



Amethyst Lane

Phase 1 Desk Study Report

For Reading Borough Council

Date: 22 February 2023

Doc ref: 26887-HYD-XX-XX-RP-GE-1000

Document control sheet

<i>Issued by</i>	Hydrock Consultants Limited Over Court Barns Over Lane Almondsbury Bristol BS32 4DF United Kingdom	T +44 (0)1454 619533 F +44 (0)1454 614125 E bristol@hydrock.com hydrock.com
<i>Client</i>	Reading Borough Council	
<i>Project name</i>	Amethyst Lane	
<i>Project title</i>	Phase 1 Desk Study Report	
<i>BIM reference</i>	26887-HYD-XX-XX-RP-GE-1000	
<i>Project reference</i>	26887	
<i>Date</i>	22/02/2023	

Document production record

<i>Issue Number</i>	P02	<i>Name</i>
<i>Prepared by</i>	Kieran Bayley BSc (Hons) MSc FGS	
<i>Checked by</i>	Richard Swayne BSc (Hons) MSc FGS CGeol RoGEP	
<i>Approved by</i>	Mark Campbell BSc (Hons) FGS FRGS	

Document revision record

<i>Issue Number</i>	<i>Status</i>	<i>Date</i>	<i>Revision Details</i>
<i>P01</i>	S2	31/01/22	First Issue
<i>P02</i>	S2	22/02/23	Revision following acquisition of factual cavities database search.

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Executive summary

Site information and setting

Objectives	The works have been commissioned to assist with the design of the development. The objectives of the Phase 1 Desk Study are to formulate a preliminary Ground Model and an Initial Conceptual Site Model of the site to identify and make a preliminary assessment of any potential geo-environmental and geotechnical risks to the proposed development.
Client	Reading Borough Council
Site name and location	Amethyst Lane, Reading, RG30 2EZ
Proposed development	The site development proposals are understood to comprise residential dwellings and respite care.
Site description	The site is roughly rectangular in shape and 0.5 Ha in area and is a derelict day care centre with 3 buildings, asphalt car park area and gardens. The site is generally flat. The surrounding area is mostly residential with a hospital adjacent to the northern boundary.

Desk study summary

Topography	The site is flat and is typically 58m above Ordnance Datum (OD).
Hydrology	There are no surface water features within or in the vicinity of the site.
Site History	The site was undeveloped with just a path running through the middle in 1881. By 1895 a small building likely associated with the farmhouse to the south was constructed. Residential properties were constructed in surrounding area between 1932 and 1960. In 1970 an occupational therapy centre had been constructed in the south of the site. By 1970 an additional building was constructed in the northern part of the site. Over time increasing residential properties have been constructed in the surrounding areas. In the current day the buildings are now derelict and the site is no longer in use.
Geology	Superficial: Lynch Hill Gravel Member. Solid: Lambeth Group over the Seaford Chalk Formation.
Natural geological hazards	Potentially soft ground and clay superficial deposits. There is the potential for chalk cavities (solution pipes and sink holes). Though not recorded on site they as they have been recorded in the vicinity of the site.
Anthropomorphic geotechnical hazards	Uncharacterised Made Ground associated with the existing structures onsite is expected.
Hydrogeology	The Lynch Hill Gravel Member and Lambeth Group are classified as secondary A Aquifers.
UXO risk	A non-specialist UXO assessment indicates a low bomb risk.

Preliminary conceptual site model based on desk study

Potential contaminant sources	Made Ground associated with historical construction activities and imported fill. Ground gas from organic material in Made Ground. Asbestos within existing buildings.
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Potential contaminant linkages (for receptors for which there is or will be a pathway)	Humans. Groundwater. Plants. Buildings / property.
Radon	The site is not in a Radon Affected Area and no radon protection measures are required.
Preliminary geotechnical hazards based on the desk study	» Uncontrolled Made Ground (variable strength and compressibility). » Soft / loose compressible ground (low strength and high settlement potential). » Shrink swell of the clay fraction of soils under the influence of vegetation. » Variable lateral and vertical changes in ground conditions. » High sulfates present in the soils. » Obstructions. » Existing below ground structures to remain (on or off-site tunnels, foundations, basements, and adjacent sub-structures). » Shallow groundwater. » Changing groundwater conditions. » Risk from flooding. » Running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls. » Solution features in Chalk. » Cavities in the Superficial Deposits due to solution features. » Dissolution (associated with "wet rock head").
Future considerations	
Further work	The following works are recommended: » As the site is in a minerals resource safe guard area, a minerals assessment may be required and further consultation with the local authority is recommended. A ground investigation will be required to: » determine the depth and distribution of Made Ground and natural strata across the site; » determine the soil strength/density profile beneath the site; » determine the thickness of the deposits beneath the site over the Seaford Chalk Formation and the competency of the Seaford Chalk Formation; » determine the depth/level of groundwater beneath the site; » determine the ground gas concentrations beneath the site; » allow sampling for chemical and geotechnical laboratory testing; and » obtain information in terms of Aggressive Chemical Environment for Concrete Class (ACEC Class).

Following investigation, assessment will be required to:

- » update the Ground Model;
- » update the Geotechnical Risk Register;
- » provide Geotechnical Design recommendations;
- » update the Conceptual Site Model (CSM), including identification of plausible pollution linkages;
- » undertake generic quantitative risk assessment of potential chemical contaminants to establish 'suitability for use' under the current planning regime;
- » discuss potential environmental liabilities associated with land contamination (soil, water and gas); and
- » provide outline mitigation recommendations to ensure the site is 'suitable for use'

This Executive Summary forms part of Hydrock Consultants Limited report number 26887-HYD-XX-XX-RP-GE-1000 and should not be used as a separate document.

1. Introduction

1.1 Terms of reference

In December 2022, Hydrock Consultants Limited (Hydrock) was commissioned by Reading Borough Council (the Client) to undertake site investigation, comprising a Phase 1 desk study at Amethyst Lane. The site is located at Amethyst Lane, Reading, RG30 2EZ.

The site is currently derelict land, that was previously a day care centre.

Hydrock understands that the proposed development is to comprise residential dwellings and respite care. A proposed development layout (HTA Design Drawing HTA-A_DR_0101 rev A, dated 07/12/22), is presented in Appendix A.

The investigation works have been undertaken in accordance with Hydrock's proposal (Email dated December 2022) and the Client's instructions to proceed (Client Email dated December 2022).

1.2 Objectives

The works have been commissioned to assist with the design of the proposed development.

