Basement Impact Assessment

6 Stukeley Street, London WC2B 5LQ

Hydrogeology and Land Stability

21 January 2016

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Summary

A basement impact assessment (BIA) has been undertaken for hydrogeology and land stability in general accordance with CPG4 (2105) for the site at 6 Stukeley Street, WC2B 5LQ in the London Borough of Camden. A basement is proposed to a formation depth of approximately 3.70 m below ground level within the existing building foot print. The existing building was constructed prior to 1873.

The BIA report considered relevant information from existing sources included in the 'Guidance for subterranean development' produced for the London Borough of Camden' (November 2010) and a Groundsure Enviro / Geoinsight Report with historical maps and BGS records.

A ground investigation at the site was undertaken by Ground and Water Ltd in November 2015 which comprised a borehole to 8 m depth below ground level, and two hand dug trial pits to expose existing foundations. The ground investigation confirmed the ground conditions as a predominantly loose granular made ground to a depth of 3.2 m which overlies the dense to very dense Lynch Hill Gravel Member to a depth of 5.0 m which in turn overlies the stiff to very stiff London Clay Formation. Groundwater was recorded at 5.60 m below ground level.

An assessment of hydrogeology has shown that the site is located on a 'secondary A aquifer', which has been confirmed as 'unproductive strata'. It is not anticipated that the development will have any significant impact on groundwater, which is currently 1.33 m below the basement formation. As a precaution it is recommended that groundwater monitoring is undertaken to confirm if seasonal fluctuations impact on the basement construction, so that appropriate mitigation measures can be designed and implemented.

An assessment of land stability has been made from the excavation and construction of the basement. It has been calculated that heave is not expected to exceed 15 mm resulting from the excavation. It has been calculated that temporary removal of lateral support to the existing foundations will result in reduced bearing capacity but with a minimum factor of safety of 1.3, which is considered acceptable for a temporary condition.

From an evaluation of the ground conditions it is concluded that a basement can be safely constructed at the site.

1 Introduction

1.1 Terms of Reference

Maund Geo-Consulting Ltd was instructed on 4 September 2015 by Chris Tomlin of Croft Structural Engineers Ltd to undertake the hydrogeology and geology sections of a Basement Impact Assessment (BIA) for a proposed development at 6 Stukeley Street WC2B 5LQ at National Grid Reference TQ303813.

1.2 Scope and Objective

This report has been written in general accordance with 'Camden geological, hydrogeological and hydrological study - Guidance for Subterranean Development' produced for the London Borough of Camden (LBC) by Arup (November 2010), hereafter referred to as the 'GSD'. The guidance sets out the methodology for a risk-based impact assessment to be undertaken with regard to hydrology, hydrogeology and land stability in support of planning policy DP27. The BIA comprises stages in which information is obtained to enable LBC to make a decision on the impact of the development for the planning application. The LBC Guidance CPG4 (July 2015) requires a BIA to be undertaken for new basements in 5 stages:

1. Screening
2. Scoping
3. Site investigation
4. Impact assessment
5. Review and decision making (By LBC)

This report includes stages 1 to 4 and has been undertaken by Dr Julian Maund, director of Maund Geo Consulting Ltd, who is a chartered engineer and chartered geologist with 30 years' experience.

As a site investigation has already been undertaken as part of the BIA for 6 Stukeley Street on 2 and 3 November 2015 the screening part of the assessment has been assessed on the basis of existing information including the site investigation, so the project has been completed in the following sequence:

1. Background information
2. Site Investigation
3. Screening
4. Scoping
5. Impact Assessment

This report considers the hydrogeological and land stability elements of the BIA only. Hydrology is considered in a separate report by Croft Structural Engineers Ltd.

2 Background Information on the Site

2.1 Information Sources

Background information has been derived from a Groundsure report obtained on 14/09/15 for the site (Appendix A). Geological information has been derived from on-line BGS sources (Geology of Britain Viewer) and the Arup Report. Mapping and aerial photography have been obtained from Streetmap and Google Earth. Information is also derived from the site investigation undertaken specifically for the proposed development by Ground and Water Ltd on 2 and 3 November 2015.

2.2 Location

The site is located on Stukeley Street, at approximate National Grid Reference TQ303813 and Post Code WC2B 5LQ in the Holborn and Covent Garden area of the London Borough of Camden (Figure1).

2.3 Description

The site curently comprises a single storey brick building between No 8 Stuckely Street adjoining to the north east and No. 4 adjoining to the south west. To the rear of the property is No. 10 Stukeley Street.

