DESK STUDY
GROUND INVESTIGATION &
BASEMENT IMPACT ASSESSMENT
REPORT

FOR

19 FITZROY SQUARE
LONDON
W1T 6EQ

JONAS

Specialists in the investigation & reclamation of brownfield sites

Report Title: **Geotechnical Desk Study, Ground Investigation & Basement Impact Assessment for 19 Fitzroy Square, London, W1T 6EQ.**

Report Status: **Final v1.0**

Job No: **P9318J754**

Date: **21 January 2016**

Quality Control: Previous Release

Version	*Date*	*Issued By*

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EXECUTIVE SUMMARY

RWA London LLP ("The Client") has commissioned Jomas Associates Ltd ('JAL'), to prepare a Basement Impact Assessment at a site referred to as 19 Fitzroy Square, London, W1T 6EQ. It is proposed that the existing building be converted to residential use with an additional level of basement to include a swimming pool:

- To assess whether the ground conditions within the local area likely represent an impediment to the proposed development.

It should be noted that the table below is an executive summary of the findings of this report and is for briefing purposes only. Reference should be made to the main report for detailed information and analysis.

Desk Study	
Site History	The earliest available maps of the area (1873) show the site and surrounding areas already developed with no significant changes to the site shown up to the present day. The surrounding area has not undergone many significant changes from 1873 to the present day with the majority of the buildings unchanged, although some may have changed in use (residential to office and vice versa). The surrounding areas appeared to show bomb damage as a result of WWII, as shown on the 1951 map. These areas were mostly rebuild or redeveloped by 1957. The majority of the land use in the surrounding area appears to have been residential with the exception of an area 100m-250m north of site that has held many industrial businesses including engineering works, X-ray works and woodworks.
Current Site Use	The site is currently configured as an office, however there are currently tenants using the site for residential purposes.
Proposed Site Use	The site is proposed to be converted to residential use including the addition of a basement gymnasium and swimming pool.
Site Setting	Information provided by the British Geological Survey indicates that the site is directly underlain by superficial deposits of the Lynch Hill Gravel. These superficial deposits are underlain by solid deposits of the London Clay Formation. No artificial deposits are reported within the site. Borehole records from approximately 49m south of the site, indicated gravels extending to approximately 2.44mbgl, underlain by clay. The superficial deposits underlying the site are identified as a Secondary A Aquifer with the underlying solid deposits identified as Unproductive. A review of the EnviroInsight Report indicates that there are no source protection zones within 500m of the site. There is one abstraction water reported 322m southwest of the site. There are no detailed river entries or surface water features reported within 250m of the site. There are no Environment Agency Zone 2 or 3 floodplains reported within 250m of the site.
Potential Sources	• Potential for made ground associated with previous development operations – on and off site (S1) • Current and previous industrial use – off site (S2)
Potential Receptors	Construction and maintenance workers, neighbouring and future site users, buried foundations and services, controlled waters (Secondary A Aquifer).

Preliminary Risk Assessment	The risk estimation matrix indicates a **low** risk as defined above. It is understood that the proposed development comprises the conversion of the existing building into residential with the addition of a basement level including a swimming pool. It is recommended that an intrusive investigation is carried out to verify the underlying ground conditions and assist with foundation design and waste disposal options. To facilitate this, samples should be obtained for chemical and geotechnical testing.
Potential Geological Hazards	The Groundsure data identifies a moderate risk of shrink / swelling clay – for full details see Section 3
Ground Investigation	
Environmental Considerations	Following generic risk assessments the majority of results were found to exceed the relevant assessment criteria. One sample identified a lead concentration of 402mg/kg which is greater than the assessment criteria employed. The site proposal indicates that the site will remain covered by a combination of the proposed building footprint and hard surfacing. A new basement is proposed beneath the existing building footprint. The hard cover provides a suitable barrier to cut the pollutant linkage between the lead concentration and site users. It is therefore considered that no remedial action is warranted. The site is underlain by superficial deposits of the Lynch Hill Gravel, identified as a Secondary A aquifer. These are underlain by solid deposits of the London Clay Formation which are identified as being Unproductive. There are no source protection zones within 500m of the site, and no surface water or potable water abstractions within 1km of the site. The nearest groundwater abstraction is reported 322m south west. On the basis of the findings of this investigation, the site is not considered to pose a significant risk to the identified sensitive receptors. Calculating the Gas Screening Value using worst case results indicates Characteristic Situation 1. This would indicate that no special precautions are required. No further remediation works are considered necessary, and the site is considered suitable for the proposed use following the adoption of the measures above. As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended.

Geotechnical Considerations	The results of the ground investigation revealed a ground profile comprising Made Ground overlying very gravelly SAND then brown becoming grey silty sandy Clay. Based upon the information obtained to date it is considered that conventional foundations may be suitable for the proposed development. Based on SPT N values of 13 at 3.0m bgl and 17 at 4.0m bgl it is considered that an allowable bearing capacity of 150kPa at 3.5m bgl is possible. An alternative approach to would be to consider a piled solution. The above comments are indicative only based on limited ground investigation data. Foundations should be designed by a suitably qualified Engineer. Once structural loads have been fully determined a full design check in accordance with BS EN 1997 should be undertaken to confirm suitability of foundation choice. Following excavation of the basement the floor slab will be founded upon London Clay strata. It is possible that a small amount of heave will occur due to the removal of the overlying ground and the slab construction should be design to accommodate this. Excavations will be required at the site for services and construction works. These are anticipated to remain stable for the short term only. It is recommended that the stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported or battered back to a safe angle. The basement excavation will be located beneath an existing structure. The progression of the basement excavation will need to consider the potential impact to existing structures both on and off site and provide adequate and appropriate support. During the investigation groundwater was not observed although the sand within BH1 was reported to be wet. During return monitoring groundwater levels were recorded between 0.98m and 1.45m below ground level. Subject to seasonal variations, any groundwater encountered during site works should be readily dealt with by conventional pumping from a sump. Based on the results of chemical testing, the required concrete class for the site is DS-1 assuming an Aggressive Chemical Environment for Concrete classification of AC-1 (AC-1s within the London Clay) in accordance with the procedures outlined in BRE Special Digest 1.
Basement Impact Assessment	
Impact Assessment	The overall assessment of the site is that the creation of a basement for the existing development will not adversely impact the site or its immediate environs, providing measures are taken to protect surrounding land and properties during construction. The proposed basement excavation will be within 5m of a public pavement. It is also within 5m of neighbouring properties. Unavoidable lateral ground movements associated with the basement excavations must be controlled during temporary and permanent works so as not to impact adversely on the stability of the surrounding ground and any associated services. From the studies that have been undertaken so far it is concluded that the construction of the building will not present a problem for ground water. It is concluded that this site can be successfully developed without causing any problems to the subterranean drainage.

1 INTRODUCTION

1.1 Terms of Reference

1.1.1 RWA London LLP ("The Client") has commissioned Jomas Associates Ltd ('JAL'), to prepare a Basement Impact Assessment at a site referred to as 19 Fitzroy Square, London, W1T 6EQ. It is proposed that the existing building will be converted to residential use with an additional level of basement to include a swimming pool.

1.1.2 Jomas' work has been undertaken in accordance with email proposal dated 15 December 2015.

1.2 Objectives

1.2.1 The objectives of JAL's investigation were as follows:

- To present a description of the present site status, based upon the published geology, hydrogeology and hydrology of the site and surrounding area;
- To review readily available historical information (i.e., Ordnance Survey maps and database search information) for the site and surrounding areas;
- To conduct an intrusive investigation, to assess ground conditions and obtain geotechnical parameters to inform preliminary foundation design;
- To assess the potential impacts that the proposal may have on ground stability, the hydrogeology and hydrology on the site and its environs.

1.3 Scope of Works

1.3.1 The following tasks were undertaken to achieve the objectives listed above:

- A walkover survey of the site;
- A desk study, which included the review of a database search report (GeoInsight Report, attached in Appendix 2) and historical Ordnance Survey maps (attached in Appendix 3);
- An intrusive investigation to assess the underlying ground conditions;
- A basement impact assessment;
- The compilation of this report, which collects and discusses the above data, and presents an assessment of the site conditions, conclusions and recommendations.

1.4 Limitations

1.4.1 Jomas Associates Ltd ('JAL') has prepared this report for the sole use of RWA London LLP in accordance with the generally accepted consulting practices and for the intended purposes as stated in the agreement under which this work was completed. This report may not be relied upon by any other party without the explicit written agreement of JAL. No other third party warranty, expressed or implied, is made as to the professional advice included in this report. This report must be used in its entirety.

1.4.2 The records search was limited to information available from public sources; this information is changing continually and frequently incomplete. Unless JAL has actual knowledge to the contrary, information obtained from public sources or provided to JAL by site personnel and other information sources, have been assumed to be correct. JAL does not assume any liability for the misinterpretation of information or for items not visible, accessible or present on the subject property at the time of this study.

1.4.3 Whilst every effort has been made to ensure the accuracy of the data supplied, and any analysis derived from it, there may be conditions at the site that have not been disclosed by the investigation, and could not therefore be taken into account. As with any site, there may be differences in soil conditions between exploratory hole positions. Furthermore, it should be noted that groundwater conditions may vary due to seasonal and other effects and may at times be significantly different from those measured by the investigation. No liability can be accepted for any such variations in these conditions.

2 SITE SETTING & HISTORICAL INFORMATION

2.1 Site Information

2.1.1 The site location plan is appended to this report as Figure 1.

Table 2.1: Site Information

Name of Site	-
Address of Site	19 Fitzroy Square, London, W1T 6EQ.
Approx. National Grid Ref.	529074, 182121
Site Area (Approx)	0.02 hectares
Site Ownership	Unknown
Site Occupation	A commercial offices building currently being occupied for residential purposes.
Local Authority	London Borough of Camden
Proposed Site Use	Residential with basement (including swimming pool)

2.2 Walkover Survey

2.2.1 The site was visited on 3rd December 2015 along with representatives from other companies involved in the project.

Table 2.2: Site Description

Area	Item	Details
On-site:	**Current Uses:**	The site is currently occupied by a building that was converted from residential to office use. Although the building is still arranged internally for use as offices, it is currently occupied as a residential building.
	Evidence of historic uses:	The building had previously been in use as offices as indicated by the internal layout.
	Surfaces:	The majority of the site is covered by the building footprint. There is a small area of outside space around the front and side of the building which is mostly covered with concrete and paving. It is noted that the building is listed and the outside paving is included in the listing.
	Vegetation:	There are no significant areas of vegetation. There is a small planted area to the side of the paving between the slabs and the building wall. There are small plants for aesthetic purposes.
	Topography/Slope Stability:	There is no significant slope to the site. The lower ground floor and paved area is approximately 3.15m below the level of the surrounding land.

Area	Item	Details
	Drainage:	Drain covers were observed around the outside areas of site.
	Services:	The site appears to be connected to normal statutory services.
	Controlled waters:	No controlled waters were noted on site.
	Tanks:	No tanks were observed on site.
Neighbouring land:	**North:**	Residential.
	East:	Residential.
	South:	Residential/park area.
	West:	Residential/commercial offices.

