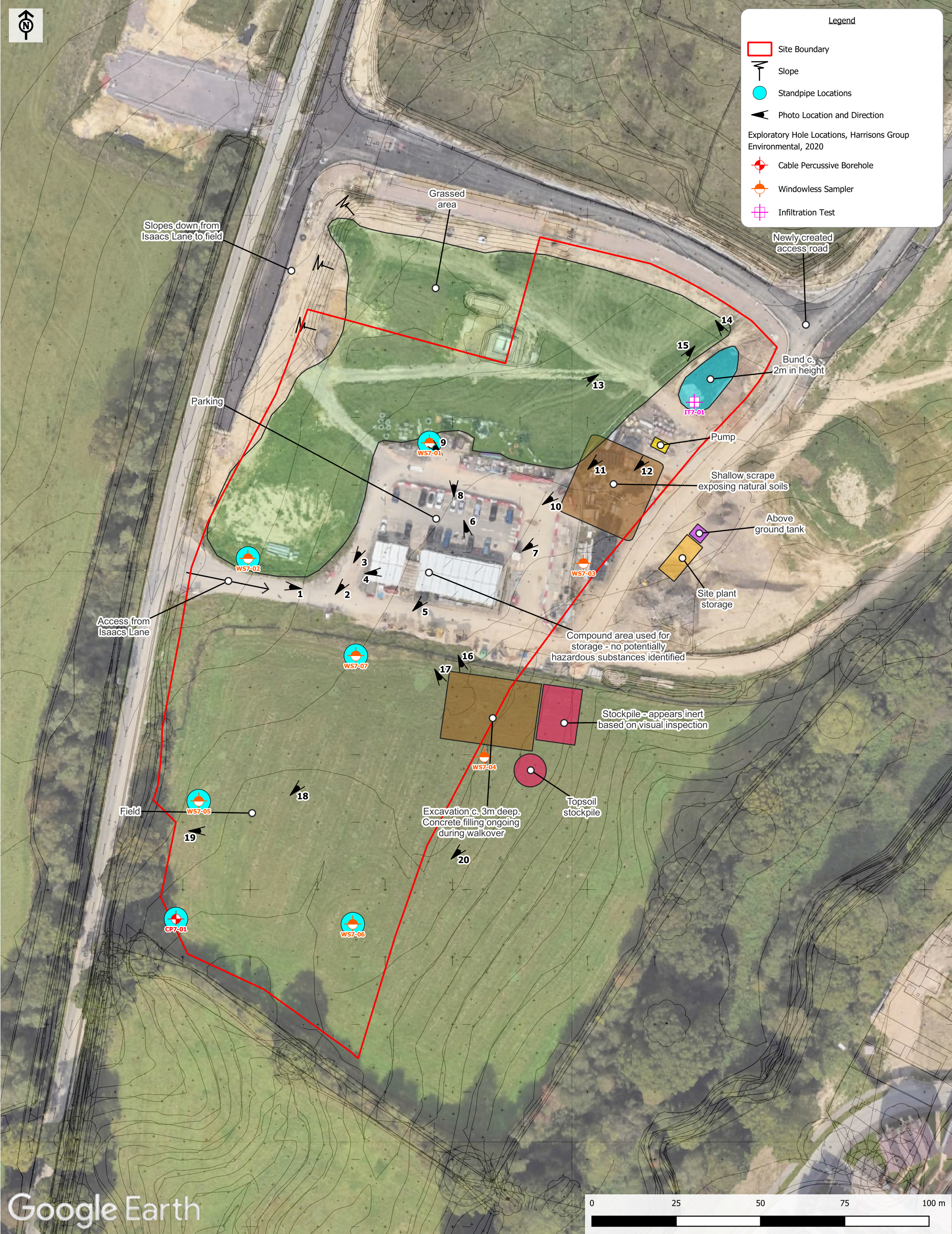
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