Figure 1 Street View Image of the site - July 2015

2.4 Present use

The site appears to be currently in use as residential accommodation.

2.5 Proposed development / use

The proposed development relevant to this BIA is understood to comprise the construction of a three storey building with a basement on the existing footprint. The construction is planned to occur in three phases:

Phase 1 - Underpin existing party walls then construct basement.

Phase 2 – Demolish existing ground floor, with temporary supports to existing party walls. Rebuild front wall, install new steel frame, build up blockwall and install new floor joists.

Phase 3 – Construct first, second and roof levels in steel / timber construction.

The proposed use is for two houses, as shown in drawings 841/200 – 206 dated 10/06/15 by Milan Babic Architects Ltd (included in Appendix B).

The basement has the same foot print as the existing building. The basement measures approximately 10.3 m in a SW – NE direction and a maximum of 5.2 m in a NW – SE direction as shown on Drawing 841/200 dated 10/06/15 by Milan Babic Architecture Ltd (Appendix B).

2.6 Topography, geomorphology and drainage

The ground level at the site is level at approximately 24 m AOD. The land in the vicinity of the site is level.

There are no discernible geomorphological features in the vicinity of the site. There are no open watercourses within at least 100 m of the site.

2.7 Geology

Geological information obtained from the Figure 4 of the GSD at 1: 10 000 and the BGS website geological mapping at 1 50 000 scale shows the site to be underlain by the Lynch Hill Gravel Member or Denham Valley Terrace, which is in turn underlain by the London Clay Formation. Figure 6 from the GSD shows a contour plot of the River Terrace Deposit thickness in Camden, which indicates the gravel may be approximately 2.5 to 3 m thick at the site. A review of boreholes in the vicinity available from the BGS Geology of Britain Viewer shows comparable geology. Borehole records from Newton Street and Great Queen Street 100 to the east and 150 m to the south respectively are included in Appendix C. In addition, a recent ground investigation undertaken at the adjacent site at 8 Stukeley Street in October 2015 indicated similar ground conditions. The exploratory hole locations are shown in Appendix C.

2.8 Hydrogeology/groundwater

The property is located on the Lynch Hill Gravel Member which is classified as 'Secondary A Aquifer – Permeable Layers'. (Figure 8 of the GSD) confirms the property is located on unproductive strata.

The site does not lie within the source protection zone of Barrow Hill Pumping Station. The Barrow Hill Pumping Station is located over 2 km to the north west of the site.

Groundsure Enviroinsight Report (Appendix A) shows the site is located on a minor aquifer with high leaching potential.

2.9 Natural Hazards

The Groundsure report (Appendix A) findings on natural hazards are summarised in table 2.1

Table 2.1 Natural Hazards

Natural Hazard	Risk (Stated by BGS in Groundsure report)	Comment
Shrink Swell	Moderate	The site is on the Lynch Hill Gravel Member, which does not have shrink swell characteristics, but the underlying London Clay Formation (LCF) has potential shrink swell properties. Due to its depth over 8 m the LCF will not show any seasonal variation.
Landslides	Very Low	Not applicable to the topography of the site
Soluble Rocks	Negligible	Not applicable to the site geology
Compressible Ground	Negligible	Clay soil of the LCF is subject to consolidation from additional imposed loads, which are limited by appropriate foundation design, however the depth to the LCF beow the Lynch Hill Gravel member reduces this risk.
Collapsible Rocks	Very Low	Not applicable to the site geology
Running sand	Very Low	Not applicable to the site geology

Natural Hazard	Risk (Stated by BGS in Groundsure report)	Comment
Radon	Not in a Radon affected area	No Radon protection measures are necessary

2.10 History of site

The Groundsure Insights Maps in Appendix D includes historical mapping surveys from 1873 to 2014.

The site was developed from the earliest survey of 1873. Stukeley Street was then named Coal Yard and then King's Arms Yard. The building site boundary appears consistent from 1896 onwards with the current site boundary.

From 1896 the building on the opposite side of the street (NE) is shown as a school. The Street is referred to as Goldsmith Street. The School became the City Literary Institute and the street was named Stukeley Street by the 1951 survey.

The building on the site itself appears little changed from the earliest survey of 1873 to the present day.

2.11 Underground features

There are no underground features (basements or tunnels) at the site, however Crossrail passes close to the site. Crossrail runs SW – NE approximately 10 to 20 m to the SE of the site (refer to Section 7 map in the Groundsure Geoinsight Report (Appendix A). The Groundsure Geoinsight Report (Appendix A) has not identified any mining, underground workings or natural cavities within at least 500 m of the site.