2.2.2 Photos taken during the site walkover are provided in Appendix 1.

2.3 Historical Mapping Information

2.3.1 The historical development of the site and its surrounding areas was evaluated following the review of a number of Ordnance Survey historic maps, procured from GroundSure, and provided in Appendix 3 of this report.

2.3.2 A summary produced from the review of the historical map is given in Table 2.3 below. Distances are taken from the site boundary.

Table 2.3: Historical Development

Dates and Scale of Map	Relevant Historical Information	
	On Site	**Off Site**
1873 – 1:10,560/1:1,056	The site is already developed with a building that appears to resemble one currently on site.	The surrounding area is already entirely developed with a large number of properties. Fitzroy Square is shown and resembles its current appearance. Regent's Park is shown approximately 500m to the north-west. A school is shown approximately 100m to the SW of site. Euston Station, St. Pancras Station and King's Cross Station are shown to the NE. British Museum is shown to the SE.
1894/5 – 1:10,560	No significant changes.	No significant changes. Two hospitals are labelled approximately 200m to the NW and one hospital is shown 250m to the south.
1896 – 1:1,056/1:2,500	No significant changes.	No significant changes.

Dates and Scale of Map	Relevant Historical Information	
	On Site	Off Site
1916 – 1:2,500	No significant changes.	Some of the buildings to the north and north east show expansion and/or redevelopment. A building approximately 175m to the north east is identified as a Public Baths.
1920 – 1:10,560	No significant changes.	Some minor reconfiguration of surrounding buildings has occurred.
1938 – 1:10,560	No significant changes.	Approximately 400m to the NW a building has been demolished. Some buildings also demolished approximately 750m to the NE. A building has been redeveloped approximately 300m to the east of site.
1951 – 1:10,560	No significant changes.	A number of buildings in the surrounding areas are shown with vacant areas, possibly indicating bomb damage. The nearest being approximately 100m-200m in all directions.
1952 – 1:2,500	No significant changes.	An empty site just over 100m to the SE is labelled as “Ruins”. Opposite the ruins is a large area of what appears to be empty land; possibly cleared as a result of bomb damage. Public baths are now shown as a car park. Empty areas of land are also shown just over 100m to the west of site; also possibly cleared due to bomb damage. Area of empty space adjacent to sites labelled “Ruins” also shown 150m-250m to the SW of site. Buildings to the north of site (100m-250m) labelled as commercial including “**Engineering Works**”, “**X-Ray Apparatus Factory**” “**Woodworks**” and “**Optical Instrument Works**”. “**Printing Works**” shown approximately 200m to the east of site.
1957 – 1:10,560	No significant changes	The areas showing as vacant on the previous large scale maps have potentially been redeveloped.
1962 – 1:1,250	Site appears the same but is now labelled as “Fitzroy House (Nursing Home)” and appears to comprise of number 16 to 19 Fitzroy Square.	Areas of ruins 100m to the east have been partially redeveloped with a building named “Adam House” and “YMCA Indian Students’ Union and Hostel”.

Dates and Scale of Map	Relevant Historical Information	
	On Site	Off Site
1964/69 1:1,250/1:10,560	Site is no longer labelled but appears the same.	Industrial buildings to the north of site have been redeveloped with entirely new buildings. Labelled buildings include "**Euston Centre**" "**Stanhope Institute**" and "**Electricity Board Depot**" Area to the SE previously cleared by bomb damage and partially rebuilt has now been entirely redeveloped. A telephone exchange and radio tower is shown just under 250m south of site.
1968/70 1:2:500	No significant changes.	Area of industrial buildings to the north of site shows some newly constructed buildings (unlabelled but appear commercial/industrial). Approximately 200m to the SE some buildings have been removed.
1982 – 1:1,250	No significant changes.	New buildings have been built in the previously cleared area approximately 200m to the SE of site. Just over 100m to the east of site a row of houses have been removed and the area is shown as undeveloped.
1985/90 1:1,250	No significant changes.	"**St. Luke's Hospital**" is shown approximately 50m east of site. New properties have been constructed at the previously cleared row of houses.
1991/93 1:1,250	No significant changes.	An area of properties approximately 200m east of site has had buildings demolished and some reconfigured.
1994 – 1:10,000	No significant changes.	Some minor building alterations. Some new industrial buildings built to the north of site. British Library Shown to the NE, adjacent to St. Pancras Station.
2002 – 1:10,000	No significant changes.	No significant changes.
2010 – 1:10,000	No significant changes.	No significant changes.
2014 – 1:10,000	No significant changes.	Some reconfiguration of surrounding buildings. Industrial area to the north shows the demolition of buildings and construction of new buildings. A hospital 250m south of site appears to have been demolished. King's Cross Station has been extended.

2.4 Previous Site Investigations

2.4.1 No previous site investigation reports were provided at the time of writing.

2.5 Proposed Development

2.5.1 The proposed development for this site is to retain the existing building and convert it to residential use along with the addition of a basement level to include a swimming pool/gymnasium area.

3 ENVIRONMENTAL SETTING

3.1.1 The following section summarises the principal geological resources of the site and its surroundings. The data discussed herein is generally based on the information given within the Groundsure Report (in Appendix 2).

3.2 Solid and Drift Geology

3.2.1 Information provided by the British Geological Survey indicates that the site is directly underlain by superficial sand and gravel deposits of the Lynch Hill Gravel Member, underlain by clay, silt and sand of the London Clay Formation.

3.2.2 Artificial deposits are not reported within the site.

3.3 British Geological Survey (BGS) Borehole Data

3.3.1 As part of the assessment, publicly available BGS borehole records were obtained and reviewed from the surrounding area. The local records obtained are presented in Appendix 4.

3.3.2 The nearest such record is located approximately 49m south east of the site. The record indicates underlying ground conditions comprising an initial 0.69m thickness of "fill", overlying gravel and sand to a depth of 2.44m. The gravel and sand is reported to be above clay which extends to the base of the borehole at 8.53m.

3.3.3 All depths should be viewed as approximate, due to the age of the borehole and corresponding use of imperial measurements.

3.3.4 Based on the proximity of the BGS registered borehole to the site it is considered that similar conditions are likely to be present beneath the site. Gravel deposits are expected to extend 2-3mbgl over the London Clay Formation.

3.3.5 If the geology on site is consistent with that at the nearby borehole and given the presence of a lower ground floor already on site, it is possible that the building already extends below the gravel and into the clay.

3.4 Hydrogeology & Hydrology

3.4.1 General information about the hydrogeology of the site was obtained from the Environment Agency website.

Groundwater Vulnerability

3.4.2 The EA operates a classification system to categorise the importance of groundwater resources (aquifers) and their sensitivity to contamination. Aquifers were formerly classified as major, minor and non-aquifers, based on the amenity value of the resource. A major aquifer is a significant resource capable of producing large quantities of water suitable for potable supply. Minor aquifers produce water in varying quantities or qualities, and if utilised are of local importance. Non aquifers are low permeability strata, which contain no significant exploitable groundwater and have very limited capacity to transmit contaminants.

3.4.3 Since 1 April 2010, the EA's Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. This comprises;

- **Secondary A** - permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;

- **Secondary B** - predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers.

- **Secondary Undifferentiated** - has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type.

- **Principal Aquifer** – this is a formation with a high primary permeability, supplying large quantities of water for public supply abstraction.

- **Unproductive Strata** - These are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Source Protection Zones (SPZ)

3.4.4 In terms of aquifer protection, the EA generally adopts a three-fold classification of SPZs for public water supply abstraction wells.

- Zone I - or 'Inner Protection Zone' is located immediately adjacent to the groundwater source and is based on a 50-day travel time. It is designed to protect against the effects of human activity and biological/chemical contaminants that may have an immediate effect on the source.
- Zone II - or 'Outer Protection Zone' is defined by a 400-day travel time to the source. The travel time is designed to provide delay and attenuation of slowly degrading pollutants.
- Zone III - or 'Total Catchment' is the total area needed to support removal of water from the borehole, and to support any discharge from the borehole.

Hydrology

3.4.5 The hydrology of the site and the area covers water abstractions, rivers, streams, other water bodies and flooding.

3.4.6 The Environment Agency defines a floodplain as the area that would naturally be affected by flooding if a river rises above its banks, or high tides and stormy seas cause flooding in coastal areas.

3.4.7 There are two different kinds of area shown on the Flood Map for Planning. They can be described as follows:

Areas that could be affected by flooding, either from rivers or the sea, if there were no flood defences. This area could be flooded:

- from the sea by a flood that has a 0.5 per cent (1 in 200) or greater chance of happening each year;

- or from a river by a flood that has a 1 per cent (1 in 100) or greater chance of happening each year.

(For planning and development purposes, this is the same as Flood Zone 3, in England only.)

- The additional extent of an extreme flood from rivers or the sea. These outlying areas are likely to be affected by a major flood, with up to a 0.1 per cent (1 in 1000) chance of occurring each year.

(For planning and development purposes, this is the same as Flood Zone 2, in England only.)

3.4.8 These two areas show the extent of the natural floodplain if there were no flood defences or certain other manmade structures and channel improvements.

3.4.9 Outside of these areas flooding from rivers and the sea is very unlikely. There is less than a 0.1 per cent (1 in 1000) chance of flooding occurring each year. The majority of England and Wales falls within this area. (For planning and development purposes, this is the same as Flood Zone 1, in England only.)

3.4.10 Some areas benefit from flood defences and these are detailed on Environment Agency mapping.

3.4.11 Flood defences do not completely remove the chance of flooding, however, and can be overtopped or fail in extreme weather conditions.

Table 3.1: Summary of Hydrogeological & Hydrology

Feature		On Site	Off Site	Potential Receptor ?
Aquifer	**Superficial:**	Secondary A Aquifer	Secondary A Aquifer	Y
	Solid:	Unproductive	Unproductive	N
Source Protection Zone		None	None	N
Abstractions		None	Nearest groundwater abstraction approx 322m SW	Y
Flood Risk		None	No environment agency flood zones within 250m	-

3.5 Radon

3.5.1 The site is reported not to lie within a Radon affected area, as less than 1% of properties are above the action level.

3.5.2 Consequently, no radon protective measures are necessary in the construction of new dwellings or extensions as described in publication BR211 (BRE, 2007).

3.6 Geological Hazards

3.6.1 The following are brief findings extracted from the GroundSure GeoInsight Report, that relate to factors that may have a potential impact upon the engineering of the proposed development.