The objectives of the Phase 1 Desk Study are to formulate a preliminary Ground Model and an Initial Conceptual Site Model (CSM) of the site to identify and make a preliminary assessment of any potential geo-environmental and geotechnical risks to the proposed development.

1.3 Scope

The scope of the Phase 1 Desk Study comprises:

- » a field reconnaissance (walkover) to determine the nature of the site and its surroundings including current and former land uses, topography and hydrology;
- » acquisition and review of:
 - » historical Ordnance Survey maps, to identify any; former potentially contaminative uses shown at the site and immediately surrounding it, and an assessment of the associated contamination risks;
 - » a third-party environmental report to identify any; flooding warning areas, local landfills, pollution incidents, abstractions, environmental permits etc. All of which may have had the potential to have environmental impact on the site;
 - » topographical, geological and hydrogeological maps;
 - » British Geological Survey (BGS) archive records;
 - » regional UXB risk maps; and
 - » factual cavities database report.
- » development of a preliminary Ground Model representing ground conditions at the site;
- » development of an initial CSM, including identification of potential contaminant linkages;
- » a qualitative assessment of geo-environmental risks identified; and
- » identification of plausible geotechnical hazards.

1.4 Available information

The following documents, reports etc have been provided to Hydrock by Reading Borough Council for use in the preparation of this report:

- » Middlemarch, September 2022, 'Tree Survey Plan', Ref: C158951A-01-01;
- » HTA Design LLP, December 2022, 'Proposed Site Plan', Ref: HTA-A_DR_0101;

- » HTA Design LLP, December 2022, 'Proposed Respite Centre Plan', Ref: HTA-A_DR_0210; and
- » Survey Solutions, October 2022, 'Utilities and Drainage Survey', Ref: 43954BWUG-01.

It is understood that the Client defined in Section 1.1 commissioned assignment of the above documents and Hydrock has assumed full reliance can be placed upon their contents. Should this not be the case, Hydrock should be informed at the earliest opportunity.

1.5 Regulatory context and guidance

The investigation work has been carried out in general compliance with recognised best practice, including (but not limited to) BS 5930:2015, BS 10175:2011+A2:2017 and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The geo-environmental section of this report is written in broad accordance with BS 10175:2011+A2:2017, EA LCRM, (2021) and the AGS (2006) 'Good Practice Guidelines for Site Investigations'.

The methods used follow a risk-based approach, the first stage of which is a Phase 1 desk study and field reconnaissance, with any potential geo-environmental risks assessed qualitatively. This is done using the 'source-pathway-receptor contaminant linkage' concept to assess risk as introduced in the Environmental Protection Act 1990 (EPA, 1990). Any potential geotechnical risks are also assessed from the Phase 1 desk study and site reconnaissance stage.

Professional judgement is then used to evaluate the findings of the risk assessments and to provide recommendations for the development.

The geotechnical section of this report is prepared in general accordance with BS EN 1997-1+A1:2013, BS EN 1997-2:2007 and BS 8004:2015.

Where relevant the relevant requirements of the current edition of NHBC Standards have also been applied.

The geo-environmental and geotechnical aspects are discussed in separate sections. Throughout the report the term 'geotechnical' is used to describe aspects relating to the physical nature of the site (such as foundation requirements). The term 'geo-environmental' is used to describe aspects relating to ground-related environmental issues (such as potential contamination). However, it should be appreciated that this is an integrated investigation and these two main aspects are inter-related. Designers should take all aspects of the investigation into account.

Remaining uncertainties and recommendations for further work are listed in Section 5 and Section 6.

2. Desk study (and field reconnaissance)

2.1 Data

A number of desk study sources have been used to assemble the following information:

- » Third-party environmental report (Groundsure report, reference GS-9297751) (Appendix D);
- » Historical Ordnance Survey mapping (Appendix C);
- » BGS Archive Records (Appendix D);
- » Zetica UXB Risk Maps (<https://zeticauxo.com/downloads-and-resources/risk-maps/>) (Appendix D); and
- » Factual Cavities Database Search (Stantec report, reference 332511450//CBH/SC/HG/JN) (Appendix D).

2.2 Site referencing

Table 2.1: Site referencing information

Item	Brief Description
Site name	Amethyst Lane
Site address	Amethyst Lane, Reading. The nearest postcode is RG30 2EZ.
Site location and grid reference	The site is located between the M78 and the M23, 2km north of Winchester city centre. The National Grid Reference of the approximate centre of the site is 469473E, 172660N. The site is approximately 0.5 Ha in area.
Site boundaries	The site is bordered by Amethyst Lane to the south, a hospital (hospice) to the north and residential properties to the east and west.



Figure 2.1: Site location

(Reproduced with permission from Groundsure)

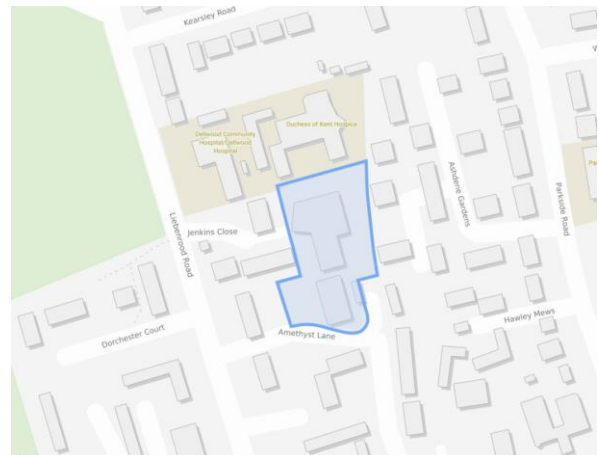


Figure 2.2: Extract from the Ordnance Survey Map.

(OS licence 100023353).

A site location plan (Hydrock Drawing 26887-HYD-XX-XX-DR-GE-1000) is presented in Appendix A.

2.3 Site description and field reconnaissance survey

A field reconnaissance survey was undertaken on 12/01/23 to visually identify assess potential geotechnical hazards, contaminant sources for future investigation and identification of possible source-pathway-receptor linkages. The weather during the field reconnaissance survey was light rain.

A description of the site is presented in .

Table 2.2. Photographs are presented in Appendix B.

