Basement Impact Assessment
1A St John's Wood Park,
London NW8 6QS

Hydrogeology and Land Stability

2 December 2015

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1 Non-Technical Summary

A basement impact assessment (BIA) has been undertaken for hydrogeology and land stability in general accordance with CPG4 (2015) for the site at 1A St John's Wood Park, London NW8 6QS. A basement is proposed as part of a development for a new house at a site currently comprising existing garages and an access road.

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 July and September 2015 which comprised boreholes to 12.5 m depth below ground level with insitu penetration testing and sampling. The ground investigation confirmed the ground conditions as made ground to a depth of 1.5 m which overlies stiff to very stiff London Clay Formation. A perched groundwater was recorded at approximately 0.5 m below ground level.

An assessment of hydrogeology has shown that the site is located on a secondary aquifer, which has been defined as 'unproductive strata'. It is anticipated that the perched water can be managed by pumping during construction

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 31 mm resulting from the main excavation, which can be accommodated within construction tolerance by the appropriate use of void formers.

The basement is located 8 m the Jubilee line tunnel. Although this is outside the 3 m exclusion zone it is recommended this distance is assessed and confirmed by LUL.

The basement is located approximately 4 m from a public highway. The impact on the highway should be assessed before during and after construction by monitoring of surface movement

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

2 Introduction

2.1 Terms of Reference

Maund Geo-Consulting Ltd was instructed on 8 July 2015 by Chris Tomlin of Croft Structural Engineers Ltd to undertake the hydrogeology and geology sections of a Basement Impact Assessment (BIA) at 1A St John's Wood Park in connection with a proposal to construct a house with a basement at the site. Outline drawings of the development are included in Appendix A)

2.2 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 '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 a new basement 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 geologist with 30 years' experience.

As a site investigation has already been undertaken as part of the BIA for 1A St John's Wood Park on 1/7/2015 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.

3 Background Information on the Site

3.1 Information Sources

Background information has been derived from a Groundsure report obtained on 16/07/15 for the site (Appendix B). Geological information has been derived from on-line BGS sources (Geology of Britain Viewer) and the GSD. Mapping and aerial photography have been obtained from Streetmap and Google Earth. Information is also derived from a recent site investigation, reported by Ground and Water Ltd (July 2015).

3.2 Location

The site is located on the west side of St John's Wood Park, at approximate National Grid Reference TQ26782674 and Post Code NW8 6QS, in Swiss Cottage, London Borough of Camden (Figure2.1).

3.3 Description

The site comprises an access road to a row of garages and six of the garages at the eastern end of the row. The access road is secured by a steel tube gate from St John's Wood Park road. Between the eastern end of the garages and St John's Wood Park is an area enclosed by a wooden panel fence to the south and a brick wall to the east and north. The enclosed area is partially obscurred by vegetation and a tree. Immedaitely to the south of the site is a row of substantial two storey brick houses.

3.4 Present use

The site appears to be used as an access road for a row of garages, and six of the garages.

3.5 Proposed use

The proposed development relevant to this BIA is understood to comprise the construction of a new house with a basement approximately 24 m long west to east and 12 m wide north to south. The proposed house has an area of approximately 12 m by 12 m, with three storeys above the basement. Outline drawings of the proposed development are shown in Appendix A.

3.6 Topography, geomorphology and drainage

The site is level at approximately 52 m AOD. The land around in the vicinity of the site has a slight fall in level to the south east.

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.

3.7 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 London Clay Formation. There are no superficial deposits within 0.5 km radius of the site.

