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Your Ref:

Our Ref: **12/19442-3**
Dec ember 2015

36 HEATH DRIVE,

LONDON NW3 7SD

BASEMENT IMPACT ASSESSMENT

Prepared for

Mr T Sanjay Wadhwani

Site Analytical Services Ltd.

CONTENTS

1.0 NON-TECHNICAL SUMMARY

1.1 Project Objectives

At the request of Martin Redston Associates, working on behalf of Mr T Sanjay Wadwhani, a Basement Impact Assessment has been carried out at 36 Heath Drive, London, NW3 7SD in support of a planning application for a proposed development which includes the minor material amendment to an approved planning application for the excavation to create a new basement with 3 front and 1 rear lightwells, erection of two storey rear extension including the reconfiguration of existing dormers to single dormer window in rear roofslope, side extensions at ground and first floor to residential house.. It is understood that the proposed basement is at a level of approximately 72.65mOD (4.0m below ground level).

1.2 Desk Study Findings

From a review of historical maps it would appear that the site was agricultural land until about 1934, when a residential property is evident. Two small extensions to the building are evident in circa 1954 but no further change is apparent. The area surrounding the site has been dominantly residential in use over the years.

1.3 Ground Conditions

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.40m in thickness resting on deposits of Superficial Head within Borehole 2 followed the London Clay Formation at depth. The Made Ground extended down to depths of between 0.25m and 1.40m (75.72mOD to 73.96mOD) in the boreholes and the material generally comprised a surface layer of grass/flower bed topsoil overlying stiff to very stiff silty sandy gravelly clay with brick fragments and ashes. Superficial Head Deposits were encountered below the Made Ground within Borehole 2 and consisted of stiff silty sandy gravelly clay. These deposits extended down to 1.60m below ground level in Borehole 2 (74.37OD). The London Clay Formation was encountered below the Made Ground and Superficial Head Deposits and consisted of stiff becoming very stiff silty clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depths of investigation of 12.00m below ground level in Boreholes 1 and 2 (63.97 to 63.36mOD). Following drilling operations groundwater monitoring piezometers were installed in Boreholes 1 to 2 to approximately 5.00m depth. Groundwater was not subsequently encountered within these monitoring standpipes after a period of approximately four weeks.

1.4 Recommendations

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

2.0 INTRODUCTION

2.1 Project Objectives

At the request of Martin Redston Associates, working on behalf of Mr T Sanjay Wadwhani a Basement Impact Assessment has been carried out at the above site in support of a planning application.

A Basement Impact Assessment was previously carried out by Site Analytical Services Limited (Report Reference 12/19442-2 dated August 2012). The purpose of this assessment is to consider the effects of a proposed basement construction on the local slope stability, surface water and groundwater regime at the existing residential property in accordance with the most recent guidance from the London Borough of Camden (see Section 2.2).

The recommendations and comments given in this report are based on the information contained from the sources cited and may include information provided by the Client and other parties, including anecdotal information. It must be noted that there may be special conditions prevailing at the site which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

2.2 Planning Policy Context

The information contained within this BIA has been produced to meet the requirements set out by Camden Planning Guidance – Basements and Lightwells (CPG4) including Camden Development Policies DP27 – Basements and Lightwells (Ref 1) in order to assist London Borough of Camden with their decision making process.

As recommended by the Guidance for Subterranean Development (Ref 1) the BIA comprises the following steps

1. Initial **screening** to identify where there are matters of concern

2. **Scoping** to further define the matters of concern

3. **Site Investigation and study** to establish baseline conditions

4. **Impact Assessment** to determine the impact of the basement on baseline conditions

5. **Review and Decision Making** (to be undertaken by LBC)

3.0 SITE DETAILS

(National Grid Reference: TQ 255 855)

3.1 Site Location

The site is situated on the east side of Heath Drive in the Frognal area of Hampstead, London, NW3 7SD and is currently occupied by a large detached two to three-storey residential property with a large rear garden and a double driveway at the front leading from a small curved access road on the east side of Heath Drive which gives pedestrian access to Bracknell Gardens to the north-east.

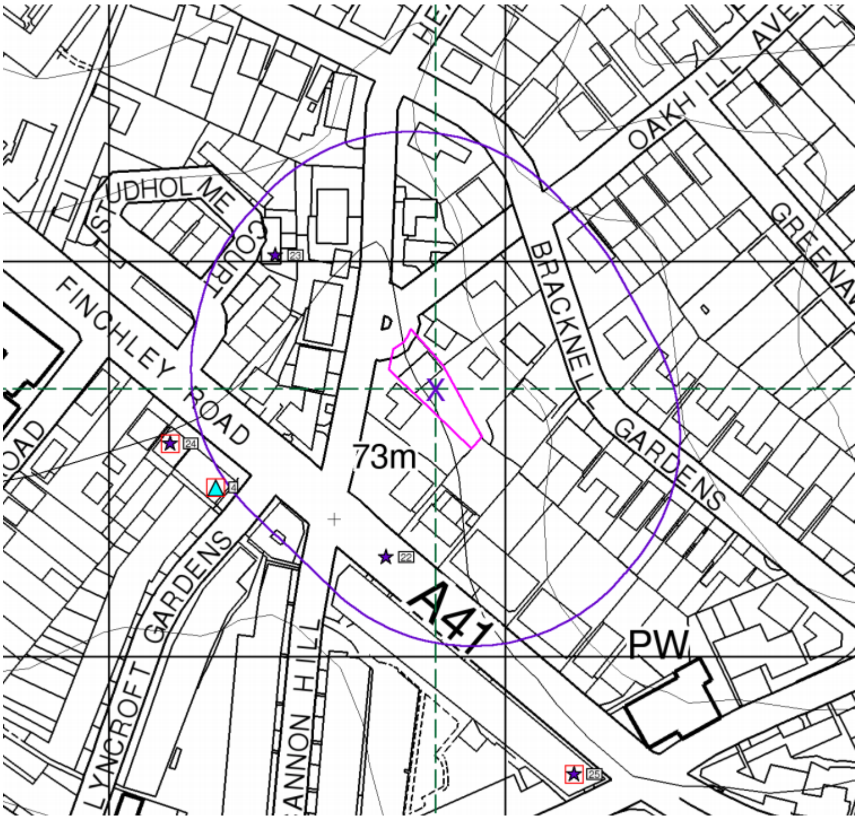

Figure 1. Site Location Plan

3.2 Site Layout and History

The site comprises of a large two to three-storey detached house with two-storeys evident at the front and rear and further accommodation within the roof space. There are some small areas of shrub beds at the front around a double tarmacadam covered driveway with three mature Conifers within the shrub bed adjacent to the road. The large rear garden comprises of a patio adjacent to the house and a large garden set mainly to lawn with shrub beds along the sides which include various conifers as well as specimens of Holly, Laurel and other similar shrubs.

The garden is bound by thick hedges and close board fencing and contains a small wooden garden shed close to the rear of the garage on the south side of the house.

The site lies on ground sloping down to the south away from Hampstead Heath towards the Finchley Road, although the site itself is mainly flat and landscaped with the front driveway having a slight slope down from the house to Heath Drive with a drop in elevation of approximately 0.5m.

The site slopes very gently to the north with levels of 74.43mOD recorded at the front of the site and 75.94m recorded in the far rear garden area. The slope angle is less than 1 in 8 (7 degrees). Also with reference to the Camden Geological, Hydrogeological and Hydrological Study, (Figure 2 below), the neighbouring properties also have slopes less than 7 degrees.