Table 3.2: Geological Hazards

Potential Hazard	Site check Hazard Rating	Details	Further Action Required?
Shrink swell	Moderate	Ground conditions predominantly high plasticity. Do not plant or remove trees or shrubs near to buildings without expert advice about their effect and management. For new build, consideration should be given to advice published by the National House Building Council (NHBC) and the Building Research Establishment (BRE). There is a probable increase in construction cost to reduce potential shrink-swell problems. For existing property, there is a probable increase in insurance risk during droughts or where vegetation with high moisture demands is present.	YES
Landslides	Very low	Slope instability problems are unlikely to be present No special actions required to avoid problems due to landslide.	No
Ground dissolution soluble rocks	Negligible	Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks.	No
Compressible deposits	Negligible	No indicators for compressible deposits identified. No special actions required to avoid problems due to compressible deposits. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with compressible deposits.	No
Collapsible Rock	Very Low	Deposits with the potential to collapse when loaded and saturated are unlikely to be present. No special ground investigation required.	No
Running sand	Very Low	Very low potential for running sand problems if water table rises or if sandy strata are exposed to water. No special actions required to avoid problems due to running sand.	No
Coal mining	No	There are no coal mining areas identified within 1000m of the site boundary.	No
Non-coal mining	No	-	No
Brine affected areas	No	-	No

3.6.2 In addition, the GeoInsight report notes the following:

- There are is reported to be a tunnel on site (i.e. beneath) serving the London Underground – Victoria Line, as well as 4No. tunnels within 250m of site all serving the London Underground.

- The site is reported to be within 5km of the High Speed 2 rail project.

4 HYDROLOGY AND FLOOD RISK

4.1 Hydrology and Flood Risk

4.1.1 In accordance with the NPPF and Camden Guidance for Subterranean Development, below is a review of flood risks posed to and from the development and recommendations for appropriate design mitigation where necessary:

Table 4.1: Flood Risks

Flood Sources	Site Status	Comment on flood risk posed to / from the development
Fluvial / Tidal	Site is not within 250m of an Environment Agency Zone 2 or zone 3 floodplain. Risk of flooding from rivers and the sea (RoFRaS) rating very low.	Proposed development is to an existing property No increase in impermeable areas hence no additional SUDS required.
Groundwater	There are reported to be areas susceptible to groundwater flooding within 50m of the site related to superficial deposits flooding.	The proposed development will not increase the potential risk of groundwater flooding. Basement will be fully waterproofed as appropriate to industry standard Low Risk
Artificial Sources	Regent's Park boating lake is located approximately 1km from site. No artificial sources within 250m	Low Risk
Surface Water / Sewer Flooding	The site is not within 250m of any surface water features. Condition, depth and location of surrounding infrastructure uncertain	No increase in impermeable areas – no SUDS required Development will utilise existing connection to sewers, gravity drainage and non-return valves Development unlikely to significantly increase the peak flow/volume of discharge from the site: Low Risk No further drainage assessment required
Climate Change	Included in the flood modelling extents Site not within climate change flood extent area	Development will not significantly increase the peak flow and volume of discharge from the site Low risk posed to and from the development

4.1.2 Based on the available data, the site is in considered to be at low risk from all sources of flooding. The basement can be constructed and operated safely in flood risk terms without increasing flood risk elsewhere and is therefore considered NPPF compliant.

Surface Water Flood Risk

Based on EA mapping, the site and highways surrounding the site are not within an area identified as a high risk for surface water flooding potential; site itself not likely to be inundated.

No increase in impermeable areas

The site is defined by the footprint of the existing building; there is no opportunity to increase impermeable areas and hence no further SUDS are required. The SUDS toolkit does not apply to this site.

4.2 Hydrogeology

4.2.1 The baseline hydrogeology of the site is based on available hydrogeological mapping, including the BGS online mapping, igeology App and London Borough of Camden SFRA.

4.2.2 The available data indicates that the geology of the area is sand and gravel to approximately 2.5m then London Clay. If present groundwater will be within the sand and gravel.

4.2.3 Below the superficial deposits, the site will be underlain by solid deposits of the London Clay formation; this acts as an aquitard up to 150m in thickness to the main London chalk aquifer.

4.2.4 The existing lower ground floor is likely to be founded on the London Clay considering the thickness of the sand and gravel deposits in the nearby borehole. The excavation of the basement is not therefore expected to encounter the main aquifer as it will be within the clay. Any perched groundwater lenses that might be encountered can be dealt with appropriately through industry standard localised de-watering.

4.2.5 The proposed basement does not extend into a sensitive groundwater body; there is unlikely to be a risk posed to or from the development to groundwater based on following industry standard basement construction techniques.

4.2.6 No groundwater flows will be impeded by the basement.

Sequential Test: within FZ1 and no additional dwelling hence pass by default.

Exception Test: FZ1 hence pass by default and low risk posed to and from other sources

4.3 Flood Resilience

4.3.1 In accordance with general basement flood policy and basement design, the proposed development will utilize the flood resilient techniques recommended in the NPPF Technical Guidance where appropriate and also the recommendations that have previously been issued by various councils.

4.3.2 These include:

- Basement to be fully waterproofed (tanked) and waterproofing to be tied in to the ground floor slab as appropriate: to reduce the turnaround time for returning the property to full operation after a flood event.
- Plasterboards will be installed in horizontal sheets rather than conventional vertical installation methods to minimise the amount of plasterboard that could be damaged in a flood event
- Wall sockets will be raised to as high as is feasible and practicable in order to minimise damage if flood waters inundate the property
- Any wood fixings on basement / ground floor will be robust and/or protected by suitable coatings in order to minimise damage during a flood event

- The basement waterproofing where feasible will be extended to an appropriate level above existing ground levels.
- The concrete sub floor as standard will likely be laid to fall to drains or gullies which will remove any build-up of ground water to a sump pump where it will be pumped into the mains sewer. This pump will be fitted with a non-return valve to prevent water backing up into the property should the mains sewer become full
- Insulation to the external walls will be specified as rigid board which has impermeable foil facings that are resistant to the passage of water vapour and double the thermal resistance of the cavity

5 LAND CONTAMINATION ASSESSMENT

5.1 Industrial and Statutory Consents

5.1.1 The Groundsure EnviroInsight Report provides information on various statutory and industrial consents on and in the vicinity of the site. The following section summarises the information collected from the available sources.

Table 5.1: Industrial and Statutory Consents

Type of Consent/Authorisation	On site	Off-site (within 500m of site, unless stated otherwise)	Potential to Impact on Site from a land contamination perspective
Discharge Consents.	None	2No 310m SW of site relating to cooling water.	X
Water Industry Act Referrals	None	None reported within 500m of the site.	X
Red List Discharges	None	None reported within 500m of the site.	X
List 1 and List 2 Dangerous Substances	None	None reported within 500m of the site.	X
Control of Major Accident Hazards (COMAH) and Notification of Installations Handling Hazardous Substances (NIHHS) Sites.	None	None reported within 500m of the site.	X
Planning Hazardous Substance Consents	None	None reported within 500m of the site.	X
Category 3 or 4 Radioactive substances Authorisations	None	32No. relating to hospitals and educational facilities. Nearest reported is 239m SE of site for the disposal of radioactive waste.	X
Pollution Incidents (List 2).	None	2No. nearest 235m west of site. “No impact” reported on land, air and water.	X
Pollution Incidents (List 1)	None	None reported within 500m of the site.	X
Contaminated Land Register Entries and Notices.	None	None reported within 500m of the site.	X
Registered Landfill Sites.	None	None reported within 500m of the site.	X
Waste Treatment and/or Transfer Sites.	None	None reported within 500m of the site.	X
Fuel Station Entries	None	1No. reported as closed, 196m south of site.	✓
Current Industrial Site Data.	None	37No. reported within 250m of site including (but not limited to): published goods, civil engineers, electronic media, electrical and electronic engineers and stone quarrying and preparation.	✓

5.1.2 **Landfill and Made Ground**

5.1.3 According to the Environment Agency there are no landfill sites within 250m of the site.

5.2 Environmental Risk - Legislative Framework

5.2.1 A qualitative risk assessment has been prepared for the site, based on the information collated. This highlights the potential sources, pathways and receptors. Intrusive investigations will be required to confirm the actual site conditions and risks.

5.2.2 Under Part IIA of the Environmental Protection Act 1990, the statutory definition of contaminated land is:

"*land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:*

(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."

5.2.3 The Statutory Guidance provided in the DEFRA Circular 01/2006 lists the following categories of significant harm:

- death, disease, serious injury, genetic mutation, birth defects or the impairment of reproduction functions in human beings;
- irreversible adverse change, or threat to endangered species, affecting an ecosystem in a protected area (i.e. site of special scientific interest);
- death, serious disease or serious physical damage to pets, livestock, game animals or fish;
- a substantial loss in yield or value of crops, timber or produce; and
- structural failure, substantial damage or substantial interference with right of occupation to any building.

5.2.4 Contaminated land will only be identified when a 'pollutant linkage' has been established.

5.2.5 A 'pollutant linkage' is defined in Part IIA as:

"A linkage between a contaminant Source and a Receptor by means of a Pathway".

5.2.6 Therefore, this report presents an assessment of the potential pollutant linkages that may be associated with the site, in order to determine whether additional investigations are required to assess their significance.

5.2.7 In accordance with the National Planning Policy Framework, where development is proposed, the developer is responsible for ensuring that the development is safe and suitable for use for the purpose for which it is intended, or can be made so by remedial action. In particular, the developer should carry out an adequate investigation to inform a risk assessment to determine:

- whether the land in question is already affected by contamination through source – pathway – receptor pollutant linkages and how those linkages are represented in a conceptual model;

- whether the development proposed will create new linkages, e.g. new pathways by which existing contaminants might reach existing or proposed receptors and whether it will introduce new vulnerable receptors; and
- what action is needed to break those linkages and avoid new ones, deal with any unacceptable risks and enable development and future occupancy of the site and neighbouring land.

5.2.8 A potential developer will need to satisfy the Local Authority that unacceptable risk from contamination will be successfully addressed through remediation without undue environmental impact during and following the development.

5.3 Conceptual Site Model

5.3.1 On the basis of the information summarised above, a conceptual site model (CSM) has been developed for the site. The CSM is used to guide the investigation activities at the site and identifies potential contamination sources, receptors (both on and off-site) and exposure pathways that may be present. The identification of such potential "pollutant linkages" is a key aspect of the evaluation of potentially contaminated land.

5.3.2 The site investigation is then undertaken in order to prove or disprove the presence of these potential source-pathway-receptor linkages. Under current legislation an environmental risk is only deemed to exist if there are proven linkages between all three elements (source, pathway and receptor).

5.3.3 This part of the report lists the potential sources, pathways and receptors at the site, and assesses based on current and future land use, whether pollution linkages are possible.