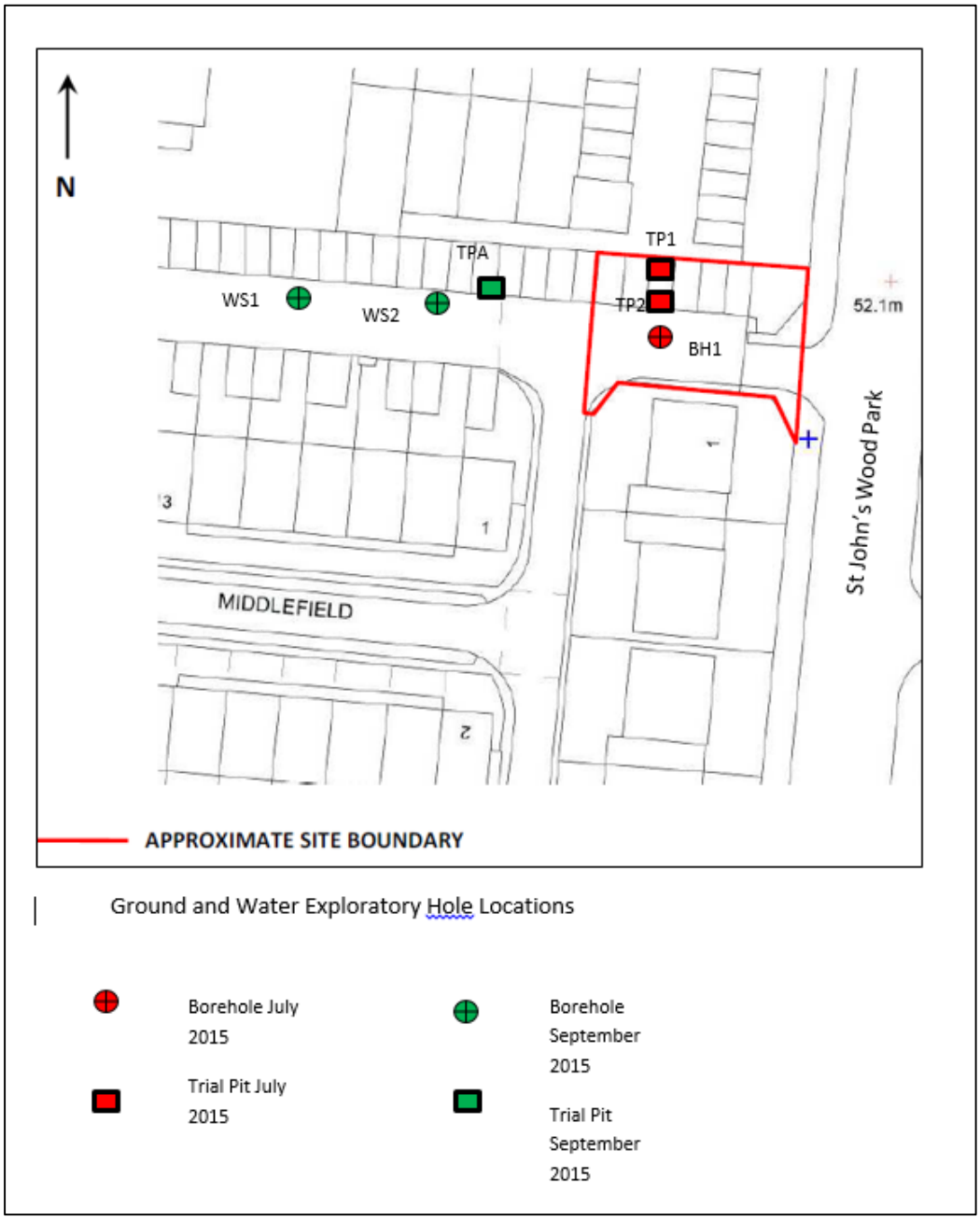


Figure 2.1 Location of 1A St John's Wood Park and Exploratory Hole Locations

3.8 Hydrogeology/groundwater

The property is located on the London Clay Formation. London Clay is classified as 'unproductive strata'. The Camden Aquifer designation map (Figure 8 of the GSD) confirms the property is located on unproductive strata.

The site lies within the outer source protection zone of Barrow Hill Pumping Station. The Barrow Hill Pumping Station is located 939 m to the east of the site.

3.9 Natural Hazards

The Groundsure report (Appendix B) findings on natural hazards are summarised in table 3.1

Table 3.1 Natural Hazards

Natural Hazard	Risk (Stated by BGS in Groundsure report)	Comment
Shrink Swell	Moderate	The site is on a clay soil, subject to shrinkage and swell from desiccation. Desiccation due to seasonal factors could be up to 1.0 m below ground level in London Clay which has a high volume change potential (NHBC)
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 is subject to consolidation from additional imposed loads, which are limited by appropriate foundation design
Collapsible Rocks	Very Low	Not applicable to the site geology
Running sand	Negligible	Not applicable to the site geology

Natural Hazard	Risk (Stated by BGS in Groundsure report)	Comment
Radon	No protection required	The BGS indicates no special radon measures need to be incorporated into the design of the proposed basement

3.10 History of site

The Groundsure report in Appendix B includes historical mapping surveys from 1871 to 1995.

The site was developed from the earliest survey of 1871 with two semi-detached houses. The 1953 survey shows former semi-detached house on the site as a 'ruin' together with other houses in the vicinity also shown as 'ruin'. It is considered this may be a result of WW2 bomb damage.

The map surveys indicate the existing properties lying immediately south of the site were constructed between 1965 and 1969. The garages were constructed between the 1953 and 1960 surveys. The site has remained largely unchanged since then to the present day.

3.11 Underground features

The closest tunnels are those of the Jubilee Line which run north south beneath St Johns Wood Park and Finchley Road.

The Groundsure report (Appendix B) indicates the Jubilee Line is 5 m from the eastern boundary of the site at St John's Wood Park and approximately 8 m from the basement footprint itself, at a depth of 18 m bgl. Another running tunnel of the Jubilee line beneath Finchley Road is 54 m from the western boundary of the site. A further railway tunnel runs east west at 49 m to the north (London Overground Railway) The approximate location of these tunnels is shown in Figure 3.1 below:

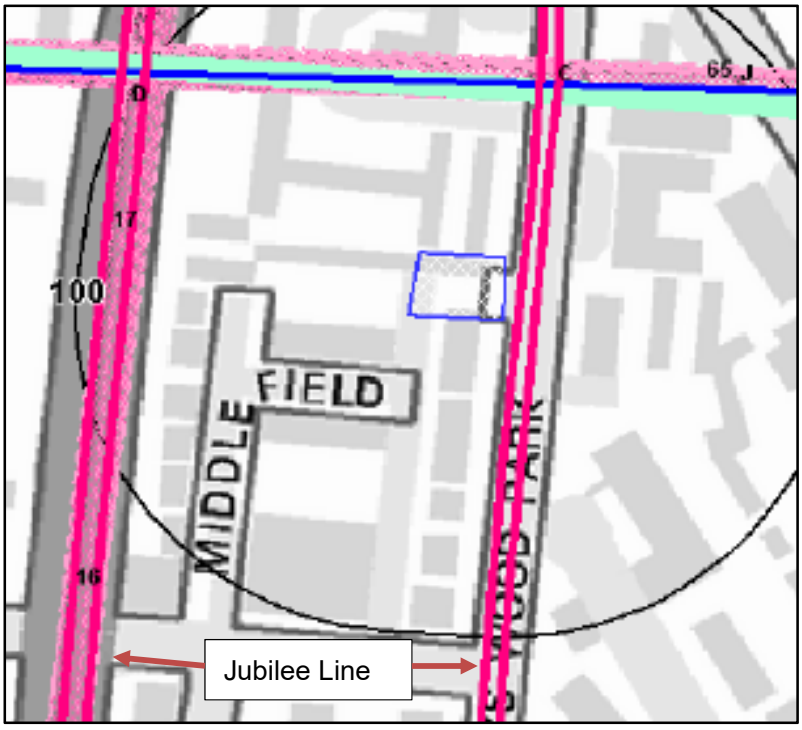


Figure 3.1 Location of railway tunnels in relation to the site at 1A St John's Wood Park

The GroundSure report (Appendix B) has not identified any mining, underground workings or natural cavities within at least 500 m of the site.