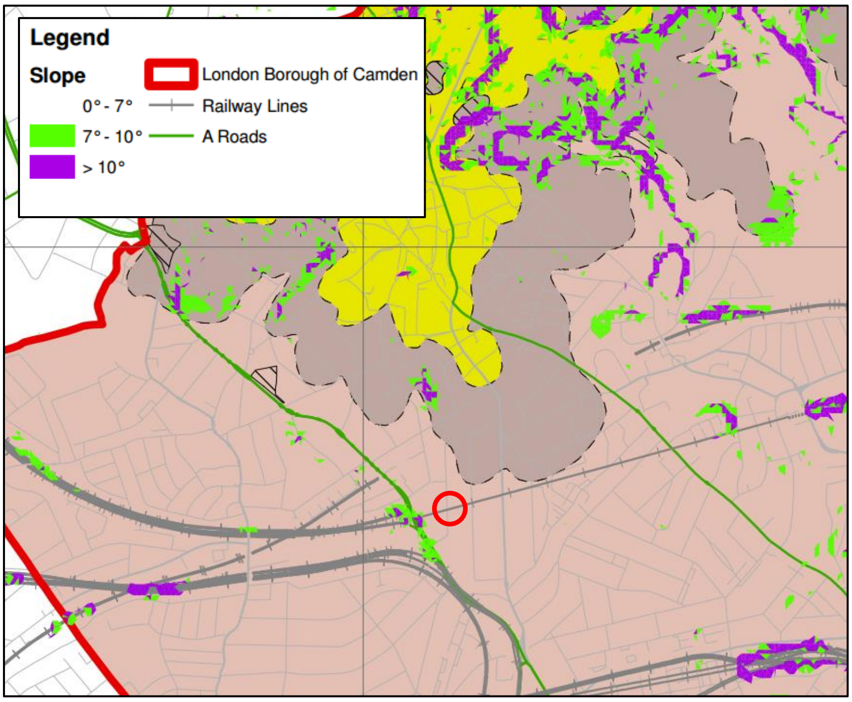

Figure 2. Exact from Figure 17 of the Camden CPG4 showing slope angles within the borough

The existing ground level in the area of the proposed basement is understood to be approximately 75.90mOD.

From a review of historical maps it would appear that the site was agricultural land until about 1934 when a residential property is evident. Two small extensions to the building are evident in circa 1954, but no further change is apparent. The area surrounding the site has been predominantly residential in use over the years.

3.3 Previous Reports

A Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23958-1) and Phase 2 Site Investigation (SAS Report Ref: 15/23958) was undertaken across the site by Site Analytical Services Limited in October 2015 and the results are discussed in this BIA.

3.4 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area is detailed in Figure 4 below and indicates the site to be underlain by the London Clay Formation. Deposits of the overlying Claygate Member are indicated to be approximately 100m to the north-east of the site.

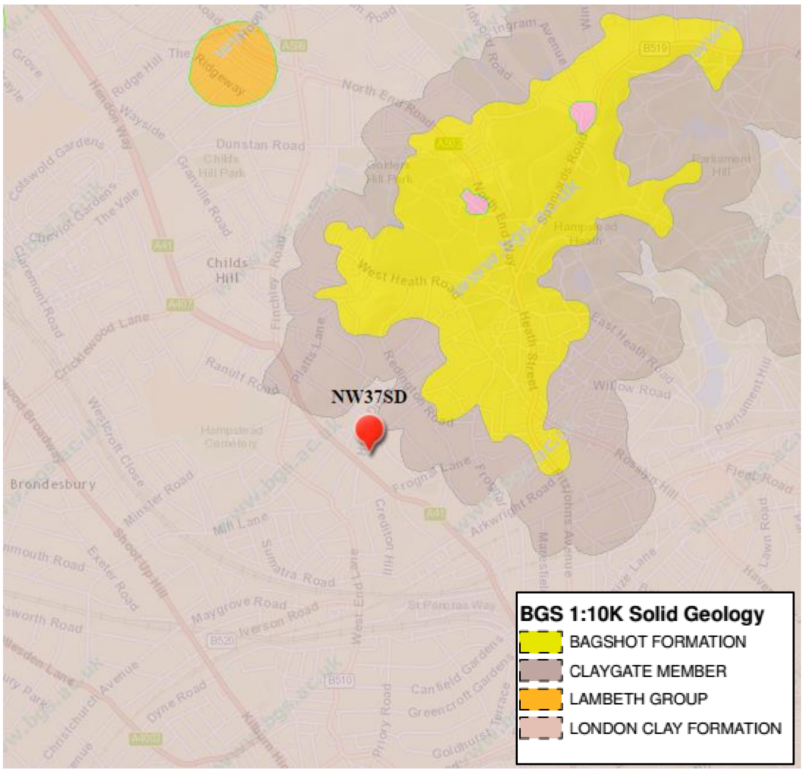

Figure 4. Geology of the Site (Ref. BGS Geoindex)

The British Geological Survey's online records indicate there are no boreholes located within 250m of the site, however a ground investigation undertaken in the rear gardens of No. 31 Heath Drive (located 30m to the north of the site) was conducted by UK Hydrosciences in June 2015 and is available on LBC Planning Website. The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised 1.9m of Made Ground over 1.0m of Superficial Head over

London Clay Formation to a depth of 5.45m (where the borehole ended). No groundwater was encountered and the material removed in the borehole remained dry throughout.

3.5 Hydrology and drainage

3.5.1 Surface Water

According to Mayes (1997) rainfall in the local area averages around 610mm and significantly less than the national average of around 900mm.

Evapotranspiration is typically 450mm/year resulting in about 160mm/year as 'hydrologically effective' rainfall which is available to infiltrate into the ground or run-off as surface water flow.

With reference to Camden Geological, Hydrogeological and Hydrological Study (1999), Talling (2011) and Barton (1992) the site is 20m east of tributaries relating to the River Westbourne (Figure 5). The spring line is shown on the annotated historical OS map dated 1879 (Figure 6).

Figure 5. Location of site (circled) relative to the 'Lost Rivers' of London (Source: Barton, 1992)

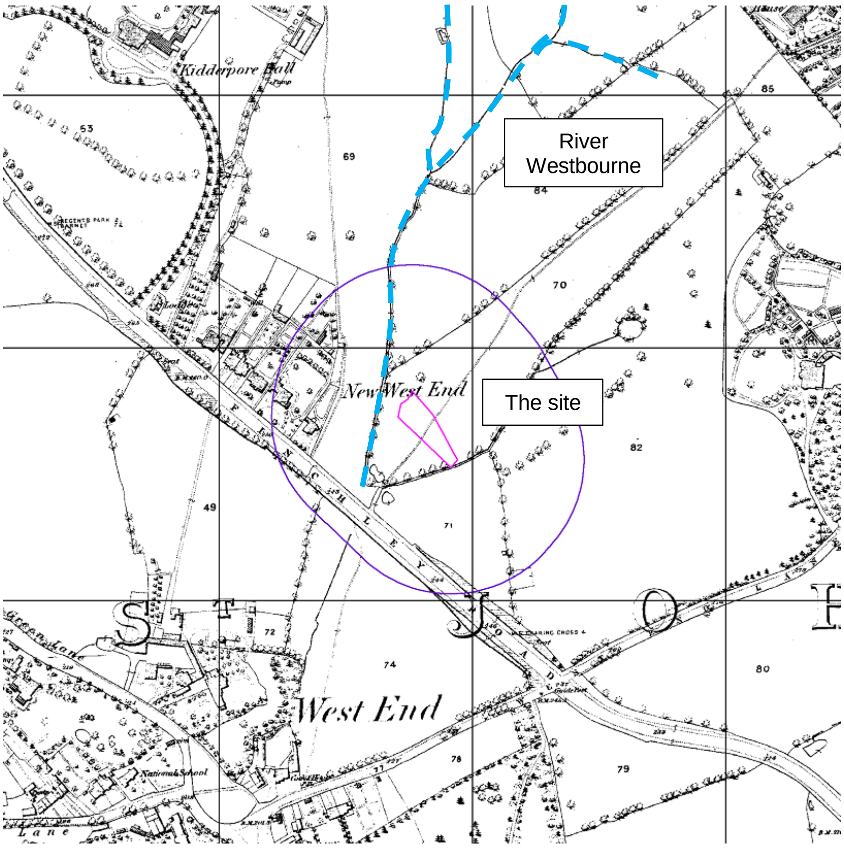

Figure 6. Location of River Tyburn and River Westbourne with respect to the site from OS map dated 1879 (Purple boundary indicates 100m distance)

The River Westbourne flowed in a southerly direction, combining with the other tributaries in West Hampstead and then flowing through Kilburn and Paddington before issuing into the Serpentine in Hyde Park. From there the river flowed south through Chelsea before flowing into the River Thames opposite Battersea Park.