5.3.4 Potential pollutant linkages identified at the site are detailed below:

Table 6.2: Potential Sources, Pathways and Receptors

Source(s)	Pathway(s)	Receptor(s)
• Potential for made ground associated with previous development operations – on and off site (S1) • Current and previous industrial use – off site (S2)	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2) • Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hard standing or via service pipe/corridors and surface water runoff. (P3) • Horizontal and vertical migration of contaminants within groundwater (P4)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5) • Controlled waters – Secondary A aquifer (R6)

5.4 Qualitative Risk Estimation

5.4.1 Based on information previously presented in this report, a qualitative risk estimation was undertaken.

5.4.2 For each potential pollutant linkage identified in the conceptual model, the potential risk can be evaluated, based on the following principle:

Overall contamination risk = Probability of event occurring x Consequence of event occurring

5.4.3 In accordance with CIRIA C552, the consequence of a risk occurring has been classified into the following categories:

- Severe
- Medium
- Mild
- Minor

5.4.4 The probability of a risk occurring has been classified into the following categories:

- High Likelihood
- Likely
- Low Likelihood
- Unlikely

5.4.5 This relationship can be represented graphically as a matrix (Table 5.3).

Table 5.3: Overall Contamination Risk Matrix

		Consequence			
		Severe	**Medium**	**Mild**	**Minor**
Probability	**High Likelihood**	Very high risk	High risk	Moderate risk	Low risk
	Medium	High risk	Moderate risk	Moderate risk	Low risk
	Low Likelihood	Moderate risk	Moderate risk	Low risk	Very low risk
	Unlikely	Low risk	Low risk	Very low risk	Very low risk

5.4.6 The risk assessment process is based on guidance provided in CIRIA C552 (2001) *Contaminated Land Risk Assessment – A Guide to Good Practice*. Further information including definitions of descriptive terms used in the risk assessment process is included in Appendix 4.

5.4.7 The degree of risk is based on a combination of the potential sources and the sensitivity of the environment. The risk classifications can be cross checked with reference to Table A4.4 in Appendix 4.

5.4.8 Hazard assessment was also carried out, the outcome of which could be:

- Urgent Action (UA) required to break existing source-pathway-receptor link.

- Ground Investigation (GI) required to gather more information
- No action required (NA)

5.4.9 The preliminary risk assessment for the site is presented in Table 5.4.

Table 5.4: Preliminary Risk Assessment for the Site

Sources	Pathways	Receptors	Consequence	Probability of pollutant linkage	Risk Estimation	Hazard Assessment
• Potential for made ground associated with previous development operations – on and off site (S1) • Current and previous industrial use – off site (S2)	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2) • Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hard standing or via service pipe/corridors and surface water runoff. (P3) • Horizontal and vertical migration of contaminants within groundwater (P4)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	Mild	Low	Low risk	GI – Ground investigation to confirm ground conditions and advise on foundation design and waste disposal.

5.4.10 It should be noted that the identification of potential pollutant linkages does not necessarily signify that the site is unsuitable for its current or proposed land use. It does however act as a way of focussing data collection at the site in accordance with regulatory guidance in CLR 11.

5.5 Outcome of Risk Assessment

5.5.1 The risk estimation matrix indicates a **low** risk as defined above.

5.5.2 It is understood that the proposed development comprises the conversion of the existing building into residential with the addition of a basement level including a swimming pool.

5.5.3 It is recommended that an intrusive investigation is carried out to verify the underlying ground conditions and assist with foundation design and waste disposal options. To facilitate this, samples should be obtained for chemical and geotechnical testing.

5.6 List of Key Contaminants

5.6.1 The possible contamination implications for both on-site and off-site sources have been assessed based on the information presented in the report. This has been achieved using guidance publications by the Environment Agency, together with other sources.

5.6.2 Based on recommendations within the guidance publications, an initial soil and water chemical testing suite would need to consider a range of contaminants as follows:

- *Metals*: cadmium, chromium, copper, lead, mercury, nickel, zinc;
- *Semi-metals and non-metals*: arsenic, boron, sulphur;
- *Inorganic chemicals*: cyanide, nitrate, sulphate and sulphide;
- *Organic chemicals*: aromatic hydrocarbons, aliphatic hydrocarbons, petroleum hydrocarbons, phenol, polyaromatic hydrocarbon;
- *Others*: pH, Asbestos

6 BASEMENT IMPACT ASSESSMENT

6.1 Screening Assessment

6.1.1 Screening is the process of determining whether or not there are areas of concern which require a BIA for a particular project. This was undertaken in previous sections by the site characterisation. Scoping is the process of producing a statement which defines further matters of concern identified in the screening stage. This defining is in terms of ground processes in order that a site specific BIA can be designed and executed by deciding what aspects identified in the screening stage require further investigation by desk research or intrusive drilling and monitoring or other work.

6.1.2 The scoping stage highlights areas of concern where further investigation, intrusive soil and water testing and groundwater monitoring may be required.

6.1.3 A series of flowcharts have been used to identify what issues are relevant to the site. Each question posed in the flowcharts is completed by answering “Yes”, “No” or “Unknown”. Any question answered with “Yes” or “Unknown” is then subsequently carried forward to the scoping phase of the assessment.

6.1.4 The results of the screening process for the site are provided in Table 6.1 below. Where further discussion is required the items have been carried forward to scoping.

6.1.5 A Site Investigation is undertaken where necessary to establish base conditions and the impact assessment determines the impact of the proposed basement on the baseline conditions, taking into account any mitigating measures proposed.

Table 6.1: Screening Assessment

Query	Y / N	Comment
Surface Flow and Flooding		
Is the site within the catchment of any ponds?	No	No evidence of any ponds or surface water features on historical or current OS maps.
As part of the site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially different from the existing route?	No	The proposed development will add a basement within the existing footprint and not affect the run off at ground level.
Will the proposed basement result in changes to the profile of the inflows (instantaneous and long-term) of surface water being received by adjacent properties or downstream watercourses?	No	There are no nearby surface water features.
Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses?	No	No surface waters in the area to be impacted.
Is the site in an area known to be at risk from surface water flooding, or is it at risk from	No	No nearby surface water features.

Query	Y / N	Comment
flooding, for example because the proposed basement is below the static water level of a nearby surface water feature?		
Subterranean (Groundwater) Flow		
Is the site located directly above an aquifer?	Yes	The site is located above superficial deposits that represent a Secondary A aquifer.
Will the proposed basement extend below the surface of the water table?	Unknown	The position of the water table within the Secondary A aquifer is not known. Basement could be excavated into the clay beneath the aquifer.
Is the site within 100m of a watercourse, well (disused or used) or a potential spring line?	No	No nearby subterranean water features.
Is the site within the catchment of any pond?	No	No nearby water features.
Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas?	No	The proposed development is to add a basement under an existing building.
As part of the site drainage, will more surface water (e.g. rainfall and run-off) than at present be discharged to the ground (e.g. via soakaways and/or SUDS)?	No	There is no reason to believe that more water than at present will be discharged to the ground.
Is the lowest point of the proposed excavation (allowing of any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring line?	No	No nearby water features.
Slope Stability		
Does the existing site include slopes, natural or manmade, greater than 7 degrees?	Yes	The external patio area is level with the lower ground floor level approximately 3.15m below surface level. There is a retaining wall around the outside.
Will the proposed re-profiling of landscaping change slopes at the property to more than 7 degrees?	No	
Does the developments neighbouring land include railway cuttings and the like, with a slope greater than 7 degrees.	No	Surrounding land is mostly residential in nature.
Is a clay stratum the shallowest stratum at the site?	No	The site is initially underlain by sand and gravel of the Lynch Hill Gravel Member.
Will any trees be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are	No	No trees will be felled as part of this development.

Query	Y / N	Comment
to be retained?		
Is there a history of seasonal shrink-swell subsidence in the local area, and/or evidence of such effects at the site?	Yes	The site is reported to be in an area with moderate risk of shrink-swell.
Is the site within an area of previously worked ground?	No	There is no evidence from the historical data that the ground in this area has been worked other than regarding the existing residential development.
Is the site within an aquifer? If so, will the proposed basement extend beneath the water table such that dewatering may be required during construction?	Unknown	The basement will extend into/below a Secondary A aquifer, however the water level is unknown.
Is the site within 50m of ponds?	No	No natural ponds are identified.
Is the site within 5m of a pedestrian 'right of way'?	Yes	The site is on the corner of two streets.
Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes	It is likely that the basement foundations will increase the differential depth of foundations relative to neighbouring properties however this is dependent on the type of foundations used at the neighbouring properties and this is currently unknown.
Is the site over (or within the exclusion of) any tunnels e.g. railway lines?	Yes	The site is reported to be above a tunnel used by London Underground for the Victoria Line.

6.2 Scoping

6.2.1 Scoping is the activity of defining in further detail the matters to be investigated as part of the BIA process. Scoping comprises of the definition of the required investigation needed in order to determine in detail the nature and significance of the potential impacts identified during screening.

6.2.2 The potential impacts for each of the matters highlighted in Table 6.1 above are discussed in further detail below together with the requirements for further investigations. Detailed assessment of the potential impacts and recommendations are provided where possible.

6.2.3 These issues include proposed changes to hard standing, the possibility of made ground and/or gravel immediately beneath the site, the shrink/swell nature of the London Clay.

6.3 Proposed Changes to Areas of External Hardstanding

6.3.1 The site is currently almost entirely covered by building footprint with a small amount of external space covered by hard-standing. It is not thought that the proposed development will result in any greater area of hard-standing cover than is currently present on the site.

6.3.2 It is not considered that there is a requirement for undertaking any further investigations, studies or impact assessment in relation to the proposed changes to areas of external hard-standing.

6.4 Past Flooding

6.4.1 Planning Policy Statement PPS25 “Development and Flood Risk” seeks to protect development from flooding as well as preventing flooding. PPS25 states that developers are responsible for providing a flood risk assessment:

- demonstrating whether any proposed development is likely to be affected by current or future flooding from any source;
- satisfying the local planning authority that the development is safe and where possible reduces flood risk overall;
- demonstrating whether the development will increase flood risk elsewhere;
- demonstrating measures proposed to deal with these effects and risks.

6.4.2 The site is not in an area which has been knowingly affected by flooding in the past. Nor is it located within 250m of a known area of flood risk.

6.5 Geological Impact

6.5.1 The published geological maps indicate that the Lynch Hill Gravel overlying London Clay Formation underlies the site.

6.5.2 The new basement construction may possibly be founded within the Lynch Hill Gravel deposits although nearby borehole data suggests it is likely to be founded within the underlying London Clay.

6.6 Impacts of Basement on Adjacent Properties and Pavement

6.6.1 The proposed basement excavation will be within 5m of a public pavement. It is also within 5m of neighbouring properties. Unavoidable lateral ground movements associated with the basement excavations must be controlled during temporary and permanent works so as not to impact adversely on the stability of the surrounding ground and any associated services.

6.6.2 It will be necessary to ensure that the basements are designed in accordance with the NHBC Standards and take due cognisance of the potential impacts highlighted above. This may be achieved by ensuring best practice engineering and design of the proposed scheme by competent persons and in full accordance with the Construction (Design and Management) Regulations. This will include:

- Establishment of exact ground conditions beneath the site;

- Establishment of the likely ground movements arising from the temporary and permanent works and the mitigation of excessive movements;
- Assessment of the impact on any adjacent structures (including adjacent properties and the adjacent pavement with potential services);
- Determination of the most appropriate methods of construction of the proposed basements;
- Undertake pre-condition surveys of adjacent structures;
- Monitor any movements and pre-existing cracks during construction;
- Establishment of contingencies to deal with adverse performance;
- Ensuring quality of workmanship by competent persons.