Table 2.2: Site description

Item	Brief Description
Site access	The site was accessed from Amethyst Lane.
Site area	The site is rectangular in shape and has an area of approximately 0.5 ha.
Elevation, topography and any geomorphic features	The site is flat and is typically 58m above Ordnance Datum (OD).
Site boundaries and surrounding land	The site boundary is secured by heras fencing along the southern boundary separating it from Amethyst Lane. To the north is Dellwood Hospital. To the east and west the site is bordered by residential properties. Further to the west is a large park.
Present land use	The site is currently a derelict day care centre comprising 3 buildings. To the east and north of the site, the buildings are surrounded by asphalt. To the west of the buildings there are overgrown former garden areas. The buildings are in generally good condition. There is light fly-tipping generally around the site. There multiple overhead BT lines, one runs north-south in the north west corner of the site. One runs roughly east-west in the north of the site, and another north south along the eastern boundary. A few more connect to the buildings from the south west corner of the site. The access to the site is a padlocked gate at the end of Amethyst Lane and just inside of the side the entrance is blocked by a bund of material to prevent vehicle access.
Vegetation	A comprehensive vegetation survey undertaken by Middlemarch is presented in Appendix A (Ref: C158951A-01-01). The Tree Survey Plan indicates that here are a significant number of trees around the site, primarily along the boundary of site. There are a variety of species, predominantly Norway maples and sycamores. There are also some hedges in the overgrown gardens.
General site sensitivity	The site is within a generally residential area.

A site survey plan (Survey Solutions Drawing 43954BWUG-01) and Photo Location Plan (Hydrock Drawing 26887-HYD-XX-XX-DR-GE-1002) showing the locations of the photographs are presented in Appendix A.

2.4 Site history

A study of historical Ordnance Survey maps (Appendix C) has been undertaken to identify any former land uses at the site and surrounding areas which may have geotechnical or geo-environmental implications for the proposed development. The key findings are summarised in Table 2.3.

Table 2.3: Site history review

Reference	Key features on site	Key features off-site
OS Map ¹ 1881 - 1882: 1:2,500	The site is largely undeveloped, comprising predominantly agricultural land with some woodland running along the eastern edge. A path runs north-south through the middle of the site.	The surrounding land comprises agricultural fields. There is a lodge approximately 120m south of the site. There is a gravel pit 200m southwest of the site. A road runs east-west approximately 120m to the south.
OS Map 1899 1:2,500	A building likely associated with the farmhouse to the south of the site is now present on site. The path running through the middle of the site is no longer present.	More farmhouses are dotted around the site, notably 'Parkhurst' approximately 30m to the south, and 'Dellwood' approximately 70m northwest of the site. The road running east-west, 120m to the south of the site, is labelled as Bath Road. Parkside Road has been constructed, running north-south approximately 110m to the east of the site. Liebenrood Road has been constructed, running north-south approximately 70m to the west of the site. The land to the west of Liebenrood Road is now labelled Prospecthill Park
OS Map 1898 - 1900 1:10,560	No notable changes.	Two brick works are indicated approximately 400m to the north and 500m northwest of the site respectively. A railway line orientated north-south is located 500m east of the site.
OS Map 1910 - 1913 1:10,560	No notable changes.	Prospecthill Park is named Prospect Park
OS Map 1932 1:2,500	No notable changes	Some residential properties are indicated approximately 175m to the north and 100m to the east of the site respectively. The gravel pit to the southwest is no longer indicated.

¹ Ordnance Survey Historical Map Information provided by Groundsure.

OS Map 1960 1:2,500	There are some additional buildings in the south of site.	'Parkhurst', to the south, has expanded. 'The Alice Jenkins Home' is now present adjacent to the western site boundary. There is a tennis court adjacent to the eastern site boundary. More residential properties are now present, notably 100m to the north and east of site.
OS Map 1970 - 1973 1:1,250	An Occupational Therapy Centre is located in the south of the site.	'Dellwood' (70m northwest of the site) is indicated as a Maternity Home. A sub-station is located approximately 40m west of the northwest corner of the site. There are more residential properties to the south west and north of the site.
OS Map 1979 – 1982 1:10,000	An additional building associated with the Occupational Therapy Centre is located in the northern half of the site.	No significant changes.
OS Map 1993 1:1,250	No significant changes.	'Dellwood' (70m northwest of the site) has now expanded and is labelled as Dellwood Community Hospital.
OS Map 1995 1:1,250	No significant changes.	'Parkhurst' has been replaced with three buildings.
OS Map 2003 1:1,250	No significant changes.	The Alice Jenkins Home has been replaced with residential properties.
OS Map 2023 1:10,000	No significant changes.	No significant changes.

2.5 Geology

The geology of the site area is shown on the 1:10,000 British Geological Survey (BGS) map extract reproduced as part of the Groundsure report and is summarised below:

Table 2.4: Geology

Ref. for Figures	Location	Stratigraphic Name	Description
Superficial Deposits (Figure 2.3)			
1	On site	Lynch Hill Gravel Member	Sand and gravel. The site is within a "Sand and Gravel Safe Guarded Resource Area" as detailed in the Central & Eastern Berkshire - Joint Minerals & Waste Plan Submission Policies Map (June 2020).
2	387m northwest	Head	Gravel, sand, silt and clay.
Solid Geology (Figure 2.4)			

1	On site.	Lambeth Group	Clay, silt and sand. The site is within a "Clay (Lambeth Group) Safe Guarded Resource Area" as detailed in the Central & Eastern Berkshire - Joint Minerals & Waste Plan Submission Policies Map (June 2020).
2	428m north	Seaford Chalk Formation	Chalk. Though outcropping to the north of the site the chalk formation is located beneath the Lambeth Group on site.
4	437m west	London Clay Formation	Clay, silt and sand.

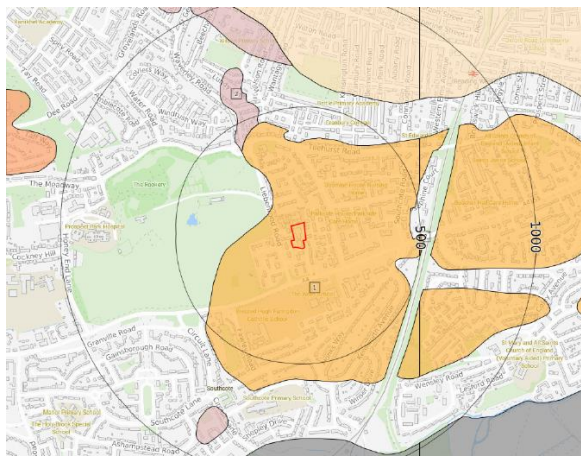


Figure 2.3: Superficial deposits.

