C Soil Technics – Ground Investigation Report

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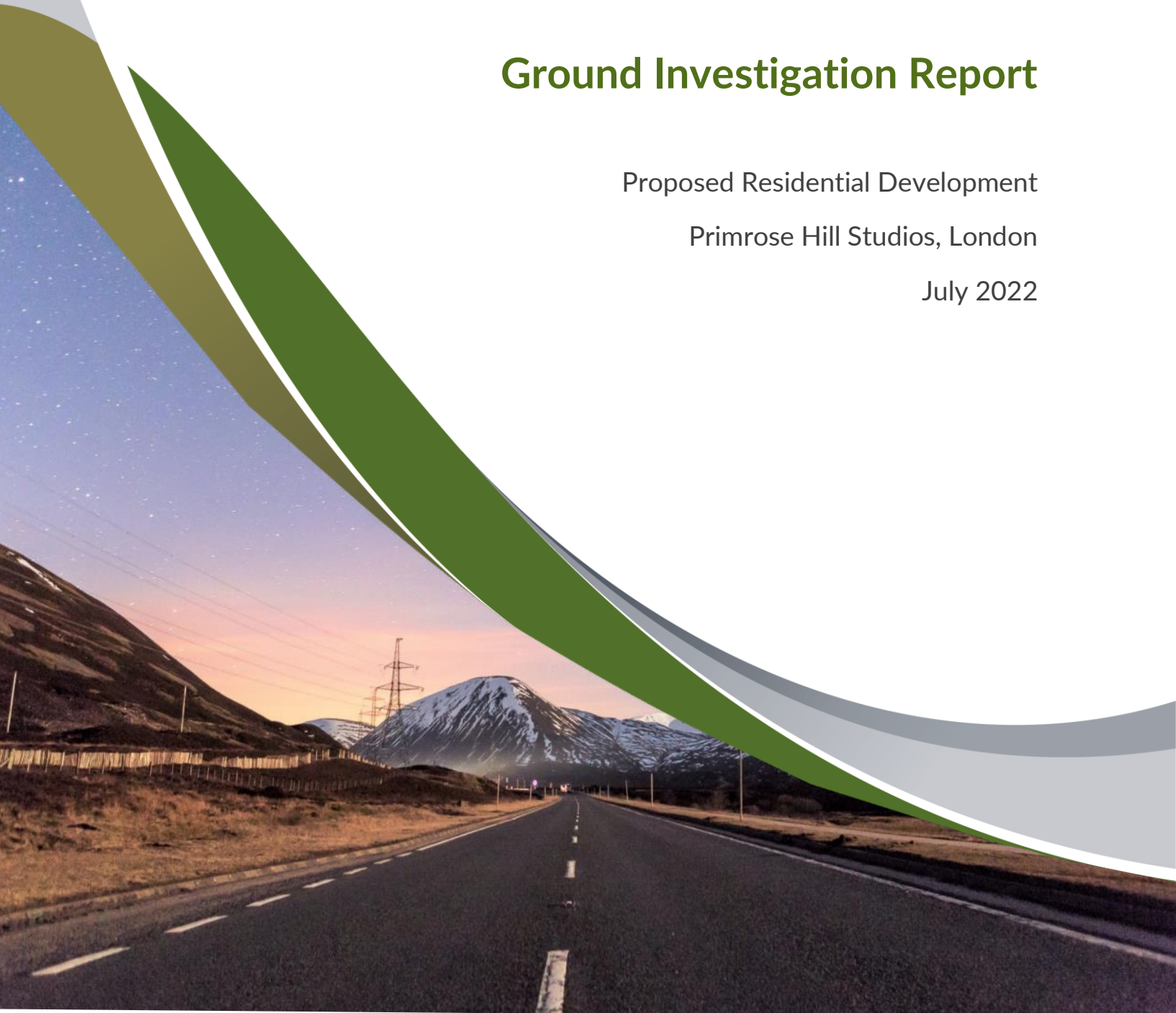
Ground Investigation Report

Proposed Residential Development

Primrose Hill Studios, London

July 2022



Project Details

Site:	Primrose Hill Studios, London
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Document history and status

Revision	Date	Description	Author	Checker	Reviewer
A	May 2022	First Issue. To be updated following receipt of outstanding laboratory test data.	ID	AW	SD
B	July 2022	Updated report following receipt of laboratory test data for waste classification.	VJ		ID
C	July 2022	Non-material adjustments to text			ID

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Drawing Register

Title	Produced by	Date	Reference
Site location plan	Soiltechnics	March 2022	D-STU5616-01
Plan showing existing site features and location of exploratory points	Soiltechnics	May 2022	D-STU5616-02
Proposed basement floor plan	Jamie Forbert – Architects	January 2022	352_2_100
Proposed ground floor plan			352_2_101
Proposed section DD			352_2_202

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Non-technical Summary

Topic	Commentary
Site description	The site is located at 12-13 Primrose Hill Studios, London, NW1 8TR. The existing site comprises two dwellings and associated garage. The site is locally flat with ground levels in the wider vicinity falling at a gentle gradient from west to east.
Development proposals	The proposed development comprises internal alterations to both properties and connecting them together. Additionally, a single storey basement is proposed under part of the site.
Ground conditions	Ground conditions comprise Made Ground overlying London Clay. Perched groundwater was encountered in one exploratory hole only, at the base of the Made Ground.
Foundation and slab solution	Underpins will be used to form a basement, with a suspended slab cast, bearing on the underpin toe.
Drainage potential	Development will cover the site and drainage should, therefore, connect to the mains services.
Chemical contamination and remedial requirements	In view of the conceptual site model for the site, no pollutant linkages have been identified and ground and ground conditions present a low risk of causing harm to identified receptors. Accordingly, no specific remediation is considered necessary.
Radon, gas risk and protection measures	No gas protection measures are considered necessary. While the site is recorded to be in an area where no radon protection is needed, subterranean structures can be more vulnerable to radon ingress. The construction and waterproofing of the basement will minimise radon ingress and are considered sufficient to mitigate the risk from radon.
Waste Classification	Made Ground has a waste code of 17-05-04 and is classified as Non-Hazardous. The composite sample marginally exceeds the threshold for fluoride for an inert landfill. Further testing during disposal may enable disposal as inert waste. No contamination was noted within natural soils and disposal will be possible within an inert landfill.

1 Introduction

1.1 Scheme Outline

1.1.1 The proposed development comprises internal alterations to both properties and connecting them together. Additionally, a single storey basement is proposed under part of the site. The basement excavation will be up to 5m deep.

1.1.2 Scheme drawings produced by the architects are provided in Appendix A.

1.2 Client instructions and confidentiality

1.2.1 This report has been prepared following instructions received from Elliott Wood on behalf of our mutual Client, Rory and Barbara Campbell-Lange.

1.2.2 This report has been prepared for the sole benefit of our above-named instructing Client, but this report, and its contents, remains the property of Soiltechnics Limited until payment in full of our invoices in connection with production of this report.

1.2.3 This report is final based on our current instructions.

1.3 Brief

1.3.1 The overall brief of works is to:

i) Support a planning application by undertaking a ground investigation at the site to establish the prevailing ground conditions.
ii) Determine geotechnical parameters and provide a geotechnical appraisal for the scheme.
iii) Assess potential contamination at the site and provide recommendations for further works and/or a remediation strategy, if required.
iv) Provide a preliminary waste classification.

1.3.2 Geotechnical investigations were carried out generally, and where practical following the recommendations of BS EN 1997:2 2007 'Eurocode 7 – Geotechnical Design – Part 2: Ground Investigation and Testing'. From a geotechnical viewpoint this is deemed to be a Ground Investigation Report (GIR) as set out in BS EN 1997:2. This report does not constitute a Geotechnical Design Report as defined in section 2.8 of BS EN 1997-1:2004+A1:2013 'Eurocode 7 – Geotechnical Design – Part 1: General Rules' and in particular will exclude assessment of lifetime actions to buildings from geotechnical influences.