6.6.3 Full details of the suitable engineering design of the scheme in addition to an appropriate construction method statement should be submitted by the Developer to the London Borough of Camden.

6.7 Proximity of the Basement to Underground Tunnels

6.7.1 The Groundsure report indicated the possibility of an underground train tunnel belonging to London Underground and serving the Victoria Line being present below the site.

6.7.2 A request for information was made to London Underground with regards to the specific location of the Underground Infrastructure and a map provided in response shows the tunnel to be located below Fitzroy Square itself, and not directly below site. Although the map provided indicates the tunnel is not located below the site, London Underground will continue to be kept informed of plans and progression of work. Information is presented in Appendix 5.

7 GROUND INVESTIGATION

7.1 Rationale for Ground Investigation

7.1.1 The site investigation has been undertaken generally in accordance with Contaminated Land Report 11, BS10175, NHBC Standards Chapter 4.1, and other associated Statutory Guidance. If required, further targeted investigations and remedial option appraisal would be dependent on the findings of this site investigation.

7.1.2 The soil sampling rationale for the site investigation was developed with reference to EA guidance 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination' (Technical Report P5-066/TR).

7.1.3 The sampling proposal was designed in order to gather data representative of the site conditions.

7.2 Scope of Ground Investigation

7.2.1 The ground investigation was undertaken on 21st December 2015 & 04th January 2016.

7.2.2 The work was undertaken in accordance with BS5930 'Code of Practice for Site Investigation' and BS10175 'Investigation of Potentially Contaminated Sites'. All works were completed without incident.

7.2.3 The investigation focused on collecting data on the following:

- Quality of Made Ground/ natural ground within the site boundaries;
- Presence of groundwater beneath the site (if any), perched or otherwise;

7.2.4 A summary of the fieldwork carried out at the site, with justifications for exploratory hole positions, are offered in Table 7.1 below.

Table 7.1: Scope of Intrusive Investigation

Investigation Type	No. of Exploratory Holes Achieved	Exploratory Hole Designation	Depth Achieved (m BGL)	Justification
CFA Borehole	1	BH1	Up to 10m bgl	To investigate ground conditions, undertake in situ tests, obtain samples for environmental & geotechnical testing, install monitoring standpipes
Modular Window Sample Borehole	1	WS1	Up to 10m bgl	
Hand Dug Trial Pits	2	HTP1 & HTP2	0.41m bgl	To investigate existing building foundations
Monitoring Wells	2	BH1 & WS1		Combined soil gas and groundwater monitoring wells.

7.2.5 The exploratory holes were completed to allow soil samples to be taken in the areas of interest identified in Table 8.1 above. In all cases, all holes were logged in accordance with BS5930:2015.

7.2.6 Exploratory hole positions were measured in using tape and reel, as shown in the exploratory hole location plan presented in Appendix 1. The exploratory hole records are included in Appendix 6.

7.2.7 The boreholes were backfilled with the arisings (in the reverse order in which they were drilled) and the ground surface was reinstated so that no depression was left.

7.3 Trial Pits o Expose Foundations

7.3.1 The two hand excavated pits exposed limited foundations.

7.3.2 HTP1 excavated in the corner of the room exposed 0.29m of brickwork down on to two brick corbels which were then founded in the sand and gravel.

7.3.3 HTP2 did not expose any foundations with the brickwall seated directly on the underlying ground once the concrete floor slab had been removed.

7.4 Sampling Rationale

7.4.1 Our soil sampling rationale for the site investigation was developed with reference to EA guidance 'Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination' (Technical Report P5-066/TR).

7.4.2 The exploratory holes were positioned by applying a combined non-targeted sampling strategy, as well as sample locations positioned with reference to sources identified from the desk study.

7.4.3 Soil samples were taken from across the site at various depths as shown in the exploratory hole logs.

7.4.4 JAL's engineers normally collect samples at appropriate depths based on field observations such as:

- appearance, colour and odour of the strata and other materials, and changes in these;
- the presence or otherwise of sub-surface features such as pipework, tanks, foundations and walls; and,
- areas of obvious damage, e.g. to the building fabric.

7.4.5 A number of the samples were taken from the top 0-1m to aid in the assessment of the pollutant linkages identified at the site. In addition, some deeper samples were taken to aid in the interpretation of fate and transport of any contamination identified.

7.4.6 Samples were stored in cool boxes (<4^{o}C) and preserved in accordance with laboratory guidance.

7.4.7 Bulk samples were collected for geotechnical analysis.

7.4.8 Groundwater strikes noted during drilling, are recorded within the exploratory hole records in Appendix 6.

7.5 Sampling Limitations

7.5.1 Due to the restricted nature of the site specialist restricted access drilling equipment was utilised. The CFA drilling rig was employed due to its capability to drill through gravel strata to greater depths. Once the thickness of the gravel was proven a window sampling rig was utilised.

7.5.2 The hand excavated trial pits were undertaken internally and were completed at the proposed locations.

7.6 Laboratory Analysis

7.6.1 A programme of chemical laboratory testing, scheduled by JAL, was carried out on selected samples of Made Ground and natural strata.

Chemical Testing

7.6.2 Soil samples were submitted to The Environmental Laboratory Ltd, East Sussex (a UKAS and MCerts accredited laboratory), for analysis.

7.6.3 The samples were analysed for a wide range of contaminants as shown in Table 7.2 below:

Table 7.2: Chemical Tests Scheduled

	No. of tests	
Test Suite	**Made Ground / Topsoil**	**Natural**
Basic Suite 2	1	2
Total Organic Carbon	-	1
Water Soluble Sulphate	2	3
Waste Acceptance Criteria	1	1

7.6.4 The determinands contained in the basic suite are as detailed in Table 7.3 below:

Table 7.3: Basic Suite of Determinands

DETERMINAND	LIMIT OF DETECTION (mg/kg)	UKAS ACCREDITATION	TECHNIQUE
Arsenic	1	Y (MCERTS)	ICPMS
Cadmium	0.5	Y (MCERTS)	ICPMS
Chromium	5	Y (MCERTS)	ICPMS
Chromium (Hexavalent)	0.02	N	Colorimetry
Lead	5	Y (MCERTS)	ICPMS
Mercury	0.5	Y (MCERTS)	ICPMS
Nickel	5	Y (MCERTS)	ICPMS
Selenium	1	PENDING	ICPMS

DETERMINAND	LIMIT OF DETECTION (mg/kg)	UKAS ACCREDITATION	TECHNIQUE
Copper	5	Y (MCERTS)	ICPMS
Zinc	45	Y (MCERTS)	ICPMS
Boron (Water Soluble)	0.5	N	ICPMS
pH Value	0.1 units	Y (MCERTS)	Electrometric
Sulphate (Water Soluble)	0.02g/l	Y (MCERTS)	Ion Chromatography
Total Cyanide	1	Y (MCERTS)	Colorimetry
Speciated PAH	0.1/0.4	Y (MCERTS)	GCFID
Phenols	5	Y (MCERTS)	HPLC
Total Petroleum Hydrocarbons (banded)	1	N	Gas Chromatography

7.6.5 To support the derivation of appropriate tier 1 screening values, 1No. sample was also analysed for total organic carbon.

Laboratory test results are summarised in Section 8, with raw laboratory data included in Appendix 7.

Geotechnical Laboratory Testing

7.6.6 In addition to the contamination assessment, soil samples were submitted to the UKAS Accredited laboratory of PSL for the following assessment.

- 5No. Atterberg Limit determinations
- 5No. Moisture Content determinations
- 3No. Particle Size Distributions;

All testing was in accordance with BS 1377.

7.6.7 The results of the geotechnical laboratory testing are presented as Appendix 8 and discussed in Section 10 of this report.

8 GROUND CONDITIONS

8.1 Soil

8.1.1 Ground conditions were logged in accordance with the requirements of BS5930:2015. Detailed exploratory hole logs are provided in Appendix 6. The ground conditions encountered are summarised in Table 8.1 below, based on the strata observed during the investigation.

Table 8.1: Ground Conditions Encountered

Stratum and Description	Encountered from (m bgl)	Base of strata (m bgl)	Thickness range (m)
MADE GROUND: Concrete over brick and ash	0.0	0.7	0.7
Yellow/brown very gravelly SAND	0.7	1.8 – 2.3	1.1 – 1.6
Firm to stiff light brown becoming grey sandy slightly gravelly CLAY Encountered to base of boreholes	1.8 – 2.3	>10.00 (encountered to terminal depth)	>7.7

8.2 Hydrogeology

8.2.1 Groundwater was encountered in window sampler hole, WS1, during the course of the investigation at 7m bgl.

Table 8.2: Water Monitoring Records

DURING DRILLING			
Exploratory Hole ID	**Depth Encountered (mbgl)**	**Depth After 20mins (mbgl)**	**Stratum**
BH1	-	-	-
WS1	7.0	Not recorded	Sandy gravelly CLAY
POST DRILLING/RETURN MONITORING			
Exploratory Hole ID	**Depth Encountered (mbgl)**	**Depth to Base of Well**	**Stratum**
BH1	0.98 – 1.05	8.12	Sand and gravel
WS1	1.4 – 1.45	7.06	Sand and gravel

8.2.2 Groundwater encountered within WS1 at 7m bgl during drilling is considered to represent water accumulated within sandy pockets/lenses within the London Clay. The water will be limited in volume and is expected to be very slow to recharge.

8.2.3 During the post drilling monitoring groundwater was recorded at shallower depths and is considered to represent the groundwater within the sand and gravel superficial deposits of the Lynch Hill Gravel.

8.3 Physical and Olfactory Evidence of Contamination

Visual or olfactory evidence of contamination was not observed during the course of the investigation.

9 RISK ASSESSMENT – ANALYTICAL FRAMEWORK

9.1 Context and Objectives

9.1.1 This section seeks to evaluate the level of risk pertaining to human health and the environment which may result from both the existing use and proposed future use of the site. It makes use of the site investigation findings, as described in the previous sections, to evaluate further the potential pollutant linkages identified in the desk study. A combination of qualitative and quantitative techniques is used, as described below.

9.1.2 The purpose of generic quantitative risk assessment is to compare concentrations of contaminants found on site against screening level generic assessment criteria (GAC) to establish whether there are actual or potential unacceptable risks. It also determines whether further detailed assessment is required. The approaches detailed all broadly fit within a tiered assessment structure in line with the framework set out in the Department of Environment, Food and Rural Affairs (DEFRA), EA and Institute for Environment and Health Publication, Guidelines for Environmental Risk Assessment and Management.

9.1.3 It should be noted that the statistical tests carried out in this report in accordance with CL:AIRE and CIEH (2008) recommendations, are for guidance purposes only and the conclusions of this report should be approved by the local authority prior to any redevelopment works being undertaken.