The watercourses have since been largely lost through a culverting system as the urban extent of the borough has grown over time.

There are no surface water features within one kilometre of the site.

The area located immediately around the site is highly developed with more than 80% of the surface covered with hardstanding. Most of the rainfall in the area will run-off hard surface areas and be collected by the local sewer network.

Surface drainage from the site is assumed to be directed to drains flowing downhill to the south along Heath Drive towards Finchley Road.

3.5.2 Flood Risk

3.5.2.1 River or Tidal flooding

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs. Based on this information a flood risk assessment will not be required.

3.5.2.2 Surface water flooding

Figure 7 shows that Heath Drive did not flood during either the 1975 or the 2002 flood events. The closest road to the property which flooded in either of these events is Kidderpore Avenue located 150m to the north-west which flooded in 2002.

Figure 7. Exact from Figure 15 of the Camden CPG4 showing roads which flooded in 1975 (light blue), in 2002 (dark blue) and 'areas with potential to be at risk from surface water flooding' (wide light blue bands)

Further modelling of surface water flooding has been undertaken by the Environment Agency and was published on its website in January 2014; an extract from their model is presented in Figure 8. Whilst this map identifies four levels of risk (high, medium, low and very low) it is understood that it is based at least in part on depths of flooding. Whilst this modelling shows a 'medium' risk of flooding for Heath Drive, the private road which leads to the property is detailed as having a 'Very Low' risk of flooding (the lowest category for the national background level of risk).

Figure 8. Extract from the Environment Agency's 'Risk of Flooding from Surface Water'. Ordnance Survey Crown copyright 2015. All rights reserved.

3.5.2.3 Sewer flooding

The London Regional Flood Risk Appraisal (2009) advises that foul sewer flooding is most likely to occur where properties are connected to the sewer system at a level below the hydraulic level of the sewage flow, which in general are often basement flats or premises in low lying areas. There is no record of sewer flooding having occurred at 36 Heath Drive and therefore the risk of sewer flooding is considered low.

3.6 Hydrogeological setting

The Environment Agency Groundwater Protection Policy uses aquifer designations that are consistent with the Water Framework Directive. These designations reflect the importance of aquifers in terms of groundwater as a resource (drinking water supply) and also their role in supporting surface water flows and wetland ecosystems.

The Bedrock geology underlying the site (London Clay) has been classified as Unproductive Strata; rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Other hydrogeological data obtained from the Phase 1 Preliminary Risk Assessment (PRA) (SAS Report Ref: 15/23985-1) for the site include:

- The underlying soil classification of the site is of high leaching potential.
- There are no Groundwater Source Protection Zones within one kilometre of the site.
- There are no groundwater abstractions within one kilometre of the site.
- There are no sensitive land uses within one kilometre of the site.

3.7 Proposed Development

Proposals for the site include the excavation to create a new basement with 3 front and 1 rear lightwells, erection of a two storey rear extension including the reconfiguration of existing dormers to single dormer window in rear roofslope, side extensions at ground and first floor to residential house.. It is understood that the proposed basement is at a level of approximately 72.65mOD (4.0m below ground level).

Sections showing the proposed developments are detailed in Figure 9 below.

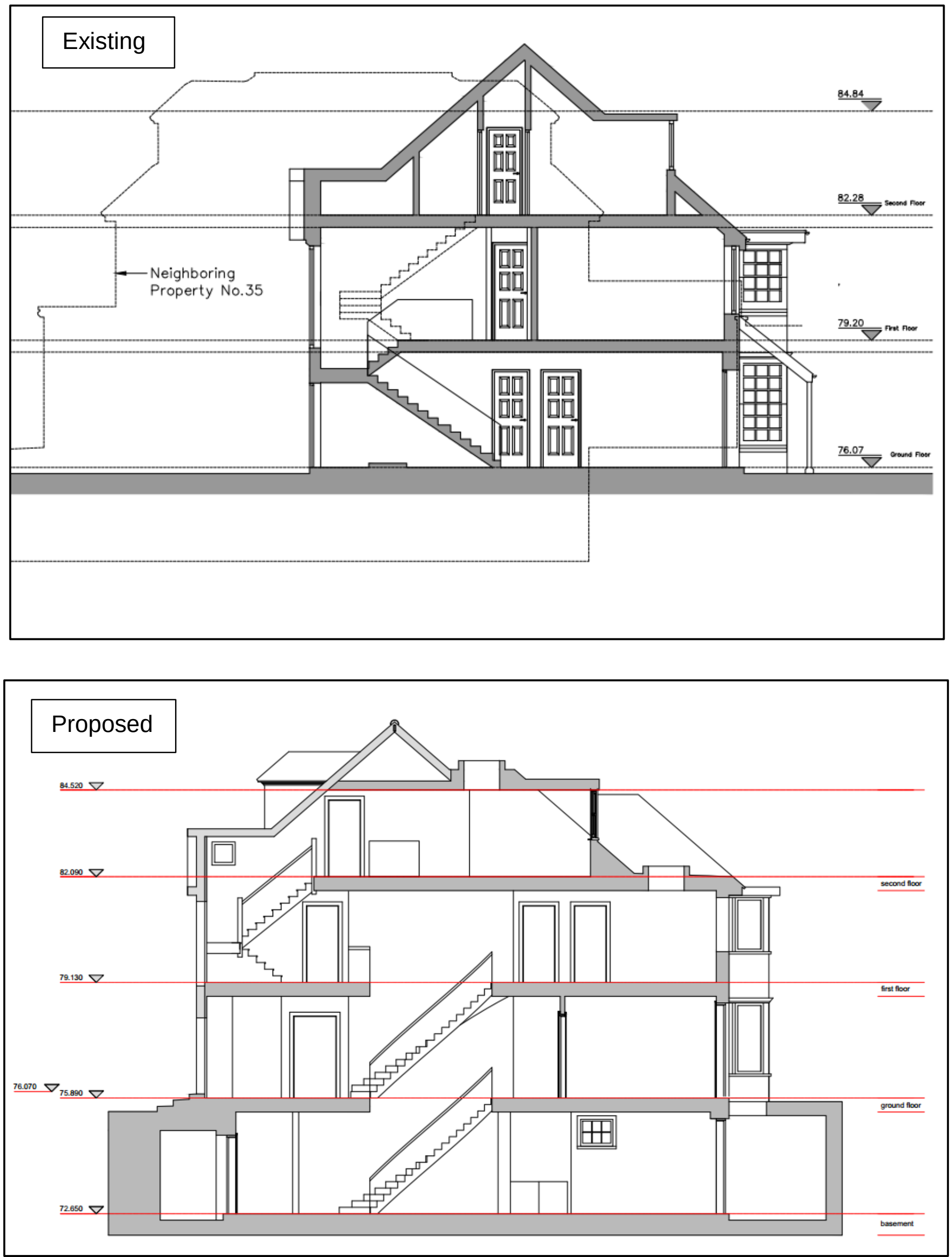

Figure 9. Sections of the existing and proposed Elevations of the property.