1.3.3 The investigation process also followed the principles of BS 10175:2011+A2:2017 'Investigation of potentially Contaminated Sites – Code of Practice'. In view of the client's requirement for rapid implementation of the investigation, the following elements, defined in BS 10175, have been completed and incorporated in this report.

a) Phase I Preliminary investigation (desk study and site reconnaissance)
b) Phase II Exploratory and detailed (intrusive) investigations

1.3.4 The investigation process also followed the principles of BS 10175:2011+A2:2017 'Investigation of potentially Contaminated Sites – Code of Practice'.

1.3.5 This investigation has been carried out and reported based on our understanding of best practice. Improved practices, technology, new information and changes in legislation may necessitate an alteration to the report in whole or part after publication. Hence, should the development commence after expiry of one year from the publication date of this report then we would recommend the report be referred back to Soiltechnics for reassessment. Equally, if the nature of the development changes, Soiltechnics should be advised and a reassessment carried out if considered appropriate.

1.4 Soiltechnics liability

1.4.1 Soiltechnics disclaims any responsibility to our Client and others in respect of any matters outside the scope of this report. This report has been prepared with reasonable skill, care and diligence in accordance with the terms of our contract, taking account of the manpower, resources, investigations and testing devoted to it by agreement with our Client. This report is confidential to our Client and Soiltechnics accepts no responsibility of whatsoever nature to third parties to whom this report or any part thereof is made known. Any such party relies upon the report at their own risk.

2 Desk Study

2.1 Sources of information

2.1.1 Reference has been made to the following sources of information:

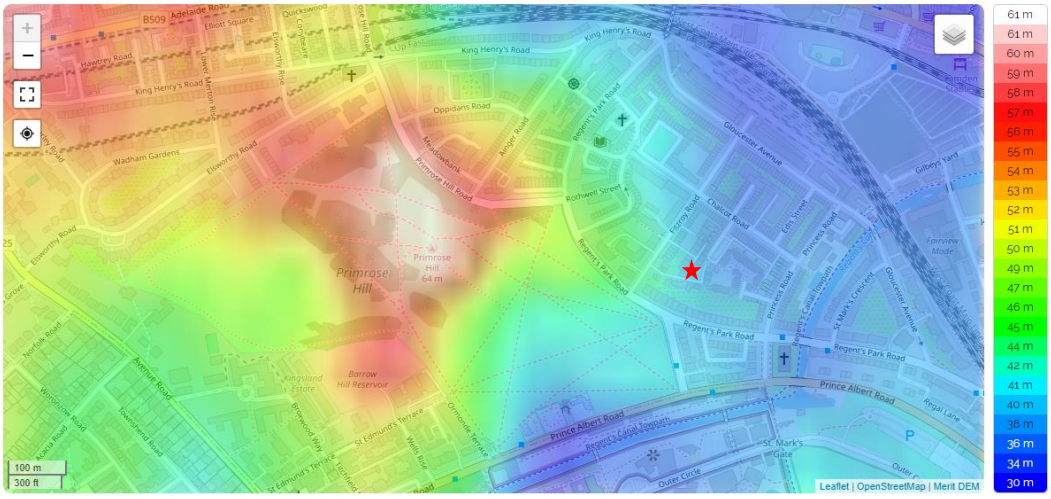
- An Envirocheck Report, which is a collation of factual data from a wide range of sources. A copy of the Envirocheck is presented as Appendix H.
- British Geological Survey (BGS) GeoIndex – Onshore database.
- 'Radon: guidance on protective measures for new buildings' (2007). Building Research Establishment (BRE).
- Ordnance Survey Maps
- Google Earth

2.2 Site Description

2.2.1 The site comprises the parcel of land associated with 12-13 Primrose Hill Studios within the London Borough of Camden. The site consists of two, two-storey, semi-detached, masonry residential dwellings and associated garages. The garages had been part demolished at the time of our investigation.

2.2.2 The site is flat at a level of approximately 33m above Ordnance Datum (AOD). In the wider vicinity ground levels fall from west to east at a gentle gradient (circa 1V:50H). The gradient steepens further west as ground levels climb toward the crest of Primrose Hill.

2.2.3 An extract of open-source topographical mapping is shown below, with the approximate site location marked with a star.



England, United Kingdom (52.53102 -1.26491)

Figure 2-A: Topographical map extract

2.2.4 Land use in the immediate area consists mainly of residential properties of masonry construction.

2.2.5 No soft landscaping is present onsite, although a series of small ornamental beds are located in the open mews just off the northern boundary.

2.2.6 The photos below show the site in general with the location of photos shown on Drawing -02.

Photo 1: Looking southeast in the area of the partially demolished garages.

Photo 2: The interior of No' 12.

Photo 3: Looking north showing the planted beds to the north (offsite).

2.3 Asbestos

2.3.1 Our investigations exclude surveys to identify the presence or indeed absence of asbestos in structures onsite. It should be noted that we did not observe evidence of obvious, potential asbestos containing materials on site within the areas of investigation.

2.4 History

2.4.1 Reference has been made to historical Ordnance Survey plans and publicly available satellite imagery. A summary of the key features is provided below.

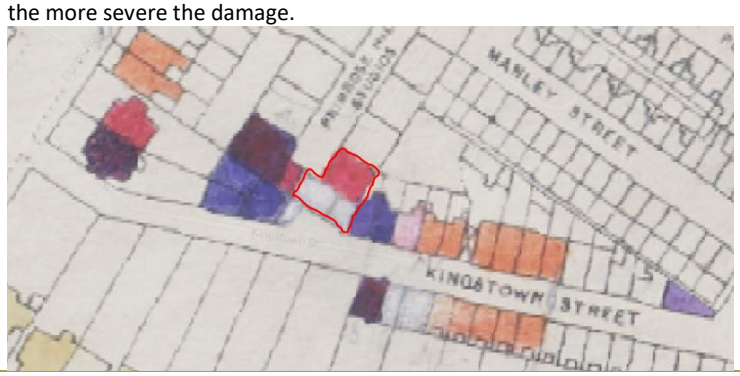
Date	Onsite	Offsite
1875	Site is part of a square parcel of undeveloped land, with a small number of trees shown onsite.	The undeveloped square of land extends northward. The surrounding area is predominantly residential with many roads in the same layout as current day. A 'Pianoforte Manufactory' (piano factory) is recorded 70m northwest. The line of Regents Canal is recorded ~250m south and east. Camden Goods Yard ~275m northeast, with associated engine yards, engineering works and garages.
1896	Site developed into the present layout, although southern structures appear smaller than current garages.	Undeveloped land now developed into Primrose Hill Studios as per the current layout.
1916	No significant change.	Pianoforte works ~150m northeast.
1945	Bomb damage maps show significant damage to the immediate area. The darker the shading the more severe the damage. 	
1954	Structures no longer recorded to the south.	Pianoforte works now recorded as an Electrical Fixings Factory. Pianoforte works to the northeast now recorded as a chemical works.
1957	Detailed building plans record number 12 as being 1 storey with a basement. Garages recorded to the south. Two storey dwelling recorded at number 13.	Area of housing ~10 – 100m east no longer recorded.
1969	No significant change.	Housing immediately adjacent to the eastern boundary no longer recorded. Factory to the west now recorded as 'Public Health Department'. Chemical works to the northeast is now recorded as a 'Works'.
1973	No significant change.	Area immediately east is essentially empty and assumed to be undergoing significant redevelopment.
1978	No significant change.	Area to the east now developed concurrent with the current layout. Public Health Department no longer labelled as such, but building still present.
1987	No significant change.	Former Public Health Department now labelled 1-28, suggesting conversion to apartments.
1991 - present	No significant change.	Works still recorded to northeast, but now also recorded as 'Eutopia Village'. Still signed as Eutopia Village today.