(Reproduced with permission from Groundsure)

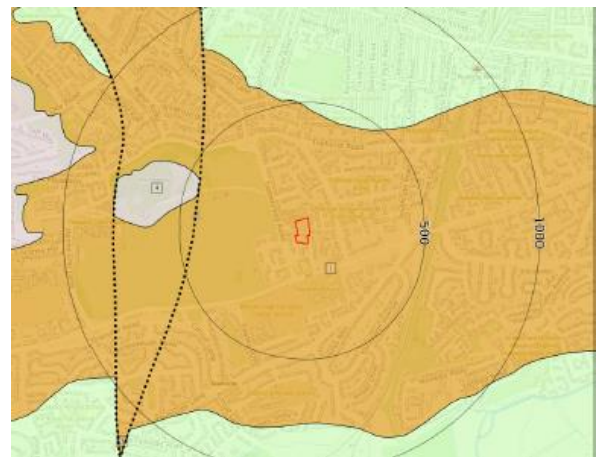


Figure 2.4: Solid geology.

(Reproduced with permission from Groundsure)

A normal fault trending north-south is located 432m west of the site.

A borehole log from the BGS archive has been reviewed and summarised below:

- » SU67SE709, located 221m to the east of the site (NGR 469720E, 172730N), drilled to a depth of 5.25m bgl (below ground level) and recorded:
 - » Made Ground between ground level and 1.9m bgl; over
 - » Mottled brown and orange very silty clay (between 1.9m and 5.25m bgl) with bands of:
 - Orange brown, occasionally mottled buff;
 - Orange brown silty fine SAND;
 - Occasional light grey, orange brown clay partings increasing with depth;
 - Orange brown mottled light grey very silty fine sandy slightly waxy CLAY; and
 - Very silty fine sand.
 - » No groundwater was recorded.

The above borehole is within similar geology to the geology expected on site and is an indication of the potential natural strata that could be expected.

2.6 Hydrogeology

2.6.1 Aquifer designations

Based on the inferred geological sequence presented in Section 2.5 and the Environment Agency's interactive aquifer designation map, the aquifer system presented in Table 2.5 applies.

Table 2.5: Aquifer system

Stratum	Aquifer Designation	Comments
Made Ground (associated with the existing structures on site)	Unclassified/ unproductive	Artificial ground not included in the classification system. Likely to be moderate to high porosity because of unconsolidated nature, but permeability is likely to be constrained to low, or low to moderate because of poor sorting and clay content.
Superficial Deposits		
Lynch Hill Gravel Member	Secondary A Aquifer	Intergranular permeability. Dominated by moderate to high permeability layers of sand and gravel.
Solid Geology		
Lambeth Group	Secondary A Aquifer	Predominantly clay of low permeability, interbedded with occasional layers of sand and gravel, of moderate to high permeability.
Seaford Chalk Formation	Principal Aquifer	A Chalk Principal Aquifer located beneath the Lambeth Group.

2.6.2 Groundwater abstraction

There are no active licensed groundwater abstractions within 1km of the site.

2.6.3 Groundwater source protection zones and groundwater vulnerability

The site is not within a groundwater Source Protection Zone (SPZ).

2.6.4 Groundwater levels, recharge, and flow

Though no groundwater was recorded within the historic borehole to the east of the site (which extended to 5.25m bgl [SU67SE709]), the Lynch Hill Gravel Member consists of permeable sands and gravels; therefore, it is possible for shallow groundwater to be present beneath the site.

The Lambeth Group is in direct contact with the superficial deposits and may provide a pathway by which leachate generated onsite can reach the underlying secondary aquifer.

2.6.5 Groundwater quality

The groundwater body beneath the site (Berkshire Downs Chalk) is currently (2019 Cycle 3) classified under the Water Framework Directive as 'poor'.

The water body is currently given a 'poor' status due to 'Quantitative Dependent Surface Water Body Status', 'Chemical Drinking Water Protected Area' and 'General Chemical Test' conditions. The objective is for the overall water body status to be 'good' by 2027.

The groundwater body is associated with the Chalk Aquifer, located beneath the predominantly clay Lambeth Group which acts as an aquiclude breaking the linkage between the site and the groundwater body.

2.6.6 Groundwater flooding

The environmental data report indicates a low risk of groundwater flooding.

2.7 Hydrology

2.7.1 Surface water system and drainage

There are no surface water features recorded within 250m of the site.

2.7.2 Surface water abstractions and discharges

There are no active licensed surface water discharges or abstractions within 1km of the site.

2.7.3 Surface water flooding

The desk study information indicates the proposed development is noted to be in a flood risk in a high flood risk area (a chance of flooding of greater than 1 in 30 (3.3%)).

No further consideration of flood risk is undertaken in this report. Specialist flood risk advice should be sought with regard to drainage and flooding.

2.8 Mining and mineral extraction

The environmental report indicates that gravel and sand quarrying has been undertaken in the wider area, although not within the site boundaries.

There are no records held by the BGS of historical underground working features within 500m of the site boundary and the BGS consider that "sporadic underground mining of restricted extent may have occurred. Potential for difficult ground conditions are unlikely and localised and are at a level where they need not be considered".

Stantec factual cavities database search report (Ref: 332511450//CBH/SC/HG/JN, dated 16 February 2023) details the distance, location and nature of recorded cavities in the vicinity of site. The report records similar features as detailed in the Groundsure report with the addition of a historical brick works/clay pit 380m to the north. This report confirms that there is no known record of mining or mineral extraction having occurred on site.

The site is within a "Sand and Gravel Safe Guarded Resource Area" and a "Clay (Lambeth Group) Safe Guarded Resource Area" as detailed in the Central & Eastern Berkshire - Joint Minerals & Waste Plan Submission Policies Map (June 2020).

As the site is in a minerals resource safe guard area, a minerals assessment may be required and further consultation with the local authority is recommended.

2.9 Natural ground instability

Trees and hedges are present around the site boundaries and sporadically across the site. Cohesive deposits of the Lambeth Group may be affected by potential for shrink-swell ground movements in clays as a result of changes in moisture content from removal or growth of trees.

Made Ground is likely to be present across the majority of the site, due to historic structures. This represents a geotechnical risk due to the presence of heterogeneous Made Ground. Foundations will need to be deepened to below the Made Ground.

2.10 Natural chalk cavities

2.10.1 Background

The site is underlain at depth by potentially soluble strata (Chalk), overlain by clay with a potentially deep water table and there is a potential risk of the formation of voids by the dissolution of the chalk.

As shown in Figure 2.5, dissolution features can include voids, collapse sinkholes, and dissolution widened discontinuities in the chalk with dissolution pipes. Subsidence sinkholes are caused by overlying granular materials collapsing into the chalk dissolution features. These often originate by material at depth collapsing into a dissolution void, causing a void to migrate upwards to form a subsidence feature at the surface.