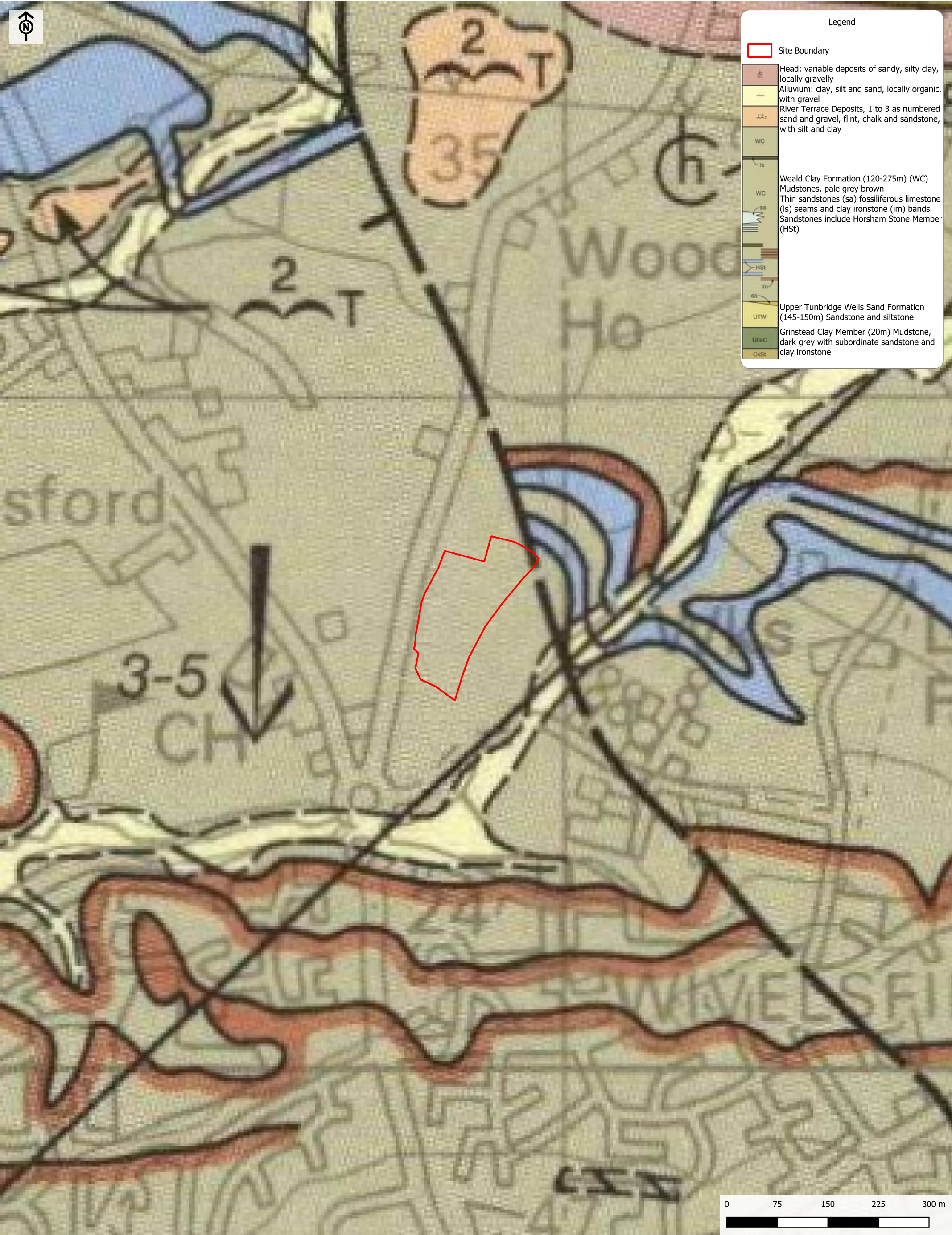
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Figure 3:
Annotated Site Layout