Table 2-A: Summary of site history

2.5 Anticipated Geology

2.5.1 A summary of the anticipated geology underlying the site is summarised as follows:

Stratum	Bedrock / superficial	Anticipated thickness (m)	Aquifer designation	Typical description
London Clay Formation	Bedrock	20-30m	Unproductive Strata	Clay/silt
Lambeth Group	Bedrock	10-15m	Secondary undifferentiated	Variably sandy/gravelly clay over gravelly sand of the Upnor Formation subdivision.
Thanet Sand Formation	Bedrock	5-10m	Secondary A	Fine silty sand
White Chalk Subgroup	Bedrock	>100m	Principal	Chalk

Table 2-B: Summary of anticipated geology at the site

2.5.2 No superficial deposits have been mapped at or in close proximity to the site. However, a nominal thickness of Made Ground associated with the general development of the site and area is anticipated.

2.5.3 Principal aquifers are defined as deposits exhibiting high permeability capable of high levels of groundwater storage. Such deposits are able to support water supply and river base flows on a strategic scale.

2.5.4 Secondary A aquifers are predominantly permeable layers capable of supporting water supplies at a local rather than strategic scale. In some cases, Secondary A aquifers can form an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.

2.5.5 Secondary undifferentiated aquifer is a designation used when it is not possible to attribute fully one of either Secondary A or Secondary B, due to the variable nature of the soils. Secondary B can be defined as: layers which may store limited amounts of ground water. These groundwater stores are generally the water bearing parts of former aquifers.

2.5.6 Unproductive strata are defined as deposits exhibiting low permeability with negligible significance for water supply or river base flow. Unproductive Strata are generally regarded as not containing groundwater in exploitable quantities.

2.5.7 Envirocheck report includes hazard ratings due to natural ground instability, which have been derived by the BGS. All of the natural hazards have been rated as low, or below with the exception of 'Potential for Shrinking or Swelling Clay Ground Stability Hazards', rated as moderate due to the plastic nature of London Clay Formation soils.

2.6 Hydrogeology

2.6.1 The underlying London Clay Formation is recorded as unproductive strata and is unlikely to contain significant water. Local borehole records support this.

2.6.2 The Made Ground, if present, may be variably permeable.

2.6.3 Given the impermeable nature of underlying soils, ground conditions are not conducive to containing significant quantities of groundwater.

2.6.4 If present, it is likely to be in discreet/confined locations and unlikely to be in direct continuity with aquifers or surface waters. As the site is at the base of a hill, it is possible that transitory water may be present in near surface Made Ground, especially during or after inclement weather.

2.6.5 The site is not located within a Source Protection Zone.

2.6.6 A cluster of surface water abstractions are recorded ~420m northeast adjacent to the Regent Canal.

2.6.7 A groundwater abstraction is recorded 466m to the south, at Regents Park (London Zoo) and a corresponding borehole record shows a borehole extending to the principal aquifer in the chalk. A further 3 licences are recorded 470m west at Barrow Pumping Station. Associated borehole records are restricted but it is assumed this abstraction, for public water supply, is from the chalk aquifer.

2.7 Hydrology

2.7.1 The nearest recorded surface water feature is Regents Canal, ~204m east of the site.

2.8 Flood risk

2.8.1 The site is not located within a fluvial flood plain, nor an area recorded at risk of surface or groundwater flooding. It is noted that most roads adjacent to the site are recorded to be at risk of a 1 in 1000 year surface water flood event.

2.8.2 This information does not constitute a site-specific Flood Risk Assessment and one may be required for the scheme.

2.9 Quarrying and Mining

2.9.1 There is no record of mining activities or quarrying within 500m of the site.

2.10 Landfill and infilled ground

2.10.1 There are no recorded current or historic landfill sites within 2000m of the site. A stretch of canal is recorded to have been infilled to the southeast, the closest section being ~315m distant.

2.10.2 Two further points of potentially infilled land correspond to small areas within London Zoo to the south. The type of infill is not recorded, but on the basis they are not recorded as landfill sites, it is likely that infill soils are unlikely to be significantly harmful.

2.11 Recent industrial activity

2.11.1 There are no active Contemporary Trade Directory or Fuel Station records within 100m of the site. Two inactive records for home furnishing manufacturers (69m E) and carpet cleaners (78m NE) are recorded at residential addresses.

2.12 Radon

2.12.1 Envirocheck use the British Geological Survey database to review reported radon levels in the area in which the site is located to establish recommended radon protection levels for new dwellings. The database records the site as being located where no protection is recommended.

2.13 Unexploded Ordnance (UXO)

2.13.1 Prior to our fieldwork activities we obtained a desk study risk review report from MACC International. The risk review concluded that there was a 'medium' risk of encountering UXO during the ground investigation. A specialist engineer supervised the intrusive investigation works.

2.14 Underground Infrastructure

2.14.1 Copies of all utility plans obtained are presented as Appendix G. The plans are provided for information only and should not be relied upon to be accurate. In addition, it is worth noting that the public utility plans provided by the asset owners typically exclude private service runs.

3 Ground Investigation

3.1 General

3.1.1 The ground investigation brief was provided by Elliott Wood.

3.1.2 The ground investigation works were carried out in general accordance with the recommendations outlined in BS 5930:2015+A1:2020 and BS EN 1997-2:2007, and constitutes a Preliminary Investigation, as defined by those standards.

3.1.3 The objectives of the fieldwork were to:

- Establish ground and groundwater conditions at the site
- Obtain samples for subsequent laboratory testing
- Prove existing foundation arrangements
- Assess contamination risks

3.2 Fieldwork summary

3.2.1 Fieldwork was undertaken between 21st March 2022 and 31st March 2022 with a summary of works presented in the following table.

3.2.2 The exploratory logs are presented within Appendix B.

Method	Qty	Final Depth Range (m bgl)	Comments
Hand-excavated trial pits	5	0.74 – 1.4	To expose existing foundations
Cable percussive borehole	1	10.0	Assess ground conditions

Table 3-A: Summary of fieldwork undertaken

3.2.3 All soils encountered were described in accordance with BS EN ISO 14688 “Identification and Classification of soil”.

3.3 Sampling

3.3.1 During the fieldwork, sampling of soil, rock and groundwater for geotechnical purposes has been undertaken in accordance with BS EN ISO 22475-1 *“Geotechnical Investigation and testing – sampling by drilling and excavation and groundwater measurements”.*

3.3.2 Samples collected for chemical analysis have been taken and handled in accordance with BS ISO 18400-105:2017 *“Soil quality — Sampling Part 105: Packaging, transport, storage and preservation of samples”.*

3.3.3 Various sampling and sub-sampling methodologies have been adopted with the primary aim of obtaining the highest quality sample class practicable.

3.4 In situ testing

3.4.1 The following table summarises the field testing carried out. The results are summarised on individual exploratory hole logs where appropriate and detailed within the Appendices indicated.

Tests	Quantity	Applicable standard / guidance	Location of Results
Pocket penetrometer	7	Manufacturer's instructions	Appendix C
Standard penetration test (SPT)	4	BS EN ISO 22476-3	

Table 3-B: Summary of field testing undertaken

3.5 Laboratory testing

3.5.1 Samples obtained from exploratory holes were sent to independent accredited laboratories for geotechnical testing.

3.5.2 Geotechnical laboratory test results are presented in Appendix D, and the total number of geotechnical tests undertaken is summarised below:

Qty	Test
4	BRE SD1 Suite B
3	Liquid limit/plastic limit/plasticity index (1 point)
3	Single stage undrained shear strength of single 100mm sample in triaxial compression
1	One dimensional consolidation test (5 days)

Table 3-C: Summary of geotechnical laboratory testing

3.5.3 Geo environmental laboratory testing has been scheduled as below. The results will be appended on receipt.

Qty	Test
3	Basic categorisation suite
1	2 stage WAC

Table 3-D: Summary of geo environmental laboratory testing

4 Ground Investigation Findings

4.1 Overview

4.1.1 The stratigraphy onsite comprised Made Ground onto London Clay Formation as anticipated.

4.2 Made Ground

4.2.1 Made Ground was encountered as both a coarse grained (sand/gravel) and fine-grained soil (clay). Gravel generally comprised brick, flint and concrete with cobbles of brick.

4.2.2 Made Ground at BH01 extended to 0.8m which is suggested as a model base depth. It is noted that Made Ground may extend up to ~3.0m underneath No' 12 where a basement was previously recorded.