The presence of layers of dense or cemented materials or cohesive layers can prevent or restrict the void reaching the surface, but creating a potential for surface subsidence in the future when conditions change. The collapse of materials into voids can cause either voids, or loosened material which can extend in a zone surrounding the central core of the collapsed material.

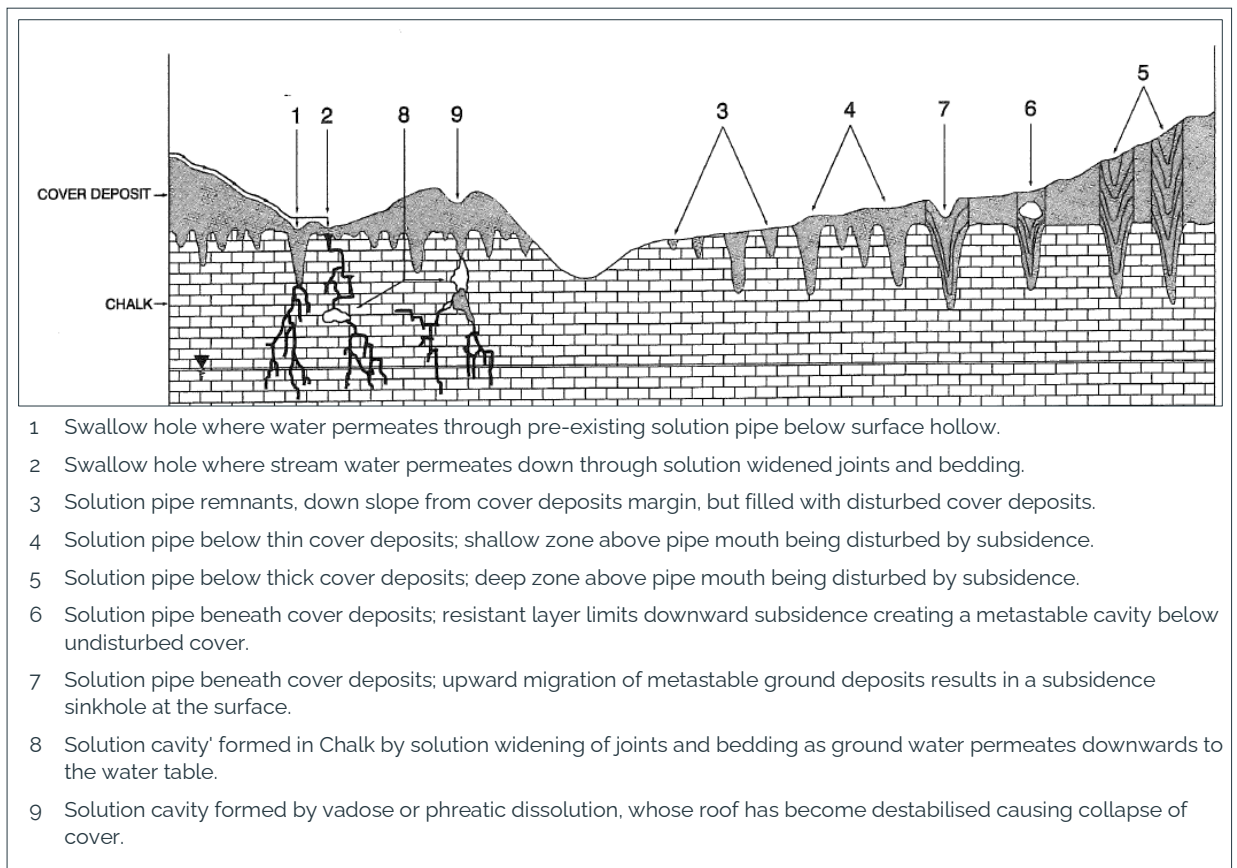


Figure 2.5: Schematic diagram of natural chalk solution features²

2.10.2 Evidence of cavities on site

There is no evidence that cavities have been, or are present, on the site. However, it should be noted the site is covered predominantly by hardstanding and buildings.

² From McDowell, et. al. Quarterly Journal of Engineering Geology and Hydrogeology 2008, v.41, p279-290.

2.10.3 Evidence of cavities in the adjacent area

Records of natural cavities indicates that there is a recorded solution pipe feature 156m north east of the site with six further records of natural cavities within 500m of the site (including solution pipes and sink holes).

Stantec factual cavities database search report (Ref: 332511450//CBH/SC/HG/JN, dated 16 February 2023) details the distance, location and nature of recorded cavities in the vicinity of site. The report records similar features as detailed in the Groundsure report.

2.10.4 Conclusions

There is documented evidence of solution pipes and sink holes in the vicinity of the site. On this basis, further consideration of the risk posed by solution features will need to be taken into account at the ground investigation and construction phases with confirmation of the thickness of the underlying deposits over the chalk and the competency of the underlying chalk.

2.11 Waste management

There are no current or historical waste management sites recorded within 250m of the site.

2.12 Regulatory Information

Information in the GroundSure Report (Appendix D), relating to various regulatory controls has been reviewed, with a summary presented below in Table 2.6.

Table 2.6: Regulatory information within 500m of the site

Regulatory Data	Distance from Site	Details	Potential Risk	Comment
Pollution Incidents	436m northeast	May 2002, oils and fuel, Category 3 – minor incident.	No	Due to its distance from the site.

There is no other regulatory information in the area that bears a potential impact on the site, due to its historic and current almost exclusively residential usage.

2.13 Natural soil chemistry

Information contained within the environmental report (Appendix D) gives indicative (estimated) concentration values for the natural soils at the site for a selection of Contaminants of Potential Concern (CoPC). These have been reproduced in Table 2.7.

Table 2.7: Natural soil chemistry

Element	Arsenic	Cadmium	Chromium	Lead	Nickel
Concentration (mg/kg)	15 - 25	1.8	60 - 90	100	15 - 30

The data in Table 2.7 is considered within the geo-environmental assessment.

2.14 Radon

The radon risk is reported in the environmental report and indicates that the site is not in a Radon Affected Area and no radon protection measures are required.

2.15 Unexploded ordnance (UXO)

In general accordance with CIRIA Report C681 (Stone et al 2009) a non-specialist UXO screening exercise has been undertaken for the purposes of ground investigation and is presented in Table 2.8 .