2.12 Other factors e.g. contamination and archaeology

The Groundsure Enviroinsight Report (Appendix A) has not identified any 'Environmental Permits, Incidents and Registers' or 'Landfill and Other Waste Sites' within at least 100 m of the site boundary.

No specific archaeological investigation has been undertaken. The 'Groundsure' survey has not identified any known 'Environmentally Designated Sensitive Sites' within 250 m of the site (Appendix A).

2.13 Flooding

The Groundsure report (Appendix A) has not identified any flooding issues within 250 m of the site. The risk of flooding from rivers is shown as 'Very Low'. The BGS indicate the susceptibility from flooding from groundwater as 'moderate'.

3 Site Investigation

A ground investigation was undertaken by Ground and Water Ltd which comprised a window sampler borehole BH1 to a depth of 3.5 m bgl and the hand excavation of two trial pits (TP/FE1 and TP/FE2) to expose foundations on 02/11/15. BH1 was advanced through the base of TP/FE2). Further work was undertaken on 03/11/2015 by extending BH1 with a hollow stem auger to a depth of 8.00 m bgl.

A groundwater monitoring standpipe was installed in BH1 to a depth of 8.00 m.

A ground investigation report of the ground investigation comprising exploratory hole records and laboratory testing by Ground and Water Ltd is included in Appendix E.

The approximate locations of the above exploratory holes together with the exploratory hole records and laboratory test results are shown in Appendix E.

3.1 Details of laboratory tests

Laboratory tests to determine the geotechnical properties of the soil was scheduled by Ground and Water Ltd were carried out by K4 Soils Laboratory generally in accordance with BS1377:1990 and BRE Special Digest 1 2005. The tests included:

1 Atterberg Limit Test

1 Particle Size Distribution Test

2 Water soluble sulphate and pH (BS1377:1990)

2 Sulphate and pH determinations (BRE SD1)

The results of the laboratory tests are included in the Ground Investigation Report in Appendix E.

4 Ground Conditions

4.1 Stratigraphy

The ground conditions encountered in BH1 are summarised in Table 4.1 below.

Table 4.1 Summary of ground conditions

Stratum	General description of Stratum	Depth at top of Strata (m)	Approx. level (m AOD)	Thickness of Strata (m bgl)
MADE GROUND	Laminate floor and screed	0	24.00	0.2
MADE GROUND	Light brown silty gravelly SAND. Sand is fine to coarse grained. Gravel occasional to abundant, fine to medium, sub-angular to sub-rounded brick, concrete and occasional tarmac	0.2	23.80	0.45
MADE GROUND	Light to dark brown gravelly very to slightly to sandy silty CLAY. Sand is fine to medium grained. Gravel is rare to occasional, fine to medium, sub-angular to sub- rounded flint, brick lignite and concrete	0.65	23.35	2.55
Lynch Hill Gravel Member	Assessed as Dense to Very Dense light brown clayey sandy GRAVEL. Gravel is abundant, fine to medium, sub-angular to rounded flint. Sand is fine grained.	3.20	20.80	1.80
London Clay Formation	Assessed as stiff to very stiff dark grey silty CLAY	5.00	19.00	Not known

Notes:

- No groundwater was encountered in the boreholes during boring
- Made ground soil layers have been summarised into sandy and clayey horizons. For full descriptions refer to Appendix E
- There is no insitu testing of the material encountered. The density / consistency is based on BH 1 from 8 Stukeley Street.

4.2 Groundwater

No groundwater was encountered during the drilling of the borehole or excavation of trial pits. A monitoring well was installed in borehole BH1. A reading of groundwater was undertaken on 09/12/15 showing groundwater level at 5.6 m bgl.

Table 4.2 Groundwater monitoring in BH 1

Date of monitoring	Groundwater Depth (metres below ground level – Approximately 24 m AOD)	Approximate Groundwater level (m AOD)
09/12/15	5.60	18.40

4.3 Consideration of the individual strata in detail, with reference to any proposed foundations.

The anticipated formation level of the basement floor slab will be approximately 3.7 m below ground level at approximately a level of 20.30 m AOD, within the dense to very dense Lynch Hill Gravel Member (LHGM).

The ground investigation did not include any density / consistency determination by insitu testing. The density / consistency is based on a ground investigation undertaken by the same contractor at the adjacent site of 8 Stukeley Street in October 2015, which shows a similar sequence of geological strata. It is advised that the ground conditions are confirmed during the excavation phase.