Figure 4-A: Extract of detailed building plans (1957)

4.3 London Clay Formation

4.3.1 London Clay Formation was encountered in BH01 from 0.8m as a firm becoming stiff, brown mottled grey clay.

Figure 4-B: BH01 soils (7.0m - 7.5m)

4.4 Groundwater

4.4.1 Groundwater was not observed in any of the exploratory holes during the fieldworks with the exception of TP05, where a slow seepage was encountered from 1.3m, with groundwater standing at 1.3m upon completion of the excavation.

4.4.2 Whilst no water was encountered in BH01, a water monitoring standpipe was installed to allow future verification monitoring. Monitoring was undertaken on 25th March 2022 and water was measured at 2.96m below ground level (pipe base at 4.0m).The water was bailed out to a depth of 3.84m to assess recharge rate. This is shown illustratively below.

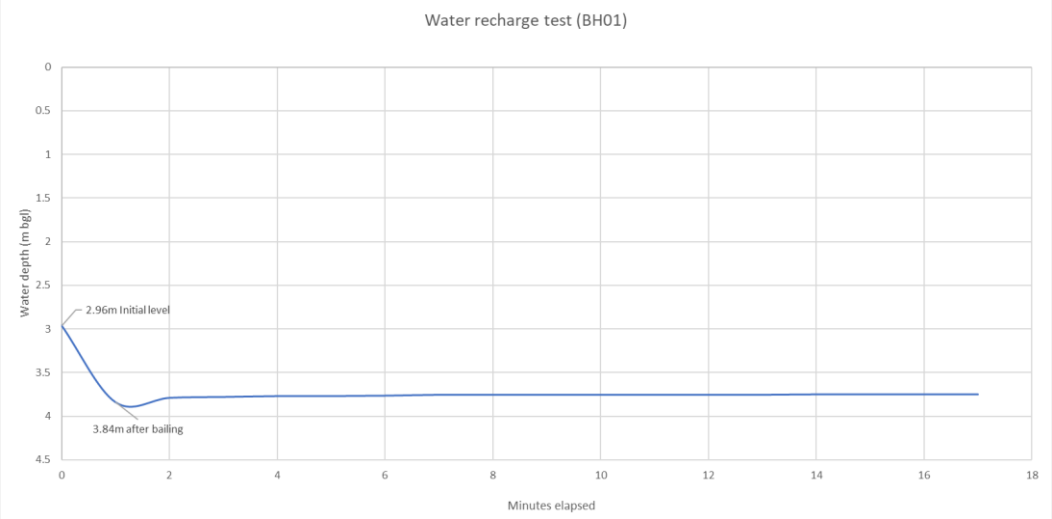


Figure 4-C: Plot showing water recharge in BH01

4.4.3 While a bentonite seal was placed around the upper pipe, it is possible that small fissures exist in the weathered London Clay Formation upper horizon. The minimal recharge suggests that there is not a standing water table and that the water entered from the Made Ground, possibly during/after rainfall, through suspected local fissures.

4.4.4 Further water monitoring onsite may allow a refinement, but in lieu of further investigation a water level of 2.96m BGL should be assumed as a cautionary approach.

4.5 Evidence of possible contamination

4.5.1 During the ground investigation works, no significant visual or olfactory evidence of contamination was noted, except for the presence of anthropogenic materials contained within the Made Ground (brick and concrete).

4.6 Obstructions and Instability

4.6.1 No in-ground obstructions or significant instability were encountered during our site investigations.

4.7 Unexploded Ordnance (UXO)

4.7.1 No anomalies were detected during fieldwork.

5 Geotechnical Discussion

5.1 Scheme overview

5.1.1 The following assessments are made on the investigatory data presented in the preceding sections of this report and are made with reference to the specific nature of the development. Should scheme proposals change then it is recommended that the validity of the conclusions of this report in relation to the revised scheme are checked.

5.1.2 The proposed development comprises internal alterations to both properties and connecting them together. Additionally, a single storey basement is proposed under part of the site. The basement excavation will be up to 5.00m deep.

5.1.3 Scheme drawings are provided in Appendix A.

5.2 Geotechnical Category

5.2.1 In accordance with BS EN1997-1:2004 + A1:2013 (Eurocode 7), the project is designated as Geotechnical Category 2. This category includes projects with *conventional types of structures and foundations with no exceptional risk, or difficult ground or loading conditions*. Furthermore, *routine design procedures* are appropriate.

5.2.2 It should be noted that this Report does not constitute a Geotechnical Design Report (GDR) as defined in Eurocode 7. Accordingly, a GDR should be prepared by the designer during the detailed design phase.

5.3 Groundwater

5.3.1 A model depth of 2.96m is suggested and should be expected to vary seasonally and in response to weather events. Further investigations would be required to enable a refinement of this level.

5.3.2 This level is above the base of the basement and would therefore be encountered during excavation of the basement. Flow rates are anticipated to be relatively low and controllable using conventional sump pumping techniques. Following construction, any temporary control of water would cease and equilibrium groundwater levels would return. Consequently, this would induce uplift forces that the development would need to restrain.

5.4 Building foundation strategy

5.4.1 The proposed construction will adopt an underpinning technique to construct reinforced concrete L shaped retaining walls around the perimeter of the basement. A reinforced suspended concrete slab will then be constructed between the toes of the L shaped retaining wall sections. It is understood that the slab will also be tied to tension piles to restrain the uplift forces.

5.5 Outline geotechnical design parameters

5.5.1 Relevant geotechnical parameters for the London Clay Formation have been derived from laboratory testing, technical standards, industry publications and wider literature. The following table summarises those parameters:

Parameter / Property	Value	Derivation
Characteristic unit weight, γ (kN/m^3)	20	BS8004
Characteristic constant volume angle of shearing resistance, ϕ (°)	22	Correlation with plasticity index
Characteristic undrained shear strength, c_u (kN/m^2)	40 + 10z where z = depth below 1m	In situ and laboratory testing
Undrained modulus, E_u (MN/m^2)	17 + 4.25z where z = depth below 1m	Correlation with c_u ($E_u = 425c_u$)

Table 5-A: Geotechnical parameters – London Clay

5.5.2 Made Ground associated with the general development of the site is anticipated to be encountered at shallow depth and would therefore also be retained by the basement walls. It was predominantly granular but did have some cohesive elements in places. Therefore, the following parameters will be adopted for design of the retaining wall:

Parameter / Property	Value	Derivation
Characteristic unit weight, γ (kN/m^3)	19	BS8004
Characteristic constant volume angle of shearing resistance, ϕ (°)	30	Material description

Table 5-B: Geotechnical parameters – Made Ground

5.6 Outline temporary and permanent works proposals

5.6.1 The L shaped retaining walls will be founded on London Clay. Ultimate limit state analyses (bearing capacity) have been undertaken in accordance with BS EN 1997-1 (Eurocode 7) to derive the following ULS values:

- Combination 1 – 370 kN/m^2
- Combination 2 – 270 kN/m^2

5.6.2 Excavation of the basement will cause an unloading of stress on the soil and consequently heave is likely to occur towards the centre of the basement and diminish towards the perimeter walls. Ignoring boundary effects and therefore adopting a worst case scenario it is estimated that total heave will be less than 25mm, which comprises immediate heave of circa 5-10mm and long-term heave of 15-20mm. Accordingly, we anticipate the structural design of the slab will account for this heave.

5.7 Ground movement and damage impact assessment

5.7.1 A ground movement analysis has been undertaken as part of a separate Basement Impact Assessment (BIA) and reference should be made to that document for further information (reference STU5616-R02).

5.7.2 Ground movement analyses have been undertaken with the aid of computer software package XDisp Version 20.1 developed by OASYS. The building damage is then assessed within the software against the damage criteria presented by Burland.

5.7.3 Settlement beneath the nearby properties (No. 1 and 34 Kingstown Street) has been assessed directly within PDisp. These calculated displacements have then been imported into XDisp and combined with the estimated ground movements due to underpin construction to determine a worst-case assessment. The results of the assessment are presented in Figure 5-A.