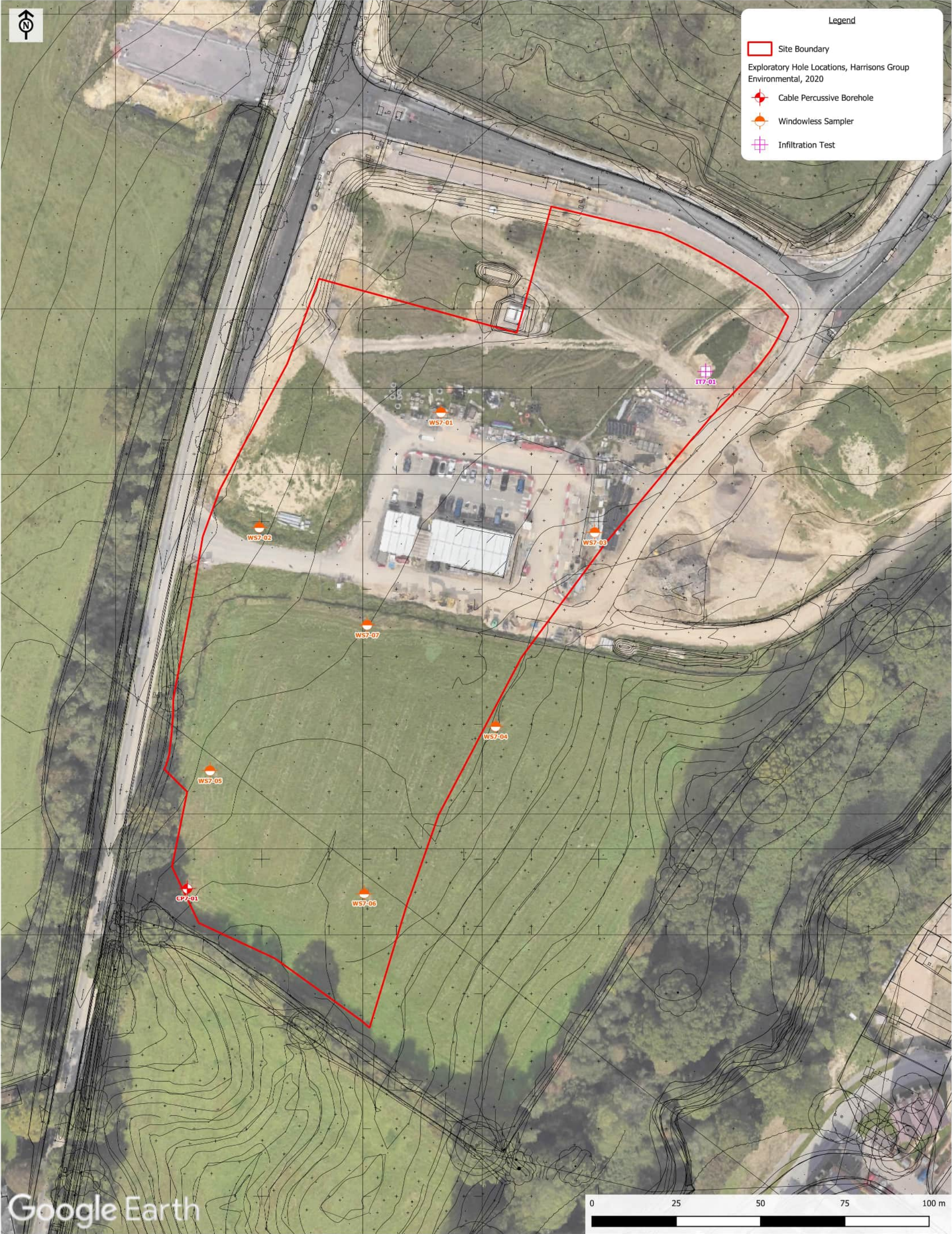
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Figure 4:
Proposed Development



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Figure 5:
Site Geology as Recorded by BGS



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Client: Homes England

Figure 6:
Exploratory Hole Locations



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Client: Homes England

Figure 7:
Overall Exploratory Hole Locations

Appendix 2

Desk Study Information



Photograph 1: Access road to Isaac's Lane



Photograph 2: Site compound area

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Client: Homes England

Site Photographs
1 - 2

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Photograph 3: Site parking area to the north of the compound



Photograph 4: Materials Storage in compound area

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Site Photographs
3 - 4

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Photograph 5: Materials storage



Photograph 6: Materials storage

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Site Photographs
 5 - 6

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Photograph 7: Pedestrian walkway connecting Eastern Bridge and Link Road and Compound area



Photograph 8: View north of the compound parking area

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Site Photographs
7 - 8

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