3.8 Results of Basement Impact Assessment Screening

A screening process has been undertaken for the site and the results are summarised in Table 1 below:

Table 1 : Summary of screening results

Item	Description	Response	Comment
Sub-terranean (Ground water Flow)	1a. Is the site located directly above an aquifer.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	1b. Will the proposed basement extend beneath the water table surface.	Unknown – to be confirmed by Ground Investigation	Given the presence of an aquifer below the site it is possible that groundwater will be encountered during any excavations for the proposed basement, however this will be confirmed by the ground investigation.
	2. Is the site within 100m of a watercourse, well (used / disused) or potential spring line.	No	There are no surface water features within 1km of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 20m east of tributaries relating to the River Westbourne From the British Geological Society 'Geoindex' the nearest water well is located approximately 1770m east of the site.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved areas.	No	The amount of hardstanding on-site is not expected to change.
	4. As part of 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	Existing drainage paths are to be utilised where possible. Whether soakaways/SUDS are used on the proposed development is to be confirmed (beyond the scope of this report). An appropriately qualified engineer should be engaged to ensure mandatory requirements are met.
	5. 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 line.	No	There are no surface water features within 1km of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 20m east of tributaries relating to the River Westbourne From the British Geological Society 'Geoindex' the nearest water well is located approximately 1770m east of the site.

Slope Stability	1. Does the existing site include slopes, natural or man-made greater than 7 degrees (approximately 1 in 8).	No	There is a slight slope from north to south across the site, but is below 7 degrees.
	2. Will the proposed re-profiling of landscaping at the site change slopes at the property boundary to more than 7 degrees (approximately 1 in 8).	No	Re-profiling of landscaping at the site is not proposed.
	3. Does the development neighbour land, including railway cuttings and the like, with a slope greater than 7 degrees (approximately 1 in 8).	No	The surrounding area drops to the south-east, but from survey information and with reference to Figure 17 from Camden CPG 4, this is at angles of less than 7 degrees.
	4. Is the site within a wider hillside setting in which the general slope is greater than 7 degrees (approximately 1 in 8).	No	There is a general slope in the area towards the south down to the south-east, but this is at an angle of less than 7 degrees.
	5. Is the London Clay the shallowest strata at the site.	Yes	With reference to available BGS records, the London Clay Formation is expected to be encountered from ground level.
	6. Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained.	Yes	It is understood that one tree is to be felled as part of the development.
	7. 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 lies above the London Clay Formation well known as having a high tendency to shrink and swell.
	8. Is the site within 100m of a watercourse or a potential spring line.	No	There are no surface water features within 1km of the site. According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 20m east of tributaries relating to the River Westbourne From the British Geological Society ‘Geoindex’ the nearest water well is located approximately 1770m east of the site.
	9. Is the site within an area of previously worked ground.	No	According to records from the BGS the site is not in the vicinity of any recorded areas of worked ground.

	10. 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.	No	The site has been classified as being situated above an unproductive (negligibly permeable) formation (London Clay) that is generally regarded as containing insignificant quantities of groundwater.
	11. Is the site within 50m of the Hampstead Heath Ponds	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	12. Is the site within 5m of a highway or pedestrian right of way.	Yes	The site lies within 5m of a private road off Heath Drive.
	13. Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.	Yes	The development will increase the depths of foundation at the site, although the foundation depths of adjacent properties are not known.
	13. Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	Unknown / outside scope of report	A full statutory service search was outside the scope of this report and must be completed prior to any excavations.
Surface Water and Flooding	1. Is the site within the catchment of the ponds chains on Hampstead Heath	No	With reference to the Camden Geological, Hydrogeological and Hydrological Study, the site is not within the catchment of the pond chains on Hampstead, nor the Golder's Hill Chain.
	2. As part of the proposed site drainage, will surface water flows (e.g. volume of rainfall and peak run-off) be materially changed from the existing route.	No	No – any additional surface water generated from an increased hardstanding area will be attenuated to ensure they are not increased or altered. The basement will be beneath the footprint of the new dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report, does not apply across these areas.
	3. Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	Yes	Yes, there will be a small change in the area of hard surfacing. The surface permeability will be affected with a slight increase in the footprint of the new building and a small decrease in the amount of paved surface in relation to the total site.

	4. 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	All surface water for the site will be contained within the site boundaries and collected as described above; hence there will be no change from the development on the quantity or quality of surface water being received by adjoining sites. The basement will be beneath the footprint of the dwelling therefore the 1m distance between the roof of the basement and ground surface as recommended by Chapter 5 of the Arup report does not apply across these areas.
	5. Will the proposed basement result in changes to the quality of surface water being received by adjacent properties or downstream watercourses.	No	The surface water quality will not be affected by the development, as in the permanent condition collected surface water will be generally be from roofs, domestic hard landscaping or collected from beneath the landscaping layer over the basement.
	6. Is the site in an area known to be at risk from surface water flooding, such as South Hampstead, West Hampstead, Gospel Oak and King's Cross, or is it at risk from flooding, for example because the proposed basement is below the static water level of a nearby surface water feature	No	Nutley Terrace did not flood during either the 1975 or the 2002 flood events. Also according to modelling by the Environment Agency, there is a 'Very Low' risk of surface water flooding (the lowest category for the national background level of risk) for No.36 and the private road.

3.9 Non Technical Summary of Chapter 3.0

The site is situated on the east side of Heath Drive in the Frognal area of Hampstead, London, NW3 7SD and is currently occupied by a large detached two to three-storey residential property with a large rear garden and a double driveway at the front leading from a small curved access road on the east side of Heath Drive which gives pedestrian access to Bracknell Gardens to the north-east.

The property is constructed on slightly sloping ground to the south.

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area indicates the site to be underlain by superficial Head Deposits with the London Clay Formation at depth. The London Clay Formation is classed as unproductive strata or a non-aquifer.

There are no surface water features within 1km of the site.

According to publications regarding Lost Rivers of London (Barton, 1992) and (Talling, 2011) and Stanford (1868) the site is 20m east of tributaries relating to the River Westbourne.

According to Environment Agency Flood maps there are no flood risk zones within 1 kilometre of the site. The EA's website also shows that this area does not fall within an area at risk of flooding from reservoirs. Based on this information a flood risk assessment will not be required. Heath Drive did not flood during either the 1975 or the 2002 flood events. Modelling of surface water flooding by the Environment Agency shows a 'Very Low' risk of flooding (the lowest category for the national background level of risk) for No.36 and the surrounding area.

The Screening Exercise has identified the following potential issues which will be carried forward to the Scoping Phase

Subterranean Groundwater Flow

- Will the proposed basement extend beneath the water table surface.

Slope Stability

- Is the London Clay the shallowest strata at the site.
- Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are 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.
- Is the site within 5m of a highway or pedestrian right of way.
- Will the proposed basement significantly increase the differential depth of foundations relative to neighbouring properties.

Surface Water and Flooding

- Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.

4.0 SCOPING PHASE

4.1 Introduction

The purpose of the scoping phase is to assess in more detail the factors to be investigated in the impact assessment. Potential impacts are assessed for each of the identified impact factors and recommendations are stated.

A conceptual ground model is usually complied at the scoping stage however, because the ground investigation has already been undertaken for this project, the conceptual ground model including the findings of the ground investigation is described under Chapter 4.

Subterranean (Groundwater Flow)

Potential Issue (Screening Question)		Potential impacts and actions
1b	Will the proposed basement extend beneath the water table surface?	**Potential impact:** Local restriction of groundwater flows (perched groundwater or below groundwater table). **Action:** Ground investigation required, the review.