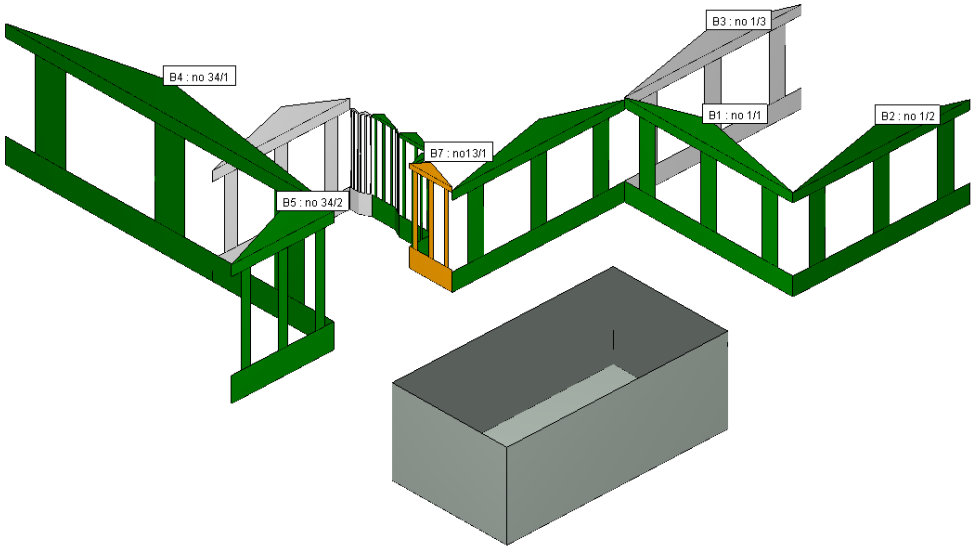


Figure 5-A: Extract from XDisp modelling Burland Categories shown.

5.7.4 The analysis indicates that the damage will generally be limited to Burland Category 0. However, there is one panel shown to be at Category 3, which indicates unacceptable levels of damage. The panel shown to be at risk is part of the site and therefore any minor damage incurred can be remediated during construction of the overall scheme. Consequently, it is catastrophic collapse that must be avoided.

5.7.5 The categorisation is not considered to be an accurate representation. The software assumes that each panel acts independently as stand-alone panels. The buildings comprise a series of interlocking panels that will offer some restraint to this rotational movement towards the excavation. The underpin excavations will be not more than 1m in length with the next bay not being excavated until the adjacent pin has gained full strength. Furthermore, the proposed basement will be propped during excavation which will limit inward yield and therefore reduce movement beneath the masonry panels. Given these factors it is considered that the Damage Category can be limited to Category 1. Nevertheless, the neighbouring properties will be monitored with appropriate trigger levels and control measures agreed prior to commencement of works.

5.8 Tension Piles

5.8.1 It is understood that tension piles may be considered subject to calculated uplift forces on the basement. A preliminary analysis of tensile pile capacity has been undertaken to assist the foundation designer if required, who will retain overall design responsibility. The assessment has been undertaken in accordance with BS EN1997-1:2004 + A1:2013 and BS 8004:2015. It is recommended that the design and installation of the piles are determined by a specialist piling contractor who has experience in pile installation in these or similar ground conditions.

5.8.2 It is assumed that the piles, if needed, will be installed using replacement piling techniques; i.e. CFA or bored piles. The assessment assumes no resistance to uplift in the 5m below the basement, due to potential heave.

5.8.3 The calculations have been undertaken with the aid of PILE, a specialist geotechnical software programme developed by OASYS. The analyses have been undertaken without explicit verification of serviceability limit state. Accordingly, set R4 partial factors have been adopted for Combination 2. A model factor of 1.4 has been adopted in the analyses.

5.8.4 It is assumed that the clay is consistent from 10m to 30m (borehole only extends to 10m at present). This would need to be validated by drilling a deeper borehole. Shaft resistance within the London Clay has been derived using a total stress approach, adopting an adhesion factor, α, of 0.5. Due to softening and polishing effects during installation, the unit shaft resistance within the London Clay has been capped at 110kN/m^2.

5.8.5 The variation of single pile tensile resistance in relation to pile toe level is presented below for three different pile diameters. It should be noted that the resistance of a single pile is reduced in the vicinity of other piles. Accordingly, detailed design of the piled foundation arrangement should take into account spacing between piles and pile group effects.

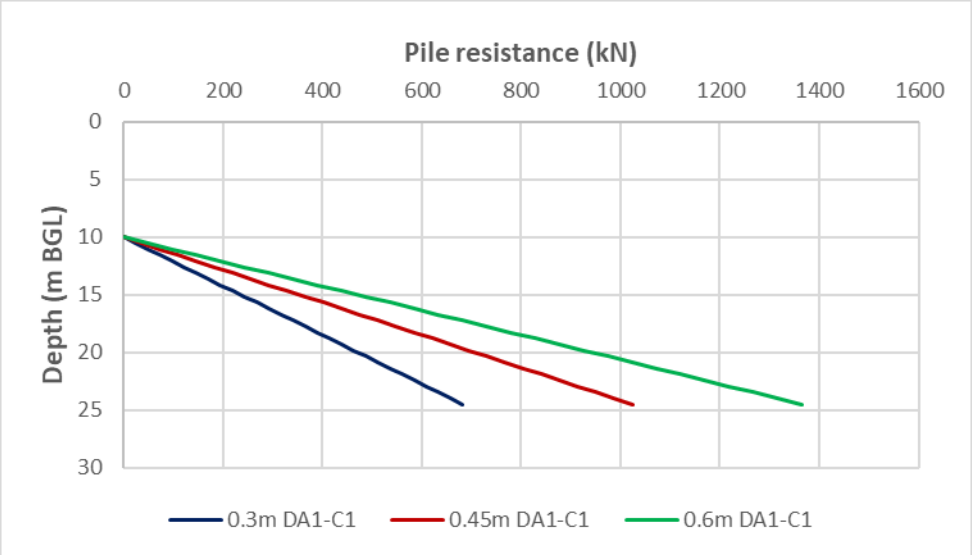


Figure 5-B: Variation of pile tensile resistance against depth – Combination 1

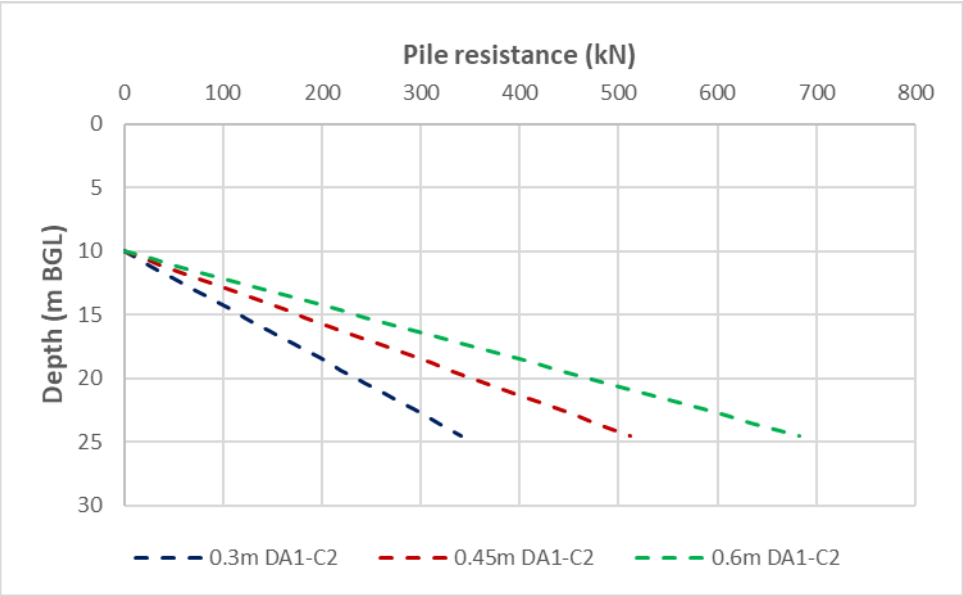


Figure 5-C: Variation of pile tensile resistance against depth – Combination 2

5.9 Ground Floor Construction

5.9.1 A suspended floor is proposed, bearing onto the L shaped underpins. The excavation of the basement will result in some heave of the underlying soils, estimated to be in the order of 25mm. A suitable void or heave protection material should be adopted.