3.12 Other factors e.g. contamination and archaeology

The GroundSure report (Appendix B) 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 B).

3.13 Flooding

The GroundSure report (Appendix B) has not identified any flooding issues within 250 m of the site.

4 Site Investigation

A ground investigation was undertaken by Ground and Water Ltd on 1st July 2015. A ground investigation report of the ground investigation comprising exploratory hole records and laboratory testing is included in Appendix C.

The ground investigation comprised:

- One Premier Windowless Sampler Borehole to a depth of 12.50 m,
- Two hand excavated trial pit (TP1 and TP2) to determine the nature of the foundation to the garages.
- The in-situ strengths of the subsoil encountered were assessed by means of standard penetrations tests,
- Disturbed soil samples were obtained from both exploratory holes for laboratory geotechnical testing and further examination.
- A sealed 63 mm diameter combined bio-gas and groundwater monitoring well was installed at a depth of 5.0 m in the borehole BH1.

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

4.1 Details of laboratory tests

Laboratory tests to determine the geotechnical properties of the soil (London Clay only) 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:

3 Moisture Content

4 Atterberg Limits

2 Sulphate and pH determinations

1 Undrained triaxial test

1 Swelling test

In addition 2 samples of Made Ground BH1 at 0.3 m and TP/FE1 at 0.3 m depth were analysed for a suit of contamination tests by QTS Environmental Ltd which included:

Semi and Heavy Metals

Asbestos Screen

Organic compounds (PAHs, Fuels Oils and BTEX)

The results of the laboratory tests are included in Appendix C.

A ground investigation was also undertaken by Ground and Water Ltd in September 2015, at land off Middlefield, adjacent to the 1A St John's Wood Park, which comprised:

- Two Premier Windowless Sampler Borehole to a depth of 12.45 m,
- Two Super Heavy Dynamic Probes from the base of the window sampler holes to 16.50 m depth.
- The in-situ strengths of the subsoil encountered were assessed by means of standard penetrations tests STPs and Dynamic Probe blows per 100 mm,
- Disturbed soil samples were obtained from both exploratory holes for laboratory geotechnical testing and further examination.
- Two sealed 63 mm diameter combined bio-gas and groundwater monitoring well was installed at a depth of 5.0 m in the borehole WS1 and WS2.
- A hand dug trial pit was excavated to expose existing foundations

The location of the exploratory holes from the September 2015 investigation is included in Figure 2.1. The exploratory hole and lab test records are included for information in Appendix D. The information from the September 2015 investigation is also considered in the BIA in conjunction with July 2015 investigation.

5 Ground Conditions

5.1 Stratigraphy

The ground conditions encountered in BH1 are summarised in Table 5.1 below:-

Table 5.1 Summary of Ground Conditions

Stratum	General description of Stratum	Depth at top of Strata	Thickness of Strata (m bgl)	Undrained Cohesion kPa / (STP)
MADE GROUND	Tarmac over black and red brown sandy gravel	0	0.4 to 0.65	n/a
HEAD DEPOSITS (Possibly Made Ground)	Dense / Stiff brown and orange very clayey fine to medium gravelly silty medium to coarse SAND and locally a sandy gravelly CLAY (in WS2 and TP FE1 only)	0.65 (WS2 only)	0.85 (proven)	81 / (18)
LONDON CLAY FORMATION	Firm brown becoming stiff to very stiff grey silty CLAY. Silt / sand lenses noted along with selenite crystals and claystones.	0.4 – 1.50	12.45 m (proven)	32 to 189 / (7 to 42)

Note – No groundwater was encountered in boreholes or trail pits during boring

Note – No groundwater was encountered in boreholes or trail pits

The undrained cohesion of the London Clay Formation is based on a correlation of SPT to undrained correlation of 4.5 assuming a plasticity index of >30% after Stroud and Butler (1975).

5.2 Groundwater

Groundwater was not encountered in BH1 when drilled on 01/07/15. A monitoring well was installed to a depth of 5.40 m in BH1. A measurement of groundwater on 04/08/15 showed a level of 0.49m bgl. Due to the apparent discrepancy between the borehole at the end of drilling and the subsequent groundwater level in the well, which might have been caused by surface water inundation, the well was bailed on 05/08/15 to a depth of 4.84 m and subsequently re-measured. Groundwater returned to 0.74 m depth on 10/08/15 indicating that there is a genuine perched water level less than 1 m

below ground level. The monitoring of WS1 and WS2 from the investigation at the adjacent site off Middlefield indicate a similar perched water level of < 1.0 m below existing ground level (approximately at 51.0 m AOD). Results of the monitoring of the wells are shown in table 5.2 below:

Table 5.2 Groundwater monitoring in BH 1

Expl. Hole No.	Approx. Ground level m AOD	Base of installation Depth	Base of installation Level	Water Depth	Water Level	Water Depth	Water Level	Water Depth	Water Level	Water Depth	Water Level	Water Depth	Water Level	Water Depth	Water Level	Water Depth	Water Level
BH1	52	5.00	47.00	0.49	51.51	0.54 (Prior to bailing)	53.46	4.23 (After bailing)	49.77	1.63	50.37	0.74	51.26	0.49	51.51	0.47	51.53
WS1	52	5.10	46.90											2.59	49.41	0.94	51.06
WS2	52	4.45	47.55											0.52	51.48	0.23	51.77
Date of Monioting				04/08/15		05/07/15		05/08/15		10/08/15		13/08/15		23/11/15		03/11/15	

Table 5.2 Notes:

1. Depth in metres below ground level,
2. Level in metres above ordnance datum

A rising head test undertaken in borehole WS2 by Ground & Water Ltd (Appendix D) has an infiltration rate of 5.82 x 10^{-6} m/s. This indicates a characteristic permeability of a clayey sand and it likely to be associated with the made ground or head deposits, which were encountered in WS2 to a depth of 1.5 m bgl.