The overall ground model is illustrated in the conceptual model (Figure 7.1) in Section 7 below.

4.3.1 Made Ground

Made ground has been described as comprising two principle layers.

An upper layer from 0.2 to 0.65 m depth is described as a granular material comprising a light brown silty gravelly SAND. Sand is fine to coarse grained. Gravel is occasional to abundant, fine to coarse, sub-angular to sub-rounded brick, concrete and tarmac. This material was assessed as very loose to loose at 8 Stukeley Street.

A lower layer from 0.65 to 3.7 m is described as mid grey-brown grey and dark brown gravelly sandy CLAY. Sand is fine to medium grained. Gravel is occasional, fine to medium, sub-angular to sub- rounded flint, brick, lignite and concrete. This material was assessed as very soft to soft at 8 Stukeley Street.

The made ground is described as an inert material with no visual or olfactory indications of contamination. The building which is founded on the made ground appears to have been constructed prior to the 1873 mapping survey, indicating the

made ground to be of at least that age. The risk of contamination of the minor aquifer from leaching of the made ground is considered to be very low.

4.3.2 Lynch Hill Gravel member

The Lynch Hill Gravel Member (LHGM) has been described as dense to very dense light brown clayey sandy GRAVEL. Gravel is abundant, fine to medium, sub-angular to rounded flint. Sand is fine grained. A Particle Size distribution test at 3.5 m (Appendix E) shows the material to be 62% gravel, 32% sand and 6% silt/clay. From the borehole at 8 Stukeley Street, the density of the LHGM is assessed as dense to very dense on the basis of N100 values from the Heavy Dynamic Probe to a depth of 4.3 m, with an evaluated angle of shearing resistance of 40^0. The deformation modulus (E) has been assessed as 60 MPa on the basis of the comparison with published values for granular materials (Look 2014).

4.3.3 London Clay Formation

The London Clay Formation (LCF) was encountered during the site investigation at a depth of 5 m bgl. The borehole at 6 Stukeley Street did not include any insitu testing of the LFC. For the purpose of the ground model the LCF is assumed to comprise a stiff to very stiff silty high plasticity over-consolidated clay. A single Atterberg limits test at 7.30 m shows a Liquid limit of 56% and plasticity index of 33%, confirming the material is a high plasticity clay.

The undrained strength is assumed to increase linearly with depth from 150 kPa at the interface with the LHGM, which is consistent with LCF at the base of the LHGM for borehole records in the vicinity (see Appendix C). The deformation modulus (E) of the LCF is assumed to increase linearly with depth from 20 MPa at 19 m AOD to 40 MPa at 0 m AOD for purposes of settlement / heave modelling in Section 5 in accordance with published data on the LCF (e.g. Stroud and Butler 1975).

4.4 A review and summary of the derived values of geotechnical parameters.

The geotechnical parameters assessed on the basis of the data obtained from the ground investigation (Appendix E) have been summarised in Table 4.2 as follows:

Table 4.2 Geotechnical Parameters

	Plasticity				Class	Undrained Cohesion	Effective cohesion	Effective angle of shearing resistance	Bulk unit weight*	Deformation Modulus E	K_a	K_p
Strata	LL (%)	PL (%)	PI (%)	MC (%)		Cu (kPa)	C' (kPa)	MPa	kN/m^3	MPa		
Made Ground (granular)	n/a	n/a	n/a	n/a	n/a	n/a	0	16	16*	10**	0.59	1.8
Made ground (cohesive)	n/a	n/a	n/a	n/a	n/a	20	5	11	16*	10**	0.61	1.5
Lynch Hill Gravel Member	n/a	n/a	n/a	n/a	n/a	n/a	0	40**	18*	60**	0.22	4.6
Weathered London Clay Formation	56	23	33	26	CH	150 (at 5.00m)	n/a	n/a	20-22*	20 – 40**	n/a	n/a

Notes:

* BS8004 2015

**Look (2014) table 11.7

*** On basis of published information (e.g. Stroud and Butler 1975)

Active and Passive pressure coefficients k_a and k_p from BS EN 1997-1

5 Geotechnical Assessment of Ground Conditions

5.1 Introduction

The information obtained from the ground investigation on the soil conditions in relation to the proposed basement construction has been assessed for impacts on existing building structures. The principle impacts are ground movements from the excavation for the basement. These movements are vertical movements of the foundation formation level from isostatic readjustment from the excavation and possible impacts of existing structures from the basement wall construction.