5.10 Aggressiveness of the ground to buried concrete

5.10.1 The aggressiveness of the ground with respect to buried concrete has been assessed in accordance with Building Research Establishment Special Digest 1: Concrete in Aggressive Ground Third Edition (2005).

5.10.2 The site is interpreted to be a greenfield site where pyrite may be present.

5.10.3 Laboratory testing has been undertaken on soil samples obtained from the investigation works.

5.10.4 Forming foundations by, for instance, cutting a trench through naturally deposited soils or driving pre-cast concrete piles through naturally deposited soils does not, generally, create disturbed ground as defined in BRE SD 1:2005. However, any arisings resulting from replacement piling or spread footing excavations used for bulk filling on site would be classified as disturbed ground

5.10.5 The classification of the strata is tabulated below:

Stratum	Disturbed / Undisturbed	Design sulphate class	Aggressive chemical environment for concrete class
Made Ground	Disturbed	DS-1	AC-1
London Clay Formation	Disturbed	DS-3	AC-2s
	Undisturbed		

Table 5-C: Summary of the aggressiveness of the ground to buried concrete

5.10.6 It should be noted that where concrete is in contact with more than one soil type then the most onerous DS and ACEC classification should be adopted.

6 Chemical contamination

6.1 General

6.1.1 Part 11A of the Environment Protection Act 1990 became statute in April 2000. The principal feature of this legislation is that the hazards associated with contaminated land should be evaluated in the context of a site-specific risk-based framework.

6.1.2 Contaminated land is defined as:

> *"any land which appears to the local authority in whose area it is situated to be in such a condition, by reasons of substances in, on or under the land, that:*
>
> *a) Significant harm is being caused or there is a significant possibility of such harm being caused; or*
>
> *b) Pollution of controlled waters is being or is likely to be caused".*

6.1.3 Further information can be obtained from the Department for the Environment, Food and Rural Affairs (DEFRA) and their web site www.defra.gov.uk.

6.2 Objectives

6.2.1 This report section discusses investigations carried out with respect to chemical contamination issues relating to the site. The investigations were carried out to determine if there are any liabilities with respect to Part IIA of the Environment Protection Act. As stated in Section 2.4.2, the investigation process followed the principles of BS 10175:2011+A2:2017 'Investigation of potentially contaminated sites – Code of Practice', with the investigation combining a desk study (preliminary investigation) together with the exploratory and main investigations (refer BS 10175 for an explanation).

6.3 Procedure to assess risks of chemical contamination

6.3.1 For the purposes of presenting this section of this report, we have adopted the following sequence in assessing risks associated with chemical contamination.

Table outlining the sequence to assess risk associated with chemical contamination

Conceptual model element	Contributory information	Outcome
Receptor	Development categorisation	Identification of receptors at risk of being harmed Criteria for risk assessment modelling
Pathways	Geology and ground conditions Development proposals	Identification of critical pathways from sources to receptors
Source	Previous site history Desk study information Site investigation and sampling	Identification of a chemical source

Table 6-A: Table outlining the sequence to assess risk associated with chemical contamination

6.4 Site characterisation

6.4.1.1 The nature of the site has a significant influence on the likely exposure pathways between potentially contaminated soils and potential receptors. The following table summarises elements which characterise the site based on desk study information:

Element	Source/criteria	Characteristic
Current land use	Observations	Two residential structures with a hardstanding courtyard. Two small garages have been part demolished with only the façade remaining.
Future land use	Advice	Single residential dwelling with basement structure.
Site history	Desk study	Assumed residential since late 1800's. Some changes to the front courtyard with the garages being a later addition. Record of former basement to no' 12.
Geology	Ground investigation	Made Ground over London Clay Formation to an estimated 20-30m.
Groundwater	Aquifer potential	London Clay Formation – Unproductive Strata
	Abstractions	None within 250m.
	Source protection zone	No.
Surface waters	Location	Regents Canal ~200m east.
	Abstractions	None within 250m.

Table 6-B: Summary of site characteristics

6.5 Identified receptors

6.5.1 The principal receptors subject to harm caused by any contamination of a site are as follows.

Principle Receptor	Detail
Humans	Residents of the current and proposed site
	Construction operatives and other site investigators
Vegetation	Plants, trees, both before and after development
Controlled waters	Surface water
	Ground water
Building materials	Materials in contact with the ground

Table 6-C: Table showing principal receptors that could be subject to harm as a result of contamination

6.5.2 The following sections consider these receptor groups in the context of the proposed development.

6.6 Human receptors

6.6.1 The Contaminated Land Exposure Assessment (CLEA) model can be used to derive guideline values, against which land quality data can be compared to allow an assessment of the likely impacts of soil contamination on humans. The parameters used within the model can be chosen to allow guideline values to be derived for a variety of land uses and exposure pathways. For example, a construction worker is likely to be exposed in different ways and for different durations than an adult in a residential setting.

6.6.2 As the current and proposed site use is residential, the critical site user (receptor) is considered to be a child under the age of 6 years.

6.6.3 Our assessment considers construction operatives as adult receptors.

6.7 Vegetation receptors

There is no significant vegetation in the current or proposed site layout, thereforevegetation will not be considered further.

6.8 Water receptors

6.8.1 The underlying soils are considered 'Unproductive Strata' without groundwater.

6.8.2 Groundwater observations from the ground investigation are set out in section 4.4 above. While groundwater is considered in respect of the design considerations, it is assumed this is negligible seepages in Made Ground during rainfall events with groundwater being largely confined above the London Clay Formation.

6.8.3 Regents Canal is some 200m away with significant built environment and positive drainage between, herefore, controlled waters are not considered to be at risk from any potential contamination at the site and will not be considered further.

6.9 Summary of identified receptors

6.9.1 Based on the above assessments, the following table summarises identified and critical receptors.

Principle Receptor	Detail	Viability	Justification	Critical receptor
Humans	Users of the current site	Yes	Residential	Child
	End user of the developed site	Yes	Residential	Child
	Construction operatives and other site investigators	Yes	Development proposed	Adult
Vegetation	Current and proposed site	No	No soft landscaping onsite	-
Controlled waters	Surface waters (Rivers, streams, ponds and above ground reservoirs)	No	No viable receptors	-
	Ground waters (used for abstraction or feeding rivers / streams etc)	No	Site over unproductive strata	-

Table 6-D: Table summarising identified receptors

6.10 Pathways to human receptors

6.10.1.1 The following table summarises potential pathways of chemical contaminants (if present) to human receptors.

Receptor group	Pathway
Current and proposed site users	Ingestion of air-borne dusts
	Ingestion of soil
	Ingestion of soil attached to vegetables
	Ingestion of home grown vegetables
	Inhalation of air-borne dusts
	Inhalation of vapours
	Dermal contact with dust
	Dermal contact with soil
Construction operatives	Ingestion of air-borne dusts
	Ingestion of soil
	Inhalation of air-borne dusts
	Inhalation of vapours
	Dermal contact with dust
	Dermal contact with soil

Table 6-E: Table of likely pathways

6.10.2 There is no soft landscaping onsite, nor any proposed.

6.10.3 The hardstanding across the site **severely** restricts pathways to current and proposed users with only inhalation of vapours potentially viable.

6.10.4 All pathways, except those associated with vegetable consumption, are considered present for construction operatives.

6.11 Assessment of sources of chemical contamination

6.11.1 Potential sources of contamination have been assessed using the following elements of the investigation process.

- History of the site
- Desk study information
- Site reconnaissance/fieldwork

6.11.2 The history of the site and its immediate surroundings based on published Ordnance Survey maps is described in Section 2. Based on published historical maps, there is no evidence to indicate the site or its immediate surroundings have been subject to specific activities likely to result in a source of chemical contamination.

6.11.3 Based on the Envirocheck data (refer Appendix H) the site has no recorded history of any pollution events or trading activities likely to result in a source of contamination, nor is it located in close proximity to a landfill site.