The high plasticity London Clay Formation typically has a permeability of 10^{-8} to 10^{-10}, however the reported presence of sandy and silty layers in the borehole records WS1 and WS2 at the Middlefield site does not preclude localised areas of higher permeability of the London Clay.

The groundwater monitoring indicates that groundwater inflows, which are anticipated to be modest on the basis of the permeability, may arise from perched water, within fill material to a depth of 1.5 m.

5.3 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 3.5 m below ground level at approximately a level of 48.50 m AOD, within the London Clay Formation (LCF). 1

It is understood from the Basement Construction Method Statement prepared by Croft Structural Engineers Ltd, that the basement will be supported by a contiguous concrete piled wall. The basement design assumes a water level of 0.5 m bgl. Total wall loading will not exceed 67kN/m while the basement floor slab will have a combined load of 13 kPa.

The overall ground model is illustrated in the conceptual model in Section 7.2 below.

5.4 Made Ground

Made ground is described as comprising two layers.

5.4.1 Tarmac over sandy gravel (subbase?)

An upper layer from 0.2 to 0.65 m depth is described as tarmac over black and red brown sandy gravel. This material is associated with pavement construction for the access road to the garages.

A broad suite of chemical contamination testing was undertaken and assessed by Ground and Water Ltd (Appendix C). The investigation at 1A St John's Wood Park recovered a sample of the made ground with a concentration of lead of 470 mg/kg from BH1 at 0.3 m, which exceeds the guidelines for an end use as 'Residential with home grown produce'. It should be noted that the architect's drawings (Appendix A) do not show any garden area for the development at the site. The Croft Structural Engineers Ltd Basement Method statement recommends that that any lead contaminated soil is delineated and removed from the site prior to construction.

5.4.2 Made Ground (Described as Head possibly Made Ground in Ground Investigation Report)

A lower layer from 0.65 to 1.5 m depth forming a deposit 0.85 m thick is described as mid brown to orange brown very clayey gravelly SAND. The sand is medium to coarse grained and the gravel is fine to medium flint. The ground investigation records describe this material as Head, possibly made ground. Similar deposits have been described from Trial Pit TPA at an adjacent site investigation (Appendix D).

This assessment considers that Head is an unlikely origin as there is no evidence of other Head deposits in the vicinity according to BGS records. Historical maps (Appendix B) from 1953 show there were many ruined buildings in the area included at the site itself. The ruined buildings may relate to bomb damage during the Second World War and the made ground may represent infilling of bomb craters, for reconstruction. The SPT N value indicated the material is dense, possibly characteristic of a selected engineering fill which has been compacted to form a subbase. The material has an assessed angle of shearing resistance of 35^0. The deformation modulus (E') has been assessed conservatively as 10 MPa.

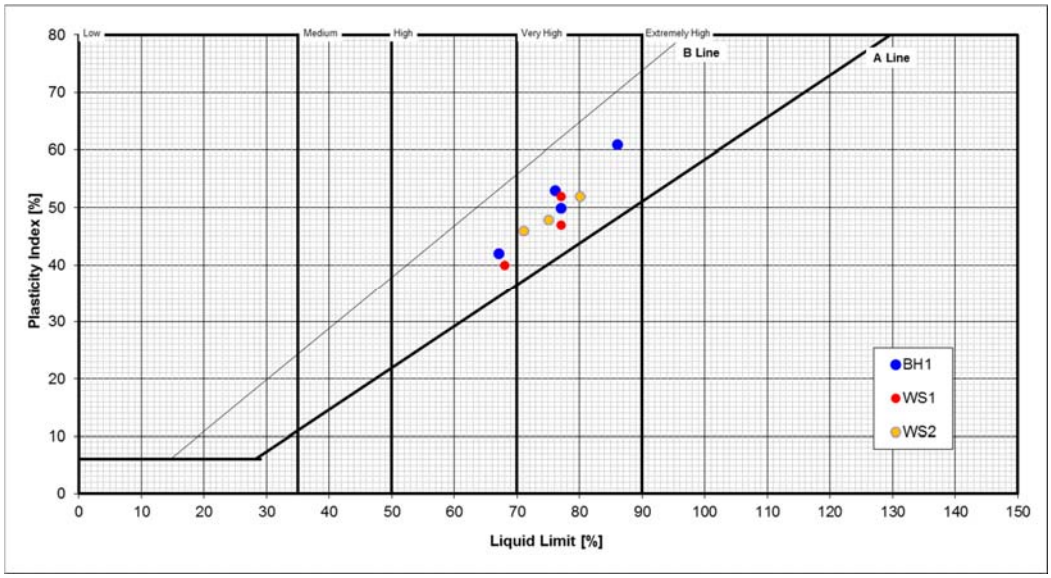
5.5 London Clay Formation

The London Clay Formation (LCF) was encountered during the site investigation from 0.4 m depth in WS1 and 1.5 m depth in WS2. The London Clay formation comprises a stiff to very stiff silty high plasticity over consolidated clay, with the presence of claystones, selenite crystals and silty fine sandy partings (See exploratory hole records in Appendix C for full details). The characteristic geotechnical properties of the LCF are given in the following sections.