5.2 Presumed Bearing resistance

The foundation formation level of the basement will be at approximately 20.30 m AOD. On the basis of an angle of shearing resistance (Φ') of 40^0 and water table at 18.4 m AOD the presumed bearing resistance will be at least 200 kPa (Tomlinson 2001). Settlement will be < 25 mm and be immediate due to the granular nature of the formation. Net long term settlement will be negligible.

5.3 Effect of Heave from soil excavation

The proposed basement will require the excavation from the exiting ground level of approximately 24.0 m AOD to approximately 20.30 m AOD. For purposes of this assessment it is assumed the unit weight of the soil (γ_k) to be removed is conservatively assessed as 20 kN/m^3 (with reference to Figure 1 of BS8004:2015) giving a total removed load of -74kPa.

The ground model is based on the ground conditions assessment in Section 4. The heave has been evaluated using Pdisp version 19.3, which shows a maximum heave of ~15 mm (without allowing for basement slab loading). (Appendix F for Pdisp output, plan and sections).

5.4 Sub –surface Concrete

The results of lab testing for sulphate and pH are summarised below in Table 5.1. The full analysis is included in Appendix E.

Table 5.1 Sulphate and pH Classification

Sample depth	Soil Type	Sulphate S04 2:1 extract	pH	Sulphate Class (DS)	ACEC Class
3.5	Lynch Hill Gravel member	0.99 %	7.55	DS-1	AC1s
7.30	London Clay Formation	0.29%	7.65	DS-1	AC1s

It is recommended that an overall design sulphate class of DS-1 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC1s is adopted.

5.5 Potential Impact on the Existing Structure from Basement Construction

The proposed basement will be supported by underpinning the existing party wall foundations using a 'hit and miss' system of reinforced concrete panels. A method statement for the proposed temporary support of the existing building while the underpinning is undertaken is contained within the Basement Method Statement included in the report with reference number BIA – 150912 by Croft Structural Engineers Ltd.

Trial pits were undertaken by Ground and Water Ltd in November 2016 (See Appendix E) to expose the existing wall footings.

Trial pit FE1 exposes the footings for party wall on the north east side of the property with No. 8 Stukeley Street. The wall has a foundation 130 mm wider than the wall from 500 to 670 mm depth. The wall thickness is 225 mmThe full depth of the footing was not exposed in the excavation due to the presence of a concrete slab at 670 mm depth. The footing has an assumed total width of 485 mm (assuming the foundations widths are symmetrical).

Trial Pit 2 exposes the south east facing back wall. The footing comprises three brick corbels extending 180 mm from the wall to a total depth of 700 mm below ground level. The wall thickness is 225 mm giving a footing width of 685 mm (assuming the foundations widths are symmetrical).

The wall loadings have been determined by Croft Structural Engineers for the party walls of 57.1 kN/m (combined dead and live) and 29.6 kN/m for the front and back walls.

The granular foundation formation fill has an assessed angle of shearing resistance of 29^0.

Table 5.2 Assessment of temporary impact of basement on existing foundations

Soil Type	Before or after excavation to foundation formation level	Frictional component kN/m ($0.5\gamma B N_\gamma$)	Cohesive component kN/m ($C_u N_c$)	Overburden kN/m ($\gamma D N_q$)	Ultimate bearing capacity kN /m	Wall load kN/m
Sand and Gravel Fill	Before- Party Wall	75	n/a	184	259	57
Sand and Gravel Fill	After - Party Wall	75	n/a	nil	75	57
Sand and Gravel Fill	Before- front and rear walls	106	n/a	184	289	29
Sand and Gravel Fill	After – front and rear walls	106	n/a	nil	106	29

Table 5.2 assesses the impact of excavation of the ground to the base of the existing foundations. It demonstrates that while the ultimate bearing capacity is reduced as a result of the excavation there is still a minimum factor of safety of 1.3 against failure for the party wall and 3.65 for the back wall. This is a temporary situation until the underpin is constructed to take the wall loading onto the dense LHGM gravel at the basement formation level. The Method Statement indicates that the existing wall will also be supported by needle beams to provide stability in the temporary situation.

6 Screening

6.1 Introduction

Screening is undertaken as outlined in Section 6.2 of the GSD recommendations. It identifies if there are hydrogeological and land stability issues associated with the proposed development that requires detailed analysis and investigation. If there are no significant issues identified in the screening stage, then further stages are not required. The report follows the flow charts set out in CPG4, and makes reference to the GSD.