6.11.4 No specific sources of contamination were observed during site investigations. Made Ground was observed in all locations. No visual of olfactory evidence of gross contamination was noted within Made Ground, and no odours or staining associated with volatile/organic contaminants. That being said, wherever there has been human activity/occupation there is a possibility that contamination may be present.In urban environments, artificially elevated concentrations of lead PAH, and asbestos are common.

6.11.5 Accordingly, the only potential source of contamination identified on site is general Made Ground.

6.12 Initial Conceptual Model

6.12.1 Based on our assessment of potential contaminative sources, identified receptors and viable pathways to receptors described in preceding paragraphs, we have produced an initial conceptual model in the form of a table which is presented in Appendix E.

6.12.2 Based on the conceptual model, the initial assessment of risk of chemical contamination causing harm to identified receptors does not exceed the low category.

6.13 Risk assessment discussion – Current site users

6.13.1 The potential pollutant linkage was limited to a pathway of vapour ingress.

6.13.2 No odours or staining of Made Ground soils was observed during site investigation and Made Ground is not considered to be likely to generate significant vapour phase contamination.

6.13.3 Therefore, the current site is considered to be suitable for its current use without remediation.

6.14 Risk assessment discussion – Proposed site users

6.14.1 The nature of the site, and potential pollutant linkages remain unchanged in the proposed case.

6.14.2 Further, the proposed basement will result in Made Ground being removed from site, and will be suitably waterproofed.

6.14.3 On this basis, the site is considered to be suitable for its proposed use without further investigation or remediation.

6.15 Risk assessment discussion – Construction operatives

6.15.1 The risk of damage to health of construction operatives and other site investigators is, in our opinion, low. No significant sources have been identified and the potential exposure to soils is limited to the excavation phase. As a precautionary approach, however, we recommend adequate hygiene precautions are adopted on site, as is good practice for any redevelopment site. Such precautions include:-

- Wearing protective clothing particularly gloves to minimise ingestion from soil contaminated hands.

- Avoiding dust by dampening the soils during the works.
- Wearing masks if processing produce dust.

6.16 Risk assessment discussion – Vegetation

6.16.1 No viable receptor has been identified.

6.17 Risk assessment discussion – Controlled waters

6.17.1 No viable receptor has been identified.

6.18 Unexpected and Previously Unencountered Contamination

6.18.1 With the development of any brownfield site, a residual risk of contamination being found that is unexpected or has not been encountered during investigation or other siteworks. Should any previously unencountered and unexpected contamination be encountered, works should be temporarily halted and a Geo-environmental Consultant informed. The Consultant should then assess the situation to determine what remedial action is required and inform the Local Authority at the earliest opportunity.

6.19 Water supply pipes

6.19.1 The site is in an urban setting and it is likely that any new underground water supply pipes will need to be barriered.

6.19.2 Thames Water should be contacted to confirm their requirements.

6.20 Statement with respect to National Planning Policy Framework

6.20.1 Based on investigations completed to date with respect to chemical contamination, we are of the opinion the proposed development (including full size basement and resulting removal of Made Ground from site) will be safe and suitable for use for the purpose for which it is intended (without the need for any additional remedial action) thus meeting the requirements of the National Planning Policy Framework section 178, and compliant with the Building Regulations Part C, 'Site preparation and resistance to contaminants and moisture'

7 Gaseous contamination

7.1 General

7.1.1 The following assessment relates to the potential for, and the effects of, gases generated by biodegradable matter. A separate, but related class of problem involves migration of vapour phase of hydrocarbons resulting from spillages of petroleum and solvents, but this is addressed under organic contamination in Section 8.

7.1.2 This section also includes a risk assessment in relation to radon gas.

7.2 Ground Gas

7.2.1 The principal ground gases considered in this section are carbon dioxide (CO_2) and methane (CH_4). (Radon is discussed in 7.6 below).

7.2.2 Following the current Building Regulations Approved Document C1, Section 2 'Resistance to Contaminants' (2004 incorporating 2010 and 2013 amendments) a risk assessment approach is required in relation to gaseous contamination based on the source-pathway-receptor conceptual model procedure. We have adopted procedures described in the following reference documents for investigation and assessments of risk of the development being affected by landfill type gases (permanent gases) and if appropriate the identification of mitigation measures.

- BS 10175:2011+A2:2017 'Investigation of potentially contaminated sites- Code of Practice'
- BS 8576:2013 'Guidance on investigations for ground gas – Permanent gases and Volatile Organic Compounds (VOCs)'
- BS 8485:2015+A1:2019 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'
- CIRIA Report C665 'Assessing risks posed by hazardous ground gases to buildings' (2007)
- NHBC report No 10627-R01(04) 'Guidance on development proposals on sites where methane and carbon dioxide are present' (January 2007)
- CL:AIRE Research Bulletin RB17 'A pragmatic approach to ground gas risk assessment' (November 2012)

7.2.3 An assessment of the risk of the site being affected by ground gases is based on the following aspects:

a) Source of the gas
b) Investigation information
c) Migration feasibility
d) Sensitivity of the development and its location relative to the source

7.3 Assessment of source of gases

7.3.1 The following table summarises the common sources of ground gases and parameters affecting the generation of ground gases.

Type	Parameters affecting the rate of gassing
Landfills	Portion of biodegradable material, rate reduces with time
Mineworkings	Flooding reduces rate of gassing
Dock silt	Portion of organic matter
Carbonate deposits	Ground / rainwater (acidic) reacts with some carbonates to produce carbon dioxide
Made Ground	Thickness of Made Ground and proportion of degradable organic matter
Naturally deposited soils/rocks	Portion of organic matter

Table 7-A: Sources of ground gas

7.3.2 As the site is not within a dockland environment or an area affected by mineworkings, and near surface soils do not exhibit high carbonate content, then potential gas sources are limited to landfills and/or soils with a high proportion of organic matter.

7.3.3 Envirocheck reports there are no recorded landfill sites or artificial deposits within 250m of the site.

7.3.4 None of the soils observed in exploratory excavations, in our opinion, exhibit significant concentrations of organic matter which are likely to produce elevated quantities of carbon dioxide and / or methane gas. No obvious evidence of soils with a high proportion of degradable material were recorded onsite and Made Ground was <1.0m where penetrated.

7.4 Source assessment summary

7.4.1 The following table summarises the possibility of a source of landfill type gases.

Potential source origin	Viability of source	Evidence
Landfills	Unlikely	Desk study information
Mineworkings	Unlikely	Desk Study information
Dock silt	Unlikely	Site remote from dockland environment
Carbonate deposits	Unlikely	Recorded and observed soil conditions do not indicate high concentrations of carbonates
Made Ground	Unlikely	Made Ground <3m thickness with no obviously degradable inclusions.
Naturally deposited soils/rocks	Unlikely	Soils exposed in exploratory excavations do not exhibit high concentrations of organic matter

Table 7-B: Ground Gas Source Assessment Summary

7.5 Landfill Gas Conclusion

7.5.1 Based on the above there is no evidence to demonstrate that there is a potential source rendering the site at a significant risk of being affected by ground gases (carbon dioxide / methane) sufficient to cause significant harm to human end users of the site, construction operatives or indeed buildings. On this basis, it is not considered necessary to consider possible pathways for migration of ground gases, and indeed implementation of further investigations to measure concentrations of ground gases. Again on the basis of evidence provided above, mitigation measures against ingress of ground gases into the proposed development are not considered necessary, with the exception of the recommendations of the following paragraph.

7.5.2 It should be noted that there is a potential migration pathway from potential remote sources (outside the scope of our investigations) via subsurface sewers or other below ground conduits which may allow gases to be transported towards the site from on/off site sources. In order to minimise risks of such migration pathways accessing buildings, we recommend all service entries are adequately sealed/trapped against the potential of gas entry.