9.2 Analytical Framework – Soils

9.2.1 There is no single methodology that covers all the various aspects of the assessment of potentially contaminated land and groundwater. Therefore, the analytical framework adopted for this investigation is made up of a number of procedures, which are outlined below. All of these are based on a Risk Assessment methodology centred on the identification and analysis of Source – Pathway – Receptor linkages.

9.2.2 The CLEA model provides a methodology for quantitative assessment of the long term risks posed to human health by exposure to contaminated soils. Toxicological data have been used to calculate Soil Guideline Values (SGV) for individual contaminants, based on the proposed site use; these represent minimal risk concentrations and may be used as screening values.

9.2.3 In the absence of any published SGVs for certain substances, or where the assumptions made in generating the SGVs do not apply to the site, JAL have derived Tier 1 screening values for initial assessment of the soil, based on available current UK guidance including the LQM/CIEH generic assessment criteria. Site-specific assessments are undertaken wherever possible and/or applicable. All assessments are carried out in accordance with the CLEA protocol.

9.2.4 CLEA requires a statistical treatment of the test results to take into account the normal variations in concentration of potential contaminants in the soil and allow comparisons to be made with published guidance.

9.2.5 The assessment criteria used for the screening of determinands within soils are identified within Table 9.1.

Table 9.1: Selected Assessment Criteria – Contaminants in Soils

Substance Group	Determinand(s)	Assessment Criteria Selected
Organic Substances		
Non-halogenated Hydrocarbons	Total Petroleum Hydrocarbons (TPHCWG banded)	LQM/CIEH
	Total Phenols	CLEA v1.06
Polycyclic Aromatic Hydrocarbons (PAH-16)	Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Phenanthrene, Anthracene, Fluoranthene, Pyrene, Benz(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Indeno(1,2,3-cd)pyrene, Dibenz(a,h)anthracene, Benzo(ghi)perylene	LQM/CIEH
Volatile Organic Compounds (VOCs/sVOCs).	Toluene, Ethylbenzene	LQM/CIEH
	Benzene, Xylenes	LQM/CIEH
Inorganic Substances		
Heavy Metals and Metalloids	Arsenic, Cadmium, Chromium, Lead, Mercury, Nickel, Selenium	LQM/CIEH/C4SL
	Copper, Zinc	LQM/CIEH
Cyanides	Free Cyanide	CLEA v1.06
Sulphates	Water Soluble Sulphate	BRE Special Digest 1:2005

BRE

9.2.6 The BRE Special Digest 1:2005, 'Concrete in Aggressive Ground' is used with soluble sulphate and pH results to assess the aggressive chemical environment of future underground concrete structures at the site.

9.3 Analytical Framework – Groundwater and Leachate

9.3.1 Where undertaken, the groundwater quality analysis comprises a Level 1 assessment in accordance with the EA Remedial Targets Methodology Document (EA, 2006).

9.3.2 The criteria used by JAL in the Level 1 assessment of groundwater and leachate quality are shown in Table 9.2.

Table 9.2: Selected Assessment Criteria – Contaminants in Water

Substance Group	Determinand(s)	Assessment Criteria Selected
Metals	Arsenic, Copper, Cyanide, Mercury, Nickel, Lead, Zinc, Chromium	EQS/DWS
	Selenium	DWS
PAHs	Sum of Four – benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene	DWS
PAHs	Benzo(a)pyrene,	DWS
PAHs	Remainder	LEC
Total Petroleum Hydrocarbons	Aliphatic C5-C6, Aliphatic >C6-C8, Aliphatic >C8-C10. Aliphatic >C10-C12, Aliphatic >C12-C16, Aliphatic >C16-C21, Aromatic C5-C7, Aromatic >C7-C8, Aromatic >C8-C10, Aromatic >C10-C12, Aromatic >C12-C16, Aromatic >C16-C21, Aromatic> C21-C35	DWS/WHO
BTEX	Benzene	DWS
	Toluene	EQS
	Ethylbenzene	EQS
	Xylene	EQS
PAHs	Sum of Four – benzo(b)fluoranthene, benzo(ghi)perylene, benzo(k)fluoranthene, indeno(1,2,3-c,d)pyrene	DWS

Environmental Quality Standards EQS

Environmental Quality Standards (EQS) have been released by the EA for dangerous substances, as identified by the EC Dangerous Substances Directive. EQS can vary for each substance, for the hardness of the water and can be different for fresh, estuarine or coastal waters.

Lowest Effect Concentration (LEC)

These criteria relate to the concentration of PAHs in groundwater. They are taken from the EA R&D Technical Report P45 – Polycyclic Aromatic Hydrocarbons (PAH): Priorities for Environmental Quality Standard Development (2001).

WHO Health

These screening criteria have been taken from the World Health Organisation Guidelines for Drinking Water Quality (1984). The health value is a guideline value representing the concentration of a contaminant that does not result in any significant risk to the receptor over a lifetime of exposure.

Further criteria have been obtained from 'Petroleum Products in Drinking-water' - Background document for development of WHO Guidelines for Drinking-water Quality (2005).

UK Drinking Water Standards (DWS)

These comprise screening criteria provided by the Drinking Water Inspectorate (DWI) in the Water Supply (Water Quality) Regulations 2006,

Urban Waste Water Treatment (England and Wales) Regulations - UWWT Regs

The Urban Waste Water Treatment (England and Wales) Regulations SI/1994/2841 as amended by SI/2003/1788 sets down minimum standards for the discharge of treated effluent from waste water treatment works to inland surface waters, groundwater, estuaries or coastal waters. Standards of (125mg/L) COD and (25mg/L) BOD have been set.

Site Specific Criteria

9.3.3 The criteria adopted in the selection of correct screening criteria from published reports as previously described, are provided within Tables 9.3.

Table 9.3: Site Specific Data

Input Details	Value
Land Use	Residential without plant uptake
Soil Type	Sandy grave / Clay
pH	8
Soil Organic Matter	1%

9.3.4 A pH value of '8' has been used for the derivation of generic screening criteria as 7.925 was the mean pH value of samples analysed.

9.3.5 As the published reports only offer the option of selecting an SOM value of 1%, 2.5% or 6%, an SOM value of 1% has been used for the generation of generic assessment criteria, as 0.175% was the mean value obtained from laboratory analysis.

9.3.6 It is understood that the site is to be converted to provide residential units with associated communal soft landscaping. As a result, the site has been assessed as residential without plant uptake.

10 GENERIC QUANTITATIVE RISK ASSESSMENT

10.1 Screening of Soil Chemical Analysis Results – Human Health Risk Assessment

10.1.1 To focus on the contaminants of potential concern (COPC), the results have been compared with the respective SGV/GAC. Those contaminants which exceed the SGV/GAC are considered to be the COPC. Those which do not exceed the respective SGV/GAC are not considered to be COPC and as such do not require further assessment in relation to the proposed development of the site.

10.1.2 Laboratory analysis for soils are summarised in Tables 10.1 to 10.3. Raw laboratory data is included in Appendix 7.

Table 10.1: Soil Laboratory Analysis Results – Metals, Metalloids, Phenol, Cyanide

Determinand	Unit	No. samples tested	Screening Criteria		Min	Max	No. Exceeding
Arsenic	mg/kg	3	40	S4UL	10.0	18.7	0
Cadmium	mg/kg	3	85	S4UL	<0.5	<0.5	0
Chromium	mg/kg	3	910	S4UL	21.1	33.7	0
Lead	mg/kg	3	310	S4UL	18.9	402	1 (WS1 @ 0.5m)
Mercury	mg/kg	3	56	S4UL	<0.5	1.6	0
Nickel	mg/kg	3	180	S4UL	18.2	30.2	0
Copper	mg/kg	3	7100	S4UL	16.6	63.7	0
Zinc	mg/kg	3	40000	S4UL	22.7	86.9	0
Total Cyanide [B]	mg/kg	3	33	CLEA v 1.06	<1.0	<1.0	0
Selenium	mg/kg	3	430	S4UL	<1.0	<1.0	0
Boron Water Soluble	mg/kg	3	11000	S4UL	<0.5	0.6	0
Phenols	mg/kg	3	440	S4UL	<5	<5	0

Notes:

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[B] Generic assessment criteria derived for free inorganic cyanide.

Table 10.2: Soil Laboratory Analysis Results – Polycyclic Aromatic Hydrocarbons (PAHs)

Determinand	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
Naphthalene	mg/kg	3	S4UL	2.3	<0.1	<0.1	0
Acenaphthylene	mg/kg	3	S4UL	2900	<0.1	<0.1	0
Acenaphthene	mg/kg	3	S4UL	3000	<0.1	<0.1	0
Fluorene	mg/kg	3	S4UL	2800	<0.1	<0.1	0
Phenanthrene	mg/kg	3	S4UL	1300	<0.1	<0.1	0
Anthracene	mg/kg	3	LQM GAC	2300	<0.1	<0.1	0
Fluoranthene	mg/kg	3	S4UL	1500	<0.1	0.2	0
Pyrene	mg/kg	3	S4UL	3700	<0.1	0.2	0
Benzo(a)anthracene	mg/kg	3	S4UL	11.0	<0.1	0.4	0
Chrysene	mg/kg	3	S4UL	30	<0.1	0.5	0
Benzo(b)fluoranthene	mg/kg	3	S4UL	3.9	<0.1	0.5	0
Benzo(k)fluoranthene	mg/kg	3	S4UL	110	<0.1	0.6	0
Benzo(a)pyrene	mg/kg	3	S4UL	3.2	<0.1	0.5	0
Indeno(123-cd)pyrene	mg/kg	3	S4UL	45	<0.1	0.3	0
Dibenz(ah)anthracene	mg/kg	3	S4UL	0.31	<0.1	0.1	0
Benzo(ghi)perylene	mg/kg	3	S4UL	360	<0.1	0.3	0
Total PAH	mg/kg	4	-		<0.4	3.8	-

Table 10.3: Soil Laboratory Analysis– Total Petroleum Hydrocarbons (TPH)

TPH Band	Unit	No. Samples Tested	Screening Criteria		Min	Max	No. Exceeding
C_8-C_{10}	mg/kg	3	S4UL	27	<0.1	<0.1	0
>C_{10}-C_{12}	mg/kg	3	S4UL	130	<0.1	<0.1	0
>C_{12}-C_{16}	mg/kg	3	S4UL	1100	<0.1	<0.1	0
>C_{16}-C_{21}	mg/kg	3	S4UL	1900	<0.1	<0.1	0
>C_{21}-C_{35}	mg/kg	3	S4UL	1900	<0.1	5.6	0
Total TPH	mg/kg	3	-	-	<0.1	5.6	-

Note: *The lower value of guidelines for Aromatic/Aliphatics has been selected

10.2 Screening of Soil Chemical Analysis Results – Potential Risks to Plant Growth

10.2.1 Zinc, copper and nickel are phytotoxins and could therefore inhibit plant growth in soft landscaped areas. Concentrations measured in soil for these determinands have been compared with the pH dependent values given in BS3882:2007.