6.2 Subterranean (Groundwater) flow

This section answers questions in Figure 1 of CPG4:

The source of information for the assessment of subterranean flow is from the Arup Report and a site specific Groundsure Environmental Insight Report obtained in September 2015 for Stukeley Street (Appendices C and D).

Table 6.1: Responses to Figure 1, CPG4

Question	Response	Action required
1a. Is the site located directly above an aquifer	The site is located on the Lynch Hill Gravel Member, a secondary A aquifer – Permeable Layers'	Safeguard against contamination of groundwater by appropriate site practice.
1b. Will the proposed basement extend beneath the water table surface.	No Preliminary indications are groundwater is 5.6 m bgl (18.40 m AOD)	Monitor groundwater levels to determine the if ground water level is effected by seasonal variations
2. Is the site within 100m of a watercourse, well, or potential spring line.	None. There are no known wells or spring-lines within 100 m of the site[b,c].	None
3. Is the site within the catchment of the pond chains on Hampstead Heath	No. The site is not within the catchment of the ponds[b]	None
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas.	No The basement is entirely within the existing building.	None
5. As part of site drainage, will more surface water than at present be discharged to ground (e.g. via soakaways and/or SUDS).	No	None
6. Is the lowest point of the proposed excavation (allowing for any drainage and foundation space under the basement floor) close to, or lower than, the mean water level in any local pond or spring lines.	No. There are no recorded local ponds or spring lines within 250 m of the site	None

a. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 8).*

b. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 11).*
c. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 14).*

In summary, the site is located on the Lynch Hill Gravel Member. A borehole drilled at the site to a depth of 8.0 m indicated that groundwater was measured at 5.60 m bgl. For further details refer to section 4 of this report.

6.3 Slope / Land Stability

This section answers questions posed by Figure 2 in CPG4.

Table 6.2: Responses to Figure 2, CPG4

Question	Response	Action required
1. Does the site include slopes, natural or man made, greater than about 1in 8?	No The site is on level ground at approximately 24.0 m AOD.	None
2. Will the proposed re-profiling of the landscaping at site change slopes at the property boundary to greater than about 1 in 8?	No.	None
3. Does the development neighbour land including railway cuttings and the like with a slope greater than about 1 in 8?	No.	None
4. Is the site within a wider hillside setting in which the general slope is greater than about 1 in 8?	No.	None
5. Is the London Clay the shallowest stratum on site?	No. London Clay is overlain by 1.8 m of superficial soil comprising 3.2 m of made ground and a further 1.80 m of very dense Lynch Hill Gravel Member.	None
6. Will any tress be felled as part of the proposed development and/or are any works proposed within any tree protection zones where trees are to be retained?	No.	None

Question	Response	Action required
7. Is there a history of shrink/swell subsidence in the local area and/or evidence of such at the site.	No records. The site is located on the Lynch Hill Gravel Member which is described as sand and gravel deposit which is not affected by shrink and swell movements	None.
8. Is the site within 100 m of a watercourse or a potential spring line?	No[a,b].	None
9. Is the site within an area of previously worked ground?	Borehole record for the site show made ground extends to 3.2 m bgl. Historical maps indicate that a building has been on the site since 1871. The made ground is therefore likely to predate 1871. The made ground is described in the borehole record for the site as a (loose) brown clayey gravelly sand with brick cement and flint and brown gravelly sandy clay with gravel of flint, lignite, brick and concrete.	Made ground is a loose / soft material and will not form a founding stratum,
10. Is the site within an aquifer?	The site is located on the Lynch Hill Gravel Member, a secondary A aquifer – Permeable Layers' (See also Table 5.1)	None
11. Is the site within 50m of the Hampstead Heath Ponds?	No.	None
12. Is the site within 5 m of a highway or pedestrian right of way?	Yes	Effects of any impact on the highway such as subsidence or damage to services will be mitigated by the hit and miss underpinning as outlined in the method statement.

Question	Response	Action required
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	New foundations may be significantly deeper than those of neighbouring properties which do not have basements. This risk will be mitigated by design in accordance with relevant design standards.	Impact assessment
14. Is the site over (or within the exclusion zone of) any tunnels?	The site is located within 10 m of a Crossrail tunnel	None

Table 6.2 (continued): Responses to Figure 2, CPG4

a. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 8).*

b. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 11).*
c. *Camden Geological, Hydrogeological, and Hydrological Study, Arup, 2010. (Fig. 14).*

d. Groundsure Report (Appendix C) October 2015

In summary, the site is located on level ground over, made ground to 3.2 m depth and the Lynch Hill Gravel Member to 5.00 m depth which overlies the London Clay Formation.
Foundation levels will be lower with respect to adjacent properties which will require mitigation measures in the retaining wall design.