5.6 Plasticity

From the laboratory testing the London Clay has a Plasticity Index ranging from 42 to 61% and a Liquid Limit ranging from 67 to 86%, as shown in the Atterberg Chart in Figure 5.1 below, characterising the material as having a high to very high plasticity, typical of the London Clay Formation (e.g. Stroud and Butler 1975).

Figure 5.1 Atterberg Chart



Ground and Water Ltd comment that the London Clay formation has a high volume change potential as classified by BRE (Digest 240) and NHBC (2012). Ground and Water have determined that the London Clay Formation is heavily over consolidated on the basis of the liquidity Index which ranges from 0.02 to 0.04.

5.7 Strength (Undrained Cohesion)

The undrained cohesion of the London Clay Formation is based on a correlation of SPT to undrained correlation of 4.5 assuming a plasticity index of >30% after Stroud and Butler (1975). From 12.5 m bgl the shear strength was assessed by super heavy dynamic probing (SHPD) by Ground and Water Ltd on the basis of the number of blows over 300 mm to give an equivalent SPT N value. The initial zone from 12.5 to

13.5 m depth from the SHDP records from DP1 and DP2 (Appendix C) was ignored in Figure 5.2 due to potential ground disturbance from removal of the casing from the Window Sampler hole giving uncharacteristically low readings, which was not considered to be representative of the actual ground conditions.

Based on the depth plot in Figure 5.2, the undrained cohesion shows a linear increase in depth from 25 kPa at 1m bgl to 250 kPa at 16 m bgl. This strength progression with depth is indicated by a design trend line for the London Clay strata at this location.

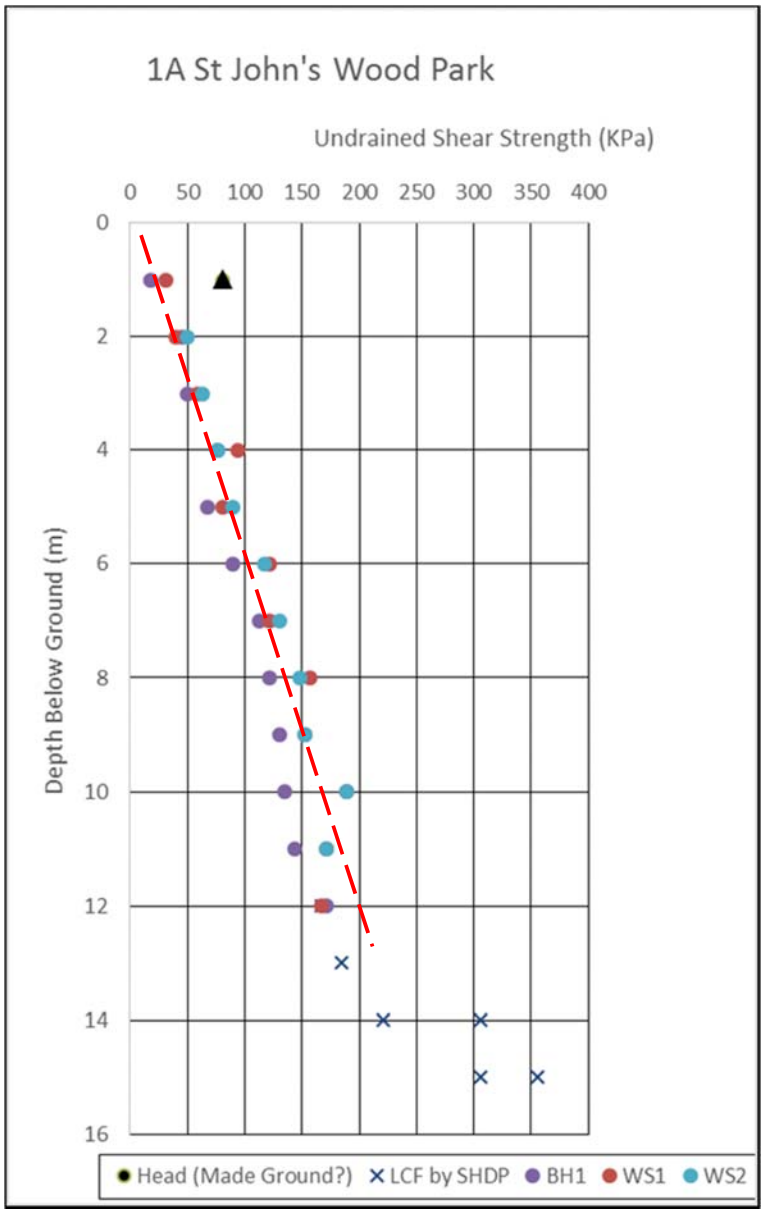


Figure 5.2 Undrained shear strength v Depth Plot

5.8 Estimation of Drained Modulus of the London Clay Formation

The Drained Modulus of the London Clay Formation from SPT N values has been made in accordance with recommendations from CIRIA 143 (1995), where E'/N = 0.9, ranging from 7 MPa at 1.0 m to 36 MPa at 12.45 m bgl

5.9 Swelling Pressure

A single disturbed sample from 3.7 m depth from WS1 was tested for a one dimensional swelling test which indicated a swelling pressure of 50 kPa (Appendix C). As this sample was recovered as a disturbed samples this can only provide an indication of the amount of swelling pressure, but it demonstrates the potential volume change from isostatic re adjustment from an excavation to this depth of the London Clay Formation.