10.2.2 Adopting a pH value of greater than 7, as indicated by the results of the laboratory analysis, the following is noted;

- Zinc concentrations revealed by this investigation were 48.8mg/kg below the threshold of 300mg/kg.
- Copper concentrations revealed by this investigation were 21.5mg/kg, below the threshold value of 200mg/kg.
- Nickel concentrations revealed by this investigation were 30.2mg/kg, below the threshold value of 110mg/kg.

10.3 Screening for Water Pipes

10.3.1 The results of the analysis have been assessed for potential impact upon water supply pipes. Table 10.4 below summarises the findings of the assessment:

Table 10.4: Screening Guide for Water Pipes

Determinand	Threshold adopted for PE (mg/kg)	Min Value for site data	Max Value from site data
Total VOCs	0.5	-	
BTEX	0.1	<0.01	
MTBE	0.1	-	
EC5-EC10	1	<1	
EC10-EC16	10	<1	
EC16-EC40	500	<1	
Naphthalene	5	<0.1	
Phenols	2	<5*	

*Laboratory detection limit

10.4 Waste Disposal

10.4.1 The results of Waste Acceptance Criteria (WAC) testing indicate that the sample from BH1 at 2.5m depth meets the non-hazardous criteria whereas the sample from WS1 at 0.5m meets the inert criteria.

10.4.2 As part of the WAC testing, the samples were also analysed for mineral oils, total BTEX (Benzene, Toluene, Ethylbenzene and Xylene) and PCBs. None of the compounds analysed for were reported above the laboratory method detection limit with the exception of total BTEX where one sample reported a concentration of 0.03mg/kg which is well below the most stringent assessment criteria of 0.38mg/kg for benzene.

11 SOIL GAS RISK ASSESSMENT

11.1 Soil Gas Results

11.1.1 Two return monitoring visits have been undertaken to monitor wells installed within boreholes at the site for soil gas concentrations and groundwater levels.

11.1.2 Two wells, BH1 and WS1 were installed during JAL's investigations and monitored on 14th and 20th January 2016.

11.1.3 The results of the monitoring undertaken are summarised in Table 11.1 below, with the monitoring records presented in Appendix 4.

Table 11.1: Summary of Gas Monitoring Data

Hole No.	CH_4 (%)	CO_2 (%)	O_2 (%)	H_2S (ppm)	Atmospheric Pressure (mb)	VOCs	Peak Flow Rate (l/hr)	Depth to water (mbgl)	Depth of hole (mbgl)
BH1	0.0	0.3 - 0.4	20.7 - 20.9	0	1001 – 1017	0.0	+0.5 - 0.6	0.98 – 1.05	8.12
WS1	0.0	0.2 – 0.3	20.8 - 21.3	0	1001 - 1017	0.0	+0.4 - 0.7	1.40 – 1.45	7.06

11.2 Screening of Results

11.2.1 As shown in Table 9.1, methane and carbon dioxide has been reported to maximum concentrations of 0.0% and 0.4% v/v to date. Oxygen levels during the monitoring visits have varied from 20.7 to 21.3% v/v. Volatile organic compounds (VOCs) were below the detection limit of the instrument. A maximum flow rate of 0.7l/hr has been reported.

11.2.2 In the assessment of risks posed by hazardous ground gases and selection of appropriate mitigation measures, CIRIA document C665 (2007) identifies two types of development, termed Situation A and Situation B.

11.2.3 Situation A relates to all development types except low rise housing. Situation B relates to low rise housing with gardens. Situation A has been adopted as the relevant category for the proposed development.

11.2.4 The soil gas assessment method is based on that proposed by Wilson & Card (1999), which was a development of a method proposed in CIRIA publication R149 (CIRIA, 1995). The method uses both gas concentrations and borehole flow rates to define a characteristic situation based on the limiting borehole gas volume flow for methane and carbon dioxide. In both these methods, the limiting borehole gas volume flow is renamed as the Gas Screening Value (GSV).

11.2.5 The Gas Screening Value (litres of gas per hour) is calculated by using the following equation

GSV = (Concentration/100) X Flow rate

Where concentration is measured in percent (%)

and flow rate is measured in litres per hour (l/hr)

11.2.6 The Characteristic Situation is then determined from Table 8.5 of CIRIA C665.

11.2.7 To accord with C665, worst case conditions are used in the calculation of GSVs for the site.

11.2.8 A worst case flow rate of 0.7/hr (maximum reported) will be used in the calculation of GSVs for the site.

For carbon dioxide and methane, the worst-case conditions and the corresponding GSV is presented below.

- **Conservative flow rate:** **0.7 l/hr flow rate**
- **Highest CO_2 concentration:** **0.4% v/v**
- **GSV Value:** **0.0028 (l/hr)**
- **Highest CH_4 concentration:** **0.0% v/v**
- **GSV Value:** **0.0(l/hr)**

11.2.9 The result of the GSV calculation would indicate that the site may be classified as Characteristic Situation 1, where no special precautions are required.

11.2.10 No further monitoring is considered necessary as the visits were mainly for groundwater monitoring.

12 SUMMARY OF RESULTS

12.1 Risk Assessment - Land Quality Impact Summary

12.1.1 Following the site investigation, the following is noted:

- It is understood that the proposed development will comprise conversion of the existing office space into residential use, including the addition of a basement gymnasium and swimming pool.
- Following generic risk assessments the majority of results were found to exceed the relevant assessment criteria. One sample identified a lead concentration of 402mg/kg which is greater than the assessment criteria employed.
- The site proposal indicates that the site will remain covered by a combination of the proposed building footprint and hard surfacing. A new basement is proposed beneath the existing building footprint. The hard cover provides a suitable barrier to cut the pollutant linkage between the lead concentration and site users. It is therefore considered that no remedial action is warranted.
- The site is underlain by superficial deposits of the Lynch Hill Gravel, identified as a Secondary A aquifer. These are underlain by solid deposits of the London Clay Formation which are identified as being Unproductive. There are no source protection zones within 500m of the site, and no surface water or potable water abstractions within 1km of the site. The nearest groundwater abstraction is reported 322m south west of the site.
- On the basis of the findings of this investigation, the site is not considered to pose a significant risk to the identified sensitive receptors.
- Calculating the Gas Screening Value using worst case results indicates Characteristic Situation 1. This would indicate that no special precautions are required.
- No further remediation works are considered necessary, and the site is considered suitable for the proposed use following the adoption of the measures above.
- As with any ground investigation, the presence of further hotspots between sampling points cannot be ruled out. Should any contamination be encountered, a suitably qualified environmental consultant should be informed immediately, so that adequate measures may be recommended.

12.1.2 The above conclusions are made subject to approval by the statutory regulatory bodies.

12.2 Review of Pollutant Linkages Following Site Investigation

12.2.1 The site CSM has been revised and updated from that suggested in the desk study in view of the ground investigation data, including soil laboratory analysis results. Table 12.1 highlights whether pollutant linkages identified in the original CSM are still relevant following the risk assessment, or whether pollutant linkages, not previously identified, exist.

Table 12.1: Plausible Pollutants Linkages Summary

Potential Source (from desk study)	Pathway	Receptor	Relevant Pollutant Linkage?	Comment
• Potential for made ground associated with previous development operations – on and off site (S1) • Current and previous industrial use – off site (S2	• Ingestion and dermal contact with contaminated soil (P1) • Inhalation or contact with potentially contaminated dust and vapours (P2)	• Construction workers (R1) • Maintenance workers (R2) • Neighbouring site users (R3) • Future site users (R4) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	**X** (if measures in 13.1 are undertaken)	see 13.1 above for remedial measures. The findings of this report should be included in the construction health and safety file, with adequate measures put in place for the protection of construction and maintenance workers.
	• Leaching through permeable soils, migration within the vadose zone (i.e., unsaturated soil above the water table) and/or lateral migration within surface water, as a result of cracked hardstanding or via service pipe/corridors and surface water runoff. (P3) Horizontal and vertical migration of contaminants within groundwater (P4)	• Neighbouring site users (R3) • Building foundations and on site buried services (water mains, electricity and sewer) (R5)	**X** (if measures in 13.1 are undertaken)	Remedial measures not required. Contact should be made with relevant utility providers to confirm if upgraded materials are required.

13 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

13.1 Ground Investigation Summary

13.1.1 No detailed structural engineering design information, with respect to the type of construction and associated structural loadings, was provided at the time of preparing this report. Consequently, a detailed discussion of all the problems that may arise during the proposed redevelopment scheme is beyond the scope of this report.

13.1.2 Practical solutions to the difficulties encountered, both prior to, and during construction, are frequently decided by structural constraints or economical factors. For these reasons, this discussion is predominantly confined to remarks of a general nature, which are based on site conditions encountered during the intrusive investigations.

13.1.3 It is understood that the proposed development comprises conversion of the existing site to provide residential accommodation with the addition of a new basement level.

13.1.4 The results of the ground investigation revealed a ground profile comprising Made Ground (0.7m thick), overlying yellow brown very gravelly SAND then brown becoming grey silty sandy Clay with occasional gravel (considered to represent the London Clay), encountered to the base of the boreholes (10.0m bgl).

13.1.5 A summary of ground conditions obtained from the ground investigation and subsequent laboratory testing, is provided in Table 13.1 and 13.2 below.

Table 13.1: Ground Conditions Encountered

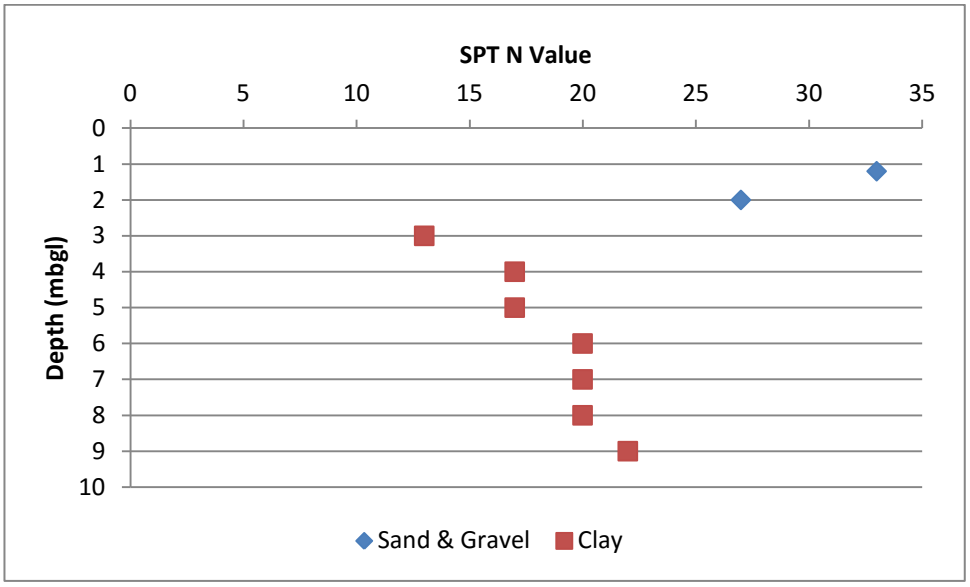
Stratum and Description	Encountered from (m bgl)	Base of strata (m bgl)	Thickness range (m)
MADE GROUND: Concrete over brick and ash	0.0	0.7	0.7
Yellow/brown very gravelly SAND	0.7	1.8 – 2.3	1.1 – 1.6
Firm to stiff light brown becoming grey sandy slightly gravelly CLAY Encountered to base of boreholes	1.8 – 2.3	>10.00 (encountered to terminal depth)	>7.7

Table 13.2: Laboratory Test Data Summary

Strata	SPT 'N' Value	Shear Strength (kPa)	Moisture content (%)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (plasticity term)	Particle Size Distribution (% passing 0.425mm)	NHBC Volume Change Classification
MADE GROUND: Concrete over brick and ash								
Yellow/brown very gravelly SAND	27 – 30							
Firm to stiff light brown becoming grey sandy slightly gravelly CLAY	13 - 22	58 - 99	33 - 35	55 - 64	25 - 27	30 - 37	80 - 100	Medium to High
Encountered to base of boreholes								

13.2 Geotechnical Data Summary

13.2.1 The results of the ground investigation revealed a ground profile comprising Made Ground overlying very gravelly SAND then brown becoming grey silty sandy CLAY.