Slope Stability

5	Is the London Clay the shallowest strata at the site?	**Potential impact:** The London Clay is prone to seasonal shrink-swell (subsidence and heave). **Action:** Ground investigation required, the review.
6	Will any trees be felled as part of the development and/or are any works proposed within any tree protection zones where trees are to be retained?	**Potential Impact:** Ground movements will occur during and after the basement construction. **Action:** Following the results of the ground investigation an approved Arboriculturalist should be appointed.
7	Is there a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site?	**Potential Impact:** Ground movements will occur during and after the basement construction. **Action:** Ground investigation required, then review.
11	Is the site within 5m of a highway or a pedestrian right of way?	**Potential impact:** Excavation of basement causes loss of support to footway/highway and damage to the services beneath them. **Action:** Ensure adequate temporary and permanent support by use of best practice working methods.

12	Will the proposed basement substantially increase the differential depth of foundations relative to neighbouring properties?	**Potential impact:** Loss of support to the ground beneath the new foundations to neighbouring properties if basement excavations are inadequately supported. **Action:** Ensure adequate temporary and permanent support by use of best practice methods.
14	Is the site over (or within the exclusion zone of) any tunnels, e.g. railway lines.	**Potential impact:** Excavation of basement damages the underlying tunnels **Action:** Ensure foundation solution is agreed with Network Rail prior to commencing on site

Surface Water and Flooding

Potential Issue (Screening Question)		**Potential impacts and actions**
3	Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	**Potential impact:** May increase flow rates to sewer, and thus increase the risk of flooding **Action:** Assess net change in hard surfaced/paved areas and, if required, recommend appropriate types of SUDS for use as site-specific mitigation.

These potential impacts have been further assessed through the ground investigation, as detailed in Section 5 below.

4.2 Non-Technical Summary of Chapter 4.0

The scoping exercise has reviewed the potential impacts for each of the items carried forward from Stage 1 screening, and has identified the following actions to be undertaken:

- A ground investigation is required (which has already been undertaken).
- Review of site's hydrogeology and groundwater control requirements.

All these actions are covered in Stage 4 or Stage 3 for the ground investigation.

5.0 SITE INVESTIGATION DATA

5.1 Records of site investigation

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in July 2012 and included two continuous flight auger boreholes (Boreholes 1 and 2) drilled to 12m below ground level.

The findings from the investigation are presented in Appendix B, including a site plan, exploratory hole logs, groundwater monitoring and laboratory test results.

5.2 Ground conditions

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.40m in thickness resting on superficial head deposits with the London Clay Formation at depth.

5.2.1 Made Ground

The Made Ground extended down to depths of between 0.25m and 1.40m (75.72mOD to 73.96mOD) in the boreholes and the material generally comprised a surface layer of grass/flower bed topsoil overlying stiff to very stiff silty sandy gravelly clay with brick fragments and ashes.

5.2.2 Superficial Head Deposits

Superficial Head Deposits were encountered below the Made Ground within Borehole 2 and consisted of stiff silty sandy gravelly clay. These deposits extended down to 1.60m below ground level in Borehole 2 (74.37OD).

5.2.3 London Clay Formation

The London Clay Formation was encountered below the Made Ground and Superficial Head Deposits and consisted of stiff becoming very stiff silty clay with occasional pockets and partings of silty fine sand and scattered gypsum crystals. These deposits extended down to the full depths of investigation of 12.00m below ground level in Boreholes 1 and 2 (63.97 to 63.36mOD).

5.3 Groundwater

Groundwater was not encountered within Borehole 1 and the soils remained essentially dry throughout. Groundwater was encountered in Borehole 2 as detailed in Table 2 below.

Exploratory Hole	Depth (m)	Level (mOD)	Notes	Stratum
BH2	11.00	64.97	Slight Seepage	Claystone within London Clay Formation

Table 2 : Groundwater Strike Summary

It must be noted that the speed of excavation is such that there may well be insufficient time for further light seepages of groundwater to enter the boreholes and trial pits and hence be detected, particularly within more cohesive soils.

Isolated pockets of groundwater may also be present perched within any less permeable material found at shallower depth on other parts of the site especially within any Made Ground.

Following drilling operations groundwater monitoring piezometers were installed in Boreholes 1 and 2 to approximately 5.00m depth.

Groundwater was subsequently recorded at respective depths a depth of 2.44m and 2.01m below ground level in the monitoring standpipes installed in Boreholes 1 and 2 after a period of approximately four to five weeks. It is considered that this water level represents the accumulation of surface run-off from the higher ground around Hampstead Heath to the north-east of the site within the relatively permeable Made Ground and Superficial Head deposits perched on top of the virtually impermeable deposits of the London Clay present at depth.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (July 2012) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

5.4 In-Situ and Laboratory Testing

The results of the laboratory and in-situ tests are presented in the interpretative report contained in Appendix A.

5.4.1 Mackintosh Probe / Hand Vane Tests

Mackintosh Probe tests were made in order to assess the relative density of the soils encountered in borehole. The results can be interpreted using the generally accepted correlation for Mackintosh Probe Tests which is as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

or

Mackintosh N300 X 0.1 = SPT 'N' Value

In the essentially cohesive natural soils encountered at the site, in-situ shear vane tests were made at regular depth increments in order to assess the undrained shear strength of the materials. The results indicate that the natural soils are of a generally high strength in accordance with BS 5930 (2015).

The results of the in-situ tests are shown on the appropriate exploratory hole record contained in Appendix A.

5.4.2 Classification Tests

Atterberg Limit tests were conducted on six selected samples taken from the cohesive natural soils in Boreholes 1 and 2 and showed the samples tested to fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained silty clay soils of high and very high plasticity and as such generally have moderate bearing and settlement characteristics, have a low permeability and a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values between 40% and 48% with all samples being at or above the upper 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

5.4.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on two natural soil samples are presented on Table 2, contained in Appendix B. The results show the natural soil samples to have water soluble sulphate contents of up to 1.41g/litre associated with slightly acidic to near neutral pH values.

5.5 Non-Technical Summary of Chapter 5.0

A site-specific ground investigation was undertaken by Site Analytical Services Limited (SAS) in July 2012 and included two continuous flight auger boreholes (Boreholes 1 and 2) drilled to 12m below ground level.

The boreholes revealed ground conditions that were consistent with the geological records and known history of the area and comprised Made Ground up to 1.40m in thickness resting on superficial head deposits with the London Clay Formation at depth.

Following drilling operations groundwater monitoring piezometers were installed in Boreholes 1 and 2 to approximately 5.00m depth.

Groundwater was subsequently recorded at respective depths a depth of 2.44m and 2.01m below ground level in the monitoring standpipes installed in Boreholes 1 and 2 after a period of approximately four to five weeks. It is considered that this water level represents the accumulation of surface run-off from the higher ground around Hampstead Heath to the north-east of the site within the relatively permeable Made Ground and Superficial Head deposits perched on top of the virtually impermeable deposits of the London Clay present at depth.

6.0 FOUNDATION DESIGN

6.1 Introduction

Proposals for the site include the partial demolition of the existing building on-site and construction of a three storey dwelling.

It is understood that the proposed basement is at a level of approximately 72.65mOD (4.0m below ground level).

6.2 Site Preparation Works

The main contractor should be informed of the site conditions and risk assessments should be undertaken to comply with the Construction Design Management (CDM) regulations. Site personnel are to be made aware of the site conditions. It is recommended that extensive searches of existing man-made services are undertaken over the site prior to final design works.

6.3 Ground Model

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows:

- Made Ground extends to depths of between 0.25m to 1.60m depth below ground level (75.72mOD to 73.96mOD).