7 Scoping

7.1 Introduction

This section considers the output from the screening survey where further actions are required. It considers the scope of information required in addressing these actions and what the potential impacts are of the basement construction. The existing ground conditions and the location of the basement can be summarised in a conceptual model as indicated in Figure 7.1.

Figure 7.1 Conceptual Site Model

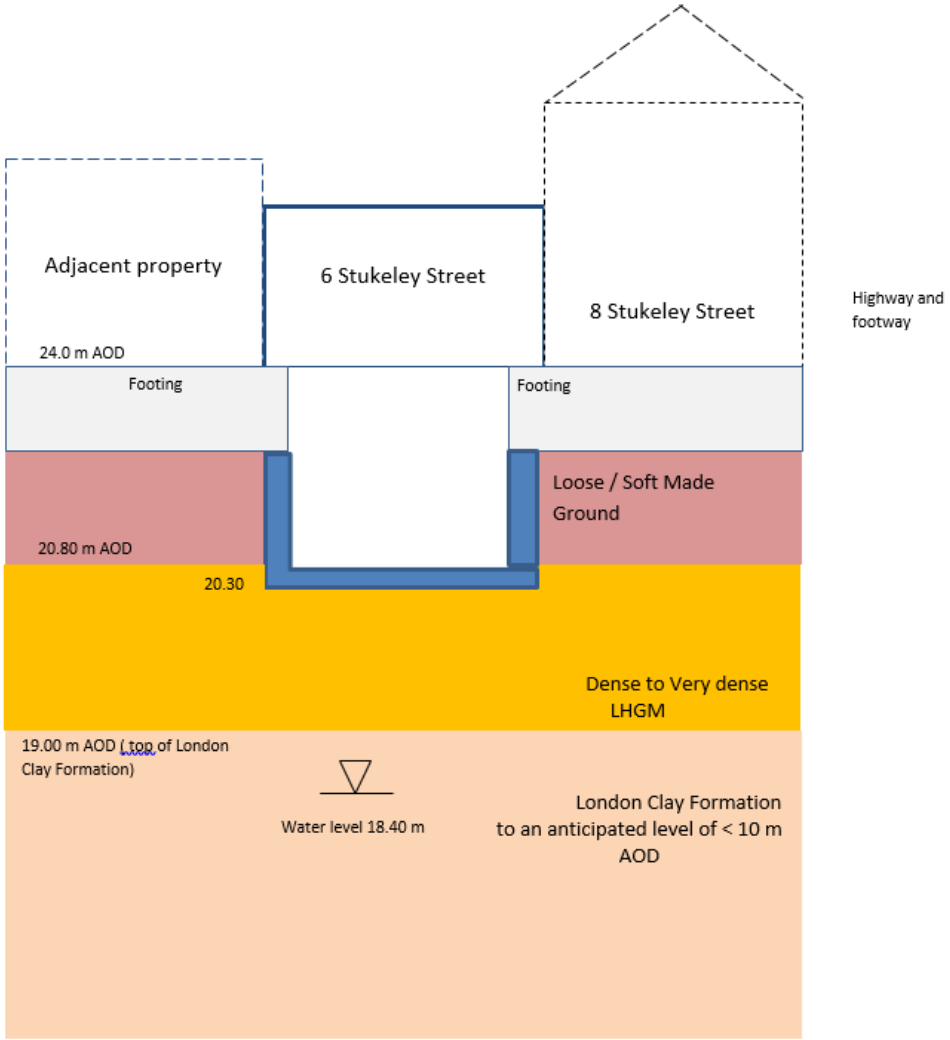

Table 7.1 Summary of Scoping Requirements - Hydrogeology

Screening questions of concern - Hydrogeology	Potential Impact	Mitigation
1a. Is the site located directly above an aquifer	The site is located on the Lynch Hill Gravel Members, a secondary A aquifer – Permeable Layers'	Safeguard against contamination of groundwater by appropriate site practice.
1b. Will the proposed basement extend beneath the water table surface.	No	Monitor groundwater levels to determine the if ground water level is effected by seasonal variations

Table 7.2 Summary of Scoping Requirements – Land Stability

Screening questions of concern – Land Stability	Potential Impact	Mitigation
9. Is the site within an area of previously worked ground?	Borehole record for the site show made ground extends to 3.2 m bgl. Historical maps indicate that a building has been on the site since 1871. The made ground is therefore likely to predate 1871. The made ground is described in the borehole record for the site as a (loose) brown clayey gravelly sand with brick cement and flint and brown gravelly sandy clay with gravel of flint brick and cement.	Made ground is a loose / soft material and will not form a founding stratum of the basement, but its strength is assessed for supporting existing footings during basement construction.