13.2.2 The shear strength of the London Clay varies with depth, and is shown in Figure below. This shows the results of the triaxial testing and the undrained shear strength inferred by the correlation suggested by Stroud (1974),

c_u = f1 x N can be applied,

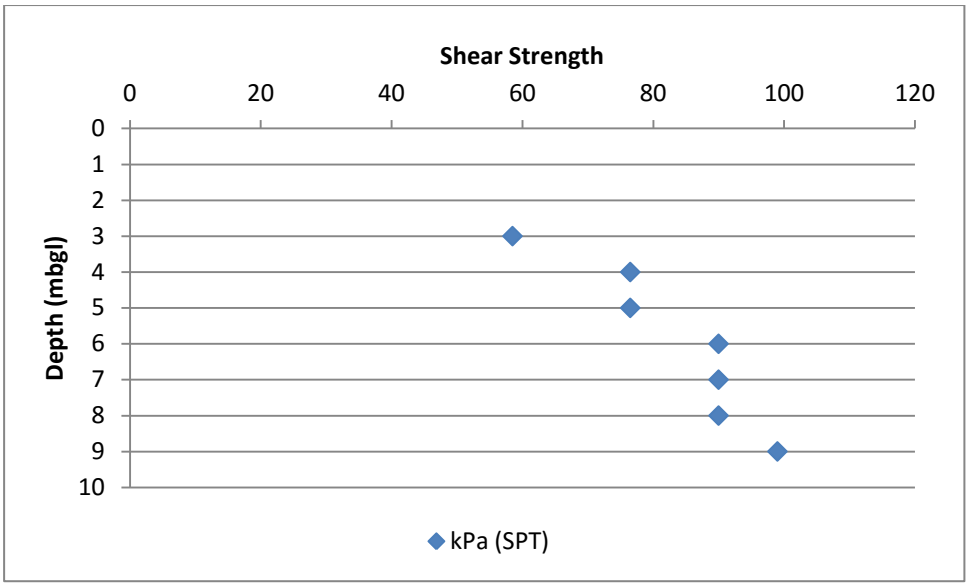
in which

c_u= mass shear strength (kN)

f1 = constant (use value of 4.5 for London Clay Formation)

N = SPT Value achieved during boring operations

13.2.3 The graph below shows the shear strength profile of the London Clay Formation encountered at the site, based on the SPT to shear strength correlation described above, as well as the results of undrained triaxial tests on undisturbed samples taken from the boreholes.



13.3 Foundations

13.3.1 Based upon the information obtained to date it is considered that conventional foundations may be suitable for the proposed development. Based on SPT N values of 13 at 3.0m bgl and 17 at 4.0m bgl it is considered that an allowable bearing capacity of 150kPa at 3.5m bgl is possible.

13.3.2 The above comments are indicative only based on limited ground investigation data. Foundations should be designed by a suitably qualified Engineer. Once structural loads have been fully determined a full design check in accordance with BS EN 1997 should be undertaken to confirm suitability of foundation choice.

13.4 Concrete in the Ground

13.4.1 Sulphate attack on building foundations occurs where sulphate solutions react with the various products of hydration in Ordinary Portland Cement (OPC) or converted High-Alumina Cement (HAC). The reaction is expansive, and therefore disruptive, not only due to the formation of minute cracks, but also due to loss of cohesion in the matrix.

13.4.2 In accordance with BRE Special Digest 1, in a data set where there are more than 10 results available, assessment should be undertaken against the average of the highest 20% of values. Where there are less than 10 results in a data set the highest value is taken.

13.4.3 Table 13.3 summarises the analysis of the aggressive nature of the ground for each of the stratum encountered within the ground investigation.

Table 13.3: Concrete in the Ground Classes

Stratum	No. Samples	pH range	WS Sulphate (ave 20% / highest)	Design Sulphate Class	ACEC Class
Made Ground	1	7.9	90	DS-1	AC-1
Gravelly SAND	1	8.1	70	DS-1	AC-1
London Clay	2	7.6 – 8.1	250	DS-1	AC-1s

13.5 Ground Floor Slabs

13.5.1 Formations of the structures should be inspected by a competent person. Any loose or soft material should be removed and replaced with well-graded, properly compacted granular fill or lean mix concrete. The formation should be blinded if left exposed for more than a few hours or if inclement weather is experienced.

13.5.2 Following excavation of the basement the floor slab will be founded upon London Clay strata. It is expected that a small amount of heave will occur due to the removal of the overlying ground and the slab construction should be design to accommodate this.

13.6 Excavations

13.6.1 Excavations will be required at the site for services and construction works. These are anticipated to remain stable for the short term only.

13.6.2 It is recommended that the stability of all excavations should be assessed during construction. The sides of any excavations into which personnel are required to enter, should be assessed and where necessary fully supported or battered back to a safe angle.

13.6.3 In addition, the basement excavation will be located beneath an existing structure. The progression of the basement excavation will need to consider the potential impact to existing structures both on and off site and provide adequate and appropriate support.

13.7 Groundwater Control

13.7.1 During the investigation groundwater was not observed although the sand within BH1 was reported to be wet.

13.7.2 During return monitoring groundwater levels were recorded between 0.98m and 1.45m below ground level.

13.7.3 Subject to seasonal variations, any groundwater encountered during site works should be readily dealt with by conventional pumping from a sump.

14 IMPACT ASSESSMENT

14.1 Geological Impact

14.1.1 The published geological maps indicate that the Lynch Hill Gravel directly underlies the site, with the London Clay underlying the gravels. The available geological information indicates that the Lynch Hill Gravel are present to 2.44m bgl with London Clay beneath. The lower ground floor of the site, which extends to approximately 3.15m below street level, means that there is a reduced thickness of the Lynch Hill Gravel present. The proposed basement will be founding within the underlying London Clay.

14.1.2 The London Clay is unlikely to be prone to seasonal shrinkage and swelling that arises due to changing water content in the soil. This is due to a lack of significant vegetation capable of removing water within the zone of influence and extensive hard cover minimising the amount of water entering the ground.

14.2 Hydrology and Hydrogeology Impact

14.2.1 Based on all the information available at the time of writing, the risk of flooding from groundwater is considered to be low. The proposed basement is unlikely to have a detectable impact on the local groundwater regime. Appropriate water proofing measures should be included within the whole of the proposed basement wall/floor design as a precaution.

14.2.2 The Lynch Hill Gravel is classed as a Secondary A aquifer but the creation of the basement is considered unlikely to have any impact upon the hydrogeology of the area.

14.2.3 The proposed dwelling will lie outside of flood risk zones and is therefore assessed as being at a very low probability of fluvial flooding.

14.2.4 There are no surface water features on or in the immediate vicinity of the site. It is therefore not anticipated that the site will make any impact upon the hydrology of the area.

14.2.5 The information available suggests that the site lies in an area that is not at risk of surface water flooding. Flooding via this source is therefore considered to be low.

14.2.6 The proposed basement construction is considered unlikely to create a reduction of impermeable area in the post development scenario.

14.2.7 No risk of flooding to the site from artificial sources has been identified.

14.3 Impacts of Basement on Adjacent Properties and Pavement

14.3.1 The proposed basement excavation will be within 5m of a public pavement. It is also within 5m from neighbouring properties. Unavoidable lateral ground movements associated with the basement excavations must be controlled during temporary and permanent works so as not to impact adversely on the stability of the surrounding ground and any associated services and structures.

14.3.2 It is recommended that the site is supported by piled walls during construction with a basement box construction inside the piles. This will ensure that the adjacent land is adequately supported in the temporary and permanent construction. Alternatively, the excavation should proceed in a manner that maintains the integrity of the ground on all sides.

14.3.3 It will be necessary to ensure that the basements are designed in accordance with the NHBC Standards and take due cognisance of the potential impacts highlighted above. This may be achieved by ensuring best practice engineering and design of the proposed scheme by competent persons and in full accordance with the Construction (Design and Management) Regulations. This will include:

- Establishment of the likely ground movements arising from the temporary and permanent works and the mitigation of excessive movements;
- Assessment of the impact on any adjacent structures (including adjacent properties and the adjacent pavement with potential services);
- Determination of the most appropriate methods of construction of the proposed basements;
- Undertake pre-condition surveys of adjacent structures;
- Monitor any movements and pre-existing cracks during construction;
- Establishment of contingencies to deal with adverse performance;
- Ensuring quality of workmanship by competent persons.

14.3.4 Full details of the suitable engineering design of the scheme in addition to an appropriate construction method statement should be submitted by the Developer to the London Borough of Camden.

15 REFERENCES

Groundsure EnviroInsight Report Ref HMD-377-2630082 December 2015

Groundsure GeoInsight Report Ref HMD-377-2630083 December 2015

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Investigation of Potentially Contaminated Sites – Code of Practice BS10175: 2011

BRE Report BR211 ;Radon: Protective measures for new dwellings, 2007

British Standards Institution (1999) BS 5930:2015 *Code of practice for site investigations*. Milton Keynes: BSI

APPENDICES

APPENDIX 1 – FIGURES

APPENDIX 2 – GROUNDSURE REPORT

APPENDIX 3 – OS HISTORICAL MAPS

APPENDIX 4 – BGS BOREHOLE RECORDS

APPENDIX 5 – LONDON UNDERGROUND INFORMATION

APPENDIX 6 – EXPLORATORY HOLE RECORD

APPENDIX 7 – CHEMICAL LABORATORY TEST RESULTS

APPENDIX 8 – GEOTECHNICAL LABORATORY TEST RESULTS

APPENDIX 9 – SOIL GAS MONITORING TEST RESULTS