5.10 Sulphate and pH

Laboratory testing for sulphate (SO_4 in 2:1 water: soil) in accordance with BS 1377: Part 3 was carried out on 2 samples which range from 0.96 to 3.22 g/l (Appendix C). The range of pH was from 7.8 to 8.2 or slightly alkaline. The soluble sulphate concentrations will require a design sulphate class of DS3, with a classification of Aggressive chemical environment for concrete of AC3 in accordance with BRE SD1 (2005).

5.11 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 C) have been summarised in Table 5.2 as follows:

Table 5.2 Geotechnical Parameters

	Plasticity				Class	Undrained Cohesion	Effective cohesion	Effective angle of friction	Bulk unit weight	Modulus E'	Earth Pressures	
Strata	LL (%)	PL (%)	PI (%)	MC (%)		Cu (kPa)	kN/m^3	Φ'	kN/m^3	MPa	K_a	K_p
Made Ground	n/a	n/a	n/a	n/a	n/a	n/a	0	29	15	n/a	n/a	n/a
Head Material (Made Ground)	n/a	n/a	n/a	n/a	n/a	n/a	0	35	18	10	0.27	3.7
London Clay	67-80	23-30	40-52	27-31	CH /CV	25 to 250	0	24	20	7-45	0.42	2.4

6 Geotechnical Assessment of Ground Conditions

6.1 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 and lateral movements of the foundation formation level from isostatic readjustment from the excavation and possible impacts of existing structures from lateral ground movements from the basement wall construction.

6.2 Presumed Bearing resistance

The anticipated formation level of the basement floor slab will be approximately 3.50 m below ground level at approximately a level of 48.5 m AOD. The undrained cohesion at the anticipated founding depth at 3.50 m is 65 kPa from the design line indicated in Figure 5.2.

A presumed bearing resistance at 3.50 m depth should be taken as 140 kPa as evaluated using the geotechnical parameters shown in Section 4 of this report by calculation (Brinch Hansen 1961).

6.3 Effect of Heave from soil excavation

The proposed basement will require the excavation from the exiting ground level of approximately 52.0 m AOD to approximately 48.50 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).

The ground model is based on the ground conditions assessment in Section 4. The heave assessment has been calculated on the net loading on the basement floor slab of 57 kPa which represent the unit load of the soil to be removed of 3.5 x 20 kPa less the total loading of the floor slab of 13 kPa. The heave has been evaluated using Pdisp version 19.3, which shows a maximum heave of < 31 mm within the main basement area (Appendix E for Pdisp output, plan and sections).

6.4 Sub –surface Concrete

The results of lab testing for sulphate and pH are summarised in section 5.10

It is recommended that an overall design sulphate class of DS-3 and an Aggressive Chemical Environment for Concrete (ACEC) class of AC3 is adopted accordance with BRE SD1 (2005).

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6.5 Potential Impact on Existing Structures from Basement Construction

The proposed development will be situated on land which currently is occupied by garages and an access road. The garages will be demolished and all surface obstructions such as foundations, pavement and hard standings will be removed. There will be no existing building above the proposed basement which will need retaining.

The proposed basement will be supported by a contiguous piled wall. A method statement for the proposed excavation is contained within the Basement Method Statement included in the report by Croft Structural Engineers Ltd. As the piles wall will be installed prior to excavation the heave of soil from unloading will be effectively restricted to the basement footprint.

7 Screening

7.1 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.

7.2 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 GSD and a site specific Groundsure Environmental Insight Report obtained in July 2015 for 1A St John' Wood Park (Appendix B).

Table 7.1: Responses to Figure 1, CPG4

Question	Response	Action required
1a. Is the site located directly above an aquifer	No. The site is located in the London Clay, a non-aquifer. The London clay extends to a depth of 84.2 m at a borehole at Swiss Cottage 300 m north (BGS ref. TQ28SE1769) and 87 m at a borehole at Waverley Place 500 m to the south (BGS ref. TQ28SE 1566).	None
1b. Will the proposed basement extend beneath the water table surface.	Yes The borehole drilled on 1 /7/2015 at the site indicated that no groundwater was encountered to a depth of 12.50 m bgl. Borehole TQ28SE1769 at Swiss Cottage indicated a rest water level of 90m bgl. Subsequent monitoring from a well installed to 5.40 m bgl indicated water at 0.49 to 1.63 m bgl. This was considered to represent perched water level as it was not consistent with regional groundwater records, however any design of the basement will allow for groundwater to surface level.	Mitigate the potential groundwater during construction by pumping.
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

Question	Response	Action required
4. Will the proposed basement development result in a change in the proportion of hard surfaced/paved areas.	No The existing area has pavement cover and buildings. The proposed development will have a building over the entire site.	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. The London Clay is relatively impermeable and as unlikely to be suitable for soakaway or SUDS drainage.	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 within the London Clay. Boreholes drilled at the site to a depth of 12.5 m indicated that from subsequent monitoring of a well in the boreholes groundwater was present between 0.49 and 1.63 m below ground level. For further details refer to Section 4 of this report.

7.3 Slope / Land Stability

This section answers questions posed by Figure 2 in CPG4.