- Superficial Head Deposits extend to a depth of 1.60m below ground level (74.37mOD) within Borehole 2 and consisted of stiff silty sandy gravelly clay.

- The London Clay Formation comprising stiff becoming very silty sandy clay with gypsum crystals to the full depths of investigation 12.00m below ground level (63.97 to 63.36mOD)

- Groundwater was encountered in the monitoring standpipes installed above 5.0m depth in Boreholes 1 and 2 but it is understood that this is due to surface water run-off into the boreholes. This suggests that the water table is deeper than 5.0m below ground level (i.e. below the base of the standpipe) across the site.

6.4 Basement Excavation

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure. Trial excavations to the proposed basement depth could be carried by the main contractor to confirm the stability of the soil and to further investigate the presence of any groundwater inflows.

6.5 Conventional Spread Foundations

A result of the inherent variability of uncontrolled fill, (Made Ground) is that it is usually unpredictable in terms of bearing capacity and settlement characteristics. Foundations should therefore, be taken through any Made Ground and either into, or onto a suitable underlying natural stratum of adequate bearing characteristics.

Based on the ground and groundwater conditions encountered in the boreholes and trial pits, it should be possible to support the proposed new development on conventional strip or basement raft foundations taken down below the Made Ground and any weak superficial soils and placed in the natural firm sandy silty clay deposits which occur at depths of between approximately 1.40m and 1.60m below ground level over the site. Foundations should be placed in the natural deposits at a minimum depth of 1.00m below final ground level in order to avoid the zone affected by seasonal moisture content changes.

Using theory from Terzaghi (1943), strip foundations placed within natural soils may be designed to allowable net bearing pressures of approximately 200kN/m^2 at 2.00m depth increasing linearly to about 250kN/m^2 at 3.00m depth in order to allow for a factor of safety of 2.5 against general shear failure. The actual allowable bearing pressure applicable will depend on the form of foundation, its geometry and depth in accordance with classical analytical methods, details of which can be obtained from “Foundation Design and Construction”, Seventh Edition, 2001 by M J Tomlinson (see references) or similar texts.

Any soft or loose pockets encountered within otherwise competent formations should be removed and replaced with well compacted granular fill.

In addition, foundations may need to be taken deeper should they be within the zones of influence of both existing or recently felled trees and any proposed tree planting. The depth of foundation required to avoid the zone likely to be affected by the root systems of trees is shown in the recommendations given in NHBC Standards, Chapter 4.2, April 2010, “Building near Trees" and it is considered that this document is relevant in this situation.

6.6 Piled Foundations

In the event that the use of conventional spread foundations proves either impracticable or uneconomical due to the size and depth of foundation required, then a piled foundation will be required. In these ground conditions, it is considered that some form of bored and in-situ cast concrete piled foundation with reinforced concrete ground beams should prove satisfactory.

The construction of a piled foundation is a specialist activity and the advice of a reputable contractor, familiar with the type of soil and groundwater conditions encountered at this site should be sought prior to finalising the foundation design. The actual pile working load will depend on the particular type of pile chosen and method of installation adopted.

To achieve the full bearing value a pile should penetrate the bearing stratum by at least five times the pile diameter.

Where piles are to be constructed in groups the bearing value of each individual pile should be reduced by a factor of about 0.8 and a calculation made to check the factor of safety against block failure.

Driven piles could also be used and would develop much higher working loads approximately 2.5 to 3 times higher than bored piles of a similar diameter at the same depth. However, the close proximity of adjacent buildings will in all probability preclude their use due to noise and vibration.

6.7 Retaining Walls

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure's construction. The excavation of the basement must not compromise the integrity of adjacent structures.

The full design of temporary and permanent retaining structures is beyond the scope of this report. However, the following design parameters for each element of soil recorded in the relevant exploratory holes are provided in Table 3 below to assist the design of these structures.

Stratum	**Depth to top (mOD)**	**Bulk Density (Mg/m3) (ɣ)**	**Effective Angle of Internal Friction (Φ)**
Made Ground	75.97 to 75.36	2.00	28
Superficial Head Deposits	75.72	2.00	21
London Clay Formation	74.37 to 73.96	2.00	23

Table 3. Retaining Wall Design Parameters

The designer should use these parameters to derive the active and passive earth pressure coefficients ka and kp. The determination of appropriate earth pressure coefficients, together with factors such as the pattern of the earth pressure distribution, will depend upon the type/geometry of the wall and overall design factors.

6.8 Chemical Attack on Buried Concrete

The results show the natural soil samples to have water soluble sulphate contents of up to 1.41g/litre associated with slightly acidic to near neutral pH values.

In these conditions, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur unless precautions are taken. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-2 conditions.

In addition, segregations of gypsum were noted within the London Clay and scattered small gypsum crystals were also noted at depth. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such deep buried concrete in accordance with full Class DS-2 conditions.

6.9 Non-Technical Summary of Chapter 6.0

On the basis of the fieldwork, the ground conditions at the site can be characterised as follows: Made Ground extends to depths of between 0.25m to 1.40m depth below ground level (75.72mOD to 73.96mOD). The Superficial Head Deposit within Borehole 2 extended to a depth of 1.60m below ground level. The London Clay Formation extends to the full depths of investigation of 12.00m below ground level(63.97 to 63.36mOD). Groundwater was not encountered in the monitoring standpipes installed above 5.0m depth. This suggests that the water table is deeper than 5m below ground level (i.e. below the base of the standpipe) across the site.

Groundwater is not expected to be encountered in the basement excavation, but it would be prudent for the chosen contractor to have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

Several methods of retaining wall construction could be considered. These may include retaining structures cast in an underpinning sequence, or the use of temporary or sacrificial works to facilitate the retaining structure’s construction. The excavation of the basement must not compromise the integrity of adjacent structures.

Based on the water soluble sulphate tests carried out as part of these works, it is considered that deterioration of buried concrete due to sulphate or acid attack is likely to occur. The final design of buried concrete according to Tables C1 and C2 of BRE Special Digest 1:2005 should be in accordance with Class DS-2 conditions.

In addition, segregations of gypsum were noted within the London Clay and also are well known to occur within London Clay deposits. Consequently, it is considered that any buried concrete at depth may be attacked by such sulphates in solution and that it would be prudent to design any such concrete in accordance with full Class DS-2 conditions.

7.0 BASEMENT IMPACT ASSESSMENT

7.1 Summary

The screening identified a number of potential impacts. The table below summarises the previously identified potential impacts and the additional information that is now available from the site investigation in consideration of each impact.

Potential Impact	Site Investigation conclusions	Impact sufficiently addressed without further justification?
The proposed basement extends beneath the water table surface.	Groundwater was not encountered in the monitoring standpipes installed above 5.0m depth. This suggests that the water table is deeper than 5.0m below ground level (i.e. below the base of the standpipe) across the site. This is below the depth of the proposed basement at 4.00m below ground level and therefore the influence of the development on groundwater is expected to be minimal. The water noticed within the standpipes was from surface water run-off through the Made Ground and superficial deposits.	Yes
Trees will be felled as part of the development	It is understood that one tree will be felled as part of the development, however as the trees are mainly on flat land they will not present a significant negative impact on slope stability. Desiccation of the shallow soils has not been found in the investigation.	Yes
There a history of seasonal shrink-swell subsidence in the local area and/or evidence of such effects at the site.	The London Clay was proven below the site and was recorded as having a high to very high susceptibility to shrinkage and shrinkage. However, the base of proposed basement will extend well below the potential depth of root action.	Yes
The site is within 5m of a highway or pedestrian right of way.	The proposed basement is not to be extended below the private road off Heath Drive and therefore it is suggested that the impact on these access roads is likely to be minimal. There is nothing unusual in the proposed development that would give rise to any concerns with regard to the stability of public highways.	Yes.
The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.	The development will result in the extension of the foundation depth of the basement relative to neighbouring properties.	No – See Section 6.2 for further details
Will the proposed basement development result in a change in the proportion of hard surfaced / paved external areas.	There is a small increase in impermeable area on-site following development, which equates to an increase in the rate of runoff from the site.	No – See Section 6.2 for further details

7.2 Outstanding risks and issues

The proposed basement will significantly increase the differential depth of foundations relative to neighbouring properties.