Table 2.8: Non-specialist UXO screening (for the purposes of ground investigation)

Data	Comment	Further Assessment Required
Site History	There is no indication of former military use from the desk study.	No
Post War Development	There is no potential bomb damage noted on the post war OS mapping.	No
Geology Type	The ground conditions comprise superficial deposits over Lambeth Group. There is the potential that UXO, if present, would remain undetected.	No
Surface Cover during WWI	The surface cover during WWII comprised open fields. There is the potential that UXO, if present, would remain undetected.	No
Indicator of Aerial Delivered UXO	Screening against the regional bomb risk map (Northamptonshire) Appendix D indicates the site to be in an area where the bomb risk is low.	No

The non-specialist UXO screening exercise has indicated no further assessment is required with regard to UXO in relation to ground investigation. Further assessment may be considered prudent for construction activities.

3. Initial Conceptual Site Model

3.1 Introduction

The initial CSM incorporates evidence from the site walkover, the Desk Study information. The formulation of an initial CSM is a key component of the LCRM methodology. The CSM incorporates a ground model of the site physical conditions and an exposure model of the possible contaminant linkages; it forms the basis for Generic Quantitative Risk Assessment (GQRA) in accordance with current guidelines.

3.2 Ground model

The preliminary ground model presented in Section 2 provides an understanding of the ground conditions and is the basis for preparing the preliminary geotechnical hazard assessment (Section 3.3) and the preliminary geo-environmental exposure model (Section 3.4).

3.3 Geotechnical hazard identification

3.3.1 Context

The preliminary geotechnical hazard identification has been undertaken in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents HD 41/15 and CD 622.

The following section sets out the identified geotechnical hazards and the development elements potentially affected (see Table E.1 in Appendix E for further information).

3.3.2 *Plausible geotechnical hazards*

Plausible geotechnical hazards identified at the site are:

- » Uncontrolled Made Ground (variable strength and compressibility).
- » Soft / loose compressible ground (low strength and high settlement potential).
- » Shrink swell of the clay fraction of soils under the influence of vegetation.
- » Variable lateral and vertical changes in ground conditions.
- » High sulfates present in the soils.
- » Obstructions.
- » Existing below ground structures to remain (on or off-site tunnels, foundations, basements, and adjacent sub-structures).
- » Shallow groundwater.
- » Changing groundwater conditions.
- » Risk from flooding.
- » Running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls.
- » Solution features in Chalk.
- » Cavities in the Superficial Deposits due to solution features.
- » Dissolution (associated with "wet rock head").

3.3.3 *Potential development elements affected*

Development elements potentially affected by geotechnical hazards are:

- » Buildings – foundations.
- » Buildings – floor Slabs
- » Buildings – basements
- » Retaining structures
- » Roads and pavements.
- » Services.
- » Gardens.
- » Concrete below ground.

Health and safety risks to site Contractors and maintenance workers have not been assessed during these works and will need to be considered separately during design.

The above plausible geotechnical hazards and development elements affected should be carried forward for investigation and assessment.

3.4 *Geo-environmental exposure model*

3.4.1 *Context*

The preliminary exposure model is used to identify geo-environmental hazards and to establish potential contaminant linkages, based on the source-pathway-receptor (SPR) approach.

A viable contaminant linkage requires all the components of an SPR to be present. If only one or two are present, there is no linkage and no further assessment is required.

3.4.2 *Potential contaminants*

For the purpose of this assessment the potential contaminants have been separated according to whether they are likely to have originated from an on-site or off-site source.

3.4.2.1 *Potential on-site sources of contamination*

- » Made Ground, associated with historical construction activities and fill, possibly including elevated concentrations of metals, metalloids, asbestos fibres, Asbestos Containing Materials (ACM), Poly Aromatic Hydrocarbons (PAHs) and petroleum hydrocarbons (S01).
- » Ground gases (carbon dioxide and methane) from organic materials in the Made Ground (S02).
- » Asbestos within existing buildings (S03).

3.4.2.2 *Potential off-site sources of contamination*

No potential off-site sources of contamination have been identified.

3.4.3 *Potential receptors*

The following potential receptors in relation to the proposed land use have been identified.

- » People (neighbours, site end users) (R01).
- » Development end use (buildings, utilities and landscaping) (R02).
- » Groundwater: Secondary A aquifer status of the Lynch Hill Gravel Member and Lambeth Group (R03).

3.4.4 Potential pathways

The following potential pathways have been identified.

- » Ingestion, skin contact, inhalation of dust and outdoor air by people (P01).
- » Direct contact with substances deleterious to building materials (P02).
- » Methane ingress via permeable soils and/or construction gaps (P03).
- » VOC and petroleum hydrocarbon vapour ingress via permeable soils and/or construction gaps (P04).
- » Root uptake by plant (P05).
- » Migration of contaminant via leachate migration through the unsaturated zone (P06).
- » Migration of contaminant from the groundwater within the Lynch Hill Gravel Member to the groundwater within the Lambeth Group aquifer (P07).

Health and safety risks to site development contractors and maintenance workers have not been assessed as part of this study and will need to be considered separately.

The above sources, pathways and receptors have been considered as part of the Preliminary Risk Assessment in accordance with LCRM (2021), are considered to be plausible in the context of this site and should be carried forward for investigation and assessment.

A summary of the plausible linkages is presented on the initial CSM provided in Appendix A. (Hydrock Drawing 26887-HYD-XX-XX-DR-GE-1001).

3.4.5 Potential implications of climate change

Climate change has the potential to change the risk profile for conceptual site models and associated contaminant linkages. The impact of climate change on the CSM is site-specific, and a qualitative assessment of the potential impact of climate change on the CSM for this site is summarised below. The assessment has primarily utilised the guidance in Environment Agency (2010)³ and SoBRA (2022)⁴ which set out the UK context to climate change and land contamination. Both guidance documents advocate a “what if” scenario approach in the context of changes in ambient temperatures, an increase in the frequency of extreme rainfall/storm events and heatwaves/droughts, and long-term changes in groundwater and sea levels.

Those “what if” scenarios that are relevant to this CSM are:

- » Increased long-term rainfall leading to increased infiltration and seasonally higher groundwater and water levels in surface waters.
- » Increased frequency and/or magnitude of extreme rainfall events leading to short-term surface flooding, surface water run-off, groundwater flooding, and/or land-based erosion.
- » Occurrence of extreme cold and hot weather events leading to changes in ground conditions such as soil temperature, evapo(trans)piration, and soil moisture (for example freeze-thaw effects and desiccation), decreased infiltration and fall in groundwater and surface water levels.
- » Long-term decrease in rainfall leading to lower infiltration and fall in groundwater and surface water levels.