Screening questions of concern – Land Stability	Potential Impact	Mitigation
10. Is the site within an aquifer?	The site is located on the Lynch Hill Gravel Members, a secondary A aquifer – Permeable Layers' (See also Table 5.1)	Safeguard against contamination of groundwater by appropriate site practice during construction
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	New foundations may be significantly deeper than those of neighbouring properties which do not have basements. This risk will be mitigated by design in accordance with relevant design standards, indicated in the Basement Method Statement	As indicated in Basement Method Statement

8 Impact Assessment

8.1 Groundwater

8.1.1 Groundwater level

The screening process has shown from preliminary borehole information that groundwater occurs at a depth of 5.60 m bgl, or approximately 18.40 m AOD. At this level groundwater will be below the excavation depth of 3.7 m (20.30 m AOD). The ground water level should be confirmed by subsequent groundwater monitoring to determine if there is any seasonal variation.

8.1.2 Impact on groundwater by any contamination from the made ground

The made ground is described as an inert material with no visual or olfactory indications of contamination. The building which is founded on the made ground appears to have been constructed prior to the 1873 mapping survey. The risk of continuation of the minor aquifer from leaching of the made ground is considered to be very low.

8.2 Land Stability

8.2.1 Is the site within an area of previously worked ground

The made ground is described as an inert material with no visual or olfactory indications of contamination. The building which is founded on the made ground appears to have been constructed prior to the 1873 mapping survey. The risk of continuation of the minor aquifer, or impact on human health from the made ground is considered to be very low, although a minor exceedance of lead (compared against residential gardens without home grown produce) was identified in TP 2 (Appendix B). As a precaution suitable Person Protective Equipment should be used by construction workers in the excavation of the made ground.

The basement foundation formation level will be below the base of the made ground, founding on the dense to very dense Lynch Hill Gravel Member.

8.2.2 Is the site within an aquifer

The site is situated over a secondary A aquifer – Permeable Layers'. Information from the borehole indicates the groundwater level is at 18.60 m AOD, or 5.60 m below ground level and 1.90 m below the basement foundation formation level. At this level the basement excavation and construction will not impact on groundwater.

Monitoring of the groundwater installation will be undertaken to confirm any seasonal fluctuations. If it is shown that the groundwater can fluctuate above the basement foundation formation level appropriate groundwater control will be designed.

8.2.3 Proximity to adjacent buildings

Due to the dense granular nature of the basement formation the impact on adjacent buildings will be negligible from heave / settlement as demonstrated in Section 5 of this report.

8.2.4 Soil removal / Excavations

The ground investigation indicates that the soil can be readily excavated using conventional plant appropriate for the access constraints imposed by the location of the property. Groundwater is not anticipated to be encountered, based on monitoring records from the site investigation for the full depth of the excavation.

The impact of the excavation on ground heave has been assessed in Section 5 of this report, which concludes that heave will be less than 15 mm, which is considered within normal construction tolerance.

An assessment of the reduction in bearing capacity for the exiting footings has been made in Section 5 of this report. It is concluded that the reduction in bearing capacity will be reduced in the temporary situation to a factor of safety 1.3 of the combined dead and live loads for the party wall and a factor of safety of 3.65 for the front and back walls.

8.2.5 Stability of Temporary Excavations

It is proposed that the basement retaining walls will be constructed using a hit and miss underpinning technique, with temporary propping which is set out in the Basement Method Statement which is included as Appendix A in report BIA –issued by Croft Structural Engineers Ltd.

8.2.6 Groundwater Control

As discussed in Section 8.1.1 groundwater is not anticipated to effect the construction works. Groundwater has been measured at 5.60 m bgl, below the basement formation level. If it is found that further to monitoring groundwater does impact the works, groundwater would be controlled by pumping to a tank prior to disposal by tanker to an approved facility. Alternatively discharge of the groundwater could be made to the sewer subject to an agreement from the local water company in terms of water quality, flow rate and quantity.

8.3 Monitoring of groundwater and ground movements

Groundwater levels should be monitored before the works. If groundwater is encountered at or above the formation level before construction, monitoring of adjacent structures and the highway should be carried out before, during and after construction.

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