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. This will require close collaboration with the appointed contractor's temporary works coordinator.

The Party Wall Act (1996) will apply to this development because neighbouring houses lie within a defined space around the proposed building works. The party wall process should be followed and adhered to during this development.

A ground movement assessment was carried out at the site by Applied Geotechnical Engineering under the instruction of Site Analytical Services Limited (Report Reference P4120). The report is provided as Appendix B to this report and concludes that the predicted level of damage to Nos. 35 and 27 Heath Drive, due to the excavation of a basement at No. 36 Heath Drive, is predicted to be very slight or less. This conclusion assumes a high standard of workmanship and adequate propping of the basement excavation.

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

Change in paved surfacing and surface water runoff.

As identified in the initial screening and scoping stages there will be a small change in the amount of hard surfacing at the site where the property will be constructed and as a result total surface water flows may increase.

Review of the proposals shows that the surface permeability will be affected with a slight increase in the footprint of the building.

Overall it is concluded that the surface water flows will not materially change in response to the small increase in hard standing. On completion of the development the surface water flows will be routed in a similar way to the existing condition, with rainwater run-off collected in a surface water drainage system and discharged to a combined sewer. It will not be necessary to consider additional mitigation measures such as SUDS or soft landscaping over to reduce the rate of any surface water run-off.

7.3 Advice on Further Work and Monitoring

A monitoring plan should be set out at design stage and should include a monitoring strategy, instrumentation and monitoring plans and action plans. Trigger levels on movements will need to be defined. Precise levelling or reflective survey targets should be installed at the garden walls and neighbouring buildings. Monitoring should take place in advance of the proposed works as a base-line survey, during the works and for a period following the completion of the works, to understand the long term effects.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations. The chosen contractor should also have a contingency plan in place to deal with any perched groundwater inflows as a precautionary measure.

7.4 Non-Technical Summary of Chapter 7.0

The excavation and construction of the basement at the site has the potential to cause some movements in the surrounding ground if not properly managed. However, it is understood that ground movements and/or instability will be managed through the proper design and construction of mitigation measures during the works. It is not considered that the proposed basement would result in a significant change to the groundwater flow regime in the vicinity of the proposal. Also, given limited scope of the scheme and limited increase in impermeable areas, the scheme is also considered compliant with the surface water management and flood risk elements of NPPF and Camden policy.

Given good workmanship, the basement to No. 36 Heath Drive can be constructed without imposing more than very slight damage on the adjoining properties. The development is not likely to significantly affect the existing local groundwater regime.

It would be prudent to continue to monitor the standpipes for as long as possible in order to determine equilibrium level and the extent of any seasonal variations.

8.0 REFERENCES

1. CIRIA Special Publication 69, 1989. The engineering implications of rising groundwater levels in the deep aquifer beneath London

2. Environment Agency, 2006. Groundwater levels in the Chalk-Basal Sands Aquifer in the London Basin

3. Tomlinson, M J, 2001. “Foundation Design and Construction”, Seventh Edition, Prentice Hall (ISBN 0-13-031180-4).

4. British Standards Institution, 2015. Code of Practice for Site Investigations, BS5930, BSI, London

5. British Standards Institution, 1986. Code of practice for foundations, BS 8004, BSI, London.

6. British Standards Institution, 2009. Code of Practice for Protection of Below Ground Structures Against Water from the Ground. BS 8102, BSI, London

7. CIRIA, 2000. Sustainable Urban Drainage Systems: Design Manual for England and Wales. CIRIA C522, Construction Industry Research and Information Association, London

8. Environment Agency Status Report 2010. Management of the London Basin Chalk Aquifer. Environment Agency

9. NHBC Standards, Chapter 4.1, "Land Quality - managing ground conditions", September 1999.

10. NHBC Standards, Chapter 4.2, "Building near Trees", April 2010.

Appendix A. Ground Investigation Interpretative Report

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Your Ref:

Our Ref: **12/19442**
August 2012

36 HEATH DRIVE,

LONDON, NW3 7SD

REPORT ON A GROUND INVESTIGATION

Prepared for

Martin Redston Consulting Engineers

Acting on behalf of

Mr T Sanjay Wadhwani

Ref: 12/19442
August 2012

Report on a Ground Investigation

At

36 Heath Drive, London, NW3 7SD

For

Mr T Sanjay Wadhwani

1.0 INTRODUCTION

At the request of Martin Redston Associates, Consulting Structural Engineers to Mr T Sanjay Wadhwani, a ground investigation was carried out in connection with a proposed basement development at the above site. A Phase 1 Preliminary Risk Assessment was presented under separate cover in a Site Analytical Services Limited report (Project No. 12/19442-1) dated July 2012 and a basement impact assessment was also presented in a Site Analytical Services Limited report (Project No. 12/19442-2) dated August 2012.

The information was required for the design and construction of foundations and infrastructure for a new single storey basement together with 5 lightwells, rear and side extensions at ground and first floor, roof re-modelling and internal refurbishments. A study to assess whether any remediation was required for the protection of the end-user from the presence of potential contamination within the soils encountered was outside the scope of the present report.

Anticipated foundation loads for the proposed building are expected to be moderate and of the order of 100-150kN/m^2. Ground slab loadings are expected to be of the order of 10-15kN/m^2.

The recommendations and comments given in this report are based on the ground conditions encountered in the exploratory holes made during the investigation and the results of the tests made in the field and the laboratory. It must be noted that there may be special conditions prevailing at the site remote from the exploratory hole locations which have not been disclosed by the investigation and which have not been taken into account in the report. No liability can be accepted for any such conditions.

This report does not constitute a full environmental audit of either the site or its immediate environs.

2.0 THE SITE AND LOCAL GEOLOGY

(National Grid Reference: TQ 255 855)

2.1 Site Description

The site is situated on the east side of Heath Drive in the Frugal area of Hampstead, London, NW3 7SD and is currently occupied by a large detached two to three-storey residential property with a large rear garden and a double driveway at the front leading from a small curved access road on the east side of Heath Drive, which gives pedestrian access to Bracknell Gardens to the north-east.

The site is surrounded by large detached residential houses along both sides of Heath Drive and the general area is mainly residential in nature, although there are various retail outlets along the Finchley Road approximately 100m south of the site.

The site lies on ground sloping down to the south away from Hampstead Heath towards the Finchley Road, although the site itself is mainly flat and landscaped with the front driveway having a slight slope down from the house to Heath Drive with a drop in elevation of approximately 0.5m.

2.2 Geology

The 1:50000 Geological Survey of Great Britain (England and Wales) covering the area (Sheet 256, 'North London', Solid and Drift Edition) indicates the site to be underlain by Superficial Head deposits resting on the London Clay Formation. Deposits of the overlying Claygate Member are recorded as outcropping about 200m to the north on higher ground.

3.0 SCOPE OF WORK

3.1 General

The scope of the investigation was agreed by the Consulting Engineers and comprised:

- The drilling of two continuous flight auger boreholes to a depth of 12m below ground level (Boreholes 1 and 2).
- The placement of gas and groundwater monitoring standpipes to a depth of 5m below ground level in both of the boreholes.
- Sampling and in-situ testing as appropriate to the ground conditions encountered in the boreholes.

- Interpretative reporting on foundation options for the proposed building works and infrastructure.