³ Environment Agency, 2010. *Guiding Principles for Land Contamination. Part 2. FAQs, technical information, detailed advice and references, March 2010.*

⁴ SoBRA, 2022. *Guidance on Assessing Risk to Controlled Waters from UK Land Contamination Under Conditions of Future Climate Change, Society of Brownfield Risk Assessment, August 2022.*

4. Desk study conclusions

4.1 Geotechnical conclusions

The following plausible geotechnical risks are identified:

- » Variable Made Ground - settlement or differential settlement of foundations, floor slabs, roads and infrastructure elements.
- » Low strength, compressible ground – risk of shear failure and excessive settlement of foundations, roads and infrastructure elements.
- » Attack of buried concrete by aggressive ground conditions – the development site may contain Made Ground and potentially sulfate bearing soils.
- » Shrinkage/swelling of clay – settlement/heave of foundations, especially where located within the influence of trees and vegetation.
- » Obstructions.
- » Changing groundwater conditions.
- » Shallow groundwater.
- » Loose Made Ground and shallow groundwater, leading to difficulty with excavation due to trench instability.
- » Potential for obstructions and the risk of instability of excavations with the impact on construction staff, vehicles and plant operators.
- » Potential for solution features and sink holes on site.
- » Risk from flooding.
- » Solution features in Chalk.
- » Cavities in the Superficial Deposits due to solution features.
- » Dissolution (associated with “wet rock head”).
- » Potential for unforeseen ground conditions and the risks associated with limited data.

These plausible risks require further investigation and assessment.

4.2 Geoenvironmental conclusions

Based on historical and current land uses:

- » It is considered that it is unlikely that the site would be classified as Contaminated Land under Part 2A of the EPA 1990.
- » The overall risk from land contamination at the site is considered to be low for the current development, as it is covered by hard standing or buildings limiting the possibility of contact with the soils, as well as the risk of significant rainwater infiltration leading to leaching.
- » The overall risk for a redeveloped site is assessed to be moderate, with some specific potentially high risks, but this would need to be confirmed by appropriate intrusive investigation, testing and assessment of the results of the investigation.

The possible pollutant linkages (for risk levels of moderate or greater) on an un-remediated redeveloped site, as determined by the desk study and walk-over, are summarised in Table 4.1:

Table 4.1: Possible Pollutant Linkages (for Risk Levels of Moderate or Greater)

Source(s)	◀ potential Impact on ▶	Receptor(s)
Metals, metalloids, PAH, petroleum hydrocarbons and asbestos in Made Ground below the site.		Site users Neighbours Groundwater
Ground gases (carbon dioxide and methane) from organic materials in the Made Ground.		Site Users Buildings
Asbestos within existing buildings		Site Users Neighbours

These possible pollutant linkages require further investigation and assessment.

5. Uncertainties and limitations

5.1 General comments

Hydrock Consultants Limited (Hydrock) has prepared this report in accordance with the instructions of Reading Borough Council (the Client), by e-mail dated December 2022 under the terms of appointment for Hydrock, for the sole and specific use of the Client and parties commissioned by them to undertake work where reliance is placed on this report. Any third parties who use the information contained herein do so at their own risk. Hydrock shall not be responsible for any use of the report or its contents for any purpose other than that for which it was prepared or for use of the report by any parties not defined in Hydrock's appointment.

This report details the findings of work carried out in January 2023. The report has been prepared by Hydrock on the basis of available information obtained during the study period. Although every reasonable effort has been made to gather all relevant information, not all potential environmental constraints or liabilities associated with the site may have been revealed.

Information provided by third parties has been used in good faith and is taken at face value; however, Hydrock cannot guarantee its accuracy or completeness.

Where the existing reports prepared by others have been provided by the Client, it is assumed that these have been either commissioned by the Client, or can be assigned to the Client, and can be relied upon by Hydrock. Should this not be the case Hydrock should be informed immediately as additional work may be required. Hydrock is not responsible for any factual errors or omissions in the supplied data, or for the opinions and recommendations of others. It is possible that the conditions described may have since changed through natural processes or later activities.

The non-specialist UXO screening has been undertaken for the purposes of ground investigation only (i.e. low risk activity in accordance with CIRIA Report C681). Further assessment should be undertaken with regards to other higher risk activities e.g. construction.

Any site boundary line depicted on plans does not imply legal ownership of land.

6. Recommendations for further work

The following works are recommended:

- » As the site is in a minerals resource safe guard area, a minerals assessment may be required and further consultation with the local authority is recommended. In order to confirm the actual risks to receptors and confirm the ground conditions with respect to potential geotechnical and geo-environmental risks, an appropriate intrusive investigation will need to be undertaken.

This investigation will need to:

- » determine the depth and distribution of Made Ground and natural strata across the site;
- » determine the soil strength/density profile beneath the site;
- » determine the thickness of the deposits beneath the site over the Seaford Chalk Formation and the competency of the Seaford Chalk Formation;
- » determine the depth/level of groundwater beneath the site;
- » determine the ground gas concentrations beneath the site;
- » allow sampling for chemical and geotechnical laboratory testing; and
- » obtain information in terms of Aggressive Chemical Environment for Concrete Class (ACEC Class).

Following investigation, assessment will be required to:

- » update the Ground Model;
- » update the Geotechnical Risk Register;
- » provide Geotechnical Design recommendations;
- » update the CSM, including identification of plausible pollution linkages;
- » undertake generic quantitative risk assessment of potential chemical contaminants to establish 'suitability for use' under the current planning regime;
- » discuss potential environmental liabilities associated with land contamination (soil, water and gas); and
- » provide outline mitigation recommendations to ensure the site is 'suitable for use'.

Appendix A Drawings

Appendix B Field reconnaissance photographs

Appendix C Historical ordnance survey maps

Appendix D Desk study research information

Appendix E Preliminary geotechnical risk register

Geotechnical hazard identification – desk study stage

Potential geotechnical hazards have been assessed in accordance with the general requirements of ICE/DETR Document 'Managing Geotechnical Risk' and the HE documents HD 41/15 and CD 622. The following pages set out the identified geotechnical risks and hazards which are associated with the proposed development and establish the approach which is to be taken to manage the risks including the geotechnical input and analysis.

Table E.1 is a preliminary assessment of possible geotechnical hazards at the site at Desk Study stage. This information is used to assist with ground investigation design.