Table 7.2: Responses to Figure 2, CPG4

Question	Response	Action required
1. Does the site include slopes, natural or man made, greater than about 1 in 8?	No The site is on level ground at approximately 52.0 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 0.5 m of made ground and / or approximately 1.5 m of head deposits (possibly made ground) .	Soil properties have been summarised in section 4 and 5 and have been taken into account in the preliminary design
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?	Unknown -Mature trees with a height of 10 m with a stem diameter of 0.4 m are assessed to occur 4.8 m from the basement which outside the tree root protection area.	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 London Clay is susceptible to seasonal shrink/swell movements and it is likely that these will occur, which is normal. The BGS define the risk of shrink / swell as 'moderate. There is no evidence or records of subsidence in the vicinity of the site.	The foundation will be below the influence of shrink swell from seasonal fluctuations therefore no specific additional action is required.
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?	No. Borehole and trial pit records for the site show made ground extends to 1.5 m bgl. It is assumed this relates to a sub base for the access road and foundations associated with the garages present on the site and potentially earlier houses which were present on the site from before 1871 to when they were demolished between 1953 and 1960. There is no historical evidence of any working of the ground	None
10. Is the site within an aquifer?	No.[a,b] (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. The site is immediately adjacent to St John's Wood Park road at a distance of approximately 4 m.	Impact assessment. Monitoring of movements before during and after construction

Question	Response	Action required
13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties?	Yes New foundations will be significantly deeper than those of neighbouring properties which do not have basements. This risk will be mitigated by outline design shown in the basement construction method statement.	Assessment in basement construction method statement
14. Is the site over (or within the exclusion zone of) any tunnels?	No[d]. The site is reported as more than the 3 m exclusion zone from the London Underground tunnel.	Further confirmation is recommended by London Underground for the exact location of the Jubilee Line tunnel.

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 July 2015

In summary, the site is located on level ground over the London Clay Formation. A layer of made ground and head up to 1.5 m thick proven, encountered in the borehole and trial pit is considered to be a subbase for the existing access road and foundations for the existing garages and former houses which were demolished between 1953 and 1960.

Foundation levels will be lower with respect to adjacent properties which will require mitigation measures in the foundation / retaining wall design.

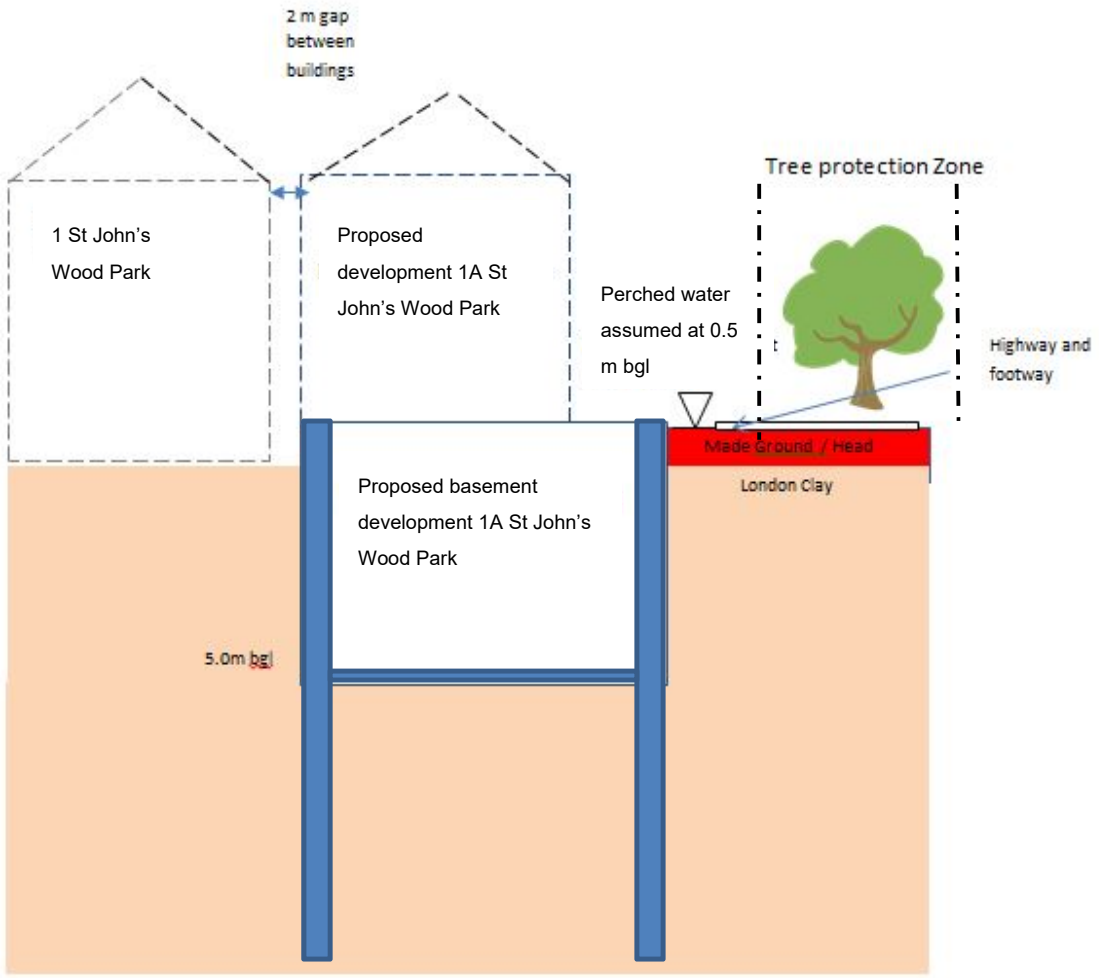
8 Scoping

8.1 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 potential impacts of the development of a basement on the site can be summarised in a conceptual model.

8.2 Conceptual Model

Figure 8.1 Conceptual Site Model



Note this is conceptual model shows the house close to the existing property at 1 St John's Wood Park and the proximity of the basement to the highway and tree protection zone in a combined section.