- A study into the possibility of the presence of toxic substances in the soil, together with comments on any remediation required was outside the scope of the present investigation.

3.2 Ground Conditions

The locations of the boreholes are shown on the site sketch plan (Figure 1).

The exploratory holes revealed ground conditions that were generally consistent with the geological records and known history of the area and comprised between 0.25m and 1.40m thickness of made ground overlying materials typical of Superficial Head deposits resting on the London Clay Formation.

For detailed information on the ground conditions encountered in the boreholes, reference should be made to the exploratory hole records presented in Appendix A.

The made ground extended down to a depth of 1.40m in Borehole 1 and to a depth of 0.25m in Borehole 2 and generally consisted of a surface layer of topsoil underlain by a mixture of brick and concrete rubble and stiff to very stiff sandy silty clay with fine gravel, ashes and brick fragments.

The underlying natural material in Borehole 2 initially consisted of stiff mottled sandy clay with occasional fine to medium flint gravel that extended down to a depth of 1.60m below ground level, although this stratum was absent in Borehole 1 and may have been replaced by made ground.

These materials were followed by stiff becoming stiff to very stiff mottled silty clay with occasional partings of silty fine sand and occasional small gypsum crystals. These deposits represent weathered London Clay and extended to respective depths of 7.50m and 6.00m below ground level in Boreholes 1 and 2.

The underlying material comprised of stiff becoming very stiff fissured silty clay with occasional partings of silty fine sand, scattered gypsum crystals and water bearing clay stone nodules. These materials are typical of the more competent unweathered London Clay Formation and extended down to the full depths of investigation of 12.0m below ground level in Boreholes 1 and 2.

3.3 Groundwater

Groundwater was not encountered during boring operations in Borehole 1 and the material remained essentially dry throughout. Groundwater was encountered as a seepage at a depth of 11.00m below ground level in Borehole 2 and is likely to be associated with a claystone nodule which are often found to be water bearing.

It must be noted that the speed of boring is such that there may well be insufficient time for light seepages of groundwater to enter the boreholes and hence be detected, particularly within more cohesive soils of low permeability.

Groundwater was subsequently recorded at respective depths a depth of 2.44m and 2.01m below ground level in the monitoring standpipes installed in Boreholes 1 and 2 after a period of approximately four to five weeks. It is considered that this water level represents the accumulation of surface run-off from the higher ground around Hampstead Heath to the north-east of the site within the relatively permeable made ground and Superficial Head deposits perched on top of the virtually impermeable deposits of the London Clay present at depth.

Isolated pockets of groundwater may be present perched within any less permeable material found at shallower depth on other parts of the site especially within any made ground.

It should be noted that the comments on groundwater conditions are based on observations made at the time of the investigation (June and July 2012) and that changes in the groundwater level could occur due to seasonal effects and also changes in drainage conditions.

4.0 IN-SITU AND LABORATORY TESTS

4.1 In-Situ Tests

In the natural cohesive soils encountered at the site, in-situ shear vane tests were made at regular depth intervals in order to assess the undrained shear strength of the material and indicated that it was of a stiff becoming very stiff consistency with increasing depth below ground level.

In the made ground encountered in Borehole 1, a Mackintosh Probe test was made in order to assess the shear strength of the material based on the methods outlined by Stroud and Butler and the normally accepted correlation as follows:

Mackintosh N75 X 0.38 = SPT 'N' Value

Or

Mackintosh N300 X 0.1 = SPT 'N' Value

The results of the in-situ tests are shown on the appropriate exploratory whole records contained in Appendix A.

4.2 Classification Tests

Atterberg Limit tests were conducted on six selected samples taken from the cohesive natural soils in Boreholes 1 and 2 and showed the samples tested to fall into Classes CH and CV according to the British Soil Classification System.

These are fine grained silty clay soils of high and very high plasticity and as such generally have moderate bearing and settlement characteristics, have a low permeability and a high susceptibility to shrinkage and swelling movements with changes in moisture content, as defined by the NHBC Standards, Chapter 4.2. The results indicated Plasticity Index values between 40% and 48% with all samples being at or above the upper 40% boundary between soils assessed as being of medium swelling and shrinkage potential and those assessed as being of high swelling and shrinkage potential.

The test results are given in Table 1, contained in Appendix B.

4.3 Sulphate and pH Analyses

The results of the sulphate and pH analyses made on two natural soil samples are presented on Table 2, contained in Appendix B. The results show the natural soil samples to have water soluble sulphate contents of up to 1.41g/litre associated with slightly acidic to near neutral pH values.

4.4 In-situ Rising Head Permeability or Soakage Tests

In order to assess the soil infiltration characteristics of the natural superficial soils at the site, an in-situ rising head permeability test was carried out in Borehole 1 using a combination of the methods detailed in Building Research Establishment Digest 365:1991 and British Standard 5930:1981.

4.5 Gas and Groundwater Monitoring Results

The standpipes installed in Boreholes 1 and 2 were monitored for gas and groundwater levels over a period of approximately four to five weeks and the results are presented on Tables 3, 3a and 3b contained in Appendix B.

The groundwater level measurements indicate that the groundwater level has stabilised after a period of about four to five weeks at respective depths of 2.44m and 2.01m below ground level in the monitoring standpipes installed in Boreholes 1 and 2. It is considered that this water level represents the accumulation of surface run-off emanating from the base of the Claygate Member recorded about 200m north of the site on the higher ground around Hampstead Heath accumulating within the relatively permeable made ground and superficial deposits perched on top of the virtually impermeable deposits of the London Clay present below.

4.5.1 Methane

Methane is a flammable asphyxiating gas, the flammable range being 5 to 15% by volume in air. If such a methane-air mixture is confined in some way and ignited it will explode. The 5% by volume concentration is termed the lower explosive limit (LEL). Methane is a buoyant gas having a density about two-thirds that of air.

Various guidelines have been published to help determine mitigation measures for landfill gas. `Landfill Gas' includes gas which may be generated in natural soils such as organic alluvium peat. Methane presents an explosion and asphyxiant hazard.

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', states that if Methane concentrations in the ground are unlikely to exceed 1% by volume and a house or small building is constructed in accordance with its recommendations, then no further protection is required. The recommendations include installing granular under slab venting and sealing floor slabs.

CIRIA Report C665 (2007) "Assessing risks posed by hazardous ground gases to buildings" provides guidance on the monitoring and control of landfill gas. The report suggests a classification system which is summarised in Table 8.5 in the document and employs a method which uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the Gas Screening Value (also named the limiting borehole gas volume flow) for methane and carbon dioxide.

4.5.2 Carbon Dioxide

Building Research Establishment Report BR212 `Construction of New Buildings on Gas-Contaminated Land', 1991 states that if carbon dioxide concentrations are above 1.5% by volume then protection should be considered to prevent gas ingress. If concentrations exceed 5% by volume, such protective measures are required. This has been superseded by CIRIA Report C665 (2007), states that if carbon dioxide concentrations are above 5% by volume then protection should be considered to prevent gas ingress.

Carbon Dioxide is a non-flammable toxic gas, which is about 1.5 times as heavy as air and is an asphyxiant hazard.

4.5.3 Carbon Monoxide

The occupational exposure standards for carbon monoxide are 30 pap for long term exposure (8 hours calculated from the HSE Guidance Note EH40, 1991) and 200 pap for short term exposure (15 minutes calculated from the HSE Guidance Note EH40, 1991) (CIRIA Report C665).

4.5.4 Hydrogen Sulphide

Hydrogen sulphide is toxic at low concentrations. The occupational exposure standard for hydrogen sulphide is 10 paps for 8-hour time weighted average reference period and 15 paps for short-term exposure (10 minutes reference period) (HSE Guidance Note EH40, 1991).