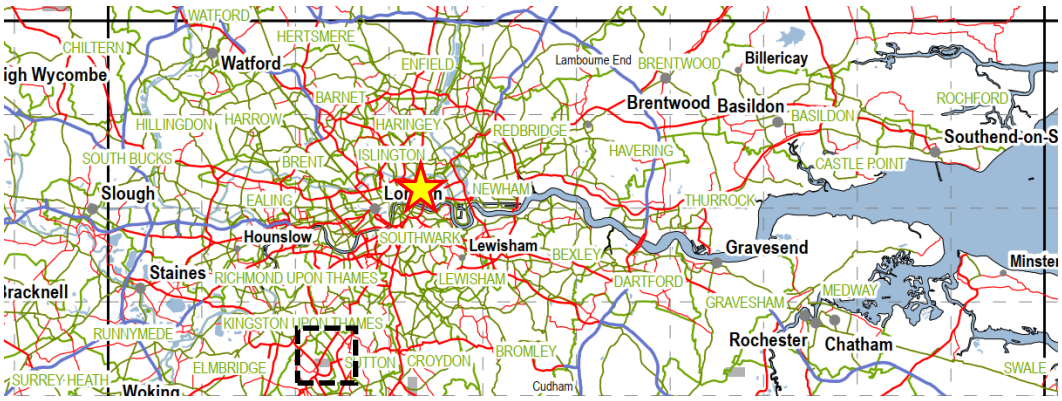
7.6 Radon

7.6.1 Radon is a gas which is derived from the natural breakdown of uranium in soil/rocks. Consequently, the underlying ground conditions are the primary factor in radon generation.

7.6.2 The BRE and BGS / HPA information used to inform our risk assessment are based on statistical analysis of measurements made in dwellings in combination with geological units, which are known to emit radon. The radon maps presented within BRE 211 (2015) show the site to be in an area where no protection is required, with no areas of recommended protection in the near vicinity.

7.6.3 The site is underlain by the London Clay Formation which is understood to have a low potential for producing radon gas.

7.6.4 An extract of the map is shown below with the site marked with a star. Shaded squares show where protection is recommended. The closest of these is also marked in a black hatched square.



7.6.5 While it is acknowledged that the actual levels of radon in a building can vary, the risk level both onsite and consistently in the wider area is recorded as 'no protection necessary'.

7.6.6 It is further acknowledged that research has shown that basements in 'non-affected' areas are at an increased risk from elevated levels of radon. That being said, the research does not appear to differentiate based on geological conditions, age of basements and construction methods. While there may be a more credible pathway into basement structures, the generation potential of the area around the site is considered to be negligible and is not contingent on the building type.

7.7 Building construction

7.7.1 Where the building type is of relevance, is the potential pathway for radon ingress into the structure, whereby basements have a greater soil/structure contact. That said, construction methods also impact the potential for radon ingress/accumulation in buildings. While the existing and proposed basements will have a greater soil/structure contact, basements will typically be constructed to prevent water ingress either through mass concrete, waterproof membranes or a combination.

7.7.2 It is further assumed that a new heating/ventilation system will be installed as part of the refurbishment/development, helping to disperse any accumulations of radon.

7.8 Risk Assessment (Radon)

7.8.1 Given the sites categorisation, the underlying geology and the nature of proposed development, it is our opinion that the risk of radon accumulation is low.

7.9 Statement with respect to National Planning Policy Framework

7.9.1 Based on investigations completed to date with respect to gaseous contamination, we are of the opinion the proposed development will be safe and suitable for use for the purpose for which it is intended (without the need for any remedial action) thus meeting the requirements of the National Planning Policy Framework section 121, and compliant with the Building Regulations Part C, 'Site preparation and resistance to contaminants and moisture'.

8 Soil and Waste Management

8.1 Waste Hierarchy

8.1.1 Under the Waste Regulations, there is a requirement to apply (where reasonable) the waste management hierarchy. Within the hierarchy, landfilling is the least preferable option and soil disposal should be limited to the necessary minimum. Examples of how the waste hierarchy can be achieved is shown below.

Stage (in order of preference)	Example application
Prevention / Reduce	Design, planning, Site Waste Management Plans (SWMP).
Reuse	Reuse of soils under exemption, permit or Materials Management Plan (MMP), sorting at the point of excavation, screening of excavated material.
Recycling	Recycling aggregate, waste segregation, screening and sorting.
Recovery	Remediation works, transfer to a Soil Treatment Facility
Pre-treatment	Non-inert materials require treatment prior to disposal. Non-hazardous or hazardous waste do not need to be treated, where such treatment would not reduce its quantity.
Disposal	If the waste hierarchy steps outline above are followed, the remaining waste is considered to have been treated and can be disposed of to a landfill without further treatment.

Table 8-: Waste management hierarchy

8.2 Materials Management

8.2.1 In terms of the development, where reasonably practicable, landfill disposal should be minimised through the reuse of site-won materials on site, and surplus suitable soils sent to off-site developments for reuse elsewhere. Early consideration of the site's overall material balance at the design stage is also critical in reducing the need for off-site disposal, limiting costs, and increasing the overall sustainability of the development.

8.2.2 Where Made Ground soils are to be reused at another development site, a Materials Management Plan (MMP) or Waste Exemption is recommended.

8.2.3 The process of an MMP determines where soils are and are not considered to be a waste. By following *'The Definition of Waste: Development Industry Code of Practice'* (DowCoP) published by CL:AIRE (2011), soils that are suitable for reuse, and have a certainty of use, are not considered to be waste and therefore do not fall under waste regulations.

8.2.4 The guidance also presents opportunities to transfer suitable materials between sites, including Soil Treatment Facilities, without the need for Waste Exemptions or Environmental Permits. Thereby increasing sustainability and reducing disposal costs.

8.2.5 Soiltechnics can provide additional support and guidance to assist in overall material management of the site.

8.3 Liability of waste management

8.3.1 Part III of the Finance Act was amended in 2018 to extend the scope of landfill tax to cover any site (not exclusively landfills) operating without an appropriate environmental permit, exemption, or MMP.

8.3.2 These changes have given HMRC the powers to work with the Environment Agency to identify non-compliant sites and pursue and penalise the person(s) illegally disposing of waste, and anyone who knowingly facilitates the disposal.

8.3.3 Sites which operate without the necessary controls in place could be liable for landfill tax at the standard rate. Additional penalties may also apply.

8.4 Waste characterisation governance

8.4.1 The classification of soils for disposal to landfill is undertaken in accordance with WM3 (v1.2GB), and a Waste Acceptance Criteria assessment (WAC) undertaken in accordance with the limits in Annex II of the Landfill Directive (Directive 1999/31/EC).

8.5 Waste populations

8.5.1 For preliminary assessment purposes, the Made Ground materials onsite site have been taken as a single waste population.

8.6 Sampling and testing

8.6.1 Three samples have been scheduled to inform the hazardous waste classification assessment. The maximum recorded concentration of each compound within the identified waste population will be adopted, as outlined in WM3, Approach D.

8.6.2 For the Waste Acceptance Criteria (WAC) assessment, a representative composite sample has been obtained by combining soils from multiple exploratory holes.

8.6.3 The rate of testing has been chosen to provide a **preliminary** waste categorisation only.

8.7 Waste characterisation

8.7.1 Observations from the fieldwork indicate that the underlying natural soils are not impacted by contamination, and therefore are considered suitable for disposal as non-hazardous waste in an inert landfill site without the requirement for further testing.

Waste Population	Hazardous Classification (LoW code)	Landfill Classification	Comments
Made Ground	Non-hazardous (17-05-04)	Non-hazardous landfill	Marginally exceeded inert waste threshold for Fluoride. Further testing may allow disposal as inert waste.
Clean, uncontaminated, natural materials	Non-hazardous (17-05-04)	Inert	Considered non-hazardous and inert without any testing required.

Table 8-A: Waste characterisation summary

8.7.2 All tested samples are classified as Non-Hazardous waste in accordance with WM3, Approach D. Waste classification results are presented in Appendix F.

9 Recommendations for Further Works

9.1.1 Further water monitoring is recommended to refine the design water level unless the current precautionary level can be accommodated by the design. Proposals for further monitoring have been provided under separate cover.

9.1.2 If a piled solution be adopted to resist potential uplift forces then it is recommended that a borehole be drilled to a depth of 5m below the proposed pile toe.