Summary of Scoping Requirements

Screening questions of concern - Hydrogeology	Potential Impact	Mitigation
1b Groundwater	Perched Groundwater level above basement formation level	To be mitigated by pumping during construction and waterproofing for long term mitigation

Screening questions of concern – Land Stability	Potential Impact	Mitigation
5/ 7- Geology / shrink swell	Settlement or heave	The depth of the basement is considered below the seasonal shrink swell depth, therefore shrink / swell will not affect the development. Assessment of heave and mitigation by suitable basement slab construction with void former to mitigate a potential heave of 31 mm.
6 Presence of trees	Impact of trees	The development is outside the root protection area
12 - within 5 m of highway	Stability of Adjacent Highway	To be mitigated by monitoring before, during and after construction
13 - differential foundation depth to adjacent property	Stability of Adjacent Property	To be mitigated by design outlined in the basement method statement, with monitoring before during and after construction

9 Impact Assessment

9.1 Groundwater

The screening process has highlighted specific concern in relation to groundwater. The borehole drilled on 01/07/2015 indicated there was no groundwater to a depth of 12.5 m. Subsequent monitoring however indicated a maximum height of groundwater between 0.94 and 0.23 m below ground level (bgl). Although it is considered that the high groundwater level relates to perched water and does not reflect the true groundwater level which has been shown to be regionally at depth of 90 m (Borehole TQ28SE1769 at Swiss Cottage indicated a rest water level of 90m bgl).

An allowance will need to be made on the basement design for perched groundwater up to at least 0.5 m below ground level (approximately 51.50 m AOD).

It is anticipated that this perched water table can be managed during construction by groundwater pumping as outline in the basement method statement by Croft Structural Engineers Ltd.

Any significant groundwater flows will be within the layer of made ground that is above the London Clay Formation. The water in this layer will be able to migrate around the basement.

9.2 Land Stability

9.2.1 Shrink Swell of the soil and ground movements

The foundation will be below the influence of shrink swell from seasonal fluctuations therefore no specific additional action is required.

Ground movements settlement / heave resulting from the basement construction has been assessed in Section 6 of this report which concludes that heave of the base of the excavation at approximately 48.50 m AOD will be less than 31 mm. This movement will be allowed for in the design of the basement floor slab. The excavation for the swimming pool may result in an estimated additional 10 mm of heave to the specific area of the pool excavation itself.

9.2.2 Presence of Trees

The presence of a tree off the north east boundary of the site is assessed to have a stem diameter of <0.4 m. A preliminary assessment indicates that the basement development will occur at 4.8 m from the tree, which is outside the tree root protection area (BS 5837:2012), therefore no further assessment is required.

9.2.3 Proximity to adjacent buildings

Ground movements settlement / heave resulting from the basement construction in proximity to adjacent properties can be evaluated once the detailed design and stiffness properties of the contiguous pile wall has been developed by the designer in

response to limit criteria for adjacent buildings. The design should use best practice in accordance with Building Regulations, CIRIA 580, BS8002 and BS EN 1997-1 Eurocode 7, in which the assessment of the requirements for any propping can be evaluated to minimise lateral displacement and corresponding settlement of the ground outside the basement. This specific assessment included in the BIA by Croft Structural Engineers has demonstrated that there will be an anticipated lateral and vertical movement of -6.7 mm and -4.9 mm respectively from excavation and installation closest to the adjacent house at 1 St John's Wood Park .

9.2.4 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 residential location of the property. The presence of Claystones is not anticipated to cause a significant obstacle to conventional plant as Claystones tend to occur as isolated cobbles / boulders in the clay. It is presumed that the excavation for the basement will only be undertaken when the perimeter retaining wall construction is complete.

9.2.5 Stability of Temporary Excavations

It is understood that the basement retaining walls will be a contiguous piled wall. Therefore excavation for the basement will be protected from instability by the piled wall. Excavation of the basement area will need to comply with appropriate health and safety criteria in terms of height and width of excavation face.

9.2.6 Groundwater Control

The boreholes records have indicated the presence possible perched groundwater to a depth of 0.23 to 0.94 m bgl associated with the predominantly granular made ground. However if groundwater is recorded during the construction works it anticipated that any inflow will be very modest, on the basis of the ground conditions encountered, which is London Clay predominantly from a depth 0.4 to 1.5 m below ground level.

It is proposed groundwater will dealt with by well point dewatering in the Basement Method Statement by Croft Structural Engineers Ltd. Any significant groundwater flows will be within the layer of made ground that is above the clay. The water in this layer will be able to migrate around the basement. The 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.

9.3 Monitoring of groundwater and ground movements

Groundwater levels should be continued to be monitored before, during and after construction. Monitoring of adjacent structures and the highway should be carried out before, during and after construction.

References

Camden Development Policy DP27 – Basement development.

Camden Planning Guidance – Basements and Lightwells CPG4 September 2013

Camden geological, hydrogeological and hydrological study – Guidance for subterranean development. Arup November 2010

BS 1377:1990. *British Standard Methods of test for soils for Civil engineering purposes*. British Standards Institution.

BS 5930:1999. *Code of practice for Site Investigation.* British Standards Institution (amended in 2010 to comply with requirements of BS ENO 14688 Parts 1 and 2).

BS EN 1997-1 Eurocode 7 Geotech Design Part1 General Rules- inc. corrigendum Feb 2009

BS EN 1997-2 Eurocode 7 Geotechnical Design Part 2 Ground Investigation and Testing – inc. corrigendum 2010

BS 8002: 1994 Earth Retaining Structures

Building Regulations 2010 HM Government.

BS 5837: 2012 Trees in relation to design, demolition and construction - Recommendations.

CIRIA C580 2003 Embedded retaining walls – guidance for economic design.

BRE Special Digest 1. *Concrete in aggressive ground.* Building Research Establishment. August 2005.