Table E.1: Possible geotechnical hazards

Hazard	Comment	Hazard status based on desk study	
		Could be present and / or affect site (i.e. Plausible)	Unlikely to be present and/or affect site
Uncontrolled Made Ground (variable strength and compressibility).	Significant Made Ground of unknown physical properties is likely to be present on site.	✓	-
Soft / loose compressible ground (low strength and high settlement potential).	The shallowest soils (particularly any Made Ground) may be soft and compressible.	✓	-
Shrink swell of the clay fraction of soils under the influence of vegetation.	Clay is expected to be present across the entire site.	✓	-
Variable lateral and vertical changes in ground conditions.	Made Ground will likely be present across a significant portion of the site, over superficial sand and gravels, over clays of the Lambeth Group.	✓	-
High sulfates present in the soils.	Potential for sulfates within Made Ground and natural soils.	✓	-

Adverse chemical ground conditions, (e.g. expansive slag).	No evidence based on current and historic land use of the site.	-	✓
Obstructions.	Underground services are present and obstructions associated with the existing structures are to be expected..	✓	-
Existing below ground structures to remain (on or off-site tunnels, foundations, basements, and adjacent sub-structures).	Underground services are present and obstructions associated with the existing structures are to be expected..	✓	-
Shallow groundwater.	The Lynch Hill Gravel Member and Lambeth group are Secondary A Aquifers.	✓	-
Changing groundwater conditions.	Presence of permeable sands and gravels may enable changing groundwater conditions .	✓	-
Risk from erosion.	No applicable.	-	✓
Risk from flooding.	The environmental report indicates a risk of surface water flooding of 1 in 30 years.	✓	-
Running sands and / or loose Made Ground, leading to difficulty with excavation and collapse of side walls.	Unknown nature of the Made Ground and shallow superficial deposits has potential to be loose, causing difficulties with excavation.	✓	-
Slope stability issues – general slopes.	The site is flat.	-	✓
Slope stability issues – retaining walls.	No retaining walls currently exist on the site or are planned for the development.	-	✓

Earthworks – settlement (due to placement of fill on soft / loose ground).	Earthworks are not anticipated.	-	✓
Earthworks – poor bearing capacity of new fill.	Earthworks are not anticipated.	-	✓
Earthworks – unsuitability of site won material to be reused as fill.	Earthworks are not anticipated.	-	✓
Solution features in Chalk.	A series of natural cavities are recorded in the vicinity of the site (including solution pipes and sinkholes). Further investigation is required with regard to the potential for solution features at the site.	✓	-
Cavities in the Superficial Deposits due to solution features.	A series of natural cavities are recorded in the vicinity of the site (including solution pipes and sinkholes). Further investigation is required with regard to the potential for solution features at the site.	✓	-
Dissolution (associated with “wet rock head”).	A series of natural cavities are recorded in the vicinity of the site (including solution pipes and sinkholes). Further investigation is required with regard to the potential for solution features at the site.	✓	-
Brine extraction.	Inadequate geology.	-	✓
Mining.	Localised small scale underground mining may have occurred. Potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered.	-	✓

Cambered ground with gulls possibly present.	Inadequate geology.	-	✓
Relict Slip Surfaces.	Inadequate geology.	-	✓
Solifluction.	Inadequate geology.	-	✓
Problematic soils (silts and rewetting etc.).	Inadequate geology.	-	✓

Appendix F Plausible source-pathway-receptor contaminant linkages

Summary of potential contaminant linkages

Table F.2 lists the plausible contaminant linkages which have been identified. These are considered as potentially unacceptable risks in line with guidelines published in LCRM (2019) and additional risk assessment is required.

Source – Pathway – Receptor Linkages have been assessed in general accordance with guidance in CIRIA Report C552 (Rudland *et al* 2001) but modified to add a 'no linkage' category and to remove low/moderate risk (See Table F.1).

It should be noted that whilst the risk assessment process undertaken in this report may identify potential risks to site demolition and redevelopment workers, consideration of occupational health and safety issues is beyond the scope of this report and need to be considered separately in the Construction Phase Health and Safety Plan.

Table F.1: Consequence versus probability assessment.

		Consequence			
Probability		Severe	Medium	Mild	Minor
	High Likelihood	Very high risk	High risk	Moderate risk	Low risk
	Likely	High risk	Moderate risk	Low risk	Very low risk
	Low Likelihood	Moderate risk	Low risk	Low risk	Very low risk
	Unlikely	Low risk	Very low risk	Very low risk	Very low risk
	No Linkage	No risk			

Table F.2: Exposure model – final source-pathway-receptor contaminant linkages

Sources	Possible Pathways	Receptors	Probability	Consequence	Risk Level	Comments	
Made Ground, associated with historical construction activities and imported fill, possibly including elevated concentrations of metals, metalloids, asbestos, PAH and petroleum hydrocarbons (S1).	Ingestion, inhalation or direct contact (P01).	People (neighbours, site end users) (R01).	Likely	Medium	Moderate	There is likely Made Ground below the site with the development of the existing structures on site and demolition of older structures/	Contact with these materials is likely. Intrusive investigation is required to assess the risk.
	Direct contact with substances deleterious to building materials (P02).	Development end use (buildings, utilities and landscaping) (R02).	Likely	Medium	Moderate		Contact with these materials is likely.
	Inhalation of fugitive dust (P01).	People (neighbours, site end users) (R01).	Low likelihood	Medium	Low		The risk of significant generation of dust is likely only during site development process and can therefore be controlled.
	Leachate migration through the unsaturated zone (P06).	Groundwater: Secondary A aquifer status of the Lynch Hill Gravel Member and Lambeth Group (R03).	Likely	Medium	Moderate		Potential for contaminants to leach through the unsaturated zone of the permeable superficial deposits. Further investigation is required.

	Migration of contaminants to the Secondary A aquifer (P07).	Groundwater: Secondary A aquifer status of the Lynch Hill Gravel Member and Lambeth Group (R03).	Low likelihood	Medium	Low		
	Root uptake (P05)	Development end use (buildings, utilities and landscaping) (R02).	Likely	Medium	Moderate		Risk of contaminated Made Ground to impact soft landscaping areas of the development needs further investigation
Ground gases (carbon dioxide and methane) from organic materials in the Made Ground (S02)..	Methane ingress via permeable soils and/or construction gaps (P03/4).	People (neighbours, site end users) (R01).	Likely	Medium to Severe	Moderate to High	Made Ground is anticipated on site which may contain organic materials. Site investigation to confirm the conditions is required. Gas monitoring will be required if potential gas generating Made Ground is encountered.	
Asbestos within existing buildings (S03).	Ingestion, skin contact, inhalation of dust and outdoor air by people (P01).	People (site end users) (R01). People (neighbours,) (R01)..	Likely Unlikely	Severe Severe	High Low	Asbestos may be present in existing buildings and in Made Ground. Careful removal will be required from buildings during demolition. However, removal under controlled conditions should limit release of fibres to the air and the ground.	